

## Appendix D: TECHNICAL STANDARDS

- I. Overview
- II. Candidate Project Evaluation and Review Process
- III. Setting the Energy Use Baseline
- IV. Energy Audit & Renewable Energy Feasibility Requirements
- V. Eligible / Ineligible Measures
- VI. Commissioning
- VII. Performance Measurement & Verification of Energy Savings
- VIII. Data Management, Program Information Management, Reporting and Analytics
- IX. Utility and Fuel Supplier Historical Usage and Project Data Information Release Form

### I - Overview

The methodology in these technical standards is designed to provide a flexible framework within which to qualify and manage the myriad eligible energy improvement projects applying to use the C-PACE financing structure.

Contractors, the Technical Administrator and Technical Reviewers should use these standards to develop and review projects for C-PACE qualification.

The Green Bank will periodically audit the project reviews conducted by the Technical Administrator and Technical Reviewers to ensure they conform to the C-PACE program guidelines.

**ALL PROJECT APPLICATIONS REGARDLESS OF CAPITAL PROVIDER** must include the information and abide by the standards described in these C-PACE Program Guidelines.

The technical methodology incorporated into the review process relies upon three established industry protocols:

1. ASTM E2797-15, Building Energy Performance Assessment (BEPA) Standard directed at data collection and baseline calculations for the energy audit;
2. ASHRAE Level I, Level II and Level III Energy Audit Guidelines; and
3. International Performance Measurement and Verification Protocol (IPMVP) for measurement and verification of the energy savings.

### II – Candidate Project Evaluation and Review Process

The purpose of technical review is for the Technical Administrator and/or approved Reviewer to confirm the SIR on the project and verify that it is greater than 1. SIR means the ratio of (x) estimated avoided energy costs plus project revenues, including all ancillary value streams such as environmental incentives and tax benefits, earned over the effective useful life (EUL) of the Energy Improvements to (y) projected debt service due in respect of the C-PACE financing – including all principal, interest, and any fees over the term of the

financing – as well as fixed or variable costs associated with the maintenance or performance of the Energy Improvements over their EUL.

Further:

- EUL for each Energy Improvement is determined through the energy audit and approved by the Technical Administrator or Reviewer. Both costs and savings for each Energy Improvement will be calculated over the EUL of that Energy Improvement.
- The C-PACE financing term may not exceed the EUL of the installed Energy Improvements. For projects with multiple Energy Improvements, a weighted average EUL will be calculated.
- Regardless of a project's weighted average EUL, C-PACE financing terms may not exceed 25 years unless approved in writing by the Green Bank.

This determination is based on the applicant's input of building energy use and cost data collected according to the ASTM E2797-15 ("ASTM BEPA") standard protocol in conjunction with an energy audit.

If an energy audit (or equivalent) has not been conducted, the applicant will be advised to conduct an energy audit (refer to Section IV of this appendix). The audit, conducted by a qualified energy auditor, should establish a representative building energy use baseline, identify and recommend Energy Improvements, estimate the useful life of each Energy Improvement, determine total project capital cost and the projected energy savings that can confidently be achieved, evaluate the project's key financial metrics, provide a commissioning plan, and an energy savings measurement and verification (M&V) plan. Applications must be prepared and submitted by an energy engineer or by a team including an energy engineer. The energy audit level (ASHRAE Level I, Level II or Level III, or equivalent) will be influenced by a number of factors, including but not limited to, the number and complexity of the Energy Improvements, and a project's anticipated total capital investment.

### **III - Setting the Energy Use Baseline**

#### **ASTM BEPA**

The ASTM Building Energy Performance Assessment (BEPA) protocol established a standardized methodology for building energy use data collection, compilation and analysis. The methodology is intended to fill data collection and analysis gaps in the ASHRAE energy audit guidelines and establish a sound, representative building energy use baseline. The ASTM BEPA methodology standardizes a number of major variables associated with data collection and analysis. This overarching methodology dictates the data and history that should be collected at each site.

To meet ASTM E2797-15 requirements, the preferred length of time that baseline building energy consumption data should be collected is three years, assuming it is available, or back to the last major renovation if completed in less than three years, with a minimum of one year of data collection. A major renovation is defined in the standard as any change that either involves expansion (or reduction) of the building's gross floor area by 10% or more, or impacts total building energy use by more than 10%.

Electricity data may be obtained online via the utility “green button” after the account owner has waived its right to access the data through signing of a release waiver (a copy of the release waiver is included in this section under Section IX of this Appendix).

For buildings where it is impossible or prohibitively difficult to obtain the required historical energy consumption data, the following methodologies may be utilized for establishing baseline building energy use.

1. Fully or partially vacant existing building whose use is not expected to change

If an existing building is partially vacant and the use is not expected to change (e.g., office space stays as office space, etc.), it may be possible to use the utility data from the occupied space and extrapolate energy consumption to the full space as if it was 100% occupied. A building energy use simulation model may then be used to estimate the energy use under the post-Energy Improvement scenario and compare this to the baseline to project the energy savings.

If the existing building is currently vacant and has been vacant for some time, and there is no utility data available, then the existing space may be modeled (building energy use simulation model, such as eQUEST, EnergyPlus, or equivalent) with the existing equipment (e.g., HVAC, windows, etc.), but operating how it would be operating under the expected use (the number of people occupying the building, the hours of operation, etc.). This would establish the baseline energy use. The model can then be used to project energy use under the post-Energy Improvement scenario and compare this to the baseline to project the energy savings.

2. Buildings undergoing repositioning or new use

If an existing building is undergoing repositioning or being developed into a new use (e.g., industrial space becoming office space such as might be found at a brownfields site where the existing building previously had industrial use but is being redeveloped into office space), a building energy use simulation model (e.g., eQUEST, EnergyPlus, or equivalent) can be used to project the baseline energy consumption associated with the new use, assuming for the baseline that the energy-using equipment meets the current CT energy code (2009 IECC with amendments). The building can then be modeled with high efficiency systems (above code). The difference (energy improvement) between the two scenarios would be viewed as the “energy savings” against which the cost of improvements would be weighed in the SIR calculation.

3. Buildings undergoing gut rehabilitation

If an energy baseline cannot be reasonably obtained using the methodology in subsection (2) above, the project should be submitted under the New Construction Pilot approval methodology.

4. Multi-tenant buildings, such as retail, office residential, etc. where the tenants are sub-metered and pay their own electricity

In multi-tenant buildings where it is prohibitively difficult to obtain the electricity meter data of all tenants (e.g. ten or more meters), C-PACE applicants may use the building's aggregate energy use, which may be supplied by the utilities via a signed waiver from the property owner. This would represent the building's pre-Energy Improvement baseline. The alternative is to collect whatever tenant energy use data is voluntarily offered and use this to model the building's energy use. To use this option, a minimum of 10% of the tenants must contribute energy use data. Once the baseline is established, a calibrated building energy use simulation model can then be used to project energy use post-Energy Improvements. The difference (energy improvement) between the two scenarios would be the "energy savings." Tenants may be willing to authorize the building owner to access their energy use because they would be getting the benefits of the energy improvements and be receiving lower energy bills.

The Green Bank has the ultimate responsibility and sole discretion to approve the appropriate energy use baseline for a particular project, depending upon the nature of the proposed project and supporting information.

#### **IV - Energy Audit and Renewable Energy Feasibility Requirements**

As a condition of financing, C-PACE legislation requires the energy audit or renewable energy feasibility analysis be conducted by a qualified individual.\*

The principal objectives of the energy audit are to:

- Identify a representative baseline.
- Data collection must be consistent with ASTM E2797-15;
- Identify and recommend, in collaboration with the property owner/manager, C-PACE-eligible Energy Improvements
- Identify the effective useful life of each Energy Improvement consistent with industry best practice;
- Estimate the total installed cost of each Energy Improvement;
- Estimate the total project capital cost;
- Identify the uncertainty (+/-) associated with the methodology used to establish Energy Improvement cost;
- Estimate the energy savings that can confidently be achieved (energy savings should be determined by the difference between projected energy use after the Energy Improvements are installed and the projected baseline energy use under similar conditions, e.g., average (normalized) weather, etc.);
- Identify the uncertainty (+/-) associated with the methodology used to estimate Energy Improvement energy savings;

- Identify an appropriate commissioning plan;
- Identify an appropriate M&V plan; and
- Determine the project's key financial metrics, including ROI, IRR, NPV, SIR, cash flow and payback time (the financial analysis performed should reflect any rebates or incentives).

\* Energy audits must be prepared and submitted by an energy engineer or by a team including an energy engineer. An energy engineer is defined as a professional holding a Certified Energy Manager (CEM) or Certified Energy Auditor (CEA) accreditation, a Professional Engineer (PE) with demonstrated relevant energy experience, or a contractor with relevant demonstrated experience as determined by the Technical Administrator.

A feasibility study must be prepared for a renewable energy system application. The principal objectives of the renewable energy feasibility study are to:

- Describe the proposed renewable energy system;
- Identify and evaluate site/building suitability for the renewable energy system;
- Identify metering (number of boxes, location, etc.);
- Identify the utility electricity and/or fuel rate structure for the property;
- Collect historic electricity and/or fuel use and cost (in accordance with ASTM E2797-15);
- Assess system expected performance and requirements to maintain optimized operation;
- Compare system expected performance (electricity and/or heat production) against total energy (electricity and/or fuel) consumption of the building;
- Identify performance guarantees and effective useful life;
- Assess total project capital cost;
- Analyze building energy savings including assumptions on avoided future utility electricity/fuel costs including assumed electricity/fuel rate escalation;
- Identify an appropriate commissioning plan;
- Identify an appropriate M&V plan; and
- Determine the project's key financial metrics, including ROI, IRR, cash flow, NPV, life cycle savings, savings-to-investment ratio and payback time based on the effective useful life of the renewable energy system (the financial analysis performed should reflect any rebates or incentives, REC credits/sale, potential excess electricity sale back to the grid, etc.).

In estimating the total project cost eligible for C-PACE funding (including up-front energy audits or renewable energy feasibility studies, the design and installation of the energy improvements, and verification of the energy savings achieved), the energy auditor may also include the cost of a preventive maintenance contract for the energy improvements, up to but not exceeding a five (5) year contract.

Completed energy audit data is submitted to the Technical Administrator or Reviewer to validate that the scope of work meets the required technical standards, Energy Improvements meet C-PACE program eligibility requirements, the recommended Energy Improvements are technically and financially feasible, and all stakeholder underwriting data needs are satisfied.

### **ASHRAE Level I Energy Audit**

An ASHRAE Level I energy audit consists of a:

- 1) Walk-through analysis to assess a building's energy cost,
- 2) Utility bill analysis to assess its efficiency (using ASTM BEPA Methodology to establish the building's baseline energy use), and
- 3) Brief on-site survey of the building.

The walk-through may be targeted at a specific building component that is intended to be replaced or upgraded or added (such as in the case of installing a solar energy system) or may include checking all major energy-using systems. Operational metrics of building equipment are typically limited to data collection of nameplates, but may be more detailed if that data are readily available. Level I energy analysis should at the minimum identify Energy Improvements and the associated potential energy savings, the estimated cost of the Energy Improvements, and specify where further consideration and more rigorous investigation is warranted.

### **ASHRAE Level II Energy Audit**

An ASHRAE Level II energy audit is a more detailed investigation and includes a more comprehensive building survey and energy analysis than a Level I audit. It also includes more detailed financial analysis. In addition to nameplate data collection, empirical data may also be acquired through various field measurements using handheld devices.

The Level II audit should at the minimum identify and provide the investment and cost savings analysis of all recommended Energy Improvements that meet the Connecticut Green Bank's and the owner's constraints and economic criteria, along with a discussion of any changes to operation and maintenance procedures. Detailed financial analysis includes ROI, IRR, NPV and payback period determination reflecting the C-PACE financing structure. Sufficient detail on projected energy savings is provided to justify project implementation.

### **ASHRAE Level III Energy Audit**

The ASHRAE Level III energy audit (often referred to as an "investment grade audit") is generally applicable to projects that are capital intensive and demand more detailed field data gathering as well as more rigorous engineering analysis. The Level III energy audit provides even more comprehensive project investment and cost savings calculations to bring a higher level of confidence that may be required for major capital investment decisions. Data collection may involve field measurements acquired through data loggers and/or an existing energy management system.

## **V – Eligible / Ineligible Measures**

### **Common Eligible Energy Conservation Measures**

Pursuant to C-PACE legislation, the project, including all eligible measures, must achieve an SIR > 1. Non energy-saving measures directly related to installation of an Energy Improvement may be determined as eligible and included in the financing in so far as the project's SIR remains greater than 1 and, per the Act, the "authority determines [these associated costs] will benefit the qualifying commercial real property." A list of approved associated measures can be found later in this section.

The measures proposed in the project must be permanently affixed to the property (i.e. the property owner cannot remove them in the event of a change of ownership), with the exception of district heating and cooling systems, as defined in the statute as "a local system consisting of a pipeline or network providing hot water, chilled water or steam from one or more sources to multiple buildings" (i.e., the pipeline and sources may be located outside of the property boundary of any given beneficiary of the system) and microgrids. Examples of permanently affixed improvements include, but are not limited to upgraded insulation, energy efficient HVAC equipment, solar photovoltaic (PV) rooftop systems, fuel cells, and natural gas piping installed underneath the property owner's land. In addition to the Energy Improvement eligibility review, the Green Bank will also review projected improvements in energy efficiency to ensure that the energy efficiencies are reasonable for the application and commercially acceptable.

The following list of predominant, long-standing, proven energy efficiency technologies is intended as a reference list for C-PACE applicants. If not included on this list, the Green Bank will review proposed Energy Improvement(s) and accept them on a case-by-case basis. For measures not included on this list, The Green Bank reserves the right to require project review by the Technical Administrator.

- High efficiency lighting
- Heating, ventilation and air conditioning (HVAC) upgrades
- New automated building and HVAC controls
- Variable speed drives (VSDs) on motors fans and pumps
- High efficiency chillers
- High efficiency boilers and furnaces
- High efficiency hot water heating systems
- Combustion and burner upgrades
- Fuel switching
- Water conservation measures to the extent they save energy
- Heat recovery and steam traps
- Building enclosure/envelope improvements
- Building automation (energy management) systems
- High efficiency air compressors with heat recovery
- Renewable energy systems (e.g., solar, fuel cells, geothermal)
- Combined heat and power systems (CHP)
- District thermal
- Microgrids.

The following end use savings technologies are generally more applicable to industrial facilities:

- New automated process controls
- Heat recovery from process air and water
- Cogeneration used for peak shaving

Shown below are key aspects of some of the most commonly applied technologies listed above, with their typical simple payback range. These payback periods are only provided for informational purposes and should not be construed as a guarantee of performance or requirement for C-PACE funding eligibility.

**Lighting (typical 2 to 3 year simple payback):**

- Daylight controls and natural day lighting designed to reduce energy and improve visual comfort
- Upgrades for existing fluorescent fixtures including electronic ballasts, T8 lamps, and reflectors
- Upgrades to LED lighting fixtures
- Meeting rooms and other intermittently occupied spaces can garner significant energy savings with the use of timers and occupancy sensors
- Smaller impact opportunities including security lighting, stairwell lighting, exterior night-time security lighting and exit signs.

**Motors (typical 3 to 5 year simple payback):**

- High efficiency electric motor replacements usually pay back when a motor is running for long periods at high load, or at the end of motor life
- The cost premium over standard motors normally can be recovered in less than 2 years
- Motor sizing to the actual load profile to improve efficiency and control electrical power factor.

**Variable Speed Drives (typical 3 to 5 year simple payback):**

- Applied to motors, pumps and fans
- Matches motor use to variable operating load
- Can save up to 40 percent in power consumption
- Can be packaged with controls
- Extends motor life.

**HVAC (typical 2 to 10 year simple payback)**

- New packaged units can increase efficiency and indoor comfort
- Proper sizing of HVAC equipment is a major opportunity, since full-load operation is more efficient than part load operation - consider fan capacity reduction or staging of 2 smaller units rather than partial loading of one large unit
- Install VSDs on HVAC motors
- Balance air and water supply systems to remove trouble spots demanding inefficient system operation
  - Improve maintenance



- Eliminate simultaneous heating and cooling
- Install economizers and direct digital controls
- Variable air volume conversions versus constant air flow
- Ventilation reduction (demand control ventilation, etc.)
- Unoccupied shutdown or temperature setback/setup (controls).

**Chillers (typical 5 to 15 year simple payback):**

- New chiller models can be up to 30-40 percent more efficient than existing equipment.
- Upgrade lead chiller(s) (base load) to high efficiency
- Manage chiller and condenser settings to minimize compressor energy
- Optimize pumping energy for distribution of chilled water
- Optimize HVAC operation to:
  - Improve temperature/humidity control
  - Eliminate unnecessary cooling loads
- CFC reclamation program/inventory - chiller replacement may achieve both CFC management and energy efficiency objectives.

**Boilers (typical 5 to 10 year simple payback):**

- Replace steam with hot water boilers for hot water heating loads
- Use of high efficiency condensing boilers
- Improve maintenance
- Optimize operation/staging in multiple boiler plants
- Optimize boiler controls
- Tune or replace burners
- Add small “pony” boilers for low loads:
  - Reduced fuel consumption/energy costs
  - Reduced emissions
  - Reduced maintenance costs
  - Higher reliability.

**Heat Recovery (typical 2 to 5 year simple payback):**

- Heat recovery devices to capture waste heat from water, process heat and exhaust air to re-use it for preheating of building intake air
  - Boiler combustion air
  - Boiler feed-water
  - Inlet water for domestic hot water.

**New Automated Building and HVAC Controls (typical 3 to 10 year simple payback):**

- Old controls may still be pneumatic systems based on compressed air - new electronic controls are more precise and reliable, with greater capabilities.

- Automate lighting, chiller, boiler and HVAC operation:
  - Load shedding
  - Optimal start/stop/warm up
  - Ventilation control.
- Whole-building energy management systems may come with other advanced control technologies:
  - Alarm monitoring and report generation
  - Preventive maintenance scheduling
- Remote monitoring/metering capabilities may be attractive.

**Building Shell and Fenestration (typical 3 to 10 year simple payback):**

- Roof insulation, combined with reflective roof coatings in warm climates, reduces energy consumption
- Review building pressurization for proper ventilation:
  - Balance exhaust and intake air quantities
  - Add weather-stripping on doors and windows
  - Seal cracks and unnecessary openings
- Window films to reduce solar heat gain and/or heat loss
- Daylighting
- Replace windows with more energy efficient glazing.

**Renewable Clean Energy Improvements for Commercial Property**

The following are examples of renewable clean energy improvements as defined in Subsection (A) of Section 16-245N of the General Statutes.

- Solar power
- Solar thermal
- Wind Power
- Geothermal energy
- Fuel Cell
- Methane Gas from landfills
- Low emission advanced renewable energy conversion technologies
- Projects that seek to deploy electric, electric hybrid, natural gas or alternative fuel vehicles and associated infrastructure and any related storage, distribution, manufacturing technologies or facilities
- Sustainable Biomass Facility

**Eligible Associated Measures**

- Capital expenditures associated with an eligible measure (i.e. new roof with solar or gas line expansion required by a fuel conversion)

- Energy/water audit costs
- Renewable Energy Feasibility Study costs
- Engineering and design expenses, including energy modeling for new construction
- Construction and installation costs, including labor and equipment
- Commissioning costs
- Prepaid operation and maintenance expenses for a period of up to five years, including measurement and verification costs incurred
- Costs of an extended warranty covering the full finance term for equipment financed
- Any capital provider fees and /or required prepaid interest
- Program and permit fees
- Leadership in Energy and Environmental Design (LEED) certification and consulting fees
- Capital improvements made alongside energy improvements as part of LEED certification
- Other project-related expenses approved by the Green Bank

### **Ineligible Measures**

All C-PACE related improvements must be permanently affixed to the commercial property and part of a retrofit to existing infrastructure, with the exception of district heating and cooling systems. The following items will not be considered as efficiency measures under the C-PACE program:

- Appliances, e.g., refrigerators, dishwashers, etc.
- Plug load devices
- Vending machine controls
- Any package of measures that does not achieve an energy savings to investment ratio (SIR) greater than one
- Any measure that is easily removed or not permanently installed
- Any measure that does not result in improved energy efficiency or renewable energy generation

### **VI – C-PACE for New Construction Pilot**

Please reference the pilot program guidelines published by Green Bank on [www.c-pace.com](http://www.c-pace.com).

### **VII – Commissioning**

To verify that any C-PACE project was installed according to the evaluated scope, all project applications are required to include a commissioning plan and subsequent report. A report by a Qualified Contractor, Registered Contractor, Technical Reviewer, or the Technical Administrator that confirms the measures were properly installed and that the project is operating as intended must be submitted to the Green Bank once project construction is complete.

### **VIII Performance Measurement & Verification of Energy Savings**

The Green Bank encourages C-PACE applicants to develop an M&V plan consistent with guidance provided by the International Performance Measurement and Verification Protocol (IPMVP) **or propose an alternative methodology** as appropriate for the project size and Energy

Improvements installed.

The IPMVP guidance provides four options for determining energy savings.

These include: Option A. Retrofit Isolation: Key Parameter Measurement

Option B. Retrofit Isolation: All Parameter

Measurement Option C. Whole Facility

Option D. Calibrated Simulation.

Options A and B focus on the performance of specific Energy Improvements that can be measured in isolation from the rest of the building. In Option A, the key energy use parameter is measured, but other minor effects can be estimated. For example, Option A might include a lighting retrofit, where an electric meter can isolate and measure electricity use for the lighting, but where the relatively minor interactive effect of less cooling in summer and more heating in winter is estimated. Reduced lighting loads will reduce air conditioning energy consumption (a cooling bonus), but increase heating consumption (a heating penalty). In Option B, all parameters necessary to evaluate energy use are measured. This might, for example, be the case with installation of a variable speed drive and controls to a motor, with a power meter installed on the electrical supply to the motor.

Options C and D are used when energy use of the Energy Improvements installed is not easily measured in isolation from the rest of building operations, or there is little measured baseline energy data, among other reasons. The Option C approach assesses savings at the whole facility level. The measured and verified energy savings in the desired reporting period (e.g., 12 months after the Energy Improvements have been installed) is determined from the difference between the actual (measured) energy use in the reporting period and the projected energy use in this same reporting period assuming the Energy Improvements had not been installed. The analysis reflects changes in the independent variables impacting building energy use (such as weather, occupancy, operating hours, etc.) for each month in reporting period as compared to the baseline. Option C is commonly applied for whole building retrofits involving multiple Energy Improvements that may be interactive. Option D uses computer simulations and building modeling (e.g., U.S. DOE 2.2- based software such as eQuest or EnergyPro), and is usually applied when baseline year energy data are not available or considered reliable.

An M&V plan should determine if and with what frequency energy consumption and/or clean energy production data will be collected for measurement purposes. An M&V plan should also determine the means by which data will be tracked and collected as well as what party is responsible for data collection (see Project Application Checklist).

The Green Bank may elect to facilitate M&V on projects submitted to the Green Bank for financing. Property owners and/or qualified TPCP may request M&V services from the Green Bank, see Third-Party Capital Provider Term Sheet (Appendix H). M&V activities may be financed as an eligible measure under the C-PACE program.

## **IX - Data Management, Program Information Management, Reporting and Analytics**

To ensure the success of the C-PACE program, data is uniformly collected on all C-PACE projects, regardless of Capital Provider. C-PACE TPCP will be required to submit data regarding project characteristics and project energy savings in a standard format to be determined by the Green Bank in its sole discretion. The Green Bank issues quarterly reports on the C-PACE Program that includes aggregated data across all closed and completed transactions. For more information, visit our Quarterly Dashboard [here](#).