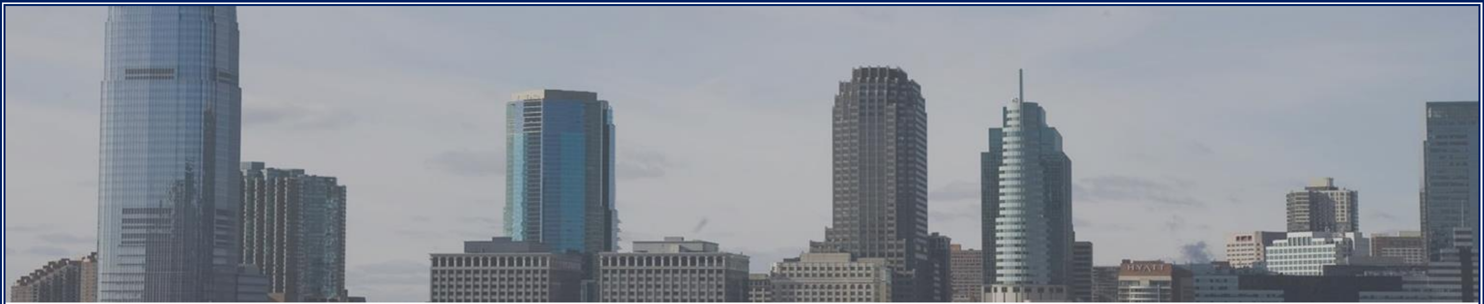

PAY FOR PERFORMANCE PROGRAM

EXISTING BUILDINGS

PARTNER GUIDELINES

VERSION 4.5

FY 2021

OCTOBER 1, 2020

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1. Introduction

PAY FOR PERFORMANCE PROGRAM – EXISTING BUILDINGS

New Jersey's Clean Energy ("NJCEP") *Pay for Performance Existing Buildings Program* ("P4P" or "Program") comprehensively addresses the energy efficiency needs of the Commercial and Industrial ("C&I") sector by working with building owners and their representatives ("Participants") to improve the energy efficiency of existing commercial, industrial, and multifamily buildings.

This Program relies on a network of contractors who have demonstrated their experience and expertise in C&I energy efficiency projects. These entities are identified as Pay for Performance Partners ("Partners"), and are afforded the privileges outlined in the Partnership Agreement and its Attachments. The Program will work to achieve the following goals:

- Create a market-based network of energy efficiency professionals capable of delivering services to developers, building owners and their representatives;
- Facilitate access to capital for comprehensive energy and energy-related improvements;
- Reach significant numbers of commercial and industrial customers with comprehensive, cost effective scopes of work;
- Reduce the C&I sector's contribution to the system peak demand;
- Improve the profitability of Participants by implementing cost effective energy improvement measures which lower energy consumption and costs.

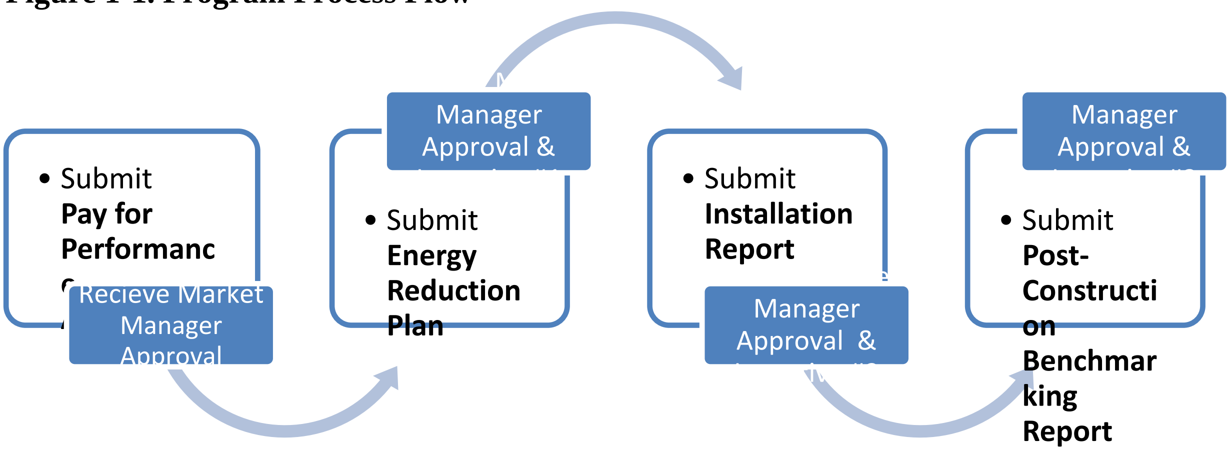
The Pay for Performance Program is open to existing commercial and industrial buildings with an annual peak kW demand electric usage of 200 kW or more, and 100 kW for multifamily buildings. Participants will be required to work with an approved Pay for Performance Partner to develop an Energy Reduction Plan ("ERP") and facilitate installation of the recommended package of energy efficiency improvements. In order to receive the full suite of incentives offered in the Program, the submitted ERP must include a package of energy efficiency measures ("EEM" or "measure") that achieve the minimum savings target of 15% reduction in total source energy consumption. In addition, the ERP must include a comprehensive mix of measures; lighting cannot make up more than 50% of the total projected savings (exceptions apply). Projects that cannot identify efficiency improvements that meet this minimum performance level will be referred to the appropriate New Jersey's Clean Energy Program(s). See Section 2.3 for the complete description of project eligibility requirements. This document presents guidelines and requirements of the Program.

2. General Requirements

2.1 Overview

The Pay for Performance Existing Buildings Program has three main deliverables that are submitted in the order shown below. All deliverables must be submitted to the program by the Partner:

Figure 1-1. Program Process Flow



1. **Pay for Performance Application**: Application form must be submitted to and approved by Program Manager prior to beginning work on the Energy Reduction Plan. This is to ensure the facility is eligible to participate, it is not a means of approving potential scopes of work. Please refer to instructions on the Application, which can be downloaded from the New Jersey's Clean Energy website (www.njcleanenergy.com) and the Partner Portal (see next page).

2. **Energy Reduction Plan "ERP" (Section 3):** Comprehensive report documenting existing building energy audit and proposed energy efficiency measures that achieve the minimum Program requirements. Submitted at the onset of the project, well enough before construction to allow for review and approval by the Program Manager.

3. **Installation Report (Section 5):** Summary report listing installed equipment as outlined in the approved Energy Reduction Plan including as-built costs and any changes that occurred during construction, as well as supporting invoices, purchase orders, etc. Submitted once construction is completed and all recommended energy-efficiency measures are implemented.

4. **Post-Construction Benchmarking Report (Section 6):** Performance report based on twelve months of operational and utility data collected once all energy-efficiency measures are installed and functioning.

2.2 Tools and Resources

In addition to these Partner Guidelines, the following tools must be used when completing Program deliverables:

- Energy Reduction Plan Excel Tables
- Energy Reduction Plan report Word template
- Model Calibration Tool
- Installation Report
- Savings Verification Tool
- Eligible Simulation Software (not provided)
- ENERGY STAR's Portfolio Manager® (web-based)

These documents, all related Program forms and tools, and other helpful resources can be downloaded from the *Partner Portal:*

URL: http://www.njcleanenergy.com/p4p-portal-login
Case sensitive password is: **tRP47px**

2.3 Project Eligibility

2.3.1 General Requirements

An eligible project is defined as a single, detached commercial or industrial building meeting the Societal Benefit Charge, Project Size, and Scope of Work requirements detailed below. Additional eligibility guidelines for specific building types are provided in the subsections below.

Societal Benefits Charge – Participants must be electric and/or gas customers of the following New Jersey investor-owned utilities and pay a monthly Societal Benefits Charge, which can be found as a line item on their utility bills:

- Atlantic City Electric
- Elizabethtown Gas
- Jersey Central Power & Light
- New Jersey Natural Gas
- PSE&G
- Rockland Electric Company
- South Jersey Gas

Project Size – The building must have an annual peak demand over 200kW in any of the preceding twelve months of utility bills. (i.e., look at the project's most recent twelve (12) months of billing data and ensure that at least one month has a demand over 200kW). For multifamily buildings annual peak demand must be over 100 kW.

Scope of Work – The project's proposed scope of work must meet all of the following requirements:

- A minimum of a 15%[1] annual source energy[2] savings target must be achieved in order to participate. Projects that cannot identify efficiency improvements that meet this minimum performance level will be referred to other appropriate New Jersey's Clean Energy Program(s). See exemption for high energy-intensity users in Section 2.3.4.
- The general rule is that no more than 50% of the total source energy savings may be derived from lighting measures. Notwithstanding the foregoing general rule, lighting measure savings over 50% may be considered if the scope of work is otherwise comprehensive in that it (a) assesses the cost-effectiveness of installing energy conservation measures in each of the following : (i) heating systems, (ii) cooling systems, (iii) ventilation systems, (iv) domestic hot water systems, and (v) building envelopes, and (b) implements all cost-effective energy conservation measures identified through the foregoing assessment or, as to any such measures not implemented, explains why such implementation would not be practicable. For example, a scope of work in a high school that does not include replacement of a 30 year-old atmospheric boiler would not be allowed to include lighting savings greater than 50% of the total source energy savings.
- In addition to lighting, other measure savings are subject to caps and regulations as outlined in Section 4.6.
- The source energy savings may not come from a single measure.
- For Participants that are customers of non-investor owned utilities (e.g. fuel oil, propane, municipal/cooperative electric) at least 50% of the source energy savings should come from investor-owned electricity and/or natural gas. For example, if a Participant is a customer of an investor-owned electric utility, but purchases heating oil, at least 50% of the total 15% savings must come from electricity. If 50% of the source energy savings does not meet this criteria, then the project must save a minimum of 100,000 kWh or 2,000 therms from investor-owned utility accounts. See exemption for fuel conversions in Section 4.6.3.

2.3.2 Campuses/Multiple Buildings

Multiple buildings must be combined and treated as a single project if ALL the following conditions apply:

- There are two or more buildings that are located on adjacent properties,
- Buildings are owned by a single entity,
- AND one of the following:
    - Buildings are master-metered
    - Buildings are served by a common heating and/or cooling plant.
    - Buildings share walls and/or are connected via a physical structure.

[1] Energy Target is rounded down to two significant figures, e.g. 0.1487 is rounded to 0.14 or 14%.
[2] https://portfoliomanager.zendesk.com/hc/en-us/articles/216670148-What-are-the-Site-to-Source-Conversion-Factors-

Since energy use for each individual building is impossible to determine, all of the buildings must be treated as a single project. The baseline will represent total energy consumption of all buildings, and savings in each of the buildings will be totaled to meet the 15% source energy savings requirement. Only one ERP will need to be submitted, and one set of incentives will be paid. Incentive caps apply.

2.3.3 Multifamily

The NJCEP suite of Programs serve both commercial and residential customers. Multifamily properties may lend themselves to either sector depending on a number of factors. Use the flow chart below to determine whether your multifamily building(s) qualify into the Residential Home Performance Program or the Commercial & Industrial Pay for Performance Program. If you believe your project has fallen into the wrong category please contact the Program Manager. Any multifamily building that is not eligible for residential Programs below will automatically be considered for Pay for Performance under the C&I suite of Programs.

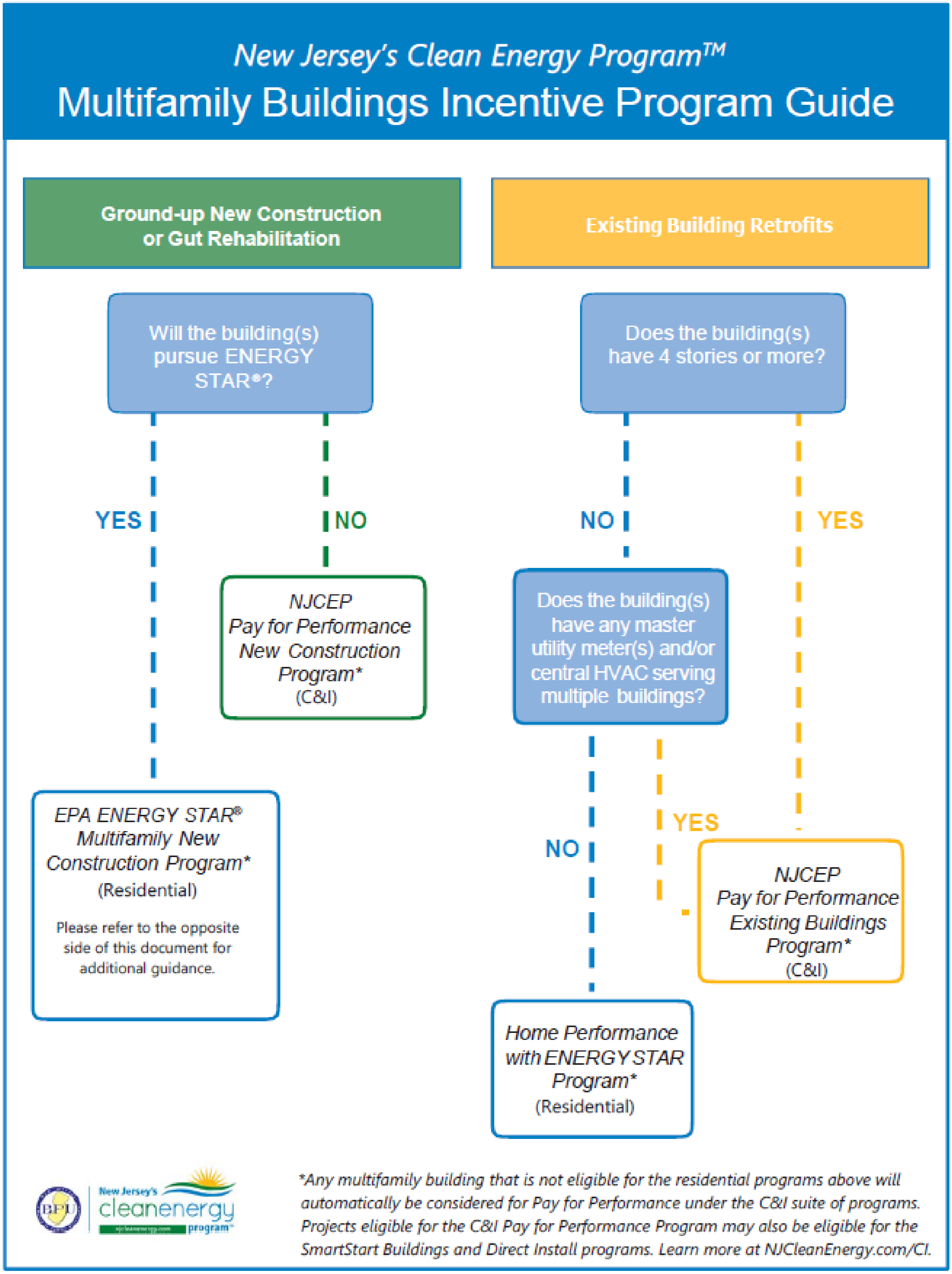
Meeting the 100kW Peak Demand

Multifamily properties that are master-metered for electric can qualify for the Program based on the billed peak demand found on the commercial utility bill(s). Multifamily properties where tenants are direct metered for electricity (i.e. utility bills do not contain billed kW demand), can qualify for the Program by assuming ***no more than 2 kW*** per apartment unit plus any billed peak demand found on the commercial utility bill(s).

Garden Style Multifamily Complexes

Garden style apartment complexes usually consist of multiple low-rise apartments, cooperatives, condominiums and/or townhouses surrounded by landscaped grounds. These types of complexes will be treated as one project under the Program. In other words, if there are ten (10) garden-style buildings that are part of one multifamily community, all ten (10) will be aggregated into one Application. Exceptions to this rule may be considered by the Program Manager on a case-by-case basis where financial constraints prevent the entire complex from participating at once, or where parts of the complex are determined to be better suited for Home Performance with ENERGY STAR. The 100kW participation threshold will be met through this aggregation (including common area and in-unit billing). The 15% savings requirement (as well as all other Program requirements) will be achieved in aggregate, as well. Only one set of incentives will be paid per project, and all incentive caps apply. All other Program rules apply.

Figure 2-1. Multifamily Decision Tree



EPA ENERGY STAR
Residential Multifamily New Construction Programs

What qualifies as Residential?

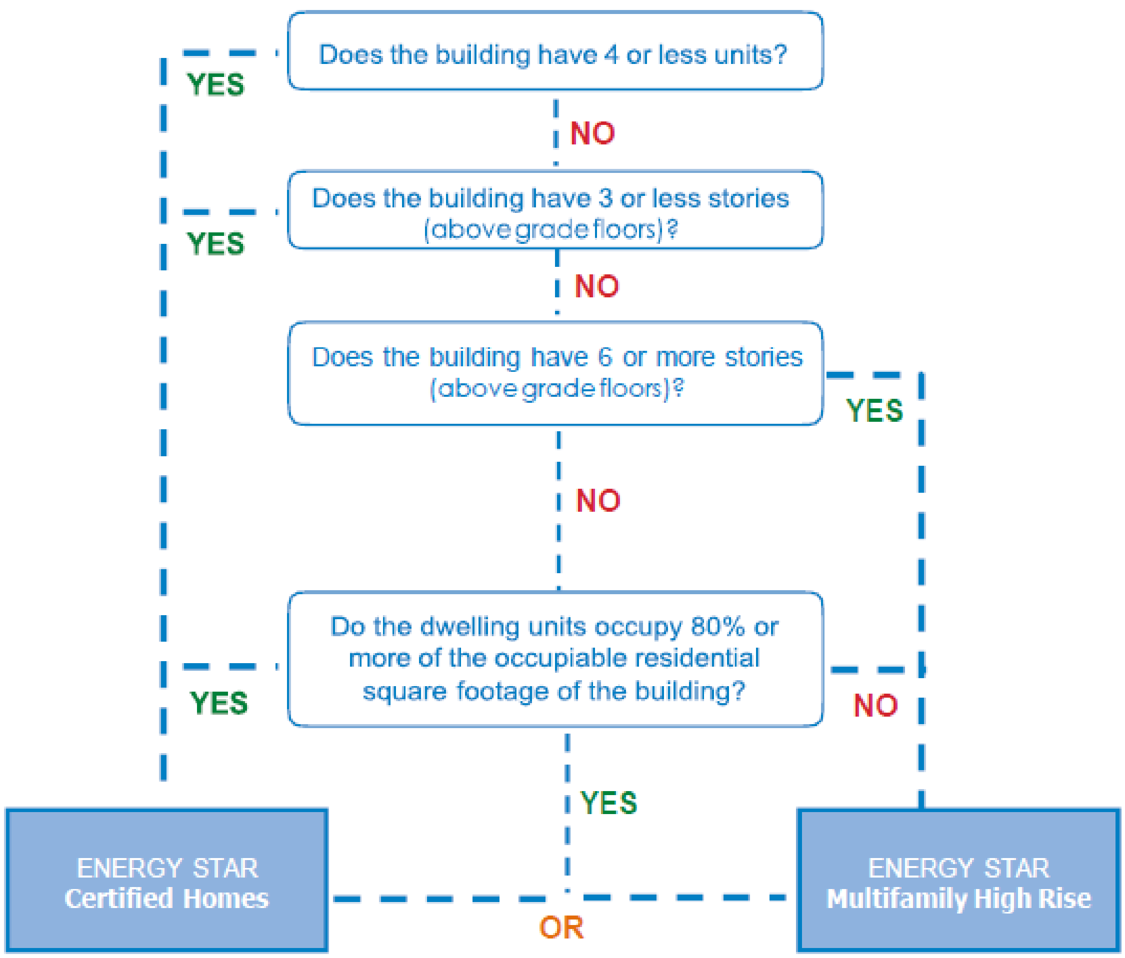
The primary use of the building must be for residential purpose, i.e. the residential and residential associated common area must occupy more than 50% of the building's occupiable square footage. This includes spaces used by residents, such as corridors, stairs, lobbies, laundry rooms, exercise rooms, and residential recreation rooms. This also includes offices used by building management, administration or maintenance and all special use areas located in the building to serve and support the residents such as day-care facilities, gyms, dining halls, etc. It does not include garage spaces.

What qualifies as New Construction?

New Construction projects can include significant gut rehabilitations when defined as a change of use, reconstruction of a vacant structure, or when construction work requires that the building be out of service for at least 30 consecutive days.

New construction of motels/hotels, nursing homes, assisted living facilities, or dormitories are currently considered commercial facilities and do not qualify under the Residential Multifamily New Construction programs below. These building types can seek incentives through the New Jersey's Clean Energy Program Commercial and Industrial suite of programs. Learn more at www.NJCleanEnergy.com/CI

If your multifamily building qualifies as *both* **New Construction** *and* **Residential**, the following decision tree can help you determine which ENERGY STAR program is right for you. Visit ENERGY STAR for additional details: https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_mfhr_bldg_eligibility



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2.3.4 High Energy-Intensity Facilities

High energy intensity facilities, such as manufacturing, pharmaceutical, chemical, refinery, packaging, food/beverage, data center, transportation, mining/mineral, paper/pulp, biotechnology, and hospitals, may participate in the Program at a reduced savings target if the facility can demonstrate that manufacturing and/or process load is equal to or greater than 50% of the total metered energy use at the building/site. Instead of the 15% annual source energy savings requirement, the project must deliver a minimum annual energy savings of 4% source energy savings.

Hospitals

50% or more of the gross floor area must be used for general medical and surgical services and 50% or more of the licensed beds must provide acute care services.

Industrial/Manufacturing

The entire building must be evaluated, including all process equipment, and minimum savings must be achieved through multiple measures. If the project scope is limited to one specific improvement (e.g. conveyor belt controls), and/or the minimum energy savings is not feasible, the project should apply for incentives under the NJCEP SmartStart Prescriptive and Custom Measures Program.

Water/Waste-Water Treatment

The entire site must be treated as one project, all buildings and process equipment must be considered, and minimum savings must be achieved through multiple measures. Incentive #1 will be based on total site square footage, which will include the total square feet of all buildings and process equipment bound by property lines. Aerial photos or site-plans demonstrating the total square footage must be submitted with the Application. Because these sites are open-plan, creating a simulated model may not be necessary if it is determined that the majority of the savings are coming from a non-modeled load (i.e. process equipment). In which case, the modeling requirements may be waived in favor of a detailed metering plan. Prior approval from the Program Manager is required. If the project scope is limited to one specific improvement (e.g. VFDs on pumps), and/or the minimum energy savings is not feasible, the project should apply for incentives under the NJCEP SmartStart Prescriptive and Custom Measures Program.

Datacenters

The entire building, datacenter included, must be treated as one project, and minimum savings must be achieved through multiple measures. The project should apply for incentives under the NJCEP SmartStart Prescriptive and Custom Measures Program if:

- The project scope is limited to one specific improvement (e.g. HVAC controls), and/or the minimum energy savings is not feasible, or
- The datacenter is a stand-alone facility (i.e. is not part of a larger office building, or other complex), or
- The datacenter is part of a larger building, but improvements are limited to the datacenter.

2.3.5 Central Plants

Buildings that are served by central plants, such as for district steam, chilled water, and hot water, may still participate in the Program as long as these fuels are appropriately metered at the building level. Savings from these fuels will count toward the 15% source energy savings target but will not receive incentives unless baseline consumption and projected savings are first traced back to investor-owned natural gas and electricity units. This must be discussed in advance and approved by Program Manager.

The process of tracing these fuels back to natural gas and electricity requires the use of conversion factors. Conversion factors must be the same in the ERP and post-retrofit period, and either based on the known efficiency and losses of the central plants, or the following defaults when the actual performance is unknown:

- District chilled water generated by electric chiller: COP 3.3 chiller efficiency, 2.5% distribution loss, with the overall system performance of COP 3.2
- District chilled water generated by gas chiller: COP 0.95 chiller efficiency, 2.5% distribution loss, with the overall system performance of COP 0.93
- District steam generated using conventional boiler technology: 80% boiler efficiency, 7.5% distribution loss, with the overall system performance of 74%
- District steam generated using combined heat and power: 106.9% generation efficiency, 7.5% distribution loss, with the overall system performance of 98.9%
- District steam generated with unknown technology: 82.6% weighted average overall efficiency based on 41.35% CHP market share
- District hot water: 80% boiler efficiency, 2.5% distribution loss, with the overall system performance of 78%

2.3.6 Local Governments, K-12 Schools, and Other Public Entities

<u>*Energy Savings Improvement Program (ESIP)*</u>

Under the New Jersey Energy Savings Improvement Program (“ESIP” or “Bill 1185”), government agencies are allowed to make energy related improvements to their facilities and pay for the costs using the value of energy savings that result from the improvements (commonly known as performance contracts through Energy Service Companies or ESCOs). Government agencies include local governments, K-12 schools, public higher education institutions, and state agencies, among others.

ESIP’s Energy Savings Plans (“ESP”) are separate and distinct deliverables from those of the P4P Program. ESPs are currently required to be submitted directly to New Jersey’s Board of Public Utilities (“BPU”) for review and approval. If the ESP leverages P4P incentives, or incentives of any other NJCEP Program, for its financial cash flow the BPU may reserve the right to delay approval of the ESP until an NJCEP incentive commitment letter is issued. In the case of P4P this would constitute an <u>ERP Approval Letter</u>.

The P4P Program may be used in conjunction with ESIP. The committed incentives (Incentives #1, #2, and #3) must be deducted from the total project cost, and the balance financed by the participant according to the agreements between them and the ESCO.

Local Government Energy Audit Program

Buildings that have received an audit report through the NJCEP Local Government Energy Audit Program ("LGEA") are still eligible to participate in the Program. The results of the audit report can be extracted and included in the ERP. Accordingly, Incentive #1 will be reduced by 50%, to$0.075 /sqft (minimum $3,750; maximum $25,000), to acknowledge the value of the audit. This reduction only applies if the date of the audit report is less than 3 years from the date of receipt of the P4P Initial Application. The customer can retain the LGEA auditing firm as their Partner (assuming they are also an approved P4P Partner), as long as they follow all local procurement laws, or can select a new Partner if they wish.

Figure 2-2. ESIP/NJCEP Interaction

Memorandum

New Jersey's Clean Energy Program™ & Energy Savings Improvement Program Interaction

New Jersey's Energy Savings Improvement Program (ESIP), through the New Jersey Board of Public Utilities, is a distinct and separate effort from *New Jersey's Clean Energy Program* (NJCEP). The guidelines below are provided to establish clarity of interaction between the two. Additionally, a Flow Chart is provided on the reverse side as a recommendation on when to submit incentive applications to various NJCEP programs relative to the ESIP timeframe.

- In some cases, during the ESIP process, energy efficiency improvements are identified that may yield incentives from one or more NJCEP incentive programs, such as Pay for Performance, Direct Install, and SmartStart. In which case, the ESCO or ESIP Lead will submit an incentive application(s) on behalf of the entity to the NJCEP Market Manager (MM). NJCEP applications are reviewed and approved by the MM only. As per standard NJCEP procedure, the MM will issue an incentive commitment letter upon approval of the application(s). This is the only form of approval for a NJCEP incentive.

- ESIP applications, or Energy Savings Plans (ESP), are submitted to the New Jersey Board of Public Utilities (BPU) ESIP Coordinator for review and approval of the financial viability of the project, based on the requirements set forth in ESIP legislation of 2009, and amended in 2012. Where an ESP includes a NJCEP incentive as a component of the finances of the proposed project, the approval of an ESP should not be construed as an approval of the NJCEP incentive.

- In most cases, the NJCEP incentives identified in the ESP are estimates and have not yet been approved by the MM. If an ESP is approved and the NJCEP incentives are later reduced or rejected through the MM review process, then the financial burden falls either on the ESCO or the entity depending on if a guarantee was included in the contract(s). Additionally, incentives that are not approved will require the ESP to be resubmitted to the ESIP Coordinator, reflecting revised calculations, before final approval can be secured. Alternatively, incentives not yet approved by the MM should not be used to leverage ESP cash flows. If time permits, it is best to have NJCEP incentive commitment letters in place prior to submitting the final ESP for approval by BPU.

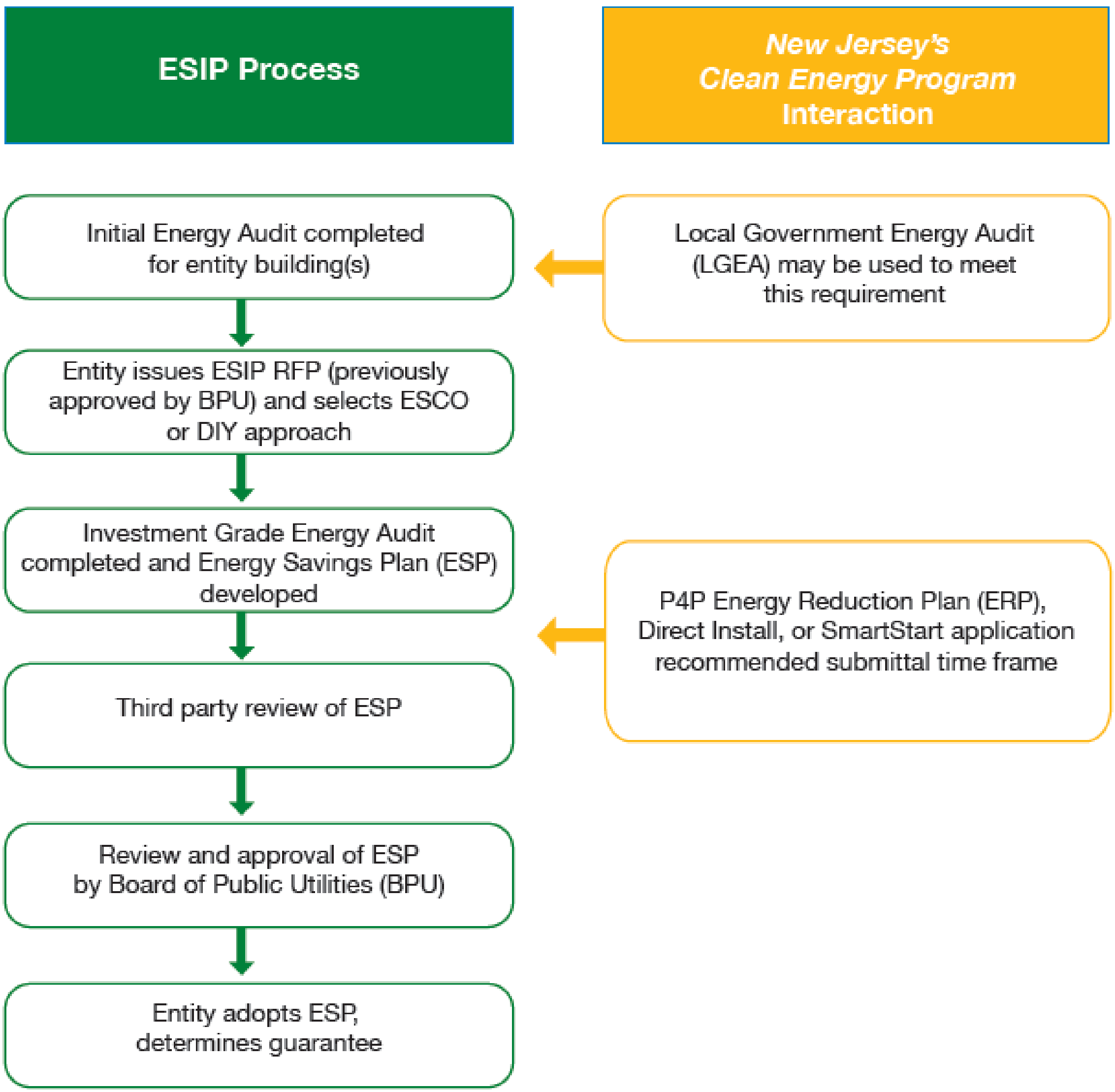
- Any/all NJCEP incentives eventually paid will go to the entity to help them pay for the project, or in some cases (such as the SmartStart program) the entity may directly assign incentives to a designated contractor. Direct Install payments are always made to the contractor.

- NJCEP incentives may require pre-inspections to be performed prior to approval of incentive applications and issuance of incentive commitment letter. Any ESIP planning or timeline should include enough time for the MM to review the application, perform a site visit to verify existing equipment, and to confirm that no work has started.

- Using savings from previously completed projects under NJCEP within an ESP is not permitted.

For additional information on the ESIP process, please visit NJCleanEnergy.com/ESIP. For questions specific to ESIP, please email ESIP@bpu.state.nj.us. For questions specific to NJCEP, please call 866-657-6278, extension 2.

New Jersey's Clean Energy Program & Energy Savings Improvement Program Interaction



For questions specific to ESIP, please email ESIP@bpu.state.nj.us. For questions specific to NJCEP, please call 866-657-6278, extension 2.

2.3.7 All Electric Buildings

All electric buildings may participate in the Program assuming that either delivery and/or supply comes from one of the NJ investor-owned utilities. Baseline energy use will consist of only electric consumption. The 15% source energy savings requirement will come from electric measures only. Incentives will be paid for electric savings. Incentive caps apply.

2.3.8 Major Renovations, Change of Use, Additions, and Vacant Buildings

Major Renovations

Gut rehabs and major renovations should be considered under the Pay for Performance New Construction Program or through one of the other NJCEP SmartStart Programs. Potential to process these types of projects under the Pay for Performance Existing Buildings Program must first be discussed with the Program Manager.

Change of Use

Projects that change the use of a space (e.g. warehouse being converted to school building) must be considered under the Pay Performance New Construction Program or through one of the other NJCEP SmartStart Programs.

Additions

Pay for Performance Existing Buildings is not equipped to handle new construction scopes of work, including additions to existing buildings. Additions can be addressed separately under the Pay for Performance New Construction Program or through one of the other NJCEP SmartStart Programs. Alternatively, depending on the size of the addition and extent of the work planned in the existing building component, the entire project (i.e. existing building and addition) can be addressed under the Pay for Performance New Construction Program.

If the existing building component *only* is to be taken through Pay for Performance Existing Buildings, then separate metering must be planned for and installed in all additions to ensure that the energy use from the addition does not factor into the energy use of the existing building. This is critical to calculating Incentive #3.

Vacant Buildings

Buildings that have been completely vacant for an extended amount of time (e.g. 2+ years) and/or for a length of time where the utility history is no longer available or relevant cannot participate in Pay for Performance Existing Buildings, but can be considered under the Pay for Performance New Construction Program or through one of the other NJCEP SmartStart Programs.

Buildings that have been partially vacant for a short amount of time (e.g. < 2 years) and have access to recent and relevant utility history may still participate in Pay for Performance Existing Buildings. If increased occupancy is expected post-retrofit, please reference Section 4.4.7. Relevant utility bills are utility bills with consumption representing the building operational and occupied rather than vacant.

2.3.9 Parking Garages and Lots

Parking Garages
Parking garages typically exist as basement levels in a building, as ground/1st floor levels, or as attached structures. Parking garages in and of themselves do not qualify for the Program, but they may be considered as part of a larger project. A parking garage must be incorporated into the project if it is on the same meter as the rest of the building(s) and/or shares any common HVAC equipment. If this is not the case, then the parking garage could be excluded from the scope of the P4P project and considered separately under other NJCEP SmartStart Programs. If the parking garage *is* included in the P4P project, the square footage cannot count towards Incentive #1 and must be excluded from total project area.

Parking Lots
Parking lots are subject to the same conditions as parking garages stated above, except parking lot square footage cannot count towards Incentive #1 under any circumstances and must be excluded from total project square feet.

All other projects not meeting the definitions outlined above will be evaluated by Program Manager on a case-by-case basis for eligibility.

2.4 Program Incentives

All Program Incentives are paid directly to the Participant, but can be assigned to the Partner if the Participant wishes to do so. Equipment for which Participants previously received incentives through other NJCEP Programs or other Programs offered by any of the New Jersey investor-owned utilities may not be eligible for incentives through this Program. Similarly, the project site may not participate or apply for incentives for energy efficient measures through other NJCEP Programs while participating in this Program. Participants must clearly identify all sources of funding in the ERP so that the combination of P4P Program incentives and all other funding does not exceed 100% of project cost.

Incentive #1: ERP Completion - This incentive helps offset the cost of services associated with the development of the ERP. Payment of Incentive #1 is contingent upon approval of the ERP and implementation of approved scope of work. Failure to complete the installation of the measures in the ERP may result in the repayment of Incentive #1. In the event the project is cancelled and Incentive #1 is not repaid, the project may still reapply to the Program in the future but another Incentive #1 will not be paid by the Program.

Incentive #2: Measure Installation - This incentive is based on projected energy savings and is paid upon successful installation of measures recommended in the approved ERP. The 15% minimum annual source energy savings is based on reducing the total energy consumption for the building. But, performance incentives (Incentive #2 and #3) will only be paid for savings associated with electricity and natural gas. For example, if Participant is a municipal electric company customer, and a customer of an investor-owned gas utility, performance incentives (Incentives #2 and #3) will only be paid for savings associated with gas measures (although electric savings will count towards the 15% savings target).

<u>Incentive #3: Post-Construction Benchmarking</u> - This incentive is paid upon approval of a Post-Construction Benchmarking Report, which verifies the projected savings outlined in the approved ERP. Incentives #2 and #3 are designed as a single performance incentive that is split in order to provide up-front financial assistance in implementing the project. Incentive #3 will be "trued-up" based on actual achieved savings so that the total performance incentive (i.e. #2 and #3) is in compliance with the Program's incentive structure. If savings are below the 15% minimum but at or above 5%, the project will still be eligible for an incentive, although at a reduced rate calculated at $0.005/kWh less and $0.05/therm less from the base incentive (i.e. $0.09/kWh and $0.90/therm) for each 1% savings below 15%. So long as the savings are at or above 5%, the minimum incentive paid is $10,000 or committed value, whichever is less, assuming all required data and documentation is submitted. If savings are less than 5% there would be no Incentive #3 paid. Incentives #1 and #2 are not required to be returned to the Program. The scaling down of incentives does not apply to high energy-intensity users, which are required to demonstrate at least 4% energy savings.

See **Table 2-1** for a full outline of Program Incentives.

Table 2-1. P4P Incentive Structure

Incentive #1: Energy Reduction Plan			
	Incentive Amount:	$0.15	per sq ft
	Minimum Incentive:	$7,500	
	Maximum Incentive:	$50,000	or 50% of facility annual energy cost
Incentive #2: Installation of Recommended Measures			
	Minimum Savings Target:	**15%**	
Electric Incentives	Base Incentive based on 15% savings:	$0.09	per projected kWh saved
	For each % over 15% add:	$0.005	
	Maximum Incentive:	$0.11	
Gas Incentives	Base Incentive based on 15 % savings:	$0.90	per projected Therm saved
	For each % over 15% add:	$0.05	
	Maximum Incentive:	$1.25	
	Incentive Cap:	**25%**	**of total project cost**
Incentive #3: Post-Construction Benchmarking Report			
	Minimum Savings Target:	**15%**	
Electric Incentives	Base Incentive based on 15% savings:	$0.09	per actual kWh saved
	For each % over 15% add:	$0.005	
	Maximum Incentive:	$0.11	
Gas Incentives	Base Incentive based on 15% savings:	$0.90	per actual Therm saved
	For each % over 15% add:	$0.05	
	Maximum Incentive:	$1.25	
	Incentive Cap:	**25%**	**of total project cost**

2.4.1 Incentive Caps

Incentives will be capped at the lesser of:

1. Project Cost Cap- Incentive #1 will be capped not to exceed 50% of the project's annual energy cost. Total of Incentives #2 and #3 is capped at 50% of total project cost. Total project cost includes materials, labor, design fees, construction management fees, and Partner fees associated with the P4P scope of work and will be considered as the lesser of the estimated costs listed in the approved ERP and actual costs listed in the Installation Report for final incentive calculation.
2. Project Cap- The total of Incentives #1, #2, and #3 combined shall not exceed $2 million per project, assuming both electric and natural gas measures are recommended and implemented. Should only electric measures, or only gas measures, be recommended and implemented then the total of Incentive #1, #2, and #3 combined shall not exceed $1 million per project. The latter applies to electric-only facilities as well.

3. Entity Cap- The participating customer's entity will be subject to an Entity Cap of $4 million per calendar year (Definition of an Entity can be found in the Board Order Docket No. EO07030203).

If total project incentive exceeds any of the above caps, Program Manager will manually adjust incentive down to comply with above incentive caps while maintaining the distribution of Incentive #1, #2, and #3 as shown in **Table 2-1** (e.g. incentive #2 and #3 will still reflect 25% of total project cost after adjustment).

In addition to the specific caps outlined above, no project shall receive incentives from one or more NJCEP programs and/or Board-approved utility programs in an amount that exceeds the total cost[3] of measures installed or performed.

2.4.2 Enhanced Incentives

Enhanced Incentives are available for certain facility types as listed below:

- Owned or operated by Municipality
- Owned or operated by a County
- Owned or operated by K-12 public schools
- Located within Urban Enterprise Zones (UEZ)
- Located within Opportunity Zones (OZ)
- Designated as Affordable Housing

Enhanced incentives are equal to an additional 100% of the incentives #2 and #3 listed above. The incentives are subject to a cap of 80% of the Applicant's cost for the project allocated between Incentive #2 and #3:

Incentive #2: Installation of Recommended Measures			
Enhanced Incentives	Electric Savings Additional Incentive	$0.09-$0.11	per projected kWh saved
	Gas Savings Additional Incentive	$0.90-$1.25	per projected Therm saved
	Incentive Cap:	**40%**	**of total project cost**

Incentive #3: Post-Construction Benchmarking Report			
Enhanced Incentives	Electric Savings Additional Incentive	$0.09-$0.11	per actual kWh saved
	Gas Savings Additional Incentive	$0.90-$1.25	per actual Therm saved
	Incentive Cap:	**40%**	**of total project cost**

To qualify for this enhanced incentive, documentation as listed below must be provided with the Application demonstrating that the entity or building location meets at least one of the eligibility categories listed above:

[3] Total cost is usually determined by reference to a sales invoice. It is not, for example, impacted by federal tax credits that will become available to the applicant on its next tax return or grants from sources other than NJCEP or Board-approved utility programs.

Eligibility Basis	Proof of Eligibility (provide as applicable)
Located in an Urban Enterprise Zone (UEZ)	The building where equipment is or will be installed must be located within the bounds of an Urban Enterprise Zone (UEZ). Please follow the steps below to confirm your facility is within the qualifying zone. The building location must be checked against the NJ Community Asset Map https://www.arcgis.com/apps/webappviewer/index.html?id=96ec274c50a34890b23263f101e4ad9b 1. Enter the address of your building in the field at the top of the map. 2. Under the Layers menu on the left side of the screen, scroll down to Urban Enterprise Zones and check to enable the layer. 3. Print or save a screenshot of the page to include with your submission. For the avoidance of doubt, companies do not need to become a Certified UEZ Business to be eligible for enhanced incentives from NJCEP.
Located in an Opportunity Zone (OZ)	The building where equipment is or will be installed must be located within the bounds of an Opportunity Zone (OZ). Please follow the steps below to confirm your facility is within the qualifying zone. The building location must be checked against the NJ Community Asset Map https://www.arcgis.com/apps/webappviewer/index.html?id=96ec274c50a34890b23263f101e4ad9b 1. Enter the address of your building in the field at the top of the map. 2. Under the Layers menu on the left side of the screen, scroll down to Opportunity Zones and check to enable the layer. 3. Print or save a screenshot of the page to include with your submission.
Owned or operated by a Municipal Entity	The building must be owned or operated by a Municipal Entity as evidenced by the name listed on the utility bill(s) for the building. If the name as shown on the utility bill(s) does not clearly delineate a Municipal Entity, other documentation may be accepted to demonstrate ownership on a case-by-case basis. Please contact the Program Manager for specific guidance. The Municipal Entity name must be recognized on the New Jersey Municipalities Search tool available at: https://www.nj.gov/nj/gov/direct/municipality.html
Owned or operated by K-12 Public School	The building must be owned or operated by a K-12 Public School as evidenced by the name listed on the utility bill(s) for the building. If the name as shown on the utility bill(s) do not clearly delineate a K-12 Public School, other documentation may be accepted to demonstrate ownership on a case-by-case basis. Please contact the Program Manager for specific guidance. The K-12 Public School name must be recognized on the New Jersey School Directory available at: https://homeroom5.doe.state.nj.us/directory/pub.php
Owned or operated by a County Entity	The building must be owned or operated by a County Entity as evidenced by the name listed on the utility bill(s) for the building. If the name as shown on the utility bill(s) does not clearly delineate a County Entity, other documentation may be accepted to demonstrate ownership on a case-by-case basis. Please contact the Program Manager for specific guidance. Enhanced incentives for Counties apply to: ➢ Buildings owned or operated by one of the counties listed here: https://www.state.nj.us/nj/gov/county/counties.html ○ This includes, among other things, buildings owned or operated by any "community college" listed here: https://www.nj.gov/highereducation/colleges/schools_sector.shtml ○ And authorities and commissions listed here: https://nj.gov/comptroller/news/docs/authoritiescommission.pdf

Affordable Housing	Any multifamily housing that an official document identifies as participating in a federal, state, or local affordable housing program. This includes, by way of example only, the New Jersey Department of Community Affairs listing of Affordable Housing available here https://www.state.nj.us/dca/divisions/codes/publications/developments.html as well as official documents showing identification by the documents regarding New Jersey Housing and Mortgage Finance Agency, United States Low Income Housing Tax Credit (LIHTC), and United States Housing and Urban Development (HUD).

2.5 Submission Guidelines

2.5.1 General

- All new submittals must be submitted to the P4P@njcleanenergy.com email;
- This also includes submittals uploaded to FTP or TRCNET. Please send an email to P4P@njcleanenergy.com notifying Program Manager of the upload and/or providing FTP access;
- All emails must contain Application Number (except new applications), Project Name, and Revision Number in the subject line;
- Partners may email resubmittals/revisions directly to assigned reviewer but must CC P4P@njcleanenergy.com;
- Sub-consultants must CC Partner of record on all email correspondence;
- Revisions must be submitted within thirty (30) days from the date Program Manager provides comments. Extensions may be available, otherwise if a response is not received by this date the application will be considered abandoned and thereby cancelled.

2.5.2 Specific

Initial Application Submittal documents should be submitted to the Program Manager at the very beginning of the project to verify that project meets minimum eligibility criteria. Work on the ERP should not begin until the Application Approval letter is issued stating that the project is eligible to participate in the Program and Incentive #1 has been committed. Approval of the Application is not an approval of the proposed scope of work.

Incentive #1 Submittal documents, including the ERP should be submitted within six (6) months of the Application approval date AND if the scope of work changes after ERP approval, such that the energy savings are significantly affected. Savings are considered to be significantly affected if the changes in the scope of work could result in the project no longer meeting the stated Program rules. For example, if a project estimates exactly 15% source energy savings, even slight changes to the scope could put the project at risk of not meeting the minimum savings criteria. Other trigger events for re-submitting an ERP include changes in estimated savings that exceed 10% of original estimates and/or the removal or addition of an entire measure (Section 5.4).

Each Appendix of the ERP shall be submitted as a single file and labeled appropriately. For example, "01234 – <Project Name> – Appendix A – Portfolio Manager.pdf". Other ancillary documents shall be submitted in a similar format.

ERP Notes:

- Partners submitting ERPs for multiple similar projects concurrently, such as for individual schools in K-12 school districts, must first submit only **one (1)** of the ERPs for review to address all comments. Once this is completed the Partner can then proceed with submitting the remaining ERPs, which shall address all comments made during review of the first ERP. This will streamline and expedite the ERP review process.
- An ERP must be approved by the Program and an approval letter sent to the Participant in order for incentives #2 and #3 to be committed. Upon receipt of an ERP, all project facilities must be pre-inspected. Measures installed prior to pre-inspection of the facility shall not be included as part of the ERP scope of work and will not be eligible for incentives. Measure installation undertaken prior to ERP approval, but after pre-inspection, is done at the Participant's own risk. In the event that an ERP is rejected by the Program, the Participant will not receive any incentives.
- Revisions to the ERP must be submitted within thirty (30) days from the date Program Manager provides comments. If a response is not received by this date, the application will be considered abandoned and thereby cancelled. You will need to reapply to the Program under all current Program rules.
- Partners may request a conference call with the Program Manager's review team to discuss reviews comments; the request should include a list of discussion questions or topics.
- Unless the Program Manager in advance approves a Partner's request to provide an incomplete or partial submittal, the Program Manager will not review such submittals and will instead notify the Partner of same. Examples of situations in which the Program Manager will consider approving the provision of an incomplete submittal include the submission of incomplete ERP Tables or draft models to facilitate an upcoming discussion between the Partner and the Program Manager.
- Similarly, if responses to the Program Manager's comments are incomplete or significantly unresponsive, the Program Manager will not review such "responses" and will instead notify the Partner of same.
- If Partner does not satisfactorily resolve the Program Manager's comments by the third iteration (i.e., rev3), the Program Manager will adjust measure-level savings to reflect the impact of unresolved comments, which in many cases will result in a decreased incentive. In cases in which the Program Manager adjusts incentives, it will notify the Partner of the adjustments. If the unresolved comments are sufficiently significant to undermine the entire application, the Program Manager will reject the application.

Incentive #2 Submittal documents should be submitted within twelve (12) months of the ERP approval date, or upon installation completion of all recommended measures, whichever comes first. A post-inspection will be conducted at this time.

Incentive #3 Submittal documents should be submitted approximately twelve (12) months after the Installation Report approval. During the term of the performance period, Partner must notify the Program Manager in a timely manner of any changes in occupancy, energy supply source, or other changes that significantly affect energy savings (Section 6.5).

The project's scope of work, proper measure selection, and successful project implementation are the Partner's sole responsibility. Make sure the most recent versions of tools and templates are used.

Please see **Table 2-2** for detailed document submittal guidelines.

2.5.3 Extensions

Incentive #1 Submittal: The Program Manager may grant an extension of up to SIX (6) months past the ERP submittal deadline.

Incentive #2 Submittal: The Program Manager may grant a project a *first extension*, not to exceed SIX (6) months past the Installation Report submittal deadline, and a *second extension* up to an additional SIX (6) months.

Incentive #3 Submittal: The Program Manager may grant a *first extension*, not to exceed SIX (6) months past the Post-Construction Benchmarking Report submittal deadline, and a *second extension* up to an additional SIX (6) months.

The following steps must be followed to request an extension to the above deadlines:

1. Partner must submit the request for an extension in writing, via hard copy or email, prior to the expiration date.
2. Request must identify the reason for the request and a schedule that identifies how much extra time is needed to complete the project.
3. Program Manager will review the request and, if approved, issue an Extension Approval letter per the timelines above.
4. Approval of a request for extension will not change or modify any other Program rules.

In addition, the Program Administrator, with the approval of Board Staff, may approve up to two extensions, each of a length set by the Program Administrator with the approval of Board Staff, beyond the extensions the Program Manager is authorized to approve above.

Table 2-2. P4P Program Document Submission Guidelines

Initial Submittal	**Pay for Performance Application:** Submit as a PDF file (*.pdf) or hard copy, signed.
	12 months of baseline utility bills: Submit as a PDF file (*.pdf) or hard copy (double sided preferred) in chronological order, separated by account. For projects with large volumes of utility data please also submit summary in Utility Tool spreadsheet.
	Brief project description: Submit as a PDF file (*.pdf) or hard copy.

Incentive #1 Submittals	**Energy Reduction Plan Report (and associated Appendices):** Submit as a PDF file (*.pdf) ---<u>upon final revision only.</u>
	Energy Reduction Plan Tables (and associated Appendices): Submit as an Excel file (*.xls)
	Appendix A: ENERGY STAR's Portfolio Manager® SEP, Data Checklist, and Score Card (if applicable). Submit as a PDF file (*.pdf). *Please share project on Portfolio Manager website with TRC. If you have shared projects with TRC before, then our username should already be on your contacts list as "Solutions, TRC". If sharing with TRC for the first time, you will need to add us as a contact first by searching for username "TRCSOLUTIONS".*
	Appendix B: 12 months of baseline utility bills (if different from Initial Submittal). Submit as a PDF file (*.pdf) or hard copy (double sided preferred) in chronological order, separated by account.
	Appendix C: Model Calibration Tool. Submit as an Excel file (*.xls)
	Appendix D: Modeling Software file(s) and Output Reports. See Section 4.2
	Appendix E: External Calculations (if applicable).
	Appendix F: Pre-Retrofit Metering Approach and Results (if applicable).
	Appendix G: Copy of Partner-Participant Contract(s). Submit as a PDF file (*.pdf), signed. Updates to contracts will indicate the revision # and must be resigned by both parties.
	Appendix H: Installation Agreement. Submit as a PDF file (*.pdf), signed.
	Request for Incentive #1: Submit as PDF file (*.pdf), signed.

Incentive #2 Submittals	**Installation Report:** Submit as an Excel file (*.xls)
	Invoices: Submit as a PDF file (*.pdf), organized by measure and consistent with as-built costs detailed in the Installation Report. Exclude sales tax.
	Request for Incentive #2: Submit as PDF file (*.pdf), signed.

Incentive #3 Submittals	**Savings Verification Tool:** Submit as an Excel file (*.xls)
	ENERGY STAR's Portfolio Manager® SEP, Data Checklist, and Score Card (if applicable): Submit as PDF file (*.pdf)
	12 months post-construction utility bills: Submit as a PDF file (*.pdf) or hard copy (double sided preferred) in chronological order, separated by account. For projects with large volumes of utility data please also submit summary in Utility Tool spreadsheet.
	Request for Incentive #3: Submit as PDF file (*.pdf), signed.

2.6 Miscellaneous

2.6.1 Business Clearance Certificate

A valid Business Assistance Tax Clearance Certificate from the State of New Jersey, Division of Taxation is required before any incentives can be released. Participants are required to use the State's Premier Business Services (PBS) portal online to file for Tax Clearance Certificates. Please visit the NJ Clean Energy website for complete instructions: www.njcleanenergy.com/TCC

2.6.2 Payment and Check Process

The Program Manager will submit Incentive Invoices to the State of New Jersey twice each month for payment of approved incentives. Upon receipt of wire transfer of payment from NJ Treasury Department, the Program Manager will issue incentive checks to Participants and/or their designated payee within approximately five business days. It can take approximately 45-60 days for checks to be mailed from the time Program Manager submits Incentive Invoices to the State.

2.6.3 Prevailing Wage Requirements

Participating projects with a contract at or above current prevailing wage contract threshold amount set pursuant to the New Jersey Prevailing Wage Act (N.J.S.A. 34:11-56.25 et seq.) are required to pay no less than prevailing wage rate to workers employed in the performance of any construction undertaken in connection with Board of Public Utilities financial assistance, or undertaken to fulfill any condition of receiving Board of

Public Utilities financial assistance, including the performance of any contract to construct, renovate or otherwise prepare a facility, the operations of which are necessary for the receipt of Board of Public Utilities financial assistance. By submitting an application, or accepting program incentives, applicant agrees to adhere to New Jersey Prevailing Wage requirements, if and to the extent that Act may apply to the work covered by the application. More information can be found at https://www.nj.gov/labor/wagehour/regperm/public_contracts_general.html

2.6.4 Dispute Resolution Process

Disputes, concerns, or complaints that arise will be addressed initially by the Program Manager or Program Staff at the point of contact. If resolution for whatever reason is not possible, there is a dispute resolution process backed by the NJ Board of Public Utilities. https://njcleanenergy.com/main/board-public-utilities/board-public-utilities-0

Appeals and disputes must be presented to the Program Administrator within **45 days** of the Program Manager's determination regarding the subject of the appeal or dispute. For contractual disputes between a system owner and installer or registrant, the NJ Division of Consumer Affairs (DCA) is the point of contact and the agency has an online complaint form.

The program is designed to allow for participation by pre-approved third party contractors that meet program requirements. One of the primary responsibilities of the program is to oversee the level of performance of the contractors that participate in the program. There are BPU approved contractor remediation procedures that will be followed if a contractor is found to violate program procedures and rules or consistently violates program requirements which may include being barred from participating in the program.

3. Energy Reduction Plan Development

3.1 Overview

The Energy Reduction Plan (“ERP”) is a report that provides a roadmap for developing and implementing a comprehensive energy efficiency improvement scope of work in C&I projects. The process required to complete the ERP is similar to an ASHRAE Level 2 energy audit, with additional requirement of using calibrated simulation to estimate EEM savings. An energy audit is a necessary first step, but is only one component of the Plan. The ERP also includes building modeling results, a financing plan, and a construction schedule. The ERP describes the specific energy efficiency measures (“EEM” or “measure”) that will be implemented to achieve the 15% savings target, identify the sources of funding that will pay for these measures, and outline their implementation schedule. The ERP must be developed in consultation with the Participant and must be adhered to closely throughout construction in order to ensure that the energy efficiency measures are installed in such a way as to realize the projected energy savings.

See **Table 3-1** for information on step-by-step ERP development, including references to Sections in these guidelines.

Table 3-1. Step-by-Step ERP Development

Step 1 Section 3.2	•Collect **12 months** of recent, consecutive utility data (electric, and all applicable fuels). This should already be completed from the Application submittal. •Enter data into ERP Excel Tables - **Utility tabs**
Step 2 Section 3.3	•Perform whole-building **audit** of existing conditions. •Enter data into ERP Excel Tables - **General Project Information tab, Area Identification tab, Occupancy tab, Envelope tab, Mechanical tab, Lighting tab, Other Equipment tab.**
Step 3 Section 4	•Using the information from the audit, develop **baseline building energy model** using one of the approved energy simulation tools (eQuest, Trane Trace, etc.) •Complete ERP Excel Table - **Modeling Approach tab.**
Step 4 Section 4.5	•Use **Model Calibration Tool** to calibrate baseline building model to actual utility bills. •If "**Overall Accuracy**" statistics **PASS** then proceed to the next step. Otherwise adjust model until calibration passes.
Step 5 Section 3.4	•**Select Energy Efficiency Measures (EEMs)** that will be implemented in the building. •Enter this information into ERP Excel Tables- **Measure Descriptions tab**.
Step 6 Section 4.6	•**Add EEMs** incrementally to baseline building model. •Complete ERP Excel Tables - **Measure Simulation tab.**
Step 7 Section 3.5, 3.6	•Complete ERP Excel Tables - **Implementation & Financing tab.** •Review ERP Excel Tables - **Project Summary & Incentives tab, and CBECS Statistics tab.**
Step 8	•Review ERP Excel Tables - **Partner Internal QC tab** and make any necessary revisions.
Step 9 Section 3.8	• Create a pre-construction Benchmark through EPA **Portfolio Manager**.
Step 10 Section 2.5	•**Submit** to Market Manager per Submission Guidelines.

3.2 Utility Bill Collection Requirements

Proper utility bill collection is critical for establishing baseline energy consumption of the project and accurate savings projections. The guidance in this section also applies to collection of post-retrofit utility data for Incentive #3 submittal purposes (Section 6.4.2).

The following is required when collecting utility bills:

- Utility data and corresponding invoices must be submitted to the Program organized by account and/or meter, and in chronological order.
- Utility bills must be collected for all accounts/meters and fuels at the facility during the baseline (pre-retrofit) period. Data for sub-meters may be collected where available and used for model calibration (Section 4.5).
- At least twelve individual values of energy consumption for each fuel (utility bills) must be available for the baseline period, except as allowed by this section. For example, baseline period could be from March 1, 2019 to February 28, 2020, and may include twelve (12) monthly bills for electricity and eighteen (18) bills for oil delivered to the facility during this period.
- Utility bill dates across accounts comprising the baseline period should be no more than 15 days out of sync.
- The meter readings corresponding to the start and end date of the baseline period must be Actual readings. A bill is considered to be an Actual bill if it has an Actual meter reading at the end of the billing period. Thus, the bill immediately preceding the start of the baseline period and the last bill of the baseline period must both be the actual bills. Flexibility may be granted where numerous accounts exist.
- Additionally, in order to avoid not having enough reading periods, there should be a reasonable amount of actual readings, for example 9 months out of 12 should be actual readings including the beginning and end readings.
- To ensure integrity of projected savings, utility bills must be no older than two (2) years from ERP submittal, but preferably within the most recent twelve (12) months.
- Actual utility invoices and utility summaries directly from the utility company are acceptable. Utility summaries from internal software is not acceptable.

The following information must be collected for the accounts/meters serving the project:

- Non-stored Energy Sources (e.g. electric, pipeline-supplied natural gas, steam)
    - The date of the meter readings
    - The amount of energy use measured for the utility billing period
    - Peak electricity demand for utility billing period
    - Total energy cost for the utility billing period, including supplier, delivery, and applicable meter fees
    - Whether the reading is actual or estimated
    - Other relevant billing information (e.g., gas tariff demand)

- Stored Energy Sources (e.g. liquid natural gas, oil, coal, wood, etc.)
  - Delivery information including the date of the delivery and the amount of fuel delivered
  - Total energy cost for the delivery
  - Inventory readings, including the amount of fuel in storage at the start and end of a period and the amount used during that period
  - The date of the inventory readings. Inventory readings need to be conducted on a regular schedule such as bi-monthly, monthly or semi-monthly
  - Change in the amount of fuel in storage

  Delivery information is mandatory; inventory readings are optional but strongly recommended to increase accuracy of the model.

Example: A mixed-use building has retail and office spaces on the first floor that are owned by various commercial entities, and multifamily units on floors 2-8. The scope of the P4P project includes the entire building. The building has the following meters:

Electricity:

Meter A: master-meter for all loads on floors 2-8 (residential portion)
Meters B1-B100: sub-meters that measure consumption in each apartment
Meter C: sub-meter that measures consumption of common spaces on floors 2-8
Meter D1-D5: meters for individual commercial tenants on 1st floor

Natural Gas:

Meter F: measures consumption of space and service hot water heating boilers that serve floors 2-8
Meter G: measures gas used for cooking and gas driers on floors 2-8
Meter H1-H5: measures space heating and hot water usage of individual commercial tenants on 1st floor

For this scenario, the Partner must collect utility bills for Meters A, C, D, F, G and H and use them to calculate the actual pre-retrofit/baseline energy consumption of the P4P project. Meter B is not required in this example since residential usage is also master-metered by Meter A.

To aid in the model calibration process (Section 4.5), the Partner should use the billing history as follows:

1. Compare monthly usage and demand (kWh and kW) of Meter A to electricity usage and demand projected by the model
2. Compare monthly usage and demand of Meter C to electricity usage and demand of common spaces in the model
3. Compare monthly usage and demand of Meters D1-D5 to electricity usage and demand of commercial spaces on the first floor projected by the model.
4. Compare monthly usage of Meter F to the total space and service hot water heating usage (therm) projected by the model

5. Compare monthly usage of Meter G to the total process load (therm) projected by the model
6. Compare monthly usage of Meters H1-H5 to modeled gas consumption of commercial spaces on the first floor.

3.2.1 Direct-Metered Multifamily Projects

Many multifamily facilities have both common commercial meters, as well as tenant residential meters. Since the Program looks to achieve 15% savings from the *whole building*, tenant data must be included in the analysis. The current policy is to collect a **10% representative sampling** of tenant utility bills both pre and post construction regardless if improvements are planned within the unit or not. This is to ensure that a proper building model is created and that savings are measured from total baseline building energy consumption.

- Scenario 1: Entire multifamily building is master-metered and landlord pays all utility bills. In this case, the Partner must collect twelve (12) months of utility bills from the landlord for electric, gas, and/or other fuels. This utility bill information will demonstrate the total baseline energy consumption of the building.

- Scenario 2: Common areas are master-metered for electric and gas and landlord pays common area bills. Residential units are direct-metered for electricity and residents pay their own electric bill. In this case, the Partner must collect twelve (12) months of utility bills for the common areas AND twelve (12) months of residential electric bills from a **10% representative sampling** of apartments.

  For example, if a multifamily building consists of 100 residential units, and 50 are one bedroom and the other 50 are two-bedroom, the 10% sampling should include twelve (12) months of electric bills from five (5) 1-bedroom apartment and five (5) two-bedroom apartments. Sampling should be taken from units on different floors and in different areas of the building (corner, middle, north, south, etc.) The 10% sampling will then be used to extrapolate the energy use of all 100 units. The total in-unit electric consumption shall then be added to the energy consumption of the common areas to establish the total baseline energy use for the building. Tenant extrapolation and addition is formulated in the ERP Excel Tables, Utility tabs.

3.2.1.1 Alternative Approach to Establishing In-Unit Electricity Usage

If the required sample of in-unit utility bills is not collected, the total daily baseline in-unit electricity consumption must be calculated using Eq.1 and values in Table 3-2 & 3-3. Note, this method cannot be used for projects with direct metered in-unit heating and/or cooling equipment that are included in the P4P scope of work.

E_i= (LTG+PLG)*A + (ES*N_s) + (DW*N_{DW}) + (CW*N_{CW}) + (CD*N_{CD}) + (WAC_i*A_{WAC}) + (FCU_i*A_{FCU})

(Eq. 1)

E_i [kWh/day] – in-unit electricity usage during month i
A_{WAC} [SF] – square foot area of in-unit spaces with room air-conditioners
A_{FCU} [SF] – square foot area of in-unit spaces served by fan-coil units

Table 3-2. Electricity Consumption of In-unit Lighting, Appliances, and Plug loads

	Units	**Value**	**Definition**
LTG	kWh/day/SF	0.00444 [1]	daily lighting kWh per SF of apartment area
PLG	kWh/day/SF	0.00646 [1]	daily kWh of miscellaneous appliances and plug loads per SF of apartment area
A	SF		total area of apartments
ES	kWh/day/unit	1.7 [3]	daily kWh of electric stoves per unit
N_S	each		total number of in-unit electric stoves in the building
DW	kWh/day/unit	0.6 [4]	daily kWh of dishwashers per unit
N_{DW}	each		total number of in-unit dishwashers in the building
CW	kWh/day/unit	0.2 [4]	daily kWh per *in-unit* clothes washer
N_{CW}	each		total number of *in-unit* clothes washers in the building
CD	kWh/day/unit	2 [3]	daily kWh per *in-unit electric* clothes dryer
N_{CD}	each		Total number of *in-unit electric* clothes dryer in the building

Table 3-3. Seasonal in-unit HVAC electricity consumption

Month	**In-unit Window AC [2] WAC_i [kWh/day/SF]**	**In-unit fan-coil unit fans (heating & cooling, cycling) [2] FCU_i [kWh/day/SF]**
January	0	0.00009
February	0	0.00007
March	0	0.00005
April	0	0.00004
May	0.0082	0.00011
June	0.0218	0.00017
July	0.0270	0.00002
August	0.0275	0.00021
September	0.0114	0.00015
October	0	0.00008
November	0	0.00002
December	0	0.00007

[1] U.S. Department of Energy Commercial Reference Building Models of the National Building Stock; National Renewable Energy Laboratory; February 2011; Deru, Michael, et al; Appendix A Reference Building Internal Load; Page 54

[2] Sample models developed with eQuest 3.65 using parameters outlined in U.S. Department of Energy Commercial Reference Building Models of the National Building Stock; National Renewable Energy Laboratory, February 2011, as well as software defaults
[3] Building America Research Benchmark Definition, Updated December 29, 2004; US Department of Energy; February 2005; Hendron, Robert; Page 23
[4] Energy consumption of refrigerator, dishwashers and clothes washers is based on information posted at www.energystar.gov, including the *Product Lists* and *Savings Calculators*, and as provided in the ENERGY STAR® Multifamily High Rise Program Simulation Guidelines, version 1.0, revision 03, issued January 2015, Section 3.10.2, pages 23-25

Example: A 110-unit multifamily building has a total floor area of 100,000 SF including 80,000 SF apartments and 20,000 SF of common spaces. Gas is master metered for the entire building, and apartments are directly metered for electricity. Units have gas stoves and there are no in-unit clothes washers/dryers. Ten (10) three-bedroom apartments have in-unit dishwashers. Most units have room air conditioners in the bedrooms, with an estimated cooled area of 30,000 SF. Common area electricity bills are available, but the in-unit bill sample could not be obtained. The baseline period includes a 16,000 kWh electricity bill for common spaces for July 17 – August 10. How can the total electricity consumption, E_{total}, be calculated for the July 17 – August 10 period?

The bill includes 15 days in July and 10 days in August. Eq. 1 is applied to the periods in July and August, and then the total consumption is calculated as shown below.

E_{July} = ((0.00444 + 0.00646)*80,000 + (0.6*10) + (0.0270*30,000))*15 days=25,320 kWh
E_{August} = ((0.00444 +0.00646)*80,000+ 0.6 *10+0.0275*30,000)*10 days = 17,030 kWh
$E_{\text{Total for July 17 – Aug 10 period}}$ = 25,320 + 17,030 + 16,000 = 58,350 kWh

E_{Total} is added to common area energy usage for the same period. The same procedure must be followed for the other months in the baseline period.

Documentation Requirements: Use provided Multifamily In-Unit Electric Usage Calculator and submit with associated deliverables (e.g. ERP).

3.2.1.2 Condominiums

In the case where all living units are directly owned by private individuals, and each owner of a living unit is responsible for the upkeep/repairs/replacement of any component within the unit (including appliances, HVAC systems, windows, etc.), it may be possible to exclude the in-unit consumption from the baseline energy load and exclude the corresponding areas from energy simulation. In this case, all Program Requirements must be met by the common areas alone (i.e. 100kW demand, 15% savings, etc.) In order to accomplish this, the residential units must be completely segregated from common areas for both metering and end-uses.

For example, a building is metered by one master-meter for all common areas with sub-meters in all units, and all units have their own heating/cooling equipment. The P4P baseline will be determined by analyzing just the common area master-meter and all equipment tied to that meter. This process shall be repeated for the post-benchmark. Incentive #1 will be based on the area of common space excluding apartments.

This approach should be discussed with the Program Manager ahead of time.

3.2.2 Allowed adjustments to Utility Bills

One or more utility bills in the baseline period may correspond to an irregular event (such as one time repairs performed in the facility) or represent a faulty or estimated, not actual, reading. Such bills must be handled as described in this section.

Justification for all modified or excluded bills must be included in the ERP and is subject to approval by Program Manager. No more than 25% of the actual billing data may be modified or excluded. Adjustments shall not be applied to the first or last monthly billing period in the baseline period. The bill that immediately precedes the first bill and the last bill in the baseline period must be an actual, not estimated, reading.

The comparisons below are made between bills and simulated data.

Irregular Deliveries

Consider a project where no fuel #2 deliveries were made in July and September. **Figure 3-1** illustrates incorrect input for this scenario, with zero usage entered for July and September. This input implies that no fuel #2 was used during these months, which is unlikely and will conflict with the modeled usage for these periods.

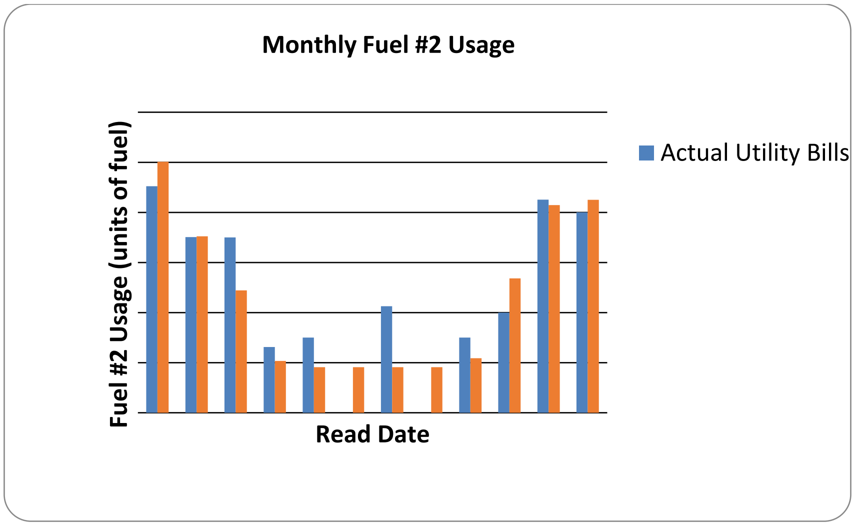


Figure 3-1. Incorrect fuel #2 usage with zero (0) gallons input for summer months

In this case, the utility data must be adjusted by combining the usage during July and August, and usage during September and October into two utility bill periods. The resulting baseline period will include ten (10) utility bills, two of which are two months long (July-August and September-October). The correct input is shown in **Figure 3-2.**

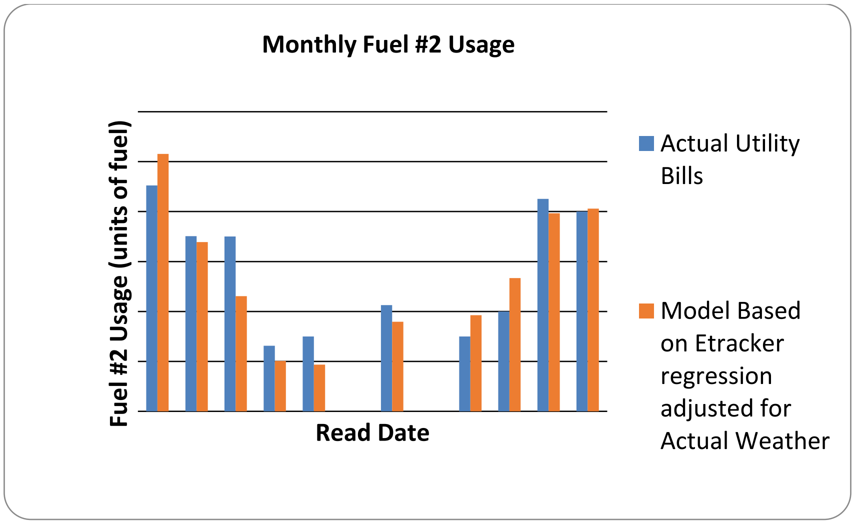


Figure 3-2. Correct fuel #2 usage with no usage input for summer months

Outliers

Outliers are the bills that do not fit the overall usage patterns, such as the bill with June 18th read date shown in **Figure 3-3.**

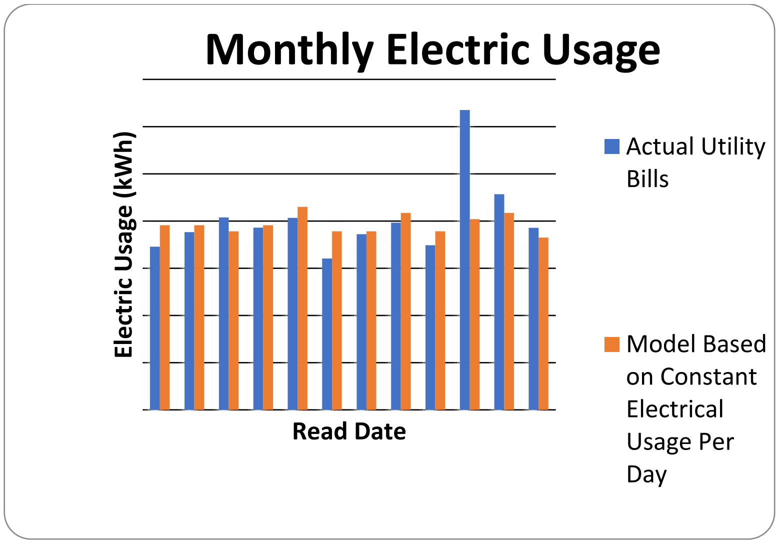


Figure 3-3. Example with outlier utility bill on June 18th

A single outlier in the actual utility data can result in a failure to pass the calibration criteria. Such bills may be eliminated from the baseline period and replaced by an estimate calculated as an average of the preceding and following months' bills normalized for billing period lengths. Excluded data points must be isolated, not consecutive, billing periods.

<u>*Estimated Bills*</u>

Some bills in the baseline period may reflect an estimate done by utility company for billing purposes, not the actual meter readings. Such utility bills must be combined with immediately following actual reading to show the total energy consumption during the combined bill period. This process is similar to what is described for irregular deliveries. The baseline period must be selected so that it ends with an actual reading, and the bill that immediately precedes the selected baseline period is also an actual reading. In order to avoid not having enough reading periods, there should be a reasonable amount of actual readings, for example 9 months out of 12 should be actual readings including the beginning and end readings.

3.3 Energy Auditing Requirements

The building audit is to be conducted or supervised by a qualified professional, holding a certification of Certified Energy Manager (CEM) or equivalent credentials. The auditor is expected to follow the industry standards for conducting comprehensive energy audits as established by such organizations as the Association of Energy Engineers (AEE), ASHRAE, and the EPA ENERGY STAR® Buildings Program. ASHRAE's "Procedures for Commercial Building Energy Audits" provides audit guidelines and forms.

3.3.1 Lighting Survey

The ERP must include a lighting survey with a table listing the location, quantity, fixture type, and fixture input wattage for all lighting in the building. At minimum all information called out in ERP Excel Tables, Lighting tab must be completed.

Typical lighting run hours can be found in **Table 4-3** and **4-4**. If annual run hours used in the simulation differ significantly from defaults, and project includes lighting EEM, then run hours should be determined from metering a representative sample of fixtures or occupancy data by space type. Sampling requirements shall be determined using the Sample Size Calculator, which is included in the ERP Excel Tables file. If the Sample Size Calculator determines that more than twenty (20) monitoring points are required in a building, the Partner may contact the Program Manager to discuss the possibility of reducing the number of required monitoring points.

Please refer to Appendix D for additional detail on data collection and metering guidelines for lighting.

3.3.2 Mechanical Survey

The ERP must include information on the existing HVAC equipment, boilers and hot water heaters, chillers and condensers, and motors/variable-speed drive (VSD) in the building. Information should also be gathered for ancillary equipment including automation and controls. At minimum all information called out in ERP Excel Tables, Mechanical tab must be completed.

Please refer to Appendix D for additional detail on data collection and metering guidelines for chillers.

3.3.3 Additional Data Collection Requirements

In addition to the project components described above, all other energy consuming systems in the building must be documented in a similar manner. Additional data collection and activities required for the development of the baseline simulation model include:

- Building envelope: dimensions, type, and thermal resistance of exterior walls, properties of windows (U-value and SHGC), air-tightness, and building orientation and shading from nearby objects. At minimum all information called out in ERP Excel Tables, Envelope tab must be completed.
- Plug loads and other major energy-consuming loads (industrial process, air compressors, etc.): major and typical plug loads, including count, nameplate data, and location, where applicable. At minimum all information called out in ERP Excel Tables, Other Equipment tab must be completed. The level of detail should be proportional with whether or not plug/other loads are being recommended for retrofit.
- Building occupants: population counts, occupancy schedules in different zones. At minimum all information called out in ERP Excel Tables, Occupancy tab must be completed.
- Interview operators and occupants to confirm schedule and any operating problems / special conditions that must be replicated in the calibrated model. They can also provide information on any deviation in the intended operation of building equipment. It is critical to note changes in building operation/occupancy that will affect energy use and thus the calibration or savings verification process See additional information in Section 4.3.1.

3.3.4 Pre-Installation Metering

Pre-metering may be necessary, especially for projects where an existing load is variable and significantly affected by process loads that cannot be directly modeled in the simulation tool. Pre-installation data should be collected for a long enough time to demonstrate a repeatable pattern or a variable that correlates to a known value. Variables may be measured for short intervals (days, weeks or months) or extracted from existing operating logs. The accuracy of meters should be verified for critical measurements. If resources permit, building ventilation and infiltration should be measured because these quantities often vary widely from expectations. One-time measurements will improve simulation accuracy without much additional cost. On/off tests can measure lighting, receptacle loads and motor control centers. These tests can be performed over a weekend using a data logger or building automation system to record whole-building energy use. Sometimes inexpensive portable loggers are also effective for short-term measurement.

For equipment where pre-metering data is not obtained, conservative default energy use assumptions must be used, as specified in Section 4. Additional guidelines for metering can be found in Appendix D.

3.4 Measure Evaluation

Information from the energy audit, along with historical energy use data, will be used to develop a baseline energy simulation for the building. Detailed operating data will be used in the model to calibrate it to actual energy use in the building. Once this is completed, the Partner will add recommended energy efficiency measures to the model in order to quantify projected savings. The calculation of energy savings must follow the Simulation Guidelines detailed in Section 4.

For each proposed measure, a description of the proposed equipment and associated existing conditions as called out in ERP Excel tables, Measure Description tab and Measure Simulation tab must be provided.

Table 3-4 contains a list of sample measures that may be considered for evaluation. A much more comprehensive list is included in ASHRAE Procedures for Commercial Building Energy Audits package found at the following link (and also available on the Partner Portal):
https://xp20.ashrae.org/PCBEA/Files/EEMs-to-Consider-2011-09-15.pdf

Table 3-4. Common Energy Efficiency Opportunities

Envelope Measures
Air-sealing (including weatherstripping)
Roof deck or attic insulation
High performance and/or ENERGY STAR® windows
Lighting Measures
ENERGY STAR® and/or Design Lights Consortium qualified LED products
Automatic interior lighting controls (e.g., occupancy sensors, bi-level lightings, etc.)
Daylight dimming controls
Photocell controls and timers for exterior lighting
DHW Measures
High efficiency DHW heaters (e.g., condensing heaters, heat pump heaters)
Solar water heaters
DHW pipe and storage tank insulation
Low flow plumbing fixtures
HVAC Measures
High efficiency packaged or split air conditioners and heat pumps
Variable refrigerant flow (VRF) heat pumps
High efficiency condensing boilers, furnaces, and unit heaters
Chiller replacements (e.g., centrifugal chillers)
Boiler and chiller controls (e.g., outdoor air reset controls)
Variable speed drives serving hot water, chilled water, and condenser water pumps
Variable speed drives serving supply, return, and exhaust fans
Air-side and water-side economizers
Exhaust air energy recovery
Temperature and ventilation setbacks
Demand control ventilation
Supply air reset and static pressure controls
Pipe insulation for hot water and chilled water piping
Duct work sealing and insulation
Variable volume air distribution systems that replace constant volume systems
Refrigeration Measures
Electrically commutated motors for evaporator fans
Refrigerated case doors and night covers
Anti-condensation heater controls
Evaporator fan controls
High efficiency refrigerated case installation
ENERGY STAR® and/or Design Lights Consortium qualified LED products
Other Measures
Elevator motor replacements and controls
High efficiency transformers
Computer management software
Receptacle load controls
ENERGY STAR® appliances and office equipment

3.4.1 Non-Eligible Measures

On-Site Renewable Energy

- Renewable energy measures include solar PV panels, wind turbines, and any other equipment that generates energy are not permitted in the ERP and cannot contribute to the 15% savings target.
- If a renewable energy measure is implemented at any point during P4P participation, it must be separately metered. The metered data must be added back into the building utility data to ensure that P4P incentives are not paid for savings related to renewable energy measures.
- Existing renewable energy equipment must have at least twelve (12) months of historic metered data, must be added to baseline building utility bills, and must be included within the baseline building model and Model Calibration Tool (Section 4.4.5).
- Ground source heat pumps, solar water heaters, and solar thermal storage are not considered renewable energy measures and may be included in the P4P scope of work.
- Renewable energy incentives may be available separately from the NJCEP Renewable Energy Programs, which are managed by a different Program Manager. Visit www.njcleanenergy.com for more information.

On-Site Combined Heat and Power/Fuel Cells

- CHP and fuel cell systems are not permitted in the ERP and cannot contribute to the 15% savings target.
- If a CHP or fuel cell is implemented at any point during P4P participation, it must be separately metered for natural gas consumption, electricity generation/output, and utilized waste heat in order to ensure accurate incentive payments.
- Existing CHP or fuel cell systems must have at least twelve (12) months of historic metered data, must be added to baseline building utility bills, and must be included within the baseline building model and Model Calibration Tool (Section 4.4.6).

  Example: P4P project involves a hotel that has an existing gas-fired CHP system. Electricity generated by CHP is used for lighting; the recovered heat is used for service water heating, with gas heating as a backup. The project is modeled in eQUEST. The baseline model includes the explicitly modeled CHP, and is calibrated to pre-retrofit utility bills which reflect electricity and gas that crossed project boundary, i.e. was actually purchased from utility company.
- Incentives for CHP and fuel cell systems are offered separately through the NJCEP C&I Programs and the Renewable Energy Programs (if fueled by renewable fuel source). Visit www.njcleanenergy.com for more information.

Retro-Commissioning

Retro-commissioning in and of itself cannot be a recommended measure. Retro-commissioning can be utilized as a means to identify energy efficiency measures, which shall then be modeled as measures and incorporated into the ERP. The cost of the retro-commissioning process may be included as part of total project cost, similar to audit cost.

Other
The following measures are also not permitted:

- Sub-metering
- Monitoring equipment
- Power factor correction equipment
- Permafrost or similar refrigerant additives
- Removal of miscellaneous plug loads or other similar non-permanent measures
- Emerging technologies, unless supported by third party evaluation/study which will be reviewed and permitted at Program Manager's discretion.
- O&M measures unless previously reviewed and permitted at Program Manager's discretion.

Most energy-efficient technologies will qualify under the Pay for Performance Program. If the scope of work recommends new or emerging technologies it is recommended that the Program Manager is contacted first to verify eligibility. When in doubt, please contact the Program Manager for clarification.

3.4.2 Minimum Performance Standards

All recommended energy efficiency measures must meet or exceed the minimum performance standards listed in Appendix A. For equipment not listed in Appendix A, recommended measure must meet or exceed ASHRAE 90.1-2016 requirements for non-residential buildings and multifamily buildings over three (3) stories high, and IECC 2018 for low-rise multifamily buildings. Equipment not regulated by these codes must be more efficient than industry standard. Program Manager may waive or modify minimum performance standards for certain equipment on a case-by-case basis based on limited market availability.

3.4.3 Measure Lifetime

The appropriate lifetime for each measure must comply with those given in *New Jersey's Clean Energy Program Protocols to Measure Resource Savings,* reproduced in Appendix B. Lifetimes that deviate from the stipulated measure lives must be justified in the ERP and are subject to approval by Program Manager.

3.4.4 Measure Cost Effectiveness

The total scope of work must be cost effective as required by the customer/applicant.

3.4.5 Energy Cost Savings

When determining cost savings from the recommended scope of work, the Partner should use a marginal rate analysis that includes consideration of demand charges and ratchet clauses, per the applicable utility rate tariff. Projects subject to a block rate structure by their local utility will realize cost savings based upon which block the energy savings occur within. As a result, a marginal rate analysis produces a more accurate cost savings projection than a straight blended rate analysis and is therefore preferred when preparing the ERP. Blended rate analysis is also acceptable. In most cases energy rate structures can be incorporated into the energy model, which produced energy cost savings for each recommended measure as well.

3.4.6 Non-Energy Savings

Energy efficiency measures included in the scope of work can occasionally provide cost savings through saving water (and associated sewer charges) and/or providing cost savings in the form of reduced equipment maintenance. Cost savings associated with reduced Operation and Maintenance (O&M) expenses can be very difficult to predict and quantify and should be claimed only in cases where solid documentation can be provided to substantiate the savings estimate.

An example might involve the removal of a central boiler plant and replacement with decentralized boilers in each building. If the central plant involved underground distribution of heated water or steam and the underground piping was in a deteriorated condition, annual repairs could be regular and expensive. In such a case, it may be reasonable to quantify the savings associated with no longer needing to maintain the underground distribution piping, based on historical costs for such maintenance and repair. Approved O&M savings may be included in the ERP Excel Tables, Measure Simulation tab and added to the Energy Cost Savings resulting in more favorable project economics.

3.4.7 Cost Estimation

The estimated cost of the project should rely on estimates that are based on previous experience and knowledge of current pricing of building materials, equipment and labor. Although there are likely other costs associated with installing measures, these can usually be aggregated into a simple percent increase above the estimated cost of materials and labor. Below is a list of items to consider when estimating costs.

- Use the ENERGY STAR® Quantity Quotes service (www.quantityquotes.net) where purchasers can register to instantly contact suppliers of ENERGY STAR® qualified products.
- Assess the quantities of items needed and the estimated hours of labor to accomplish installations.
- Use previous contacts to help itemize local prices of labor and materials. Develop accepted pricing ranges based on evaluation of completed projects. Build a database of unit pricing from this information and keep it current.
- Contact contractors and vendors for information on unit pricing and labor costs.
- Consult straight materials and labor costs from R.S. Means handbook or other industry standard estimating guide. Include overhead and profit (O&P) as appropriate. Means should be no more than two years old. Add 3% per year out of date. Be sure to use City Indices, as the differences can be large.
- Use recognized equipment catalogs for retail equipment prices.
- Include bulk pricing initiatives or schedules where available.

- Account for associated demolition, construction and finishing work that may be required for certain installations.
- Unless in-house labor is proposed, assume all installations will be performed by an outside contractor, who will charge competitive/prevailing wage rates.
- Design and analysis costs must be included, to the extent reasonable, in the cost of the measures for which they are associated. For example, if design of a new heating system is required, the cost of this design must be included as part of the cost of the heating system. This allows for the cost effectiveness of measures to be more fairly assessed.
- Costs must be limited to the measure components for which savings are being claimed. For example, a project specifies that all linear fluorescent lamps will be replaced with linear LED lamps. The cost of the measure should include the design, material, and labor of the LED lamps. It would not include any miscellaneous electrical work needed to repair existing fixtures prior to retrofit.
- Construction Management and Partner Fees are generally not associated with specific measures but are required to be included in the overall project cost.

3.5 Financing Plan

The scope of the financing plan will vary in complexity depending on the anticipated sources of funding for the project. For Program Participants who have sufficient funds in reserve to cover the construction costs of the project, the financial plan will be very simple. Conversely, for Participants who are planning to include public funding, the financing plan will be more complex.

The objective of the financing plan is to clearly present a detailed description of how the proposed energy efficiency scope of work is intended to be financed. The plan is seen as a critical component of a well prepared project and illustrates that the Participant, in collaboration with the Partner, as necessary, has considered how the proposed construction project will be financed. The plan should provide enough detail to ensure that all parties (Participant, Partner, and the Program Manager) are aware of the intended sources of funding for the energy efficiency project. At minimum all information called out in ERP Excel tables, Implementation and Financing tab must be completed.

3.6 Implementation Plan

The objective of the implementation plan is to clearly present a detailed description of how and when the proposed project is intended to be installed. The plan should provide enough detail to ensure that all parties (Participant, Partner, and the Program Manager) are aware of the proposed schedule for addressing all necessary regulatory approvals, design requirements, bid document preparation, as well as the installation of each of the measures included in the project.

The implementation schedule should include a detailed description of the proposed schedule for installing all of the measures included in the energy efficiency scope of work. At minimum all information called out in ERP Excel tables, Implementation and Financing tab must be completed. Estimated Construction Start and End Dates should be within the Program allowances, as described in Section 2.5.

3.6.1 Materials and Installation Standards / Specifications

It is the responsibility of the Partner to ensure that all performance assumptions made in the comprehensive energy assessment and reflected in the ERP are translated into bid and construction documents. A scope of work should contain performance specifications or references to the specifications for the materials and equipment to be installed. Additionally, the scope of work should include enough information about installation standards to insure that competitive bidding is fair in scope and pricing and that potential contractors understand the importance of following the performance specifications.

3.7 Staff Training and Certification

Building operations and maintenance practices are a critical component to achieving improved energy performance in commercial and industrial buildings. Partners and Participants are strongly encouraged to consider staff training and certification as part of their scope of work to help insure that the projected energy performance is realized with the newly installed measures.

3.8 EPA's ENERGY STAR Portfolio Manager®

As part of the ERP development, the project must be benchmarked using EPA's ENERGY STAR Portfolio Manager. The following steps should be followed to accomplish this task:

1. Create a Portfolio Manager account on the ENERGY STAR website, unless one already exists (www.energystar.gov/benchmark).

2. Enter building specific information into Portfolio Manager. The building information required for input into Portfolio Manager includes at least one (1) year of pre-retrofit utility bills, which should be identical to the utility data entered into the ERP, and information on each of the different spaces in the building (e.g. floor area, operating hours, number of workers, percent heated, etc). Some inputs may need to be adjusted after the building energy audit is complete.
    a. **Note:** Portfolio Manager requires twelve (12) full months of utility data from the 1st of the month to the 31st in order to properly generate reports. If your utility data starts and ends mid-month you will need to input thirteen (13) or fourteen (14) months of data.

3. Once all required information is entered, generate the following reports: "Statement of Energy Performance", "Data Checklist", and "Score Card" (if applicable) and include this report with the ERP submission as an Appendix.

4. Share project on ENERGY STAR Portfolio Manager website with Program Manager. If you have shared projects with TRC before, then our username should

already be on your contacts list as "Solutions, TRC". If sharing with TRC for the first time, you will need to add us as a contact first by searching for username "TRCSOLUTIONS".

4. Simulation Guidelines

In order for the project to qualify for incentives under the Program, the Partner must create a whole-building simulation, calibrate it to pre-retrofit utility bills, and model recommended energy efficiency measures. This section is intended to assist the Partner in this process.

4.1 Overview & General Methodology

The methodology used by the Program is based on ASHRAE Guideline 14[4] Whole Building Calibrated Simulation approach. The approach involves the use of computer simulation to create a pre-retrofit model of energy use of the project (the baseline model). This model is calibrated against actual utility bills and available site measurements to obtain the calibrated baseline model. The calibrated baseline model is then used to evaluate energy and demand savings from various energy efficiency measures, as described in this document.

The energy analysis must involve the following steps:

Step 1 Gather building data for the baseline period to support whole building energy simulation, including utility bill data, architectural and mechanical drawings (if available), dimensions, construction and condition of building envelope components, name plate data for HVAC and other building systems, operating schedules. Much of this information is acquired during the energy audit of the building (Section 3).

Step 2 Perform measurements as required to support energy simulation inputs and modeling of energy efficiency measures, as described in Sections 3.3.4, 4.3 and Appendix D.

Step 3 Input the data into simulation software and run the model, as described in Section 4.4.

Step 4 Compare simulation outputs to monthly utility bills and spot measurements (if applicable) using the Model Calibration Tool, refine model until acceptable calibration is achieved as described in Section 4.5 to obtain the calibrated baseline model.

Step 5 Incorporate energy efficiency measures included in the proposed scope of work into the calibrated baseline model to obtain the projected post-retrofit model as described in Section 4.6.

[4] ASHRAE Guideline 14-2014 Measurement of Energy and Demand Savings

Step 6 Enter simulated baseline and measure-level annual energy consumption into ERP Excel Tables, Measure Simulation tab to calculate measure-level and total projected savings.

Rigor and depth of site data collection and energy analysis must be consistent with the financial implications of over- or under-reporting of a project's performance. In other words, measures that generate high incentives should be analyzed much more thoroughly than low impact measures. For high impact measures, emphasis must be made on accuracy of modeled parameters that drive savings, with inputs supported by direct measurements as appropriate.

Accuracy tradeoffs should be accompanied by increased conservativeness in any estimates and judgments. In other words, if direct measurements of impactful parameters were not performed, estimates must be conservative and are subject to program approval. Where judgments are made about uncertain quantities, they should be designed to under-estimate *savings*.

The reporting of *energy savings* should consider all effects of an EEM on all end uses in the building. For example, measures that reduce internal loads are expected to affect heating, cooling, fan, and pump consumption as well as the loads that they are directly associated with, such as lighting or plug-in equipment.

4.2 Documentation Requirements

Table 4-1 lists required modeling files and reports that shall be submitted as an Appendix of the ERP. Reports should be organized in a way that clearly identifies the data associated with the baseline and each energy efficiency measure. Additional files and reports may be requested by Program Manager. If non-standard weather file was used for the simulation, such as a custom file with actual weather conditions during baseline period, such file must be included in the submittal as well.

Model simulation output reports shall be provided as separate files rather than part of the ERP word/.pdf document. Further, one file shall be submitted for the baseline simulation, and one file shall be submitted for each energy efficiency measure. The files shall minimally include the reports listed in **Table 4-1** and submitted in the following formats:

- eQuest users shall submit files using "*.sim" formats.
- DOE-2 users shall submit files using "*.pdf" or "*.doc" formats.
- TRACE users and other approved software package users shall submit files in "*.pdf" format.

Table 4-1. Modeling Documents for Submittal

Software	Modeling Files	Key Output Report (for baseline and each EEM)
DOE-2 (including eQuest)	*.pd2, *.inp, *.prd *(eQuest only)*	Building Energy Performance Summary (BEPS) Building Energy Performance–Utility (BEPU) Energy Cost Summary (ES-D) Summary portion of LV-D report SV-A report PS-C report PS-E report
TRACE	*.TAF	Project Information Energy Cost Budget/ PRM Energy Consumption Summary Monthly Energy Consumption Monthly Equipment Energy Consumption Entered Values Plants Entered Values Systems System Checksums
HAP	HAP file	EA Credit 1 Summary Annual Cost Summary Energy Cost Budget by System Component Zone Temperature Report and Unmet Report (for systems and plants) Monthly Energy Use by Component Monthly Air and System and Plant Simulation Results Air Systems Input Data Boilers Input Data Chilled Water Input Data Chiller Input Data Space Input Data
EnergyPlus	*.idf file for each simulation run	Annual Building Utility Performance Summary LEED Summary METERS.csv Input Verification and Results Summary Demand End Use Components Summary Source Energy End Use Components Summary Climatic Data Summary Equipment Summary Envelope Summary Surface Shadowing Summary Shading Summary Lighting Summary HVAC Sizing Summary System Summary Component Sizing Summary Outside Air Summary Object Count Summary
Other		Consult with Program Manager

4.3 Metering Requirements

For each project, a description of any metering activities completed must be included as part of the ERP. The objective of the metering requirements is to support the development of an accurate building model and savings projections. The Program metering requirements are based on the 2016 International Performance Measurement and Verifications Protocol ("IPMVP") and the 2015 Federal Energy Management Program ("FEMP") M&V Guidelines, Version 4.0.

All projects must follow **Option D**, Calibrated Simulation, as defined by the IPMVP. Calibrated simulation involves the use of computer software to predict building energy consumption and savings from energy-efficiency measures. Options A and B, as defined by the IPMVP, may be used as guidelines for data collection to help create a more accurate model.

Metering via Options A and B <u>must</u> be performed on equipment that:

- Cannot be directly modeled in the simulation software, especially if it will be replaced or significantly affected as part of the scope of work. For most projects, this will be limited to process equipment, but may also be required for certain energy efficiency measures, such as low-flow water fixtures, appliance and plug load upgrades, etc. Direct metering of this equipment may not be necessary if sufficient EMS/BMS data is available.
- Requires modeling inputs that are out of the ordinary or unusual. Examples may include facilities that require very high or very low indoor air temperatures.
- Has unknown or variable loads. The FEMP Protocols indicate that the simulated calibration process will benefit the most from metering of end-uses for which the least amount of data is available.

The ERP Excel Tables contain designated spaces for inputting information on any metering data collected, as well as a designated Appendix. Information on metering done must include:

- A description of the metering method and schedule for the pre-retrofit period,
- How the data was used to support savings calculations and/or model inputs,
- A description of any variables/assumptions that may differ between the pre- and post-retrofit periods, and
- A description of the metering method and schedule for the post-retrofit period, if applicable.

If existing HVAC system capacities and/or flow rates are unknown and determined using auto-sizing in the whole building simulation tool, the auto-sized values must be "hard-entered" into the baseline simulation to ensure that they remain unchanged in the subsequent EEM, unless EEM includes HVAC system retrofit. For example, an EEM that includes lighting fixture replacement affects heating and cooling loads, thus if cooling system capacities and flow rates are modeled as auto-sized, the model will show additional unjustified savings from downsizing the cooling system.
<u>For simulation inputs that are not directly metered or measured, appropriate conservative assumptions must be used.</u>

4.3.1 Facility Baseline Variables

In many cases, the energy use and/or demand depend on factors unrelated to building components. The most common example is outdoor temperature, which will affect the energy used to supply heating and cooling to the building and is captured by Program tools. Other examples include:

- Building occupancy (e.g. number of guest in hotel, types of tenants)
- Production volumes (e.g. number of items produced at industrial facility)
- Hours of operation (e.g. number of shifts, hours open)

These key baseline variables may vary between baseline and post-retrofit period and must be recorded in as much detail as possible in ERP Excel Tables, Modeling Approach tab. Any changes in these variables will need to be adjusted for with consultation by the Program Manager when submitting for Incentive #3 (Section 6.5).

The most impactful baseline variables specific to different building types are typically reflected in EPA's ENERGY STAR Portfolio Manager® (Section 3.8). Changes in these parameters during post-retrofit period compared to pre-retrofit (as entered during ERP development stage) must be reported.

The following are examples of why and how baselines could be adjusted:

- **Changes in occupancy.** The ERP requires information on baseline occupancy levels. If significant changes in future occupancy are expected and predictable (e.g. hotel, multifamily, etc.), the ERP must also include known details of these changes, as well as defined procedures for dealing with them. Refer to Section 4.4.7 on how to model anticipated known changes in occupancy in the ERP.

- **Changes in hours of operation.** Similar to changes in occupancy, the ERP requires information on baseline hours of operation and whether future significant changes are known and/or predictable.

- **Tenant changes/improvements**. These changes may be predictable but, because of the numerous unknowns and possible "what-if" scenarios they involve, Partners do not need to provide detailed calculation methods covering each eventuality. But, the ERP shall include detailed baseline information on each tenant including tenant business type, hours of operation, and major energy consuming equipment. In general, a Partner is responsible for delivering savings that would not have otherwise occurred without participation in the Program. Therefore, increases/decreases in a facility's operating hours, increases/reductions in the amount of conditioned space, and changes in equipment (outside of approved ERP) due to tenant variations will not be counted towards savings and must be adjusted for in the post-construction performance period.

- **Changes in process loads.** For some facility types, such as wastewater treatment plants and manufacturing facilities, energy consumption is dependent on the volume and/or type of process loads more so than weather. The ERP shall include detail as to the type of process load present and the unit of measurement. For example, in an industrial laundry facility the type of load is "laundry" and the unit of measurement may be "pounds". The ERP should also include defined procedures for dealing with process changes so as to properly account for them during post-construction savings verification.

- **New/unexpected addition of loads.** These include a variety of changes, such as addition/removal of equipment outside of the ERP scope of work, unexpected construction in areas of the building, etc. Because these changes are unpredictable it is often not possible to plan for them at the ERP stage. Efforts will be made by the Partner and Program Manager to account for these changes through a baseline adjustment but will need to leverage information from the Partner including details of the change, timing of the change, and list of added or reduced loads.

4.3.2 Metering Examples

Metering would be required if a new ENERGY STAR® commercial refrigerator were to be installed in a restaurant. The existing refrigerator would be monitored over a period of at least three (3) weeks in order to determine the baseline energy use. This information could be extrapolated to determine annual energy use, and entered into the model as a plug load. Energy use of the proposed equipment should be based on both baseline energy use schedule and manufacturer's data.

Pre-metering would not be required for an HVAC motor that will be retrofitted with a VFD. In this case, the motor would be entered in the baseline model without a VFD and the model will determine the load and run time. The proposed model will include the VFD and, again, the model will use the calculated load to determine post-retrofit energy use of the motor with the VFD.

4.3.3 Post-Retrofit Metering

Post-retrofit metering is not specifically required in the Program. Instead whole-building energy savings are measured using IPMVP Option C. However, industry best practice includes commissioning of major equipment to confirm that the equipment is operating as intended, and thus the proposed energy use is similar to that projected in the ERP. New equipment may also be metered to confirm post-retrofit energy use. Metering is a useful tool to identify measures that aren't performing as intended if post-retrofit utility bills are not showing the expected decrease in energy consumption.

4.3.4 Determining Metering Duration

The metering and monitoring period must be long enough to accurately represent the annual amount of energy consumed by the affected equipment. The required duration depends on the measure. For instance, if a system that operates according to a well-defined schedule under a constant load, such as a constant-speed exhaust fan motor, the period required for determining annual savings could be short. In this case, measured energy savings can be extrapolated to account for the entire year. If, however, the equipment's use varies across both day and season, as with air-conditioning equipment, a much longer metering or monitoring period may be required to characterize the system.

If energy consumption varies by more than 10% from one month to the next, measurement duration should be sufficient enough to document these variances. In addition, changes that will affect the baseline adjustment by more than 10% should also be documented and explained. Any major energy consumption variances due to seasonal activity increases or periodic fluctuations must also be described in the ERP.

Note that any auxiliary energy-consuming equipment *must* be metered and modeled if its energy consumption changes as a result of project installation. Additional details on measure-specific metering requirements can be found in Appendix D.

4.3.5 Calibration and Accuracy

Sensors and meters used to collect metering data should be calibrated to known standards (such as those of the National Institute of Standards and Technology). Measurements should be made using a meter with accuracy at or approaching ±2% of reading for power measurements and ±5% for flow measurements.

4.3.6 Submitting Metered Data

If requested, metering data must be provided in formats usable by the Program Manager, and not based on products or software that are not publicly available. If special software products are required for the reading or analysis of Partner submittals, the Program Manager may reject the data or request the Partner to provide the software.

Both “raw” and “compiled” data may be required by the Program Manager to support surveys, savings estimates, and calculations. The Partner must maintain electronic and paper copies of all metered data throughout the term of the project participation.

4.3.7 Multiple Buildings

Using the multiple building metering approach will reduce the required total number of monitoring points. A multiple building metering approach can be used only for multiple buildings with common measures and similar occupancy, usage, and energy consumption patterns. If any of these variables are significantly different, individual metering must be used for each building. The Program Manager encourages the use of a multiple building approach when possible to minimize metering costs. As buildings are aggregated together, it is imperative to carefully select the usage groups. Spaces within a single usage group should have an expected range in hours of operation of no more than ±15%. Failure to follow this guideline can result in incorrect calculation of energy savings, and hence incentive amounts.

4.3.8 Limitations on Metering Costs

The Program intends to enforce only cost-effective metering requirements. If the cost to conduct Program-specific metering activities is equal to or less that 15% of the total estimated incentive payment as defined in the ERP, the metering cost is considered to be cost-effective. If a Partner estimates that metering costs will exceed 15% of the estimated incentive payment, the Partner may contact the Program Manager to discuss how to best reduce costs.

For the purpose of estimating cost-effectiveness, metering costs are those costs directly associated with Program metering activities and reporting and that are necessary to meet the metering requirements set forth in the Partner Guidelines. Costs associated with energy audits, site surveys, Program non-metering submittals, and regular inspections are not considered metering costs since they would be required for any energy retrofit project. All claims that the costs of metering activities are excessive must be verifiable through documentation and are subject to Program Manager review.

4.3.9 Supporting Information

According to the IPMVP, the major challenges associated with Option D are accurate computer modeling and calibration to measured energy data. The protocols suggest the following to control costs while maintaining reasonable accuracy:

- The simulation analysis should be conducted by trained personnel who are experienced with both the software and the calibration techniques.
- Input data should represent the best available information, including as much actual performance data from key components in the facility as possible.
- Simulation inputs must be adjusted so results match both the demand and consumption data from monthly utility bills, within acceptable tolerances using the Model Calibration Tool.

4.3.10 References

Please refer to following for additional guidance on metering protocols and best practice:

International Performance Measurement and Verification Protocol, Core Concepts Applications Guides Available for free download at www.evo-world.org

M&V Guidelines: Measurement and Verification for Performance-Based Contracts, Version 4.0. Prepared for the US DOE Federal Energy Management Program. Available, along with other M&V resources, at https://www.energy.gov/sites/prod/files/2016/01/f28/mv_guide_4_0.pdf.

4.4 Simulation Requirements

4.4.1 Simulation Software

Simulation software must be compliant with ASHRAE 90.1 Section 11 or Appendix G. Examples of allowed tools include eQUEST, HAP, EnergyPlus, and Trane Trace. Approval for use in LEED and Federal Tax Deductions for Commercial Buildings Program may serve as the proxy to demonstrate compliance with this requirement. The following additional requirements and limitations apply:

- Each energy efficiency measure must be modeled incrementally so that the final projected post-retrofit model includes all measures. This will ensure that interactive affects are accounted for. In eQuest the “parametric runs” function must be used to model all energy efficiency measures where possible. In TRACE 700, the “Alternates” function must be used. Keep in mind that TRACE 700 only allows up to four (4) Alternates; therefore, if modeling more than three (3) measures, Alternate-4 should be ‘saved as’ Alternate-1 and additional measures modeled as subsequent Alternates. Model submissions that do not incorporate parametric runs (eQuest), alternates (TRACE), or an equivalent process will not be accepted.

- eQUEST Wizard Mode has many limitations that prevent the user from modifying or overwriting set defaults. The default values found in Wizard typically do not reflect the actual system's characteristics and its performance. Therefore, the models created entirely in Wizard Mode including Energy Efficiency Measure Wizard will not be accepted.

- By default Trace runs a Reduced Year analysis, which may result in significantly different results compared to Full Year analysis. Reduced Year analysis involves simulating building operation for a typical weekday, Saturday and Sunday for each month of the year. A Building load for each day type is then scaled to create the building hourly load profile. If you select Full Year analysis, the program simulates building operation for all 8760 hours in a year. Full Year analysis must be used when calibrating the model and estimating EEM savings in P4P program.

- For projects requiring analysis of custom refrigeration systems and where such systems are included in the P4P scope such as skating rinks, supermarkets, and refrigerated warehouses, the approved simulation tools include refrigeration version of eQUEST v3.65 and EnergyPlus

- For eQuest projects with dedicated outdoor air systems (DOAS) or variable refrigerant flow (VRF) systems included in the scope of work, the eQUEST v3.65 build 7175 or later with DOE 2.3 simulation engine shall be used. Unless approved by the Program Manager, work-around methods to simulate these systems in the DOE 2.2 simulation engine are not permitted.

4.4.2 External Calculations[5]

- If the approved simulation tool used for the project cannot adequately model a design, material, or device, then the energy savings associated with this component may be calculated using an external calculation method such as custom spreadsheets. Any exceptional calculations that can be modeled using software keywords will not be accepted. **If unsure whether a measure can be modeled through exceptional calculations, please check with the Program Manager prior to ERP submittal.** The resulting savings may then be subtracted from the usage projected by post-retrofit model. Spreadsheets may also be used to support simulation inputs.

- Unless approved by the Program Manager, at no time shall the total exceptional savings constitute more than 50% source energy savings. Spreadsheet calculations alone will not provide sufficient/accurate results, since they do not account for the many interactions between systems and components and will not be accepted.

- RETScreen may be used for modeling savings from solar water heating measures and certain other renewable energy technologies. RETScreen is a free tool developed and maintained by Natural Resources Canada. This software can be

[5] Approach adopted by ASHRAE 90.1-2016 and modified for this document.

downloaded at http://www.retscreen.net/ang/home.php. The results must then be integrated into the compliant simulation tool.

- Vendor-supplied and proprietary tools that were not / cannot be peer-reviewed cannot be used as external calculations to estimate EEM savings.

Documentation for Exceptional Calculation Methods must include:

1. Copies of all spreadsheets used to perform the calculations labeled as an Appendix to the ERP. *.PDF calculations will not be accepted.
2. Step-by-step documentation of the calculation detailed enough to reproduce the results.
3. The predicted energy savings by energy type, the energy cost savings, a narrative explaining the exceptional calculation method, and theoretical or empirical information supporting the accuracy of the method.
4. When using exceptional calculation methods, please select ‘Custom Calcs’ in ERP Excel Tables, Measure Simulation tab (*Savings Calculation Method)*. In the *Changes Made to Previous Model Run*, the description should include the exact name of the supplemental spreadsheet submitted.

4.4.3 General Simulation Requirements

Baseline Model:

- Baseline and energy efficiency measures must be created in the same simulation program, and use the same weather data and energy rate structure.
- The baseline model inputs shall be consistent with the existing conditions documented during the energy audit and/or found on as-built drawings of the baseline building.
- All end use components (e.g., lighting, plug loads, HVAC equipment, central plant equipment) that are connected to the building meter(s) shall be modeled, including but not limited to exhaust fans, parking garage ventilation fans, snow-melt and freeze-protection equipment, façade lighting, parking lot lighting, swimming pool heaters and pumps, elevators and escalators, refrigeration and cooking.
- HVAC system inputs for the baseline and energy efficiency measures must be based on the actual performance of the existing or proposed system at the project conditions, including part load characteristics, climate, capacity, etc.
- Thermal blocks/HVAC zones shall be modeled as required by ASHRAE 90.1 Appendix G, which calls for modeling each HVAC zone in the existing building as a separate thermal block. Multiple thermal zones may be combined when all of the conditions below are met:

  - The space use classification is the same throughout the zone (e.g., several office spaces may be combined together if other conditions in this section are met, but not office space and conference room).
  - All HVAC zones in the thermal zone that are adjacent to glazed exterior walls face the same orientation, or their orientations vary by less than 45 degrees. For example, office space with north-facing windows cannot be combined with a south-facing office space.
  - All of the zones are served by the same HVAC system or by the same kind of HVAC system.
- Unmet load hours (e.g. hours when spaces in a building are under-heated or under-cooled) reported by the calibrated simulation are within the limits allowed by Section G3.1.2.2 of ASHRAE 90.1-2016 Appendix G. Exceptions to this rule will be considered by the Program Manager on a case by case basis.

Energy Efficiency Measure Modeling (see Section 4.6 for measure specific requirements):

- Each energy efficiency measure must be modeled incrementally (per Section 4.4.1) so that the final projected post-retrofit model includes all measures.
- Only parameters of the systems that are being retrofitted shall vary between the baseline and post-retrofit model. All other systems shall be modeled the same.
- ERP Excel Tables must include all key model inputs used in the simulation software that corresponds to an EEM, including baseline and proposed parameters. Key model inputs include, but are not limited to, the following:
  - Equipment capacity
  - Equipment size
  - Equipment efficiency
  - Appliance and lighting power density
  - R-values, U-factors, SHGC, etc.

  ERP Excel Tables, Measure Simulation tab, *Changes Made to Previous Run* must detail the existing and proposed model inputs and be consistent with the energy model.

  ERPs missing a significant number of key model inputs will not be accepted. Please refer to *Technical Topic- Example Measure Descriptions* for appropriate level of detail required.
- Simulation inputs that are modified to model EEM savings must be based on manufacturer specifications or site measurements. If direct measurements cannot be performed, conservative assumptions must be used and are subject to approval by Program Manager. For example, if a building is reported to be overheated in winter but energy audit is performed in summer and temperature measurements in a representative sample of spaces cannot be performed, partner must use

conservative indoor temperature change when modeling EEMs aimed at improving temperature control. Baseline values of parameters addressed by retrofit must not be established via model calibration process.

- Operating condition assumptions such as heating temperature set points, lighting system operating hours, etc., must be modeled the same in the baseline and each EEM, unless directly affected by the retrofit. For example, the rate and schedule of mechanical ventilation must be the same in the baseline and each EEM unless the change in design ventilation rate or demand control ventilation is included in the ERP.
- Where the retrofit specifically addresses operating conditions and/or usage patterns, such as lighting occupancy controls, daylighting, automated energy management systems, etc., documentation must be provided to justify the model inputs used to project the savings, such as references to field studies.

4.4.4 Multiple Buildings

When a project includes multiple buildings, the model and calibration approach depends on the metering configurations and whether the buildings have similar envelope and mechanical systems. Regardless of the approach determined below, all buildings must be captured in a single model. Multiple models representing different buildings will not be accepted unless previously reviewed and approved by Program Manager.

Buildings are considered to have similar envelopes if all of the following conditions are met:

- Building geometries are similar.
- Total conditioned building area differs by no more than 20%.
- Percentage of area taken by common spaces differs by no more than 20 percentage points.
- Spaces in buildings are of a similar occupancy type.
- Areas of surfaces of each type (exterior and below grade walls, windows, roof, slab) differ by no more than 20%.
- Thermal properties of envelope components are similar.
- Infiltration rates are similar.

For example, there are two 60,000 SF, 6-story buildings in the project. One building has 12,000 SF of corridors and common spaces (20% of total building area). The other building has the same corridor area, plus a community room, rental office and laundry on the first floor, with the total area of common spaces equal to 20,000 SF (33% of total building area). The percentage of common spaces in each of these buildings differ by 13 percentage points (33%-20%), and the buildings have spaces of different occupancy types; therefore, they may not be considered as similar envelopes.

Buildings are considered to have similar mechanical systems if all of the following conditions are met:

- HVAC or domestic hot water equipment in buildings is of similar type

- Overall plant efficiency varies by no more than 5 percentage points.
- Mechanical ventilation rates are similar.

Buildings are considered to have similar usage if the annual fuel usage per square foot of conditioned floor area differs by no more than 10%.

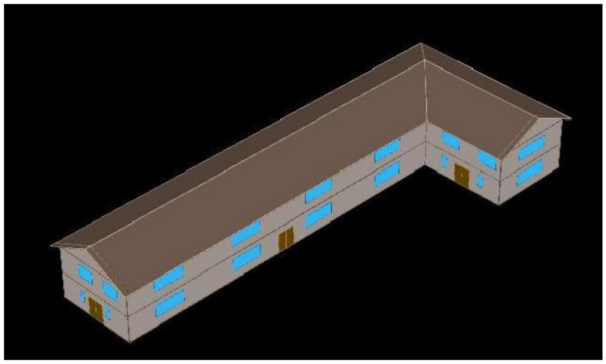
The summary **Table 4-2** below shows modeling approaches for multiple building projects depending on the similarity of envelope and mechanical systems:

Table 4-2. Multiple Building Modeling

	Similarity of Buildings and Systems	**Type and Similarity of Heating Bills**	**Modeling Approach**
Case A	Non-similar envelope or mechanical	Billing for heating fuel is either per apartment or per building.	Buildings must be explicitly modeled and individually calibrated to the corresponding set of utility bills.
Case B	Similar envelope and mechanical	Billing for heating fuel is either per apartment or per building; usage is similar between buildings.	Create single model representing *one* building; calibrate to area-weighted average annual usage.
Case C	Similar envelope and mechanical	The meter or billing data for heating fuel applies to multiple buildings.	Create single model representing *all* buildings that are served by a single heating-fuel meter; calibrate to the total annual usage shown for all fuels used at those buildings.
Case D	Non-similar mechanical systems	The meter or billing data for heating fuel applies to multiple buildings.	If simulation tool supports explicit modeling of non-identical HVAC systems in a single model file, the same approach as for Case C may be used. For tools that do not have this capability (such as TREAT), separate models must be created representing each building, and the total heating usage of these models must be calibrated to utility bills.

Example: Country Apartments complex consists of 25 two-story buildings with 327 apartments, including 190 one-bedroom, 72 two-bedroom deluxe, 56 two-bedroom junior, and 8 three-bedroom apartments. The gross floor area of the apartment complex is approximately 200,000 SF.

Using the guidelines previously described, it was determined that the buildings within the complex have both similar envelope and mechanical systems. Additionally, each building has its own boiler plant. Therefore, as Case B requires, a typical building was modeled and a multiplier added to represent the total square footage of the complex. An eQuest screenshot of the typical buildings is shown below:



The total utility consumption of the complex was then calibrated against this model. EEMs were then be modeled like any other project. Because a multiplier was used within eQUEST, the savings results were extrapolated to the entire complex.

It is important to remember that all buildings in a project must be 'similar' as defined in the preceding section. For example, if one building is served by a new boiler while the other is service by an original boiler to be replaced in the retrofit, the buildings are not similar and each must be explicitly modeled. Similarly, some but not all buildings may need insulation added in attics. So both the existing condition and scope of work for different buildings should be similar. In other words, buildings should be scaled up or down versions of each other. Another important consideration is utility bills. For example, if one building has significantly different heating kBtu/SF than another building, it means that even though the two may appear 'similar', they are actually not. Reason for discrepancy should be investigated – for example, is it due to the fact that some apartments were vacant in one building? In this case we could still consider them similar and assume some average occupancy rates in the model. Or it could be something like high distribution losses from buried pipes in one building and not the other, in which case the scope of measures will likely be different between the two, which would make them not similar.

4.4.5 Solar Photovoltaic (PV) Modeling

Solar PV panels are not an eligible measure in the Program and cannot contribute to the 15% savings requirement (Section 3.4.1).

If PV is implemented in the project at any point during Program participation, it must be separately metered. The metered data must be added back into the building utility data for Incentive #3 submittal to ensure that P4P incentives are not paid for savings related to renewable energy measures (Section 6).

Existing PV energy equipment must have at least twelve months of historic metered data, must be added to the baseline building utility bills, and must be included within the baseline building model and Model Calibration Tool. If the modeling software does not allow explicit PV modeling, PV Watts can be used to calculate solar energy generation.

Key Inputs

- Capacity – capacity of the generator in kW (per inverter if applicable)

- PV Module
- Mount Type
- Number of Inverters

ERP Documentation

The existing parameters used in simulation must be clearly detailed in the ERP. The details may be in included in the ERP Excel Tables, Mechanical tab, *Other Mechanical Systems* table. The PV meter should be entered as a separate meter in the Utility tab so that measure savings from the model can be allocated amongst grid kWh, solar kWh, natural gas, etc. Although unlikely, any energy efficiency measure that also results in additional solar kWh generation will not qualify for incentives but can count towards the 15% source energy savings target.

Model Calibration

For calibration purposes, any kWh associated with PV may be bundled with grid kWh and calibrated per the typical process.

Modeling

Please reference *Technical Topic- Modeling PV in Existing Buildings* for an example of how to model existing solar PV in eQuest. Generally, the PV system must be assigned to a dedicated electric meter.

If surplus power generation is sold, a surplus meter should be specified as well. Some software packages have the ability to model a surplus meter. This means that any additional electricity produced beyond the needs of the building will be assigned to this meter as long as the meter is defined as an 'electric sale' meter. If the electricity is not sold, then there is no need for this meter to be defined.

4.4.6 Combined Heat and Power (CHP) Modeling

CHP, and related systems, are not an eligible measure in the Program and cannot contribute to the 15% savings requirement (Section 3.4.1). For projects with an existing CHP plant, the CHP must be explicitly captured in the energy modeling software and calibrated to utility bills.

Key Model Inputs

- Capacity of CHP (kW)
- Heat input ratio (ratio of fuel consumption to design electrical output, when both are in the same units, in terms of the higher heating value of the fuel)
- Fraction of input recoverable for exhaust and engine jacket
- Loop assigned (HW, DHW).

Model Calibration

The model must be calibrated for both CHP electricity and grid electricity (i.e. the two electric 'meters' cannot be combined since that can skew recovered heat simulated).

The model will not calibrate if it does not match the utility bills closely. Please make sure to collect twelve months of **all** utility bills, which should encompass all energy usage—electricity, natural gas, CHP gas use, etc. Then, make sure to develop the model to reflect the actual building.

ERP Documentation

- Electricity (kWh) generated by the CHP and consumed on site can be entered in ERP Excel Tables, Electric Totals tab, Column DC
- Utilized (not recovered) waste heat from the CHP can be entered into ERP Excel Tables, Steam tab or Hot Water tab, etc. depending on how the waste heat is being used on site.
- Any assumptions about the system must be detailed in the ERP Excel Tables, Modeling Approach tab so they can be applied on the back end for savings verification (this includes calculating how much waste heat is being produced, utilized and dumped).
- Spreadsheet calculations, calculation methodology, and relevant equipment data must be submitted to justify model inputs per Section 4.4.2.

Note: Subject to Program Manager discretion, only savings to grid natural gas consumed by the CHP will qualify for incentives, rather than savings to intermediate electricity and utilized waste heat. For example, energy efficiency measures (e.g. boilers, etc.) that have downstream CHP gas savings may qualify, as well as efficiency improvements to the CHP that will result in gas savings (e.g. more efficient recovery and utilization of waste heat). CHP improvements that only result in additional kWh generation do not qualify.

Modeling

Please reference *Technical Topic- Modeling Combined Heat and Power* for an example of how to model existing CHP in eQuest. Generally, there are three to five meters that must be explicitly modeled so that incentives can be calculated and model can be calibrated:

1. Grid electric
2. Grid gas
3. CHP gas
4. Renewable electric (e.g. solar PV; if applicable)
5. Surplus meter (if applicable)

CHP can be modeled by creating an electric generator, and the software will assign gas usage to electric end uses. Default performance curves may be used. However, if manufacturer data is available, custom performance curves can be created and submitted for review. Heat recovered to supplement the HW loop and DHW loop should be modeled separately, if applicable.

4.4.7 Modeling Anticipated Changes in Occupancy

The below guidance shall be followed when preparing an ERP for a project where a building(s) is not 100% occupied in the existing case, and building occupancy is anticipated/known to increase after construction is complete.

Overview:

- Occupied tenant spaces and common area spaces are treated as a typical P4P Existing Buildings project and shall be modeled using existing conditions and calibrated using the Model Calibration Tool.

- Unoccupied tenant spaces with anticipated future occupancy are treated as a baseline adjustment meeting ASHRAE 90.1-2016 mandatory and prescriptive requirements.
- Improvements to unoccupied spaces shall be modeled separately from occupied spaces and common area spaces using separate parametric runs (eQuest) or alternatives (TRACE).
- Post-retrofit period shall begin when the building reaches the occupancy level approved for use in the ERP (exceptions apply if the building does not reach this occupancy level within 1 year of the post-installation inspection).
- Monthly occupancy data shall be provided in the existing and post-retrofit cases.

Definitions:

- **Occupied Space** – Tenant spaces that are occupied during the baseline period that will be treated as a typical P4P Existing Buildings project.
- **Unoccupied Space** – Tenant spaces that are unoccupied during the baseline period that may be occupied after project completion. These spaces are treated as a baseline adjustment only if there is anticipated change in occupancy.
- **Common Area Space** – Non-tenant spaces such as corridors, lobbies, and stairwells that will be treated as a typical P4P Existing Buildings project. These spaces have no anticipated operational or occupancy changes in the existing and proposed cases.
- **Anticipated Future Occupancy Consumption** – Baseline consumption of the unoccupied space determined using ASHRAE 90.1-2016, occupied space characteristics (e.g. schedules), and anticipated future occupancy of the building.

Modeling Approach:

1. **Baseline Model -** Create a baseline model that consists of occupied, common area, and unoccupied spaces as they are during the baseline period. All existing loads that contribute to the project's baseline utility bills must be modeled, including loads in occupied and common area spaces that were conditioned during the pre-retrofit period, and any loads in unoccupied spaces that correspond to pre-retrofit utility bills. These may include but are not limited to:

   a. Heating, cooling, ventilation, and pump energy consumption of the entire building.
   b. Plug loads and lighting in the occupied and common area spaces.
   c. Lighting or plug loads in unoccupied spaces (if any).

2. **Model Calibration -** calibrate the baseline model to pre-retrofit bills as required by the program.

3. **Adjusted Baseline -** Create an adjusted baseline model as follows using a parametric run (eQuest), alternative (TRACE), or a saved-as second model (if necessary).

   For unoccupied tenant spaces ***with anticipated future occupancy****:

   a. Plug loads, DHW loads, DHW schedule, lighting schedule, and plug load schedule used to calibrate existing consumption in occupied spaces shall be applied to the unoccupied spaces. Where applicable, schedules such as lighting shall not exceed Partner Guidelines requirements.

   b. Baseline lighting systems shall be modeled per ASHRAE 90.1-2016 and include mandatory and prescriptive requirements with particular attention to Section 9.4. In the 'Lighting' tab of the ERP, no existing fixtures should be listed for spaces that are unoccupied.

   c. All other systems and controls dedicated to the unoccupied space, including but not limited to air-handlers, equipment and lighting controls, etc. must be modeled as meeting mandatory and prescriptive requirements of 90.1 2016.

   d. HVAC systems that are shared and serve both occupied and unoccupied spaces can be modeled reflecting the existing equipment *if the existing HVAC systems do <u>not</u> have to be replaced to accommodate the increase in occupancy (i.e. larger capacity equipment).* Otherwise, the occupied space shall be modeled using the existing HVAC systems, and the unoccupied space shall be modeled using an HVAC system that meets mandatory and prescriptive requirements of 90.1-2016.

<u>***Notes:**</u>

- Baseline adjustments shall not be modeled for unoccupied tenant spaces that do not have anticipated future occupancy. For example, if lease records show that 75% of the unoccupied spaces will be leased following construction, baseline adjustments shall not be applied to 25% of the unoccupied spaces.

- The future occupancy assumed using this approach shall be justified and submitted to the Program Manager for approval. Assuming 100% future occupancy in the model is not acceptable without supporting documentation.

For example, if lease records show that 75% of the unoccupied spaces will be leased following construction, 75% occupancy shall be used to determine the baseline adjustment.

4. **Efficiency Measures** - Improvements to systems in occupied / common spaces must be modeled separately from improvements to systems in unoccupied spaces. Consider the example below for a project that includes boiler replacement serving the entire building, lighting fixture replacement, and lighting controls.

    a. *Parametric Run/Alternative 1 (PR/A 1):* Boiler replacement, based on the Adjusted Baseline.
    b. *Parametric Run/Alternative 2 (PR/A 2):* Lighting retrofit to replace fixtures in occupied and common spaces, based on PR/A 1.
    c. *Parametric Run/Alternative 3 (PR/A 3):* Lighting controls in occupied and common spaces, based on PR/A 2.
    d. *Parametric Run/Alternative 4 (PR/A 4):* Lighting fixtures in unoccupied spaces with future anticipated occupancy (improvement over 90.1-2016 requirements) based on PR/A 3.
    e. *Parametric Run/Alternative 5 (PR/A 5):* Lighting controls in previously unoccupied spaces with future anticipated occupancy (improvement over 90.1-2016 requirements) based on PR/A 4.
    f. Parametric runs or alternatives shall not be modeled for unoccupied spaces with no anticipated changes in occupancy.

Post-Retrofit Period Requirements:

The P4P post-retrofit period should start once all systems are installed and the building meets the occupancy level approved for use in the ERP. Standard P4P post-retrofit period starts after the approval of the Installation Report and is submitted within 15 months, although extensions are available if the building has delayed occupancy.

If it is determined that the building occupancy levels will never reach the approved occupancy levels used in the ERP within the allowed time frame, an appropriate post-retrofit occupancy fraction shall be used to adjust the baseline consumption for the purpose of calculating Incentive #3. Percent occupancy should be calculated as a function of square footage rather than number of tenant spaces. *Note that the baseline generated to account for reduced occupancy will not be a function of adjusting the post-retrofit bills proportionally. Please discuss with the Program Manager prior to submitting Incentive #3 documentation to confirm the approach.*

Documentation Requirements:

1. The difference in monthly energy consumption between the Baseline Model and Adjusted Baseline Model must be added to the ERP Excel Tables, Utility tabs in order to accurately measure savings from the adjusted baseline usage.

2. An explanation regarding how existing occupancy was determined shall be provided in the ERP Excel Tables, Modeling Approach tab. Monthly occupancy records for pre-retrofit period used in the Energy Reduction Plan shall be provided.
3. An explanation regarding how anticipated future occupancy was determined shall be provided in the ERP Excel Tables, Modeling Approach tab.
4. The entire modeling approach used to establish the 'anticipated future occupancy' baseline shall be clearly documented in the 'Baseline Facility Variables' table of the ERP Excel Tables, Modeling Approach tab. This tab should include discussions of the occupied space variables and schedules that were applied to the unoccupied spaces with anticipated future occupancy in the baseline model.
5. Partners shall track occupancy monthly during post-retrofit period, and include both sets of occupancy records in the Incentive #3 submittal. For example, lease records and/or monthly records on the number of employees occupying the building may be used. It is unlikely that building goes from partially occupied to 100% (or 75%, etc.) occupied immediately after retrofit is installed. Instead, occupancy may increase over time as spaces are rented out. These characteristics must be accounted for in the final baseline adjustment in the Savings Verification Tool.

4.5 Model Calibration

4.5.1 General Approach

The model is calibrated by comparing utility bills for the baseline period to the usage projected by the baseline model for the same weather conditions. Since building components and operating conditions in the baseline simulation are set to match the actual pre-retrofit building characteristics, the difference in simulated and actual conditions is limited to weather. Hourly simulation is usually performed for the thirty year average conditions, while utility bills correspond to the actual weather during the billing periods. In order to exclude the impact of different weather conditions from the model-to-billing comparison, the two data sets must be weather-normalized. Two weather normalization approaches are allowed:

Option 1: Develop the energy model of the building prior to retrofit and run it using thirty year average weather file (TMY2 or TMY3) to calculate energy consumption during typical weather conditions. Use the Model Calibration Tool and ETracker software that can be downloaded from http://academic.udayton.edu/kissock/http/Weather/ETDist.ZIP to perform weather-normalization and verify that acceptable model-to-billing calibration is achieved. Typical weather files are provided by the Program, and are also commonly included with the approved software tools from tool vendors.

Option 2: Develop the baseline model and run it using the weather file with the actual conditions during the baseline period. Use the Model Calibration Tool to verify that the acceptable model-to-billing calibration is achieved. Actual weather files must be purchased by the Partner from private vendors not associated with the Program, such as Weather Analytics (http://www.weatheranalytics.com) Regression methodology and calibration precision used in the Program is based on requirements of ASHRAE Guideline 14.

Please reference *Technical Topic- Model Calibration & Weather Data* for additional information on Calibration function.

4.5.2 Calibration Accuracy

In order to verify that the model is sufficiently close to actual billing data, three parameters are tracked for each fuel: Mean Bias Error, Coefficient of Variance, and Savings Uncertainty.

Mean Bias Error (MBE) or *Relative Error* measures how close the energy use predicted by the model corresponds to the metered data for the baseline period. MBE accounts for differences in the total annual consumption for a given fuel, showing the percentage by which the model over- or under-estimates the consumption relative to the actual bills:

$$MBE = (ASEU_{base,total} - MSEU_{base,total}) / ASEU_{base,total}$$

The MBE must not exceed 5% in order to satisfy P4P calibration requirements.

Coefficient of variation of the root mean squared error (CVRMSE), quantifies variation in consumption between the model and actual billing data during each bill period. The CVRMSE must not exceed 15% for electricity and 30% for other fuels in order to satisfy P4P calibration requirements.

Uncertainty measures how accurately the regression model fits the modeled data. The savings uncertainty must not exceed 50% of the total desired savings at 68% confidence.

In addition to the accuracy statistics for the individual fuels, the Model Calibration Tool also calculates the *Overall Accuracy Statistics* for the project as a whole. The overall statistics is determined as the weighted average of the corresponding metrics for individual fuels. Weighing is done based on source energy usage of individual fuels for MBE and CVRMSE, and based on source energy savings for individual fuels for the Savings Uncertainty.

In order for the project to achieve the required calibration, the project must pass Overall Accuracy Statistics, as indicated in the Model Calibration Tool.

4.5.3 Calibration Procedure

Calibrating the energy model to utility bills requires close examination and possible adjustments to both the billing data and energy simulation parameters. The first step is to evaluate the general usage patterns of the project by plotting the monthly utility bills and model results side-by-side. The charts included in Model Calibration Tool may be used for this analysis. Once the actual utility bills and model results are plotted, it is helpful to follow the steps below to identify any discrepancies between the modeled and actual energy use. Typically, to help calibrate the model to utility bills, adjustments should be made to model inputs for which the least information is known and/or where direct measurements were not, or cannot, be performed.

1. *Review annual usage profile of electricity bills*. Many buildings have usage peak during summer months associated with cooling, lower consumption during spring/fall months, and another peak during winter that may be associated with

electric heat, longer fan / pump runtime to facilitate heating, and longer lighting runtime hours. Consider the following:

a. Is the usage profile consistent with the findings of energy audit? For example, if there is cooling in the building but utility bills do not show an increase in consumption during summer, possible reasons may include:

    i. The bills do not include all of the meters serving the building. In this case, the utility data must be verified to include the usage of the entire building.

    ii. There is simultaneous heating/cooling during mild weather that keeps electricity consumption flat throughout the year. This should be verified by site observations, captured in energy simulation, and addressed in the retrofit.

    iii. Cooling load is insignificant, for example only a few apartments in a multi-family building have room air conditioners. This should be captured in the energy simulation.

    iv. Cooling load in the building is mostly due to the internal heat gains from people and equipment (not weather-dependent), and economizer is not functioning properly. In this case, verify conditions on-site, include it in the energy model, and address in the retrofit.

b. Are there seasonal variations in usage? For example, a drop in consumption in summer may be associated with school or college vacation, peaks during holiday seasons may be associated with increased sales, etc. If so, these usage variations should be captured in the energy simulation.

c. Are there unexpected / unexplainable drops or peaks in monthly usage values?

    i. An unusually high/low individual bill may correspond to an estimated meter reading, or the bill that immediately follows an estimated bill. Verify the type of the bill (i.e. estimated vs actual) and perform the adjustment as described in Section 3.2.2.

    ii. The atypical bill may correspond to a one time event/activity, for example a construction or repair work, or represent a faulty unreliable data point. The utility bills may need to be adjusted as described in Section 3.2.2.

2. *Compare usage profile of electricity bills to model predictions* for the same periods.

    a. Compare usage during *spring/fall months* when heating/cooling loads are low. Adjust lighting, equipment, and service hot water heating (if electrically heated) to match the utility bills.

        i. Compare model inputs to findings of energy audit in the related areas, including lighting and equipment power and runtime, etc.

ii. Adjust inputs that were not directly measured, such as hot water consumption, piping losses, and lighting and equipment runtime to reduce the gap between model projections and utility bills, ensuring that the inputs are within reason.

iii. Verify that pre-retrofit billing data reflects the same loads as the energy model. For example, some of the loads connected to the utility meter, such as exterior lighting or garage ventilation, may not be accounted for in the model.

iv. Review available sub-meter readings. For example, if there is a sub-meter that measures electricity consumption of common spaces in a multi-family building, verify that modeled usage of common spaces is reasonably aligned with the readings of this sub-meter.

v. Fan/pump energy may remain high during mild weather. Review how air-side and water-side components of HVAC system function under low heating/cooling loads. Capture the equipment control in the energy simulation.

b. Compare usage during heating and cooling months. Adjust model inputs keeping in mind typical patterns outlined below.

i. Increasing infiltration rate increases heating load and reduces cooling load during milder months.

ii. Increasing window SHGC increases cooling load and reduces heating load.

iii. Increasing surface insulation reduces heating load but has a fairly small effect on cooling.

iv. Increase in internal loads from lighting, equipment and people, or increase in the fraction of internal load that contributes to the space sensible/latent heat gains reduces heating load and increases cooling load.

v. Increase in fan energy reduces heating load and increases cooling load if fans are located in the supply air stream.

vi. Increase in heating thermostat setpoint / setback temperatures and reduction in setback hours increase heating usage.

vii. Reduction in cooling thermostat setpoint / setup temperature and reduction in setup hours increase cooling usage.

viii. Verify that modeled equipment efficiencies at design and part load conditions are in line with site observations.

ix. Verify distribution losses due to conduction and leakage from ductwork and piping are captured.

x. Take advantage of sub-meters that may be available for certain systems or portions of the building, or measure usage of individual system components to verify operation.

3. Repeat steps 1 and 2 for Fuel #2, starting with adjusting the usage during spring/fall months and the calibrating consumption during heating/cooling season.
4. Use the Model Calibration Tool to verify that the acceptable calibration is achieved. Detailed instructions on using the tool are included on the Instructions page of the spreadsheet. The required calibration is achieved if Overall Accuracy Statistics "Passes All Criteria" flag is displayed on the Results page of the worksheet. No further actions are required in this case, unless there is a change in the model or utility bills. If overall calibration is not achieved, review the accuracy statistics for the individual fuels and adjust the model or utility bills focusing on the fuel with the accuracy statistics outside of the passing range, as described in Steps 1-3 above. Suggestions below outline the course of action depending on the statistical parameter that fell outside of the acceptable range.
   a. *MBE* is outside of the acceptable range if the model over- or under-projects the annual consumption of the corresponding fuel by more than 5%. The adjustments performed to address this issue should be focused on aligning the model projections with the total annual usage of the given fuel.
   b. *CVRMSE* is outside of the acceptable range if the individual utility bills do not sufficiently align with the model projections for the same bill period. The adjustments performed to address this issue should focus on aligning the usage pattern of the given fuel.
   c. *Savings Uncertainty* is outside of the acceptable range if the regression analysis of the modeled energy consumption did not result in a good statistical fit. This may occur if the expected savings are low, which requires better fit to produce reliable savings projection. The criterion is waived for fuels with expected savings of 5% of less, as entered on the Input page of Model Calibration Tool. To address the issue, verify the projected savings percentage and adjust HDD Base Temperature and/or CDD Base Temperature on the Input page to better represent building operation. HDD and CDD Base Temperatures are lower than the defaults used in Model Calibration Tool for buildings with high internal gains.

4.5.4 Multiple Fuels

There may be instances were a facility purchases and consumes multiple fuels, such as electricity, natural gas, and oil. In such cases, the following calibration procedure should be applied:

1. Model each fuel explicitly, so that the baseline model shows monthly consumption of each fuel (e.g. electricity, gas, and oil).
2. In the calibration spreadsheet, aggregate utility bills and model results for both non-electric fuels (e.g. oil & gas) into total non-electric MMBtu/month, and verify calibration as outlined above.
3. Manually calculate consumption of each non-electric fuel for the model and bills, and make sure that model is within 10% of bills.

4.6 Simulating Measure-Level Savings

4.6.1 Measure Interactivity

Individual measures aggregated into a proposed work scope will often interact with each other and impact the anticipated savings performance. For instance, analysis may indicate that installing new windows in an existing building might save 50 MMBtu/year or, installing a new boiler in the same building might save 25 MMBtu/year. However, if you install the boiler first, careful analysis will show that the windows, installed second, might save only 40 MMBtu/year. Conversely, you could install the windows first, saving 50 MMBtu/year, but then the boiler would only save 15 MMBtu/year, since in either case the boiler/window combination must correspond to the same savings, 65 MMBtu/year.

The savings attributable to a package are almost always less than the sum of the savings each measure would produce if implemented in the original building. These interactions are taken into account when the building is modeled following the below process. All measures that can be represented in the simulation software must be included in the model.

To account for interactive effects and to allocate them among measures, the measures must first be *ranked*. The order may be based on cost-effectiveness of each measure, or the sequence in which measures would likely have been implemented had they been implemented individually. The measures are then added sequentially based on the established ranking as follows:

Step 1 The calibrated baseline model is modified so that it includes the highest ranked measure (M1) to calculate usage of the Baseline with Measure #1.

Step 2 The savings associated with Measure #1 are estimated by comparing the baseline model to the Baseline + M1 Model.

Step 3 The Baseline+M1 model is then modified to include the measure that was ranked the second (Measure #2) to obtain the Baseline+M1+M2

Step 4 The savings associated with Measure #2 are estimated by comparing the Baseline +M1 to Baseline+M1+M2.

Step 5 Repeat with the remaining measures until the model includes all the measures (is equivalent to the post-retrofit Model).

In eQuest the “parametric runs” function must be used to model all energy efficiency measures where possible. In TRACE 700, the “Alternates” function must be used. Keep in mind that TRACE 700 only allows up to four (4) Alternates; therefore if modeling more than three (3) measures, Alternate-4 should be ‘saved as’ Alternate-1 and additional measures modeled as subsequent Alternates. <u>Model submissions that do not incorporate parametric runs (eQuest), alternates (TRACE), or an equivalent process will not be accepted.</u>

4.6.2 Measure Granularity

Multiple components or systems may be grouped and reported as a single measure provided that these components/systems belong to the same end use. Distinct energy efficiency measures should not be combined if individual components have separate baselines OR if individual components improve efficiency, reduce flow rates, and/or reduce hours of operation. For example, different types of lighting fixtures may be modeled and reported as a single measure, but lighting fixtures and occupancy sensors cannot be combined. Similarly, lighting and HVAC system upgrades cannot be combined. Measure granularity is defined by the available measures in the ERP Excel Tables, Measure Description tab.

4.6.3 Cap on Measures with High Savings Uncertainty

Savings from some of the measures included in the ERP may be difficult to quantify reliable due to lack of explicit support in the simulation tool, uncertainty in existing conditions, or due to high likelihood of the differences between the modeled ideal and likely actual post-retrofit performance. To address this uncertainty, contribution of savings from such measures to Incentive #2 shall not exceed 50% of the project's total source energy savings. If additional savings are realized, they will be captured in Incentive #3 which is based on the verified savings of the project. Examples of measures that are subject to the cap include the following:

- BMS and HVAC control measures, including but not limited to thermostat setbacks, variable speed drives, ventilation controls such as demand control ventilation (DCV), energy recovery, optimal equipment start/stop, supply air temperature reset, and chiller/boiler plant optimization and sequencing, among others.
- Measures based on exceptional calculations
- Measures where existing and/or proposed conditions cannot be reliably established. For example, for projects involving decentralization of central plant equipment, the energy savings associated with reduced transmission losses and changes in pump energy would be subject to this cap.

4.6.4 Measure Specific Modeling Requirements

The below guidelines provide modeling requirements for common energy efficiency measures and must be followed on all projects.

4.6.4.1 Lighting Fixture Improvement

- Wattage of fixtures included in an EEM must reflect the total effective input wattage of bulb and ballast, and established using the following methods:
    - Default fixture wattage as populated by ERP Excel Tables, Lighting tab
    - Manufacturer data for proposed fixtures (manufacturer specifications may be requested by Program Manager)
    - New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (see Appendix C)
    - Field measurements (for existing fixtures only)

- Fixture nomenclature must comply with ERP Excel Tables, Lighting tab drop-down options or as designated by one of the methods above. Nondescript fixture codes are not acceptable.

- When EEM includes replacement of existing incandescent bulbs with screw-in CFL, the modeled reduction in wattage must not exceed 3.4:1. For example, wattage of CFL that replaces 60W incandescent bulb should be modeled as no less than 60/3.4=18W. This is different from what is suggested by CFL manufacturers' packaging, which often recommends a 4:1 reduction, or even more. In addition, care must be taken with special populations (such as seniors) to provide appropriate lighting levels.

- When EEM includes replacement of existing incandescent fixtures with screw-in LED, the modeled reduction in wattage must not exceed 4.5:1.

- Modeled interior lighting runtime must be based either on site measurements (Section 3.3.1) or typical runtime hours (excluding impact of lighting controls) for the building type shown in **Table 4-3** below.

- Typical exterior lighting fixtures should be modeled as lit twelve (12) hours per day on average.

Table 4-3. Lighting Runtime Hours

Building Type	**Equivalent Full Load Runtime hours/year, NJ Protocols**
Education – Primary School	1,440
Education – Secondary School	2,575
Education – Community College	3,792
Education – University	3,073
Education – Other School	2,305
Grocery	7,134
Lodging Hotel (Guest Rooms)	1,145
Lodging Motel	8,736
Manufacturing – Light Industrial	4,290
Medical – Hospital	8,760
Medical – Clinic	3,909
Office- Large	2,969
Office-Small	2,950
Residential – Common Area	7,665
Residential – Tenant Area & Related	See below
Restaurant – Sit-Down	4,368
Restaurant – Fast-Food	6,188
Retail – 3-Story Large	4,920
Retail – Single-Story Large	4.926
Retail – Small	4,926

Storage Conditioned	4,290
Storage Heated or Unconditioned	4,290
Warehouse	4,116
Other	See below

- Apartment lighting included in retrofit must be modeled with operating hours from **Table 4-4** below based on the room type. Alternatively, 3.3 hours/day runtime may be assumed for the existing incandescent fixtures to be retrofitted with screw-in CFLs or LEDs and 2.5 hours per day may be assumed for the existing fixtures to be replaced with new pin-based CFL fixtures.

Table 4-4. Apartment Lighting Runtime Hours

Room Type	**Average Lighting Usage (hrs/day)**
Kitchen/Dining	3.5
Living Room	3.5
Hall	2.5
In-unit laundry/utility room	2.5
Bedroom	2.0
Bathroom	2.0

- For building types outside the scope of **Table 4-3**, annual lighting hours, excluding impact of lighting controls, shall not exceed the sum of the following:
    - (Weekday hours per week open) x 50.6 weeks x 90%
    - (Weekday hours per week closed) x 50.6 weeks x 5% + 9.6 hours
    - (Weekend hours per week open) x 52 weeks x 90%
    - (Weekend hours per week closed) x 52 weeks x 5%

  For example, if a library is open 9-6pm Monday through Friday, open 9-1pm on Saturday, and closed on Sunday, annual lighting hours shall not exceed 2,550, which is calculated as the sum of the following:
    - (45 hours per week open on weekdays) x 50.6 weeks x 90% = 2,049 hours
    - (75 hours per week closed on Weekdays) x 50.6 weeks x 5% + 9.6 = 200 hours
    - (4 hours per week open on weekends) x 52 weeks x 90% = 187 hours
    - (44 hours per week closed on weekends) x 52 weeks x 5% = 114 hours

- The weighted-average annual runtime hours of the project are calculated automatically in ERP Excel Tables, Lighting tab based on inputs selected in same tab. Modeled annual runtime hours are then compared to this value based on kWh lighting energy savings from simulation reports divided by lighting wattage reduction from ERP Excel Table, Lighting tab. Modeling assumptions must be supported by direct measurements (Section 3.3.1) if the modeled runtime exceeds the values shown in the **Tables 4-3** and **4-4** above and as calculated by ERP Excel Table, Lighting tab. The tables above are intended to be an absolute cap on lighting hours modeled. The

Program Manager may request changes to modeled run-time hours if modeled run-time hours exceed values in Table 4-3 and are not supported by direct measurements.

- Modeling results should show lighting energy savings, heating penalty if improved fixtures are located in heated space, and cooling savings if improved fixtures are located in cooled space. Fan and pump energy may change slightly for EEMs involving fixtures in conditioned spaces.

- Comprehensive lighting retrofits are subject to the Rehabilitation Subcode of New Jersey's Uniform Construction Code[6] which states that "the total replacement of a building lighting system or a newly installed building lighting system shall meet Section 404 (N1104) of the residential energy code or Section 9.1.2 of the commercial energy code, as applicable." The code also states that "the total replacement of a lighting system with a room, space, or tenancy shall be required to meet Section 9.1.2 for the room, space, or tenancy only." For the alteration of any lighting system in an interior space, ASHRAE 90.1-2016 Section 9.1.2 requires that "the space shall comply with the lighting power density (LPD) allowances of Section 9.5.1 or 9.6.1 and the control requirements of section 9.4.1.1 (a), (b), (c), (d), (g), (h), and (i) as applicable to that space.." The exception to 9.1.2 requires that "lighting alterations that only involve the replacement of lamps plus ballasts/drivers or only involve one-for-one luminaire need only comply with LPD requirements and section 9.4.1.1(h) [automatic full off] and 9.4.1.1(i) [scheduled shutoff]." These requirements also do not apply to alterations that involve 20% of less of the connected lighting load in a space or area provided that such alterations do not increase the installed lighting power. Projects that include comprehensive interior lighting retrofits in the scope of work must install lighting controls per ASHRAE 90.1-2016 requirements to comply the New Jersey Administrative Code and its Uniform Construction Code**.** Depending on the nature of the retrofit, mandatory lighting control requirements will vary. **It is the responsibility of the Partner to ensure that all projects enrolled in P4P comply with all local, state, and federal codes.**

- For the alteration of any exterior lighting system, ASHRAE 90.1-2016 Section 9.1.2 requires that the "lighting system shall comply with the lighting power density (LPD) requirements of Section 9.4.2 applicable to the area illuminated by that lighting system and the applicable control requirements of Sections 9.4.1.4 and 9.4.2." Therefore, projects that include exterior lighting retrofits in the scope of work must install lighting controls per ASHRAE 90.1-2016 requirements to comply the New Jersey Administrative Code and its Uniform Construction Code. **It is the responsibility of the Partner to ensure that all projects enrolled in P4P comply with all local, state, and federal codes.**

[6] https://www.state.nj.us/dca/divisions/codes/codreg/pdf_regs/njac_5_23_6.pdf

4.6.4.2 Lighting Occupancy Sensor Installation

- Savings from installing lighting occupancy sensors, timing controls, and automatically controlled bi-level lighting must be modeled by adjusting either the installed lighting wattage OR fixture runtime by the percentage fraction from **Table 4-5** below, depending on the type of space and installed technology. ERP Excel Table, Lighting tab will also select a default reduction factor based on control type selected. Deviation from ERP Excel Tables or **Table 4-5** below must be justified in the ERP.

Table 4-5. Power Adjustment Factors for Automatic Lighting Controls

Automatic Control Device	**Non-24-hour Occupied Buildings (< 5,000 ft²)**	**All Other Buildings**
Programmable timing control	10%	0%
Occupant sensor	31%	31%
Occupant sensor and Programmable timing controls	31%	31%
Bi-level parking garage controls	31%	31%
Bi-level controls in hotel and multifamily corridors	31%	31%
Scene controller with timeclock	20%	20%
Key-card controls in hotel guestrooms	30%	30%
Shared sporadically used spaces such as stairs, restrooms or storage	40%	40%

4.6.4.3 Daylighting Controls

- Daylighting sensors (DS) must be *explicitly* modeled in the whole-building simulation tool used for the project. If the simulation tool does not have capability to explicitly model DS, the *annual lighting kWh savings* may be calculated using a specialized daylighting software, or estimated based on space and control type. The estimated percent lighting measure savings must not exceed thresholds outlined in Section 2.3.1 and is subject to Program approval. The EEM savings must still be modeled in the whole-building simulation tool by applying the annual lighting kWh percent savings to the wattage OR runtime hours of *fixtures controlled by DS*. As referenced above, daylighting controls are often required for projects that include comprehensive lighting retrofits. If unknown, the following visible transmittance (VT) values shall be used for fenestration to appropriately estimate savings from daylighting:
    - Single glazing: VT-0.76 for clear glass; VT-0.70 for tinted glass
    - Double glazing: VT-0.66 for clear glass; VT-0.50 for tinted glass
    - Triple glazing: VT-0.59 for clear glass; VT-0.42 for tinted glass

4.6.4.4 Air-sealing Measures

- ERP must include the itemized scope of air-sealing work, such as number of windows to be weather-stripped, linear feet of ceiling/wall joint sealed, etc. The scope of work must be entered into ERP Excel Tables, Air-sealing tab to calculate estimated ACH reduction from the air-sealing measures. Post-retrofit ACH calculated by the worksheet must then be entered into simulation tool to estimate savings from air-sealing EEM. Field research has shown that extensive air sealing measures can reduce a building's total infiltration rate by 18% to 38%. Consistent with that, the worksheet caps the combined percentage reduction at 38%. This does not include the portion of infiltration that is attributable to occupant behavior, such as opened windows due to poor heating control.

- In the Air-sealing tab, it is important to enter all building components affected by the improvements in both their original and proposed states to get a proper comparison of pre- and post-improvement air leakage. Thus, if un-weather-stripped double-hung windows with a total perimeter of 342 linear feet are to be replaced with new windows, then the equivalent area in square feet must be determined and entered into the Post-Retrofit Quantity column, with the window's NFRC Air Leakage rating entered into the NFRC AL column. If only half of those windows are replaced, and the remainder are fitted with storm windows, then replacement window quantities must be adjusted, and the storm window improvement should be entered in an additional row with only the quantity affected by that improvement. Building components that are not directly affected by the air sealing measures should not be entered.

4.6.4.5 Envelope Insulation

- Savings from insulating attic, crawlspace, and other surfaces separating conditioned spaces from unconditioned spaces or exterior depend on (a) thermal properties of the treated surface prior to retrofit, (b) rated R-value and placement of new insulation, and (c) the area of surface being insulated. These three aspects of insulation EEM must be clearly identified in the ERP.

- If different cross-sections through non steel-framed surfaces have different R-values, then the overall effective R-value for those surfaces must be calculated by first calculating the U-values of each cross-section and then pro-rating the U-value by the corresponding fraction of surface area. Construction libraries of approved simulation tools may be used but must represent the combined thermal properties of the frame and cavity sections.

- Effective R-values of metal frame constructions must be based on ASHRAE Standard 90.1-2016 Appendix A. If the pre-retrofit or post-retrofit conditions include insulation that has an intermediate R-value between those provided, interpolate between the framing/cavity R-values shown in the table. For example, if cavity insulation was determined to be R-20, but table only provides effective R-value for R-19 and R-21 cavity insulation for the given construction, then the average of these values may be used to model a surface with R-20 cavity insulation.

- If gaps or other defects in the existing insulation are discovered, then its U-value may be de-rated. The de-rating procedure must be explained in the ERP. ERP must also include pictures documenting site conditions if wall insulation EEM is modeled with overall pre-retrofit thermal properties below R-7, and if attic insulation EEM is modeled with overall pre-retrofit thermal properties below R-11.

- The following is an example of attic roof thermal properties for insulation installed in wood frame cavity.

TABLE A2.4 Assembly U-Factors for Attic Roofs with Wood Joists

Rated R-Value of Insulation Alone	Overall U-Factor for Entire Assembly
Wood-Framed Attic, Standard Framing	
None	U-0.613
R-11	U-0.091
R-13	U-0.081
R-19	U-0.053
R-30	U-0.034
R-38	U-0.027
R-49	U-0.021
R-60	U-0.017
R-71	U-0.015
R-82	U-0.013
R-93	U-0.011
R-104	U-0.010
R-115	U-0.009
R-126	U-0.008

4.6.4.6 Window Improvement

- For projects involving window replacement, the following properties must be used based on ASHRAE 90.1 Appendix A to model existing windows included in EEM unless exact building-specific information is available:

Table A8.2 Assembly *U-Factors*, Assembly *SHGCs*, and Assembly Visible Transmittances (*VTs*) for Unlabeled *Vertical Fenestration*

		Unlabeled *Vertical Fenestration*					
		Clear Glass			*Tinted* Glass		
Frame Type	Glazing Type	*U-Factor*	*SHGC*	*VT*	*U-Factor*	*SHGC*	*VT*
All frame types	Single glazing	1.25	0.82	0.76	1.25	0.70	0.58
	Glass block	0.60	0.56	0.56	NA	NA	NA
Wood, vinyl, or fiberglass frames	Double glazing	0.60	0.59	0.64	0.60	0.42	0.39
	Triple glazing	0.45	0.52	0.57	0.45	0.34	0.21
Metal and other frame types	Double glazing	0.90	0.68	0.66	0.90	0.50	0.40
	Triple glazing	0.70	0.60	0.59	0.70	0.42	0.22

- Where the ERP calls for ENERGY STAR® windows but the window manufacturer and model number is not specified, windows with U-0.30 and SHGC of 0.40 must be modeled, based on EPA minimum performance criteria for these products as of September 2020. If ENERGY STAR® windows are not available for the installation, the actual properties of the specified window must be used.

- The following information must be included in the ERP for each window improvement:
  - Pre- and post-retrofit number of panes (1,2,3, glass block)
  - Pre- and post-retrofit frame type (wood, vinyl, fiberglass, metal, other)
  - Pre- and post-retrofit U-value
  - Pre-and post- retrofit SHGC
  - Number of windows affected and window dimensions, sufficient to calculate the total area of improved fenestration in square foot (e.g., twenty (20) 5' by 3' windows)

4.6.4.7 Derating HVAC Equipment Efficiency

- Efficiency of existing equipment affected by retrofit may be de-rated as follows due to age:

$$\textbf{Efficiency}_{\textbf{derated}} = \textbf{Efficiency}_{\textbf{original}} \mathbf{*(1\text{-}M)}^{\textbf{age}}$$

<u>Where:</u>

- $Efficiency_{original}$ = nameplate efficiency. For equipment in which nameplate efficiency is unavailable, ASHRAE 90.1-2016 shall be used as a proxy. The Program Manager may request nameplate photos or specification sheets to justify $Efficiency_{original}$. If electrical efficiency is calculated based on nameplate electric specifications (e.g., volts, amps, phase), assumed power factor (PF) shall not exceed 0.75.
- Age = equipment age or the equipment measure life in years per Appendix B, whichever is less.
- M = maintenance factor:
  - $\mathbf{M_a}$ = Maintenance factor for equipment that received annual professional maintenance
  - $\mathbf{M_b}$ = Maintenance factor for equipment that was seldom or never maintained

Table 4-6. HVAC Maintenance Factors

Equipment Type	$\mathbf{M_a}$	$\mathbf{M_b}$
Gas burning furnaces and boilers *(new)*	0.0025	0.0050
Oil burning furnaces and boilers *(new)*	0.0050	0.0075
Air conditioners and heat pumps *(new)*	0.0050	0.0100
Gas DHW heaters *(new)*	0.0025	0.0050
Electric DHW heaters *(new)*	0.0050	0.0075
Electric chillers *(new)*	0.0025	0.0050

- *<u>Example:</u>* A 22 year old, 11 EER air conditioner received annual professional maintenance.
  - Efficiency $_{derated}$ = Efficiency $_{original}$*(1-M)^{age} = 11 EER *(1 – 0.005) $^{\text{minimum of (22 years old, 15 year lifetime)}}$
  - Efficiency $_{derated}$ = 10.2 EER (not 9.9 EER since measure life [15 yrs] < equipment age [22 yrs])

- In the ERP Tables, the nameplate efficiency should be reported in the appropriate efficiency column. If equipment is derated in the model, the corresponding cell of the 'Additional Notes' should include the M factor used and calculated derated efficiency.

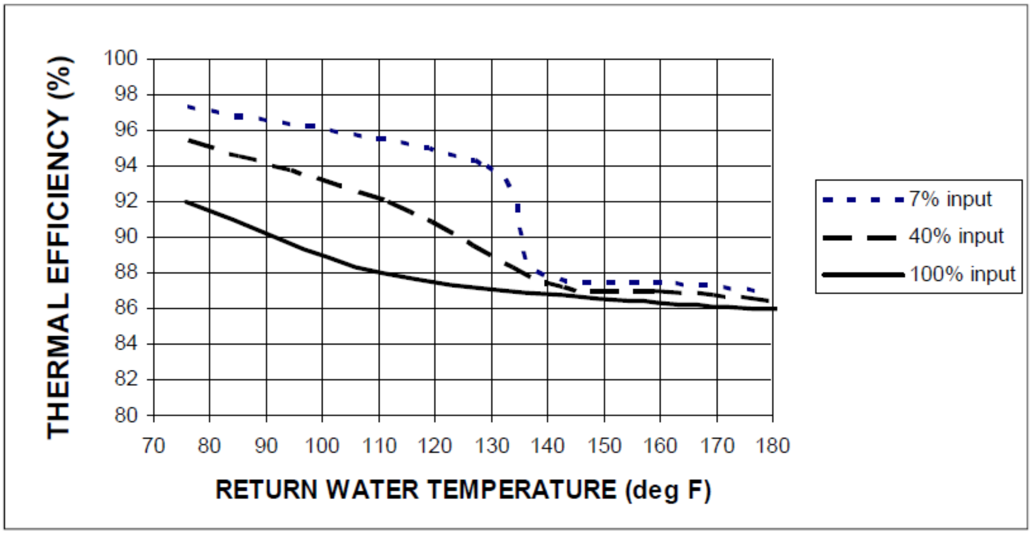
- The following information must be provided in ERP for each heating/cooling system EEM:
  - Pre/post retrofit input capacity
  - Pre/post retrofit thermal efficiency
  - Pre/post retrofit equipment type (e.g. atmospheric boiler)
  - Pre/post retrofit supply and return water temperature if EEM involves condensing boilers.

4.6.4.8 Boilers

<u>Condensing Boilers</u>

- Condensing boiler performance is dependent on return water temperature and variations in load. In general, the efficiency of a condensing boiler increases as return water temperature and part load ratio decreases. **Figure 4-1** below is a graph that demonstrates typical condensing boiler efficiencies at various return water temperatures and part load ratios. As depicted below, condensing boiler efficiency drops considerably when return water temperature is greater than 130°F.

Figure 4-1. Condensing Boiler Performance Curve



- For measures involving installation of condensing boilers, existing return water temperature must be verified during the site visit and included in the ERP. If measurements of return water temperature were not performed during the site visit, 180°F supply and 160°F return water temperature must be assumed in the existing and proposed cases. Performance credit for lower return water temperature compared to the existing case may be claimed if documentation is submitted justifying the proposed supply and return water temperature (e.g. sequence of operations) and existing temperatures were verified.

- Design supply and return water temperatures must be explicitly entered into the simulation tool if the tool can automatically capture their impact on boiler efficiency (such as eQUEST). If the tool is not capable of automatically adjusting efficiency based on entered loop temperatures (such as TRACE), efficiency entered into the simulation tool must be adjusted manually to reflect manufacturer's performance data for the boiler at actual operating conditions.

- *eQuest Example:*
    - The proposed scope of work includes the installation of a 1,000 MBH condensing boiler, which is rated at 92% thermal efficiency at 80°F return water temperature and at full load (i.e., AHRI rating conditions). Boiler literature states that condensing boilers can achieve efficiencies up to 98% thermal efficiency, which would occur at very low return water temperatures and part load ratios. The current design supply hot water temperature is 180°F, with 20°F design temperature drop.
    - The heat input ratio (HIR) for the condensing boiler must reflect the return water temperature input and full load capacity. Therefore, HIR of 1.087 (HIR = 1 / 92%) should be used in the simulation tool rather than HIR of 1.02 (HIR = 1 / 98%). When the equipment operates at part load, eQuest will capture boiler efficiency improvements.
    - Electric Input Ratio (EIR) should be left as the default to capture electricity usage associated with fans, controls, etc. Alternatively, EIR can be calculated using boiler specifications.
    - eQuest software contains default condensing boiler curves that can be used to simulate the improvement. However, several boiler manufacturers have performance curves readily available for their equipment. Custom performance curves may be simulated in the proposed case if the curves and curve formula are provided as part of the submission.

- *Trane TRACE Example:*
    - Using the example presented for eQuest, for existing buildings, if return temperature is unknown, then the boiler efficiency at 160°F must be assumed. While literature rates equipment up to 98% thermal efficiency and equipment operates at 92% efficiency at 80°F water temperature, 86% efficiency must be used in the model (refer to graph on page 1). If existing supply and return temperature was measured, then the efficiency at the proposed return water

temperature may be modeled. For example, if the return water temperature is equal to 100°F, then 89% efficiency may be modeled.
  - Ancillary electricity usage associated with fans and controls shall be explicitly modeled. If this information is not available on specification sheets or drawings, 1.26 kW per 1 MMBtu/h boiler capacity shall be used.

- *Documentation Requirements:*
  - Cut sheets for the proposed condensing boiler with AHRI efficiency or AHRI certificate from ahridirectory.org must be submitted with the ERP.
  - For Trane projects, boiler curves must be submitted justifying proposed efficiency if modeled efficiency is greater than 86% thermal efficiency. Alternatively, the curve presented in the figure above may be used and referenced in the ERP tables.
  - For eQuest projects, boiler curves must be submitted if credit is claimed using custom performance curves.
  - Existing temperature measurements should be listed in the 'Additional Notes' column of the 'Boilers and Domestic Hot Water Heaters' table located in the 'Mechanical' tab of the ERP Tables.
  - If credit is claimed for reducing return water temperature, the temperature must be documented in the 'Measure Descriptions' tab and 'Changes Made to Previous Run' of the 'Measure Simulation' tab. Documentation must be submitted justifying the reduction in return water temperature (e.g. sequence of operations).

Ancillary Boiler Improvements

- Credit may be claimed for ancillary boiler improvements such as improved boiler turn-down ratios, draft fan improvements, and draft fan controls if proposed conditions can be adequately established through specification sheets and/or drawings.
- Ancillary boiler improvements may be grouped together as one EEM but shall be modeled separately from the boiler system type and efficiency improvements.
- Because existing conditions are often difficult to establish, modeled source energy savings for ancillary boiler improvements contribute to the cap of measures with high savings uncertainty. If additional savings are realized compared to savings projections, Incentive #3 will increase to reflect measured and verified savings of the project. See section 4.6.3.

4.6.4.9 Piping Insulation

- If savings from pipe insulation cannot be modeled directly in the simulation tool by specifying existing and proposed pipe heat loss coefficient (UA value) or equivalent explicit input, the following external calculation must be used to estimate savings:

$$\Delta\text{therm} = L \text{ x } [(UA/L)_{ex} - (UA/L)_{prop}] / \eta \times \Delta T \times EFLH/100{,}000$$

  - L = length of insulation installed

- ΔT = average temperature difference between water within the pipe and air temperature during heating season (°F); ΔT = 100˚F for HW heating pipes, ΔT = 130˚F for steam heating pipes, ΔT = 60˚F for service water heating pipes
- UA/L = overall pipe heat loss coefficient per unit length (Btu/hr-°F-ft) from **Table 4-7** below
- η_{heater} = post-retrofit water heater or boiler efficiency
- EFLH = annual operating hours; 8760 for service hot water, 965 for residential space heating, 900 for space heating in all other types of buildings

Table 4-7. Pipe Heat Loss Coefficient (UA/L)

Baseline Uninsulated Pipe Heat Loss Coefficient (UA/L) in Btu/hr-°F-ft

Pipe Size (nominal) (in.)	Bare Copper Piping			Bare Steel Piping	
	Service Hot Water	Hot water heat	Steam heat	Hot water heat	Steam heat
0.75	0.40	0.45	0.49	0.73	0.78
1	0.50	0.56	0.61	0.89	0.95
1.25	0.59	0.67	0.72	1.10	1.18
1.5	0.68	0.78	0.83	1.24	1.33
2	0.86	0.98	1.05	1.52	1.63
2.5	1.04	1.18	1.26	1.81	1.94
3	1.21	1.37	1.47	2.16	2.32
4	1.54	1.75	1.88	2.72	2.92

Insulated Copper Pipe Heat Loss Coefficient (UA/L) in Btu/hr-°F-ft

Pipe Size (nominal) (in.)	Fiberglass				Rigid foam			
	0.5 in	1.0 in	1.5 in	2.0 in	0.5 in	1.0 in	1.5 in	2.0 in
0.75	0.17	0.11	0.09	0.08	0.12	0.08	0.06	0.05
1	0.21	0.13	0.10	0.09	0.15	0.09	0.07	0.06
1.25	0.24	0.15	0.11	0.10	0.17	0.10	0.08	0.07
1.5	0.27	0.16	0.13	0.11	0.20	0.12	0.09	0.08
2	0.34	0.20	0.15	0.12	0.24	0.14	0.11	0.09
2.5	0.41	0.23	0.17	0.14	0.29	0.17	0.12	0.10
3	0.47	0.26	0.19	0.16	0.34	0.19	0.14	0.11
4	0.60	0.33	0.24	0.19	0.43	0.24	0.17	0.14

Insulated Steel Pipe Heat Loss Coefficient (UA/L) in Btu/hr-°F-ft

Pipe Size (nominal) (in.)	Fiberglass				Rigid foam			
	0.5 in	1.0 in	1.5 in	2.0 in	0.5 in	1.0 in	1.5 in	2.0 in
0.75	0.20	0.12	0.10	0.08	0.14	0.09	0.07	0.06
1	0.23	0.14	0.11	0.09	0.17	0.10	0.08	0.07
1.25	0.28	0.17	0.13	0.11	0.20	0.12	0.09	0.08
1.5	0.31	0.18	0.14	0.12	0.22	0.13	0.10	0.08
2	0.37	0.21	0.16	0.13	0.27	0.15	0.12	0.10
2.5	0.44	0.25	0.18	0.15	0.32	0.18	0.13	0.11
3	0.52	0.29	0.21	0.17	0.38	0.21	0.15	0.12
4	0.65	0.36	0.26	0.21	0.47	0.26	0.18	0.15

4.6.4.10 Programmable Thermostats and Thermostat Setbacks

Multifamily Buildings

Thermostat Setback

- For multifamily buildings, replacement of non-programmable thermostats with programmable thermostats and/or BMS thermostatic control strategies in installations where heating and/or cooling energy bills **are paid by tenants** must be modeled as no more than **3°F** setback for eight hours a day for heating, and no more than a **2°F** temperature offset (increase in space temperature) for six hours a day for cooling, if applicable.

- This measure is not allowed in the scope of work if utility bills are **not paid by tenants.**

Apartment Overheating

- Credit can be claimed for measures that reduce apartment overheating if proper on-site measurements of existing temperatures is performed. For this measure, the set point reduction cannot exceed **2°F.** If modeled energy savings are based on the reduction of space temperature in units where occupants have unlimited apartment-level control over the heating set-point, the post-retrofit temperature during occupied periods should not be less than **74°F** in buildings with owner-paid corresponding utilities, or **72°F** in buildings with resident-paid corresponding utilities. All existing temperature measurements must be provided in the *Temperature Measurements* section of the ERP Excel Tables, Other Equipment tab.

- Since residents often open windows to prevent overheating, infiltration credit can also be claimed with the overheating measure. The model can be adjusted to reduce the proposed infiltration by **10% or 0.1 ACH, whichever is less**. The existing and proposed ACH must be documented in the *Changes Made to Previous Model Runs* in the ERP Excel Tables, Measure Simulation. Also, a description of these on-site conditions must be provided in the Envelope tab, which indicate windows were open in order to compensate for overheating.

Commercial Buildings

Thermostat Setback – Unoccupied

- For commercial buildings, replacement of non-programmable thermostats (or uncontrolled spaces) with programmable thermostats and/or BMS thermostatic control strategies must be modeled as no more than **4°F** setback for heating during unoccupied periods, and no more than **3°F** offset (increase in space temperature) for cooling during unoccupied periods, if applicable.

- Larger setbacks during unoccupied periods may be applied in cases where representative on-site temperature measurements are performed and documentation is provided showing proposed temperatures (e.g. sequence of operations for BMS). The existing temperature measurements must be documented in the ERP and the proposed documentation must be submitted for review and approval. The documentation provided must clearly outline the proposed hourly heating and cooling schedule. *Simulated* setbacks during unoccupied periods may not drop below **60°F** during winter months or exceed **85°F** during summer months.

Thermostat Setback – Occupied

- Credit can be claimed for measures that reduce space temperatures during occupied periods if proper on-site measurements of existing temperatures is performed. The post-retrofit temperature during occupied periods may not be less than **72°F** for heating and no higher than **75°F** for cooling. All existing temperature measurements must be provided in the *Temperature Measurements* section of the ERP Excel Tables, Other Equipment tab. Unoccupied setbacks can be measured from the revised occupied setpoint.

General

- Improvements that include a specific upper-limit to indoor temperatures, such as range-limited thermostats, shall be modeled using an interior space temperature that is no less than the specific upper limit.

- For EEMs involving programmable thermostats, ERP must clearly document the modeled pre- and post-retrofit schedule, including occupied and un-occupied temperature and hours and variation by day of week and season. Both heating and cooling schedules must be included as applicable.

- Modeled source energy savings for this EEM contribute to the cap of measures with high savings uncertainty. If additional savings are realized compared to savings projections, Incentive #3 will increase to reflect measured and verified savings of the project. See section 4.6.3.

4.6.4.11 Plug and Process Load Reduction Measures

- EEMs saving energy by eliminating or reducing idle or stand-by power consumption of connected plug loads through the use of the following eligible plug load controls. The percentages presented in the following tables represent the maximum energy reduction percentage that can be claimed for the plug load control.

  - *Load Sensing Controls:* Monitors a specific devices power state and de-energizes connected auxiliary units when the monitored devise enters a low power state.

Load Sensing Control	
Space Type	**Percent Energy Reduction from Baseline**
Workstation	4%
Print Rooms	32%

  - *Occupancy Sensing Controls:* Automatically de-energize devices when no user is present for a set period of time.

Occupancy Control	
Space Type	**Percent Energy Reduction from Baseline**
All	21%

  - *Scheduled Timer Control:* Allows users to set a schedule to energize and de-energize devices based on the devices usage pattern and space schedule.

Schedule Timer Control	
Space Type	**Percent Energy Reduction from Baseline**
Workstation	26%
Print Rooms	50%
Break Rooms	46%

- ○ *Modeling Methodology:* The appropriate percent energy reduction may be applied as either a power adjustment or a schedule adjustment, not both. The percent energy reductions should only be applied to plug loads connected to specified plug load controls. For example, if one out of ten computer monitors is outfitted with occupancy controls, then the percent energy reduction should only be applied to 10% of the computer monitor load.

- ○ The annual energy used for each plug load type should be taken from **Table 4-9** below. If the modeled EEMs pertain to plug loads not mentioned in **Table 4-9**, please provide documentation for how the controlled load was determined.

- EEMs involving reduction to loads that are not regulated by state energy code, such as those related to process loads, may qualify for incentive. Examples of such measures are listed below, including the calculation methods that must be used to estimate savings for these measures. On average, most plug load devices operate at power levels much lower than the nameplate rating. To estimate actual operating power, nameplate power is multiplied by a usage factor. A common rule of thumb for the usage factor is 0.3. If equipment included in the EEM is located in the heated / cooled space, the calculated process load savings must be integrated into the simulation tool to capture the EEM impact on heating/cooling loads.

  - ○ *Transformer Replacement*: Acceptable external energy savings calculations and field measurements that may serve as inputs to these calculations are described in the following implementation manual:
    - ▪ Transformer Replacement Program for Low Voltage Dry-Type 25-300 KVA Transformers Implementation Manual, National Grid January 24, 2018 https://www.nationalgridus.com/media/pronet/transformer-replacement-program-implementation-manual.pdf
    - ▪ If measurements are not performed, **Table 4-8** shall be used to estimate energy savings.

Table 4-8. Typical Annual kWh Losses and Savings for Transformer Replacements

Table 4. Typical Annual kWh Losses and Savings for Same Size pre-TP-1 Replacement[5]

Size (kVA)	Expected Annual Losses, kWh (pre-TP-1)	Expected Annual Losses, kWh (TP-1)	Expected Annual Losses, kWh (NEMA Premium®)	Expected Annual Savings, kWh (TP-1)	Expected Annual Savings, kWh (NEMA Premium®)
15	1,600	1,300	900	300	700
30	2,500	2,000	1,400	500	1,100
45	3,200	2,500	1,800	700	1,400
75	4,600	3,200	2,300	1,400	2,300
112.5	6,000	4,800	3,400	1,200	2,600
150	6,800	5,400	3,800	1,400	3,000
225	8,900	7,100	5,000	1,800	3,900
300	11,100	8,900	6,200	2,200	4,900
500	16,800	13,400	9,400	3,400	7,400
750	22,300	17,800	12,500	4,500	9,800
1000	27,300	21,800	15,300	5,500	12,000

  - EEM description must include size, number, and efficiency grade (i.e. pre-TP-1 or TP-1 compliant) of existing transformers to be replaced, and corresponding parameters of the new transformers to be installed, including the minimum efficiency grade (such as NEMA Premium Efficiency).

- *Computer / Monitor Replacement:* If energy consumption and runtime of existing computers and monitors is not determined via acceptable measurements, the estimated savings based on ENERGY STAR® Office Equipment Savings Calculator provided at the EPA website may be used, as listed in **Table 4-8** below.

Table 4-9. ENERGY STAR® Office Equipment Savings Calculator

	Electricity consumption by Conventional unit(s) (kWh)	Electricity consumption by ENERGY STAR unit(s) (kWh)	Electricity savings (kWh)	% Savings with ENERGY STAR
Desktop Computer	408	275	133	33%
Laptop Computer	125	85	40	32%
Computer Monitor	72	57	15	21%
Scanner	67.6	65	2.6	4%
Copier				
- Laser - Monochrome	146	73	73	50%
- Laser - Color	550	514	39	7%
FAX Machine				
- Ink Jet	28	14	14	50%
- Laser	156	78	78	50%
Multifunction Device				
- Ink Jet	27	12	15	54%
- Laser - Monochrome	156	78	78	50%
- Laser - Color	551	328	223	40%
Printer				
- Ink Jet	27	16	11	41%
- Laser - Monochrome	78	52	26	33%
- Laser - Color	452	287	165	36%

  - The ERP must include number and location of equipment being replaced and the new equipment, and clearly state that the new equipment must be ENERGY STAR® rated.

- *Improvement to Vending Machine Controls:* The measure commonly involves installation of occupancy sensors and plug load controllers to reduce the unnecessary operation of vending machines during unoccupied periods. The

EPA website suggests savings of ~1,700 kWh/year per machine, which may be used to estimate EEM savings, unless measurements are performed, so long as reductions do not exceed specified limits as stated above. See also case studies as https://www.energystar.gov/products/other/vending_machines

- The ERP must include number of vending machines affected by retrofit.

- *Documentation Requirements:*
  - The existing devices, quantity, and annual energy use should be included in the ERP Excel Tables, Other Equipment. The proposed devices and quantity of devices controlled as well as the type and total number of controllers should be included in the ERP Excel Tables, Measure Descriptions tab.
  - Additionally, to support modeling inputs and for ease of review, Partners shall use calculators provided in the ERP Tables. Treating this measure using 'Custom Calculations' and entering the results into the 'Measure Simulation' tab of the ERP Tables is not acceptable as this does not capture interactivity with HVAC systems.

4.6.4.12 Hot Water Flow Reduction

- This EEM may involve installation of low-flow fixtures (e.g. shower heads, bathroom and kitchen faucets) in residential facilities such as multifamily buildings and dormitories, as well as commercial applications such as flow reduction on commercial dishwashing equipment by replacing pre-rinse spray valves, etc. The following calculation must be used to estimate savings from such EEMs:

$$\text{Savings} = N \times M \times D \times (F_{base} - F_{eff}) \times 8.33 \times DT \times (1/Eff) / C$$

Component	Description	Value
N	Number of fixtures	Based on proposed scope
M	Daily runtime, minutes	20 minutes for showerheads, 30 minutes for aerators
D	Days per year of facility operation	Based on facility
Fbase	Baseline device flow rate (gal/m)	Average flow rates measured on a representative sample of existing fixtures; estimates are not allowed.
Feff	Low flow device flow rate (gal/m)	Maximum flow rate of specified fixtures
DT	Difference in temperature (°F) between cold intake and mixed water temperature	50°F for showerheads and faucet aerators, 70°F for pre-rinse spray valves
Eff	Efficiency of water heating equipment	Based on actual post-retrofit equipment
C	Conversion factor from Btu to Therms or kWh	100,000 for gas water heating (Therms), 3,413 for electric water heating (kWh)
8.33	Heat content of water Btu/gal/°F	

- EEM must only include fixtures that include hot water flow. Toilets or other cold-water fixtures may not be included.
- ERP must include the following for each type of affected fixtures:
    - Fixture quantity.
    - Flow rate GPM before retrofit, measured on representative sample of fixtures (see ERP Excel Tables, Other Equipment tab).
    - Flow rate GPM after retrofit, based on manufacturer's specification.

4.6.4.13 Building Management Systems, HVAC Controls

HVAC Control Measure Granularity

- Building Management System (BMS) EEMs, both new and upgraded, shall not be grouped into one single measure. Instead, each individual control strategy shall be a separate EEM, modeled as a separate alternative or parametric run. For example, setback controls, demand control ventilation, chiller sequencing, and supply air temperature reset shall be modeled as separate EEMs. Failure to comply with this requirement will result in rejection of this measure from the project's P4P scope of work subject to remodeling.

- HVAC controls and system improvements shall be modeled separately rather than grouped together. For example, outdoor air reset controls serving a new condensing boiler shall be modeled as two separate measures to allow verifying the cap on contribution of the control measures toward projected savings – see Section 4.6.3.

- HVAC controls shall be explicitly modeled using the appropriate software keywords. For example, boiler or chillers controls that are simulated as a percent improvement in boiler or chiller efficiency will not be accepted.

HVAC Control Ruleset

- For EEMs involving a reduction in net outdoor air, the Partner shall provide documentation to justify existing outdoor air flow rates and outdoor air flow fractions.

- For EEMs involving changes in outdoor air schedules, ventilation fan shutdown or cycling during unoccupied periods, the existing ventilation schedule must be verified through on-site measurements and provided as part of the ERP submission. If measurements are not provided, modeled ventilation schedules shall not be reduced by more than 6 hours per day on weekdays and 10 hours per day on weekends.

- For EEMs involving demand control ventilation (DCV), DCV shall be modeled explicitly in the simulation tool using software keywords rather than percent reductions in outdoor air flow. The proposed ventilation rates shall not be less than required by ASHRAE 62.1-2016.

- For EEMs involving static pressure reset, the performance curve shall be modeled using the following equation:

  $P_{fan} = 0.0407599 + 0.088045 \times PLR_{fan} - 0.072926 \times (PLR_{fan})^2 + 0.943798 \times (PLR_{fan})^3$
  Where:

  P_{fan} = fraction of full-load fan power
  PLR_{fan} = fan part-load ratio (current CFM/design CFM)

- For EEMs involving hot-water supply temperature reset, unless specified on design drawings, hot-water supply shall be reset based on the outdoor dry-bulb temperature using the following schedule: 180°F at 20°F and below, 160°F at 50°F and above, and ramped linearly between 180°F and 160°F at temperatures between 20°F and 50°F.

- For EEMs involving supply air temperature reset, the air temperature for cooling shall be set no higher than 5°F under the minimum cooling load conditions.

- For EEMs involving chilled-water supply temperature reset, unless specified on design drawings, chilled-water supply shall be reset based on the outdoor dry-bulb temperature using the following schedule: 44°F at 80°F and above, 54°F at 60°F and below, and ramped linearly between 44°F and 54°F at temperatures between 80°F and 60°F.

- Due to significantly uncertainty in BMS and HVAC control savings as measured and verified through P4P projects awarded Incentive 3 to date, modeled source energy savings of all BMS and HVAC control measures combined **shall not exceed 50% of the project's total source energy savings***. If additional savings are realized compared to savings projections, Incentive #3 will increase to reflect measured and verified savings of the project. See section 4.6.3.

  **This cap applies to EEMs including but not limited to thermostat setbacks, variable speed drives, ventilation controls such as demand control ventilation (DCV), energy recovery, optimal equipment start/stop, supply air temperature reset, and chiller/boiler plant optimization and sequencing, among others.*
  Please discuss with the Program Manager prior to submitting the ERP if you would like to verify if this cap applies to a control strategy or HVAC measure.

4.6.4.14 Measures Involving Fuel Conversions

- Fuel conversion measures may involve:
  - Switching from oil/propane heating to natural gas heating
  - Switching electric resistance heating to natural gas heating
- Recommended measures that convert from one fuel-type equipment to another fuel-type equipment will be considered under the Program. Incentives will only be paid on NET savings resulting from the fuel conversion. Note that the fuel conversion itself

will not necessarily save energy, rather the efficiency improvement will yield energy savings.

Example:

- Existing boiler uses 30,000 gallons of Oil #2 per year and is being replaced with a more efficient natural gas boiler that can meet heating loads using only 20,000 therms per year.
- Savings Calculations:
  - 30,000 gallons of Oil #2 = 4,200 MMBtu
  - 20,000 therms of Natural Gas = 2,000 MMBtu
  - Net savings are 4,200 MMBtu – 2,000 MMBtu = 2,200 MMBtu.

  The P4P incentive will be calculated based on 2,200 MMBtu savings.

- The following process should be followed to properly demonstrate fuel conversions in the ERP.
  - Method #1:
    - Baseline utility consumption, including baseline model and model calibratiom, should only include electricity and/or oil/propane that the building currently uses.
    - ERP Excel Table, Utility Info tab and General Project Information tab select “Yes” for question on whether project is performing a fuel conversion.
    - EEM #1 should be the first model run converting from oil/propane meter to natural gas meter (or electric meter to natural gas meter) for space/water heating and will reflect oil/propane savings (or electric savings) for this run and the resulting natural gas increase (negative value).
    - Remaining measure savings can be input as normal from subsequent model runs.
    - The ERP Excel Tables will then take the net savings between oil/propane (or electric) and natural gas and generate the appropriate incentive.
  - Method #2:
    - Same process as above, except the fuel conversion can be lumped with the affected measure run. For example if EEM #1 is switching from electric resistant heat to new high-efficiency natural gas boilers then the first measure would show a large electricity savings and a natural gas increase from the new recommended boilers.

4.6.4.15 Dual-Fuel Measures

- The Program will consider dual-fuel measures, such as boilers or hot water heaters capable of running on both natural gas and oil.
- The 15% minimum annual source energy savings is based on reducing the total energy consumption for the building. But, performance incentives (Incentive #2 and

#3) will only be paid for savings associated with electricity and natural gas consistent with Section 2.3.1 and 2.4.

- Therefore, any dual-fuel measures will need to project ratio of savings for each fuel type based on historic energy consumption and future anticipated use and document this in the ERP. Incentives will be committed and paid based on the portion of natural gas savings projected and realized.

4.6.4.16 Improvements to Commercial Refrigeration Equipment Rated by AHRI

Commercial refrigeration equipment addressed by this section includes the following types:

- Walk-in refrigerators
- Walk-in freezers
- Refrigerated casework and/or display cases

Per the *Refrigeration Modeling Method* section of the ANSI/ASHRAE/IEC Standard 90.1-2016 Performance Rating Method Reference Manual (2016 PRM RM)[7], two aspects of performance must be accounted for:

- Electricity consumption of the refrigeration equipment
- Internal heat gain/removal into the thermal zone for the purposes of HVAC interactivity

Both aspects shall be explicitly captured in the model.

To claim credit for commercial refrigeration systems, where the new equipment has efficiency ratings based on the AHRI 1200, Partners shall use the Refrigeration Energy Calculator available on the Partner Portal. Refer to the Technical Topic on the Partner Portal for example screenshots how to model these systems in DOE2/eQuest.

AHRI Certificates and Refrigeration Energy Calculator

- Partners shall gather AHRI 1200 certificates from manufactures for each refrigeration unit. The certificates would be in the format shown in the AHRI 1200 Data Format tab of the Program's Refrigeration Energy Calculator, which is available for download in the Partner Portal.
- Using the Refrigeration Energy Calculator and the AHRI 1200 certificates, Partners shall report each refrigeration unit type as separate columns in the *Ref Data Entry* tab.
- To determine the applicable equipment class geometry (e.g., HZO, SVO, etc), Partners shall use diagrams of Appendix D of AHRI 1200 for reference.

[7] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

- The Refrigeration Energy Calculator will automatically calculate baseline kWh/day allowances of each eligible commercial refrigeration unit, which shall be used if measurements were not performed.

<u>*Refrigeration Energy Input*</u>

- Refrigeration energy (excluding internal gains/losses) should be modeled as a direct load to the electric meter or assigned to a thermal zone but with the zero sensible and latent heat gains to the space.

<u>*HVAC Interactivity Modeling Input*</u>

- The Refrigeration Energy Calculator will calculate Q per thermal zone on the *Model Inputs* tab for the purposes of modeling internal heat gain or removal for each thermal zone to capture HVAC system interactivity.
- Note: Q is the rate of heat removal from the space due to the continuous operation of the refrigeration system (kBtu/h). Q can be positive or negative depending on condenser location.

<u>*Custom Refrigeration Systems Outside the Scope of AHRI 1200*</u>

Projects with EEMs involving custom refrigeration systems that are not covered by AHRI 1200, such as those serving skating rinks and refrigerated warehouses and similar facilities, must be modeled using whole building simulation tools that support explicit modeling of such systems, as described in Section 4.4.1. This approach may also be taken for AHRI rated systems that wish to claim higher savings than calculated by the Refrigeration Energy Calculator. Note that in this case, on-site metering will be required.

4.6.4.17 Measures that Increase Energy Use

- There may be instances where recommended measures cause an increase in the energy use of the building or facility. For example:
    - Existing ventilation rates of a building are determined to be inadequate to maintain the health and comfort of building occupants. HVAC improvements are planned as part of the P4P scope of work and will include an increase to the ventilation rates in the building.
    - An existing building has spaces that were not cooled but the project includes installing new high-efficiency air-conditioning units to provide cooling.
    - Project includes providing additional efficient lighting to spaces previously unlit or poorly lit.

- Such measures should be discussed with Program Manager ahead of time for inclusion in the ERP and will be approved on a case-by-case basis. A potential solution is to establish a corresponding baseline for the measure using ASHRAE 90.1 and calculate savings for the improved measure efficiency. That baseline is then added to the existing consumption. This must also be accounted for at the post-construction stage (Section 6.5).

4.6.4.18 Modeling Cooling and Heating Efficiency

- Electric efficiency without supply fan power must be calculated and modeled separately from AHRI efficiency[8] for existing and proposed air-side heating and cooling systems such as packaged terminal air conditioners, roof top units, and heat pumps.

- If equipment is derated per Section 4.6.4.7, efficiency without supply fan power should be calculated using derated efficiency.

- ASHRAE 90.1-2016 provides equations to extract fan power from efficiency ratings (i.e., EER or COP without supply fan power).

Equations*:*

1. $COP_{nfcooling} = 7.84 \times (10^{-8}) \times EER \times Q + 0.338 \times EER$

2. $COP_{nfcooling} = -0.0076 \times SEER^2 + 0.3796 \times SEER$

3. $COP_{nfheating} = 1.48 \times (10^{-7}) \times COP_{47} \times Q + 1.062 \times COP_{47}$
   (applies to heat-pump heating efficiency only)

4. $COP_{nfheating} = -0.0296 \times HSPF^2 + 0.7134 \times HSPF$

***Where*:**

– $COP_{nfcooling}$ and $COP_{nfheating}$ are the packaged HVAC equipment cooling and heating efficiency, respectively.

– EER, SEER, COP_{47}, and HSPF shall be at AHRI test conditions.

– Q is the AHRI-rated cooling capacity in Btu/h.

Note: The EIR entered in eQuest is equal to 1 / COPnf.

4.6.4.19 Destratification Fans

To model destratification fans, savings should be modeled by *adjusting the thermostat setpoint* and by *increasing the equipment load* in the space. Modeled decrease in heating temperature must be justified by temperature measurements in the subject spaces prior to retrofit to evaluate air stratification. Temperature measurements must be listed in ERP Excel Tables, Other Equipment tab, *Temperature Measurements*.

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[8] ASHRAE 90.1-2016 Appendix G3.1.2.1 states: All HVAC equipment in the baseline building design shall be modeled at the minimum efficiency levels, both part and full load, in accordance with Tables G3.5.1 through G3.5.6. Where efficiency ratings [such as EER and COP,] include fan energy, the efficiency rating shall be adjusted to remove supply fan energy..

If a BMS measure is included in the scope of work, the fan destratification EEM must be modeled *after* the BMS EEM, the measured temperatures must be adjusted to account for the new temperature settings, to avoid double-counting of savings.

Example
The temperature at the ceiling is 85°F and the temperature near the floor is 70°F, then the average temperature of air without de-stratification fans is (85°F+70°F)/2=77.5°F.

If the proposed fans reduce stratification to 3°F (70°F near floor, 70+3=73°F next to ceiling), then the average air temperature becomes (70+73)/2=71.5°F.

The savings should be modeled by changing thermostat setpoint in the space from 77.5°F to 71.5°F.

In addition, energy consumed by the de-stratification fan must be included in the simulation by increasing equipment load in the space. Fan energy calculations and key variables must be included with the submission.

4.6.4.20 Multifamily In-Unit Improvements

- If the proposed scope of work does *not* include EEMs that address in-unit electricity consumption, the 15% target must be met by EEMs reducing consumption only on common meters, such as VFD on pumps serving the central boiler loop, central HVAC, etc.
- If proposed scope includes improvements to systems inside apartments that contribute to in-unit electricity consumption, such as in-unit hardwired lighting or refrigerators, then savings from such EEMs may not exceed stipulated savings based on the current NJCEP protocols[9] and these Guidelines. For such projects, the 15% target may be met by combined savings from in-unit and common space EEMs.
- With prior approval from Program Manager, a different M&V method, such as Retrofit Isolation approach, may be used for in-unit EEMs that do not have stipulated savings, or to document savings that exceed stipulated values.

4.6.4.21 Elevator Improvements

Elevators are a regulated load in ASHRAE 90.1-2016 and have mandatory requirements. Performance credit may be claimed for any component that meets or exceeds mandatory or baseline requirements such as fan power, lighting power density, elevator motor efficiency, and elevator mechanical efficiency.

If existing conditions are unknown, the following proxies may be used to establish the Baseline:

– ≤ 4 stories: hydraulic motor, 58% mechanical efficiency

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[9] http://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an

- > 4 stories: traction motor, 64% mechanical efficiency
- 0.33 W/CFM for ventilation fans
- 3.14 W/SqFt lighting power density

Cab motor power shall be calculated using the following equations:

$$bhp = (Weight\ of\ Car + Rated\ Load - Counterweight)\ x\ Speed\ of\ Car / (33{,}000\ x\ h_{mechanical})$$

$$P_m = bhp * 746 / h_{motor}$$

Where:

- *Weight of Car* = proposed design elevator car weight, lb
- *Rated Load* = proposed design elevator load at which to operate, lb
- *Counterweight of Car* = elevator counterweight,
    - *hydraulic elevators:* no counterweight
    - *traction elevators*: same as in proposed design; if not specified, weight of car + 40% of rated load
- *Speed of Car* = speed of the proposed elevator, ft/min
- *Pm* = peak cab motor power
- $h_{mechanical}$ = mechanical efficiency of the elevator
- h_{motor} = motor efficiency

    - Cab motor efficiency (h_{motor}) shall be determined using the following tables if existing conditions cannot be verified
        - Table G3.9.3 for hydraulic baseline elevators
        - Table G3.9.1 for traction baseline elevators

Table G3.9.3 ***Performance Rating Method*** **Hydraulic Elevator Motor** ***Efficiency***

Horsepower	Full-Load *Efficiency*
10	72%
20	75%
30	78%
40	78%
100	80%

Table G3.9.1 *Performance Rating Method* Motor *Efficiency* Requirements

Motor Horsepower	Minimum Nominal Full-Load *Efficiency*, %
1.0	82.5
1.5	84.0
2.0	84.0
3.0	87.5
5.0	87.5
7.5	89.5
10.0	89.5
15.0	91.0
20.0	91.0
25.0	92.4
30.0	92.4
40.0	93.0
50.0	93.0
60.0	93.6
75.0	94.1
100.0	94.5
125.0	94.5
150.0	95.0
200.0	95.0

Elevator full load hours shall be calculated as follows:

$$EFLH_{elev} = DH \times 365$$

Where:

- $EFLH_{elev}$ = elevator effective full load hours
- DH = average travel time from the below, based on building type and size, and the elevator application type. Alterative elevator run hours may be considered upon Program Manager approval.

Table 4-10. Elevator Usage Categories

Usage Intensity/ Frequency	Very Low Very Seldom	Low Seldom	Medium Occasionally	High Frequently	Very High Very Frequently
Average Travel Time (hours per day)	0.2	0.5	1.5	3	6
Typical Type of Buildings and Use	Residential building with up to 6 dwellings. Small office or administrative building with few operations.	Residential building with up to 20 dwellings. Small Office or Administrative Building with 2 to 5 floors. Small Hotels Goods lift with few operations.	Residential building with up to 50 dwellings. Small office or administrative building with up to 10 floors. Medium Sized Hotels Goods lift with medium operations	Residential building with more than 50 dwellings. Tall office or administrative building with more than 10 floors. Large Hotel Small to Medium Sized Hospitals Good lift in production process with a single shaft.	Office or administration building over 100 meters in height. Large Hospital Goods lift in production process with several shafts.

In terms of hours of operation, existing elevator fans and lighting shall operate as observed during the site visit.

<u>Proposed Design:</u>

The proposed design elevator cab motor power [Watt] must be calculated as follows:

$$P_{m,prop} = bHP_{prop} \; x \; 746/h_{motor,prop}$$

Where:

– bHP_{prop} and $H_{motor,prop}$ are the brake horse power and electrical efficiency of the proposed elevator motor, respectively. Tables G3.9.3 & G3.9.1 referenced above must be used as applicable if the proposed elevator motor efficiency is unavailable.

- Design fan and lighting power shall be based on design documents.
- The same effective full load hours (EFLHelev) must be modeled for the existing and proposed cases.
- If the proposed elevator cab lighting has occupancy sensor controls, the annual lighting runtime must be equal to EFLHelev.

If elevator EEMs are included in the P4P scope of work, Partners shall use the Elevator Energy Consumption Calculator available on the Partner Portal to justify energy savings and/or model inputs. **Example:**

The proposed case of a 10-floor office building includes four (4) passenger elevators (Car 1) and one (1) service elevator (Car 2). Parameters of both elevators are shown in the figure below

	Elevator ID	1	2
Application	Elevator Name	Car 1	Car 2
	Quantity	4	1
	Passanger or service elevator?	Passenger	Service
	Buildings and elevator type	Office or administrative building 6 - 10 floors	Goods lift with few operations
	Average Travel Time (hours per day)	1.5	0.5
	Usage Type: Intensity/ Frequency	Medium/ Occasionally	Low/ Seldom
	Number of Stories Served (including below grade floors)	10	10
Proposed Design	Counterweight of Car (lbs) (if unknown, leave blank)		
	Weight of Car (lb.)	8,098	8,824
	Rated Load (lb.)	3,500	4,000
	Speed of Car (ft./min)	1,200	1,200
	bhp	81.94	53.43
	Motor efficiency (%)	94.5%	93.6%
	Cabin Fan Power (Watt)	90	90
	Cabin Airflow (CFM)	325	325
	Cabin Lighting Power (Watt)	100	100
	Cabin Occupancy Sensor Lighting Controls (Y/N)	Yes	Yes
	Cab Area (Square Feet)	56	56

Figure 4-2. Elevator Calculator - Description of the Proposed Equipment

4.6.4.22 Measures Involving Electric Motors

For EEMs involving pumps and fans, brake horsepower (bHP) and motor efficiency (%) shall be used to calculate power (kW) inputs. If bHP is unknown, a load factor of 80% may be used to convert horsepower (HP) to bHP. For example, for a 20 HP hot water pump, the pump power would be equal to 13.12 kW (20 HP x 0.8 bHP/HP x 0.746 kW/HP ÷ 91%).

4.6.4.23 Measures Involving Plant Decentralization

Improvements involving the replacement of the central heating and/or cooling plant with multiple distributed systems shall be split into two separate EEMs:

- The first EEM shall capture savings from replacing the central plant with distributed heating/cooling systems that minimally comply with ASRHAE Standard 90.1 – 2016. It will include the *deactivation* of existing pumps, *deactivation* of existing plant systems, changes in distribution losses, *activation* of proposed pumps, and *activation* of proposed plant systems. In the first EEM, proposed plant systems shall be set equal to ASHRAE 90.1-2016 efficiencies. This EEM is subject to the uncertainty cap described in Section 4.6.3.

- The second EEM shall reflect plant efficiency improvements from ASHRAE 90.1-2016 efficiencies to proposed specifications. This EEM is *not* subject to the uncertainty cap described in Section 4.6.3.

- This process should be repeated for each plant system type (e.g., decentralization of chillers and boilers should be modeled using at least four EEMs rather than two).

5. Measure Implementation

5.1 Overview

Upon approval of the Energy Reduction Plan, the implementation of recommended measures may begin. Installation of measures can be performed by Participant's in-house staff, by the Partner, or sub-contracted to other firms. The Partner must remain involved during the entire construction phase in order to ensure that all of the measures are being installed properly and are in-line with the approved ERP.

5.2 Timelines for Installation

All measures must be installed within twelve (12) months of ERP approval. Extensions may be granted per Section 2.5.1.

Program will allow for extensions so long as applicant can demonstrate proof of significant project advancement. This could be in the form of copies of permits, equipment invoices, installation invoices indicating percentage complete, updated project schedules, etc. The Program Manager reserves the right to conduct an inspection of the project to confirm project advancement.

5.3 Documentation Requirements

Per Section 2.5

5.4 Changes in Scope of Work

The Program recognizes that changes to the scope of work may occur during construction. Changes to the scope of work that deviate from the approved ERP shall be handled per **Table 5-1** below. The project, after changes in scope, must still meet all Program requirements including: save at least 15% in source energy savings (of which at least 50% must come from investor owned utilities where applicable); savings may not come from a single measure; and lighting cannot account for more than 50% of total savings (exceptions apply). All modified measures must still comply with Section 3.4 Note, the IRR is <u>not</u> re-calculated at Installation Report submittal (only applies to Applications received prior to July 1st, 2015).

Table 5-1. Changes to Scope of Work *after* ERP is Approved

#	Scenario	Action
1	Minor modifications to the approved scope of work. Example: • Equipment substitutions for equal or better • Small fluctuation in lighting fixture quantity *Rule of thumb*: Change in overall savings ≤ 10%* from approved ERP	• ERP resubmittal not necessary. • Installation Report and installed savings shall reflect projected savings as approved in ERP and incentives will be committed and paid as-is. If project achieves slightly higher or lower savings this will be accounted for at Incentive #3. • Actual installed measure specifications must be included in Installation Report.

2	Significant modification to the approved scope of work resulting in substantial ***increase*** in energy savings or ***addition*** of new measure
	
	Rule of thumb: Change in overall savings > 10%* from approved ERP
		• ERP must be revised and re-submitted.
		  ○ Addition of a new measure requires that corresponding existing equipment was listed in the original ERP and previously included in the pre-construction inspection.
		  ○ It is recommended that the revised ERP be submitted prior to completion of the modified scope of work to ensure project still complies with Partner Guidelines and requirements, and/or if a second pre-inspection is needed. Otherwise the revised ERP can be submitted along with the Installation Report.
		• Program Manager will re-review the ERP submittal to ensure modifications still meet Partner Guidelines and revise incentives #2 and #3.
		• Installation Report shall reflect revised ERP measures and savings, including actual installed measure specifications.

3	Significant modification to the approved scope of work resulting in substantial ***decrease*** in energy savings or ***removal*** of measure *Rule of thumb*: Change in overall savings > 10%* from approved ERP	• ERP must be revised as described in Scenario 2. • Incentives #2 and #3 will be paid based on the reduced scope of work/savings.

4	No significant changes to equipment impacting savings, but an ***increase*** or ***decrease*** in project cost from what was estimated in the approved ERP.	• Total of Incentives #2 and #3 is capped at 50% of total project cost. Total project cost includes materials, labor, design fees, construction management fees, and Partner fees associated with the P4P scope of work. The 50% cap will apply to the *lesser of* the estimated costs listed in the approved ERP or actual costs listed in the Installation Report for final incentive calculation. • Measure/CM fees/Partner fees/project costs that are significantly higher or lower in the Installation Report compared to the ERP must include accompanying explanation. ○ *Rule of thumb:* 25%

*10% is calculated based on overall source energy reduction. For example, if project is projecting 30% savings, then modifications to any ECM must cause less than a 10% fluctuation to overall savings. This means that savings adjustments cannot cause the 30% to dip below 27% [(30%-27%) / 30% = 10%].

5.5 Inspections

When construction is completed, the Partner must perform a site inspection and measurements to verify installation and performance of all measures matches the approved ERP prior to submitting the completed Installation Report. Upon receipt and review of the Installation Report, Program Manager will perform a site inspection. If the conditions are found to be different from those represented in the ERP and/or Installation Report, the Program Manager may refuse any further incentive payments until the discrepancies are resolved.

After measures are installed, the Partner should continue to monitor utility bills or perform measurements as applicable, to confirm that the reduction in energy use is similar to that projected in the ERP. This will help to identify potential issues or equipment that is not operating as intended. The Partner should perform site visits, retro-commissioning, or other corrective steps, as required, if post-retrofit use is higher than projected (Section 6).

6. Post-Construction Benchmarking Report

6.1 Overview

The objective of the Post-Construction Benchmarking Report is to document actual energy savings. In cases where the project achieves or exceeds the energy savings target outlined in the approved ERP, the Program Manager will remit payment for Incentive #3. If the energy savings do not meet the target, the Program Manager will work with the Partners to understand why savings are not reaching projected levels.

Incentives #2 and #3 are designed as a single performance incentive that is split in order to provide up-front financial assistance in implementing the project. Incentive #3 will be "trued-up" based on actual achieved savings so that the total performance incentive (i.e. #2 and #3) is in compliance with the Program's incentive structure. If savings are below the 15% minimum but at or above 5%, the project will still be eligible for an incentive, although at a reduced rate calculated at $0.005/kWh less and $0.05/therm less from the base incentive (i.e. $0.09/kWh and $0.90/therm) for each 1% savings below 15%. So long as the savings are at or above 5%, the minimum incentive paid is $10,000 or committed value, whichever is less, assuming all required data and documentation is submitted. If savings are less than 5% there would be no Incentive #3 paid. Incentives #1 and #2 are not required to be returned to the Program. The scaling down of incentives does not apply to high energy-intensity users, which are required to demonstrate at least 4% energy savings.

6.2 Timelines for Installation

The minimum monitoring period is twelve (12) months from Installation Report approval date, with additional extensions available per Section 2.5.1 to make any equipment adjustments and attempt to reach the savings target.

6.3 Documentation Requirements

Per Section 2.5

6.4 P4P Savings Verification Tool

6.4.1 General Approach

When measuring retrofit savings in buildings, it is important to eliminate the effect of changing weather conditions on energy consumption. To achieve that, ETracker is used to perform regression analysis on pre-retrofit bills to establish correlation between energy consumption and weather. ETracker merges the energy use and temperature data, and develops a best-fit regression model of pre-retrofit energy use and temperature. To measure energy savings, the actual post-retrofit bills are compared to ETracker prediction of how much energy the building would have consumed during post-retrofit period if it were not retrofitted. This method of measuring savings is recommended by the International Performance, Measurements and Verification Protocols (IPMVP), the Federal Energy Management Program (FEMP) Measurement and Verification Guidelines and ASHRAE Guideline 14.

The saving uncertainty for each fuel is calculated based on ASHRAE Guideline 14, with the acceptable threshold established at 50% of projected savings at 68% confidence level. The Overall Savings Uncertainty is determined as weighted average of corresponding metrics for individual fuels. Weighing is done based on contribution of each fuel toward the total source energy consumption.

The P4P Savings Verification Tool compares the overall uncertainty to 50% of projected savings. Projects with overall uncertainty below 50% pass the verification.

6.4.2 Utility Bill Collection

Twelve (12) months of pre-retrofit and post-retrofit bills for each fuel must be included in the analysis. Pre-retrofit billing data must be copied from the approved ERP, and exclude any utility data adjustments done for the purpose of achieving calibration. Post-retrofit utility bills must be collected per guidelines in Section 3.2 and must include all meters/fuels analyzed in the pre-retrofit period. Fuel conversions projects must also include utility data of new fuels (e.g. pre-retrofit measured oil use and post-retrofit measures natural gas use). Permissible utility bill adjustments are detailed in Section 3.2.2.

For post-retrofit bills, the last billing period of the utility bills must be of a length such that the total length of the post-retrofit period is between 360 and 370 days (see Section 6.4.4 for the methodology for making adjustments to the bills if the last period of the billing history causes the utility data to span more than 370 days).

In the case of irregular fuel deliveries, the utility data must be adjusted by combining the usage across months with deliveries and no deliveries and then prorating it such that 12 billing periods are included in the post-retrofit period (see Section 6.4.5 for an example).

6.4.2.1 Multifamily Projects Using Alternative Approach to Establishing In-Unit Electricity Usage

Projects that used the alternative procedure described in Section 3.2 at the ERP stage must document achieved savings as follows:

1. Pre-retrofit and post-retrofit consumption entered into P4P Savings Verification Tool (SVT) must include *only* the common area bills, and regular process to verify savings must be followed. Tenant in-unit electric consumption calculated using the alternative procedure described in this document should not be included in either pre-retrofit or post-retrofit inputs.

2. If there were *no* in-unit EEMs in the P4P scope, then the common bill savings will be the basis of Incentive #3. If there *were* in-unit EEMs in the P4P scope, then stipulated in-unit EEM savings approved in the ERP stage must be added to the realized weather-normalized source energy savings from SVT to calculate the total achieved savings.

3. Submit both the SVT with common area bills and the stipulated savings calculations to Program Manager and describe the used approach in the cover email. The Program Manager will reconcile the common area actual savings and the stipulated in-unit savings and inform the Partner of the final incentive #3 amount to be received.

6.4.3 Examples

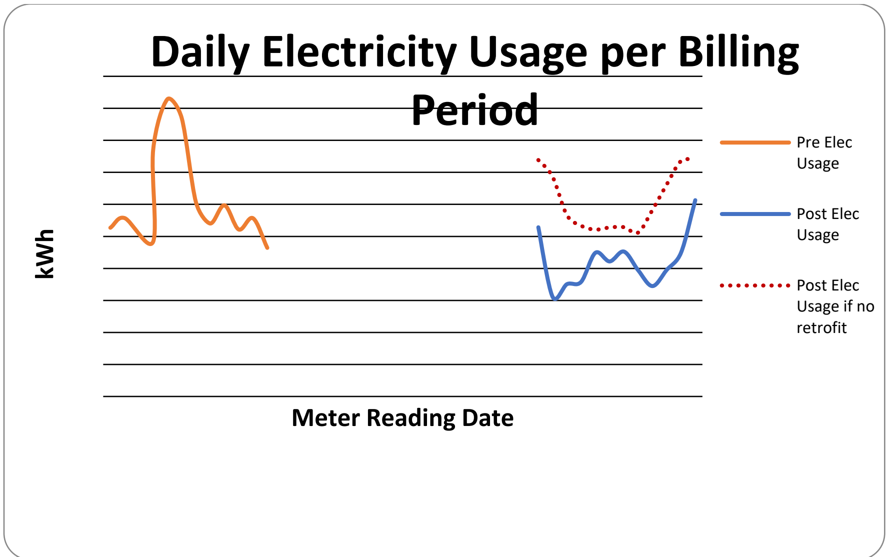
Project A: North Tower Office Complex

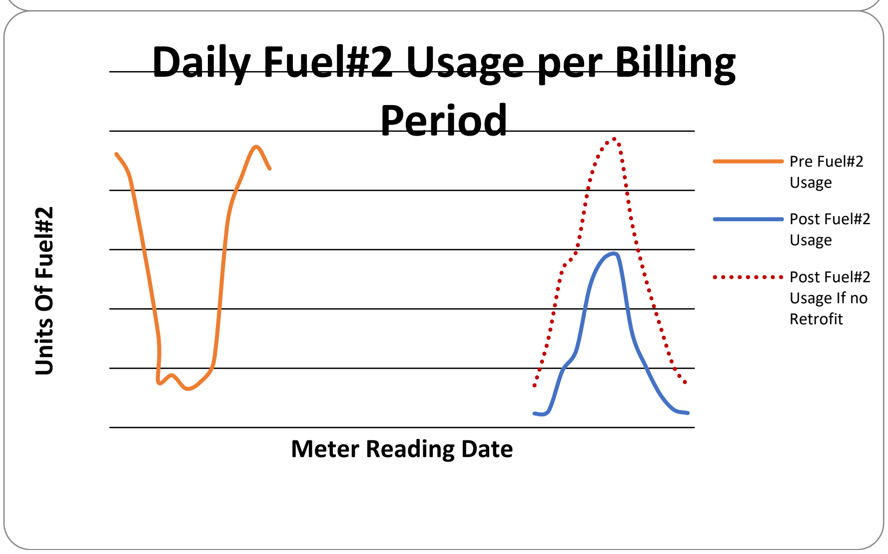
There are twelve (12) actual gas and electric bills for both pre- and post-retrofit periods. These bills are entered on the Inputs page of the P4P Savings Verification Tool:

Actual Pre-Retrofit Electric Bills				Actual Post-Retrofit Electric Bills		
Number Electric Billing Periods		12		Number Electric Billing Periods		12
Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)		Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)
2/26/2007	30	7,905		8/26/2009	28	7,399
3/28/2007	30	8,358		9/25/2009	30	4,667
4/30/2007	33	7,978		10/26/2009	31	5,436
5/30/2007	30	11,542		11/24/2009	29	5,191
6/27/2007	28	12,999		12/28/2009	34	7,630
7/29/2007	32	13,921		1/27/2010	30	6,328
8/27/2007	29	8,801		2/27/2010	31	7,016
9/25/2007	29	7,835		3/29/2010	30	5,910
10/25/2007	30	8,957		4/29/2010	31	5,345
11/27/2007	33	8,605		5/27/2010	28	5,535
12/27/2007	30	8,351		6/28/2010	32	7,183
1/28/2008	32	7,427		7/28/2010	30	9,197

Actual Pre-retrofit Fuel #2 Bills		Natural Gas(Therms)		Actual Post-retrofit Fuel #2 Bills		Natural Gas(Therms)
Number Fuel Billing periods		12		Number Fuel Billing periods		12
Read Date	Billing Period Length (days)	Billed Fuel #2 (units of fuel)		Read Date	Billing Period Length (days)	Billed Fuel #2 (units of fuel)
2/26/2007	30	2,768		8/26/2009	28	132
3/28/2007	30	2,513		9/25/2009	30	165
4/30/2007	33	1,039		10/26/2009	31	592
5/30/2007	30	465		11/24/2009	29	756
6/27/2007	28	493		12/28/2009	34	1,631
7/29/2007	32	420		1/27/2010	30	1,716
8/27/2007	29	442		2/27/2010	31	1,788
9/25/2007	29	648		3/29/2010	30	960
10/25/2007	30	2,096		4/29/2010	31	634
11/27/2007	33	2,796		5/27/2010	28	317
12/27/2007	30	2,840		6/28/2010	32	192
1/28/2008	32	2,794		7/28/2010	30	146

After all steps described on the Instructions page of the P4P Savings Verification Tool are completed, Results tab of the tool should show the following graphs and savings summary table.





Actual Savings Summary Table			
	Electricity (kWH)	Fuel#2 (Therms)	Total Source Energy (MMBtu)
Total Savings	34,658	9,993	1,441
% Savings	31%	53%	44%
Total Uncertainty	+-6,758.23	+-3,577.54	+-451.59
Uncertainty % of savings	26%	28%	28%

Pre-and post-retrofit bills for both fuels are actual, and show predictable pattern with no outliers. The project achieved 44% overall source energy savings and met P4P uncertainty requirements.

Project B: Wetzel East Multifamily Complex

The project has twelve (12) actual pre- and post-retrofit bills for both fuels, as shown below:

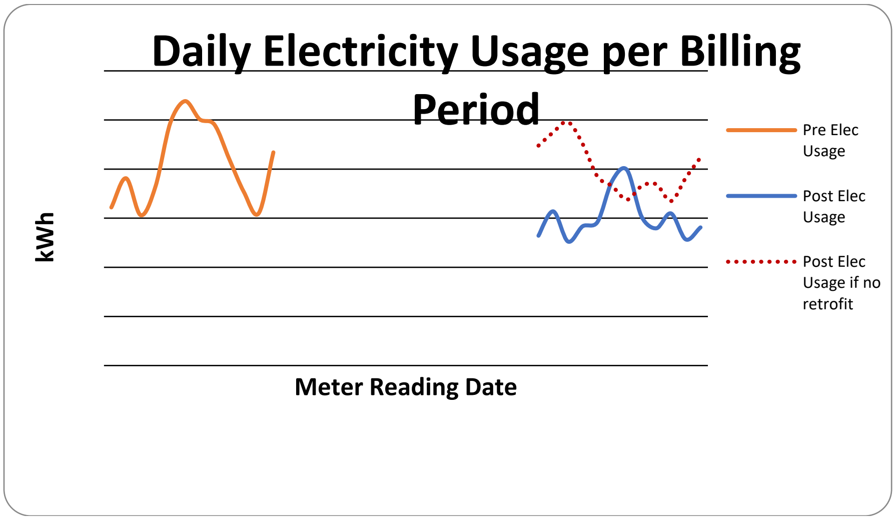
Actual Pre-Retrofit Electric Bills		
Number Electric Billing Periods		12
Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)
1/25/2007	28	4,508
2/22/2007	28	5,338
3/26/2007	32	4,897
4/25/2007	30	5,474
5/26/2007	31	7,656
6/25/2007	30	8,077
7/26/2007	31	7,771
8/23/2007	28	6,868
9/22/2007	30	6,312
10/23/2007	31	5,475
11/24/2007	32	4,958
12/22/2007	28	6,077

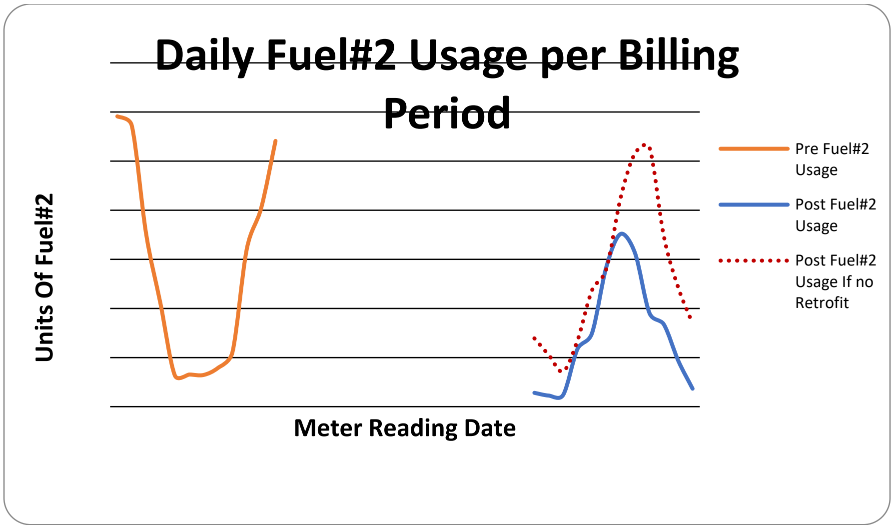
Actual Post-Retrofit Electric Bills		
Number Electric Billing Periods		12
Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)
6/24/2009	32	4,230
7/26/2009	32	5,023
8/24/2009	29	3,662
9/23/2009	30	4,255
10/23/2009	30	4,382
11/21/2009	29	5,451
12/22/2009	31	6,177
1/25/2010	34	5,154
2/25/2010	31	4,331
3/25/2010	28	4,336
4/26/2010	32	4,109
5/25/2010	29	4,079

Actual Pre-retrofit Fuel #2 Bills		Natural Gas(Therms)
Number Fuel Billing periods		12
Read Date	Billing Period Length (days)	Billed Fuel #2 (units of fuel)
1/25/2007	28	1,655
2/22/2007	28	1,603
3/26/2007	32	1,127
4/25/2007	30	629
5/26/2007	31	197
6/25/2007	30	196
7/26/2007	31	200
8/23/2007	28	221
9/22/2007	30	331
10/23/2007	31	994
11/24/2007	32	1,293
12/22/2007	28	1,515

Actual Post-retrofit Fuel #2 Bills		Natural Gas(Therms)
Number Fuel Billing periods		12
Read Date	Billing Period Length (days)	Billed Fuel #2 (units of fuel)
6/24/2009	32	90
7/26/2009	32	72
8/24/2009	29	69
9/23/2009	30	353
10/23/2009	30	447
11/21/2009	29	824
12/22/2009	31	1,090
1/25/2010	34	1,062
2/25/2010	31	591
3/25/2010	28	469
4/26/2010	32	300
5/25/2010	29	106

After the steps described on Instructions page of the P4P Savings Verification Tool are completed, Results tab of the tool shows the following graphs and savings summary table.





Actual Savings Summary Table			
	Electricity (kWH)	**Fuel#2 (Therms)**	**Total Source Energy (MMBtu)**
Total Savings	18,725	4,392	673
% Savings	25%	45%	36%
Total Uncertainty	+-2677.65	+-1690.78	+-207.54
Uncertainty % of savings	24%	36%	32%

Post-retrofit electricity bills do not follow expected pattern, with usage going down in summer. This is different from pre-retrofit electricity usage profile, which had a prominent summer peak. Unless the scope of retrofit explains the change, post-retrofit bills should be investigated. For example, cooling plant may be on a separate meter, and the readings of this meter may not have been accounted for in the analysis.

Project C: Multifamily Green Garden Apartments

Multifamily building with direct-metered in-unit consumption had gas bills and common area electric bills available for pre-retrofit (baseline) period. In-unit consumption for the project was calculated using alternative procedure described in Section 3.2.1.1. The resulting baseline consumption and savings is shown below.

	Pre-retrofit (Baseline)	
Gas consumption based on utility bills	6,517 MMBtu	
Electricity consumption on common meters' utility bills	321,200 kWh	1,301,200 kWh
In-unit consumption calculated using alternative procedure	980,000 kWh	

	ERP Savings	
Modeled gas savings	2,280 MMBtu	
Modeled common area electricity savings	64,200 kWh	164,200 kWh
Stipulated in-unit savings	100,000 kWh	

Post-retrofit utility bills for gas and common area electricity were collected, with usage shown below. Since ERP savings for in-unit EEM were 100,000 kWh, post-retrofit in-unit consumption is stipulated to be 880,000 kWh.

	Post-retrofit	
Gas consumption based on utility bills	4,236 MMBtu	
Electricity consumption on common meters' utility bills	257,558 kWh	1,201,200 kWh
In-unit consumption accounting for stipulated savings	880,000 kWh	

Pre- and post-retrofit gas bills, and *common area electric bills* (but not in-unit bills) are entered into SVT for both the pre-retrofit and post-retrofit periods. SVT inputs for pre/post electricity bills are shown below.

Actual Pre-Retrofit Electric Bills		
Number Electric Billing Periods		**12**
Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)
5/12/2011	30	24,800
6/13/2011	32	30,000
7/13/2011	30	22,000
8/11/2011	29	32,800
9/12/2011	32	31,600
10/11/2011	29	26,800
11/12/2011	32	27,100
12/12/2011	30	27,100
1/12/2012	31	24,800
2/10/2012	29	30,400
3/13/2012	32	29,000
4/12/2012	30	24,800

Actual Post-Retrofit Electric Bills		
Number Electric Billing Periods		**11**
Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)
7/12/2013	30	16,600
8/12/2013	31	11,200
9/10/2013	29	13,400
10/10/2013	30	24,600
11/8/2013	29	22,000
12/12/2013	34	25,800
1/11/2014	30	22,600
2/13/2014	61	25,000
3/12/2014	29	24,679
4/11/2014	29	24,679
5/13/2014	32	21,800
6/12/2014	30	25,200

Following the regular SVT steps, the actual savings (excluding savings from in-unit EEMs) are established as shown below. The stipulated in-unit savings of 100,000 kWh will be added to the actual electricity savings by the Program Manager.

Table-1	Annual Consumption	Projected Savings	% Savings	Actual Savings (Calculated by Tool)
Electricity (kBtu)	4,098,494	560,250	14%	238,840
Natural Gas (kBtu)	6,517,000	2,280,000	35%	2,394,000
District Steam (kBtu)	0	0	0%	0
District Hot Water (kBtu)	0	0	0%	
Source Energy Use Intensity (kBtu/ft2)	136.7	28.4		0.0
Source Energy Use Reduction			**20.8%**	**16.1%**

6.4.4 Allowed Post-Retrofit Adjustment for Billing Periods Spanning more than 370 Days

Electricity bills for a billing period are shown below. The last period spans 45 days, resulting in a total 381-day billing period. The last billing period of utility bills must be adjusted so that the total length of the total billing period is 365 days.

Actual Electricity Billing History			
Billing Period Start Date	**Read Date**	**Days in Billing Period**	**Billed kWh Usage**
	8/10/18		
8/11/18	9/11/18	32	432,708
9/12/18	10/10/18	29	316,977
10/11/18	11/8/18	29	190,220
11/9/18	12/11/18	33	212,338
12/12/18	1/11/19	31	198,054
1/12/19	2/11/19	31	216,598
2/12/19	3/13/19	30	198,333
3/14/19	4/11/19	29	163,524
4/12/19	5/13/19	32	167,349
5/14/19	6/12/19	30	252,509
6/13/19	7/12/19	30	346,775
7/13/19	8/26/19	45	640,789
	Total:	381 days	3,336,174 kWh

This is accomplished by calculating the daily average electricity use during the last billing period, adjusting the length of the final period such that total billing period spans 365 days, and prorating the kWh usage associated with the adjusted final period. The table below shows the adjusted utility data using this method. Highlighted in red are the values that have been modified.

Adjusted Electricity Billing History			
Billing Period Start Date	**Read Date**	**Days in Billing Period**	**Billed kWh Usage**
	8/10/18		
8/11/18	9/11/18	32	432,708
9/12/18	10/10/18	29	316,977
10/11/18	11/8/18	29	190,220
11/9/18	12/11/18	33	212,338
12/12/18	1/11/19	31	198,054
1/12/19	2/11/19	31	216,598
2/12/19	3/13/19	30	198,333
3/14/19	4/11/19	29	163,524
4/12/19	5/13/19	32	167,349
5/14/19	6/12/19	30	252,509
6/13/19	7/12/19	30	346,775
7/13/19	**8/10/19**	**29**	**412,953**
	Total:	**365 days**	**3,108,338 kWh**

6.4.5 Allowed Post-Retrofit Adjustment for Irregular Deliveries

Consider a project where no fuel #2 deliveries were made in July and September. The table below illustrates the incorrect input for this scenario, with zero usage entered for July and September. This input implies that no fuel #2 was used during these months, which is unlikely and will conflict with the modeled usage for these periods.

Actual Post-Retrofit Fuel #2 Bills		Fuel Oil and/or Propane (MMBtu)
Number Fuel Billing periods		**12**
Read Date	Billing Period Length (days)	Billed Fuel #2 (units of fuel)
2/28/2018	29	5,068
3/31/2018	31	4,618
4/30/2018	30	2,973
5/31/2018	31	1,981
6/30/2018	30	580
7/31/2018	31	-
8/31/2018	31	1,193
9/30/2018	30	-
10/31/2018	31	1,941
11/30/2018	30	1,821
12/31/2018	31	4,533
1/31/2019	31	4,268

In this case, the utility data must be adjusted by combining the usage during July and August, and usage during September and October, calculating the daily average fuel oil use for each period and then multiplying the fuel usage per day for each period by the number of days in each month (associated with the period) to arrive at fuel usage for July, August, September, and October. The resulting baseline period will include ten (12) utility bills. See table below for correct data input.

Actual Post-Retrofit Fuel #2 Bills		Fuel Oil and/or Propane (MMBtu)
Number Fuel Billing periods		12
Read Date	Billing Period Length (days)	Billed Fuel #2 (units of fuel)
2/28/2018	29	5,068
3/31/2018	31	4,618
4/30/2018	30	2,973
5/31/2018	31	1,981
6/30/2018	30	580
7/31/2018	31	597
8/31/2018	31	597
9/30/2018	30	955
10/31/2018	31	986
11/30/2018	30	1,821
12/31/2018	31	4,533
1/31/2019	31	4,268

6.5 Post-Construction Baseline Adjustments

It is not uncommon for changes to occur in the baseline energy use between the ERP approval and the post-construction period. If, at any time during construction or in the post-construction period there are changes in the facility, outside of the approved ERP scope of work, that affect energy use, the Partner must notify the Program Manager.

Prior to submittal of the Post-Construction Benchmarking Report these facility changes may need to be incorporated as baseline adjustments. The nature of adjustments must be explicitly described, coordinated with, and approved by the Program Manager. The degree of adjustments allowed and the procedure will largely depend on the level of detail, accuracy of information, and supporting documentation provided to the Program surrounding the change(s). Generally, baseline adjustments are only permitted for key variables identified in the ERP (Section 4.3.1).

The general procedure to account for changes is to adjust pre-approved inputs in the approved baseline model to reflect the new conditions, then adjust the post-retrofit utility bills accordingly prior to evaluating actual savings. Utility bills adjustment involves adding/subtracting monthly consumption of post-retrofit utility bills entered into the Savings Verification Tool based on the difference in monthly consumption between original and adjusted baseline model.

Unusually high achieved energy savings, as compared to the approved ERP, will require justification. Generally, the below instances may increase energy savings, but cannot count towards the final incentive and shall undergo a baseline adjustment:

1. Reduction in occupancy; space vacancy
2. Reduction in shifts or operating hours not related to energy efficiency measures
3. Building or equipment shut down for an extended period of time
4. Reduction in process through put
5. Unaccounted for utility bills
6. Measures or improvements done outside of the P4P scope of work

Whereas these instances could count towards a higher final incentive:

1. P4P measure(s) performing better than expected
2. More energy conscious behavior by occupants or building managers

6.6 Tracking Partial Year Savings

Even though the program does not require “progress” submittals for Incentive #3, Partners are **strongly encouraged** to not wait until the end of one year post-retrofit period to begin tracking the achieved savings. Post-retrofit bills should be **continuously monitored** to ensure that project is on track to realize projected savings, and to allow for an opportunity to troubleshoot and fix possible issues that may lead to under-performance early in the verification period.

Billing data should be entered into SVT and analyzed on a continuous basis as monthly bills arrive. SVT can calculate weather-normalized savings for a partial year, and will show a warning to stress preliminary nature of the results, as shown in below. Utility bills for all fuels must be entered - for example, if project uses electricity and gas, and analysis covers a period from May to September, both electric and gas bills from May to September must be entered into SVT.

Note: Partial Year Warning is displayed on the ‘Results’ tab and reads as follows:
“Post-Retrofit period for Electricity includes 153 days and 5 billing periods. The actual consumption during the minimum of 365 days and 12 billing periods must be reported in order to calculate the incentive. Post-Retrofit period for Fuel #2 includes 156 days and 5 billing periods. The actual consumption during the minimum of 365 days and 12 billing periods must be reported in order to calculate the incentive.”

Partial year savings projected by SVT must be interpreted keeping in mind the scope of EEMs included in the ERP, as illustrated in the following examples:

Example 1:

Q: Project uses gas for space and Service Water Heating (SWH). ERP included installation of low flow showerheads and envelope improvements in addition to other measures, and projected annual gas savings of 18%. Verification period started in May 2014, and partner entered gas bills for May, June, and July into SVT. SVT showed no gas savings for the three months. How can this result be interpreted?

A: Partner should investigate reasons for under-performance and take corrective actions because SWH usage was not reduced as expected from low flow showerhead installation.

If the project had no SWH-related measures, then a lack of gas savings in summer would not have been of concern. Realized savings have to be compared to modeled performance during similar period (not the projected *annual* savings) to establish whether the project is on track to meet the ERP target.

Example 2:

Q: Project's scope includes replacement of atmospheric boilers with new condensing units, added attic insulation, installing premium efficiency motors with Variable Speed Drives (VSD) on space heating pumps, programmable thermostats with set maximum, and exterior lighting upgrades. The Partner copied pre-retrofit utility bills from Model Calibration Tool (MCT) into SVT, and entered consumption from October 2014 through February 2015 into SVT. (Note that pictures below show only electricity, however both electric and gas bills must be entered into SVT for the analysis period.)

Actual Pre-Retrofit Electric Bills		
Number Electric Billing Periods		12
Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)
2/4/2010	30	28,494
3/4/2010	28	29,594
4/4/2010	31	33,078
5/4/2010	30	28,508
6/4/2010	31	22,622
7/4/2010	30	19,092
8/4/2010	31	15,218
9/4/2010	31	16,511
10/4/2010	30	17,152
11/4/2010	31	28,393
12/4/2010	30	29,161
12/31/2010	27	28,282

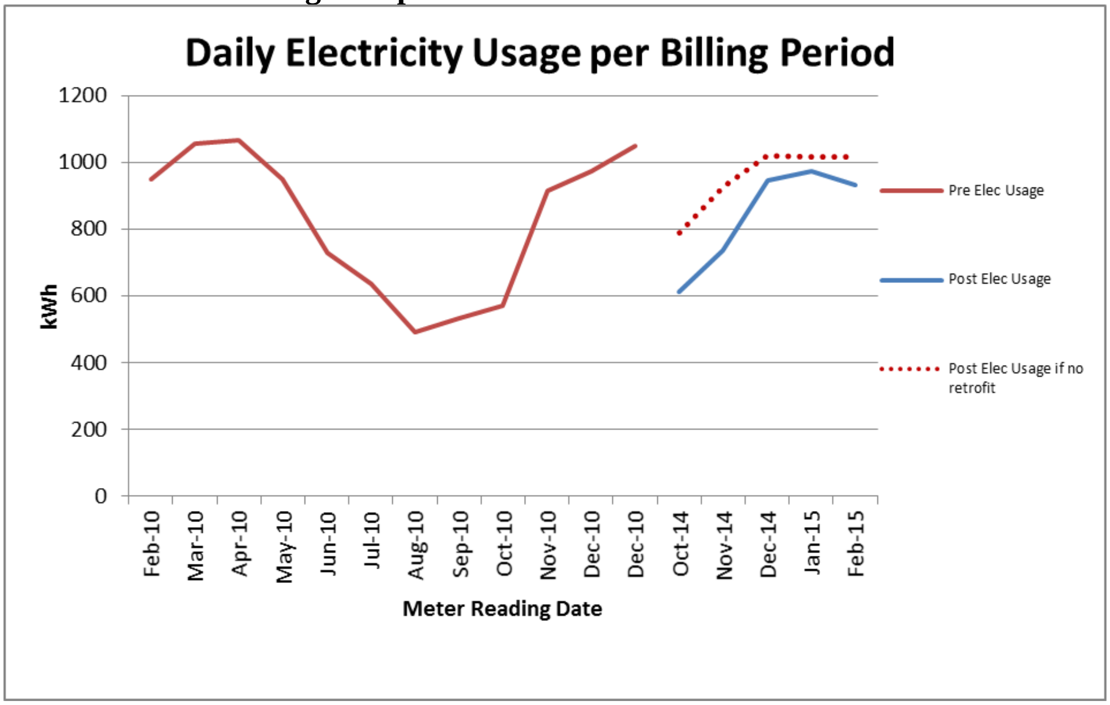
Pre-Retrofit Electric Bills

Actual Post-Retrofit Electric Bills		
Number Electric Billing Periods		5
Read Date (last day of period)	Billing Period Length (elapsed days)	Billed Electric (kWh)
10/7/2014	28	17,091
11/6/2014	30	22,062
12/8/2014	32	30,219
1/8/2015	31	30,219
2/9/2015	32	29,837

Post-Retrofit Electric Bills

The results of the SVT analysis of partial year data are shown below. Are trends in post-retrofit electricity consumption of concern?

SVT Estimated Savings Graph



A: Achieved electricity savings dropped between November 2014 and December 2014 and continued to drop into January 2015, with the actual post-retrofit electricity usage (blue line) approaching the estimated electricity usage at post-retrofit weather conditions if retrofit hasn't been performed (red dotted line). This conflicts with the modeled electricity savings, which were higher during winter months due to increased lighting runtime (and savings), and additional heating season savings due to space heating pump improvements.

To refine the analysis of achieved savings, a % Improvement column is added to the table in the SVT as shown below, with the monthly savings percentage calculated as the ratio of Achieved Savings to Projected Pre-Retrofit Total Load. Savings decreased from 22% in October to 4% in January, which likely indicate that there are penalties during heating season that cancel some lighting savings.

For example, the penalties may be associated with higher than expected parasitic loads from condensing boilers or new controls, or increased use of supplemental electric heating with new thermostats.

Electricity					
Post-Retrofit Bill Read Data	**Post Retrofit Average Temperature (°F)**	**Projected Pre-Retrofit Total Load (kWh)**	**Actual Post-Retrofit Load (kWh)**	**Achieved Savings (kWh)**	**% Improvement**
7-Oct-14	63.71	22042.51	17091.00	4951.51	22%
6-Nov-14	56.17	27808.47	22062.00	5746.47	21%
8-Dec-14	42.19	32637.83	30218.50	2419.33	7%
8-Jan-15	37.00	31548.64	30218.50	1330.14	4%
9-Feb-15	30.66	32478.92	29837.00	2641.92	8%

Analyzing month-to-month performance provides clues for trouble-shooting potential issues, and reduces the impact of the issues on Incentive #3, since the problems can be fixed early in the post-retrofit period minimizing their impact on the annual realized savings.

7. Building Performance with ENERGY STAR®

7.1 Description

New Jersey's Clean Energy Program (NJCEP) has partnered with the U.S. Environmental Protection Agency (EPA) to improve building energy efficiency in commercial facilities. The new program, Building Performance with ENERGY STAR (BPwES), helps states and utility companies in their efforts to promote comprehensive, whole-building energy upgrades for businesses.

Owning a building that achieves top energy performance is a sign of good management, but owning a portfolio of buildings that achieves continuous improvement in energy performance demonstrates superior management and environmental leadership. Through Building Performance with ENERGY STAR, NJCEP will help its customers use EPA's benchmarking tool, Portfolio Manager, to assess energy performance across their portfolio, prioritize the best initial opportunities for strategic energy upgrades, and establish a plan for staging and implementing profitable improvements over time.

BPwES is designed to be coupled with the Pay for Performance Program. Although no additional incentives are available through BPwES, businesses participating in the Program have the opportunity to gain ENERGY STAR recognition as industry leaders through the adoption and implementation of whole-building energy efficiency management strategies. Additionally, participants in the BPwES program will be promoted by EPA and NJCEP as charter partners in what will likely become a widely recognized, nationwide effort.

7.2 Eligibility

NJCEP is targeting organizations that:

- Are headquartered or have a major presence in New Jersey
- Have multiple facilities
- Are high energy users that best fit the parameters of the initiative

Although these are the target sectors, all customers who are interested in P4P are also encouraged to participate in Building Performance with ENERGY STAR.

7.3 Steps to Participation

Step 1 Customer requests benchmarking service for their facilities. Program Manager will benchmark selected buildings using EPA's Portfolio Manager. This service is provided ***at no cost*** through the Sector-Specific offering. Email benchmarking@trcsolutions.com to get started or visit www.njcleanenergy.com/ssb

Step 2 Customer establishes "Energy Team." Program Manager discusses the results of the benchmarking report with the Energy Team and prioritizes buildings for more in-depth energy analysis.

Step 3 Customer initiates communication with a Partner to address buildings that were recommended for P4P*. Partner submits the P4P application. Additionally, Partner must submit **BPwES Participation Agreement** (can be downloaded from www.njcleanenergy.com/ssb).

Step 4 The P4P application and BPwES Participation Agreement are reviewed and approved by Program Manager. Partner begins the in-depth energy analysis of buildings and begins to develop the ERP.

Step 5 The ERP must meet all requirements of the P4P Program as outlined in these guidelines. Additionally, the Customer must fill out and submit **EPA's Energy Program Assessment Matrix** (available for download on ENERGY STAR website[10]).

Step 6 Customer works with Partner to move through the P4P Program and collects Program incentives.

Step 7 Partner re-submits an updated Energy Program Assessment Matrix, along with the Post-Construction Benchmarking Report, at the end of the Program.

Step 8 Customer receives ENERGY STAR recognition, as well as P4P Program incentives, energy savings benefits, and an established Energy Management Program for their facilities.

*Buildings that do not qualify for Pay for Performance will be directed to other applicable NJCEP incentive Programs.

[10] http://www.energystar.gov/index.cfm?c=tools_resources.bus_energy_management_tools_resources

Appendix A

Minimum Performance Standards

This Appendix contains information on minimum performance standards for measures included in the project work scope (derived from the NJ SmartStart Buildings Program).

Proposed measures must meet or exceed the minimum efficiencies and/or requirements as listed within this Appendix. For equipment not listed here, minimum efficiencies and/or requirements must meet or exceed ASHRAE 90.1-2016 for non-residential buildings and multifamily buildings over 3 story high, and IECC 2018 for low rise multifamily buildings. Equipment not regulated by these codes must be more efficient than industry standard. Requirements may be waived or modified by Program Manager on a case by case basis due to limited market availability of equipment.

Additionally, all applicable equipment must be new and listed by UL or other OSHA approved Nationally Recognized Testing Laboratory (NRTL), such as CSA, in accordance with applicable US standards. Manufacturer's specification sheets may be requested by Program Manager to confirm performance.

A-1. Chillers

Electric Chillers: Proposed equipment must comply with both Full Load and Part Load (IPLV) values below.

	Constant Speed		Variable Speed		Constant Speed		Variable Speed	
	Full Load kW/ton	IPLV kW/ton	Full Load kW/ton	IPLV kW/ton	Full Load EER	IPLV EER	Full Load EER	IPLV EER
Air Cooled								
tons < 150					10.30	13.70	9.70	16.12
tons ≥ 150					10.30	14.00	9.70	16.42
Water Cooled Positive Displacement								
tons < 75	0.735	0.600	0.780	0.490				
75 ≤ tons < 150	0.706	0.560	0.750	0.480				
150 ≤ tons < 300	0.647	0.540	0.680	0.431				
300 ≤ tons < 600	0.598	0.520	0.625	0.402				
tons ≥ 600	0.549	0.500	0.585	0.372				
Water Cooled Centrifugal								
tons < 150	0.598	0.550	0.695	0.431				
150 ≤ tons < 300	0.598	0.550	0.635	0.392				
300 ≤ tons < 400	0.549	0.520	0.595	0.382				
400 ≤ tons < 600	0.549	0.500	0.585	0.372				
tons ≥ 600	0.549	0.500	0.585	0.372				

- *Air-cooled chillers - Efficiencies above are based on the unit's compressor kW per capacity (tons) at AHRI conditions.*

- *Water-cooled chillers - All water-cooled chillers must be submitted at AHRI Standard 550/590 conditions. If an applicant has a water-cooled centrifugal chiller that is designed to operate at other than the AHRI standard conditions the procedure in ASHRAE Standard 90.1-2016, Section 6.4.1.2.1 may be used by the applicant to adjust the manufacturer's published efficiency at non-AHRI conditions to the efficiency at AHRI standard conditions. The applicant will need to provide the manufacturer's non-AHRI ratings as well as the calculations for the chiller efficiency at AHRI conditions.*

Gas Absorption Chillers and Gas Engine Driven Chillers

Full or part load efficiency, all sizes	> 1.1 COP.

- *Gas Absorption Chillers - Full and part-load efficiencies are determined in accordance with AHRI Standard 550/590/2003. Chillers > 400 tons must be two-stage in order to qualify.*

A-2. Electric Unitary HVAC

- Proposed equipment must meet all efficiency requirements as stated in the tables below:

Equipment Type	Cooling Capacity (Btu/h)	Minimum Efficiency		
		SEER	EER	IEER
Unitary HVAC Split System	< 65,000	14.0		
Unitary HVAC Single Package	<65,000	14.3		
Unitary HVAC Single Package or Split System	≥ 65,000 and < 135,000		11.5	13.0
	≥ 135,000 and < 240,000		11.5	12.4
Central DX AC	≥ 240,000 and < 760,000		10.5	11.6
	≥ 760,000		9.7	11.2

Equipment Type	Cooling Capacity (Btu/h)	Minimum Efficiency				
		SEER	HSPF	EER	IEER	COP
Air Source Heat Pump Split System	< 65,000	14.3	8.4			
Air Source Heat Pump Single Package	< 65,000	14.3	8.2			
Air Source Heat Pump Split System	≥ 65,000 and < 135,000			11.5	12.2	3.4
	≥ 135,000 and < 240,000			11.5	11.6	3.3
	≥ 240,000			9.5	10.6	3.2
Air Source Heat Pump Single Package	≥ 65,000 and < 135,000			11.5	12.2	3.4
	≥ 135,000 and < 240,000			11.5	11.6	3.3
	≥ 240,000			9.5	10.6	3.2

Equipment Type	Cooling Capacity (Btu/h)	Minimum Efficiency	
		EER	COP
Water to Air, Water Loop Heat Pump	< 17,000	12.4	4.3
	≥ 17,000 and < 65,000	13.3	4.3
	≥ 65,000 and < 135,000	13.3	4.3

Equipment Type	Cooling Capacity (Btu/hr)	Minimum Efficiency	
		EER	COP
Packaged Terminal AC	< 7,000	12.0	
	≥ 7,000	12.0	
	≥ 8,000	11.7	
	≥ 9,000	11.4	
	≥ 10,000	11.1	
	≥ 11,000	10.8	
	≥ 12,000	10.5	
	≥ 13,000	10.2	
	≥ 14,000	9.9	
	≥ 15,000	9.6	
Packaged Terminal Heat Pump	< 7,000	12.0	3.4
	≥ 7,000	12.0	3.4
	≥ 8,000	11.7	3.3
	≥ 9,000	11.4	3.3
	≥ 10,000	11.1	3.2
	≥ 11,000	10.8	3.2
	≥ 12,000	10.5	3.1
	≥ 13,000	10.2	3.1
	≥ 14,000	9.9	3.0
	≥ 15,000	9.6	3.0

Equipment Type	Cooling Capacity (Btu/h)	Minimum Efficiency	
		EER	COP
Single Packaged Vertical AC - SPVAC	< 65,000	10.2	
	≥ 65,000 and < 135,000	10.2	
	> 135,000 and < 240,000	10.2	
Single Packaged Vertical Heat Pump - SPVHP	< 65,000	10.2	3.1
	≥ 65,000 and < 135,000	10.2	3.1
	≥ 135,000 and < 240,000	10.2	3.1

- *Efficiencies listed above are based on equipment capacity at AHRI Certified Net Capacity and Rating at operating conditions.*

- *Both indoor and outdoor components of a Split System must be replaced to qualify for an incentive*

A-3. Ground Source Heat Pumps

- Proposed equipment must meet all efficiency requirements as stated in the table below:

Equipment Type	Cooling Capacity	Minimum Qualifying Efficiency	
	Btu/h	EER	COP
Groundwater Source Heat Pump	< 135,000	18.4	3.7
Ground Source Heat Pump	< 135,000	14.4	3.2

- ➢ *Performance ratings (EER, COP) for qualifying closed loop Ground Source Heat Pump equipment are calculated at 77 degrees Fahrenheit entering water temperature per test procedure ISO-13256-1.*
- ➢ *No incentives are available for open loop Ground Source Heat Pump equipment.*

A-4. Gas Heating

Gas Boilers			
	Size Category (MBH input)	Non-Condensing	Condensing
Hot Water	< 300	85% AFUE	88% AFUE
Hot Water	≥ 300 and ≤ 2,500	85% Et	88% Et
Hot Water	> 2,500	85% Ec	88% Ec
Steam	< 300	82% AFUE	N/A
Steam, all except natural draft	≥ 300	81% Et	N/A
Steam, natural draft	≥ 300	79% Et	N/A

Gas Furnaces	
Capacity	Minimum Efficiency
All size	95% AFUE

- ➢ *Efficiencies listed above are based on equipment capacity at AHRI Certified Net Capacity and Rating at operating conditions.*

A-5. Gas Water Heating

- Eligible equipment must meet the efficiencies stated for the given tank style and size in order to qualify as a measure.

U.S. DOE Definitions of Tank Style and Size		Minimum Efficiency
Gas-fired, Storage	≤ 75,000 Btu/h *(consumer)*	0.64 UEF
	>75,000 Btu/h and ≤ 105,000 Btu/h *(residential duty commercial)*	82% Et or 0.64 UEF
	>105,000 Btu/h *(commercial)*	82% Et
Gas-fired, Instant (tankless)	< 200,000 Btu/h *(consumer)*	90% Et or 0.90 UEF
	≥ 200,000 Btu/h *(commercial)*	90% Et

➢ *Gas Water Heating equipment capacity at AHRI Certified Net Capacity and Rating at operating conditions.*

A-6. Premium Motors

- Motors must meet Federal Standards as shown below, or ASHRAE 90.1-2016, whichever is more stringent:

TABLE 5—NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS) AT 60 HZ

Motor horsepower/ standard kilowatt equivalent	Nominal full-load efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20/15	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30/22	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40/30	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50/37	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60/45	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75/55	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100/75	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125/90	95.0	94.1	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.0	94.1	95.8	95.8	95.8	95.4	94.1	94.1
200/150	95.4	95.0	96.2	95.8	95.8	95.4	94.5	94.1
250/186	95.8	95.0	96.2	95.8	95.8	95.8	95.0	95.0
300/224	95.8	95.4	96.2	95.8	95.8	95.8		
350/261	95.8	95.4	96.2	95.8	95.8	95.8		
400/298	95.8	95.8	96.2	95.8				
450/336	95.8	96.2	96.2	96.2				
500/373	95.8	96.2	96.2	96.2				

TABLE 6—NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN C AND IEC DESIGN H MOTORS AT 60 HZ

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency (%)					
	4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	92.4	93.0	91.7	91.7	89.5	90.2
20/15	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	93.6	93.6	93.0	93.0	90.2	91.0
30/22	93.6	94.1	93.0	93.6	91.7	91.7
40/30	94.1	94.1	94.1	94.1	91.7	91.7
50/37	94.5	94.5	94.1	94.1	92.4	92.4
60/45	95.0	95.0	94.5	94.5	92.4	93.0
75/55	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.4	95.4	95.0	95.0	93.6	94.1
125/90	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.8	95.8	95.8	95.4	94.1	94.1
200/150	96.2	95.8	95.8	95.4	94.5	94.1

Table 7—Nominal Full-Load Efficiencies of Fire Pump Electric Motors at 60 Hz

Motor horsepower/ standard kilowatt equivalent	Nominal full-load efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	75.5		82.5	82.5	80.0	80.0	74.0	74.0
1.5/1.1	82.5	82.5	84.0	84.0	85.5	84.0	77.0	75.5
2/1.5	84.0	84.0	84.0	84.0	86.5	85.5	82.5	85.5
3/2.2	85.5	84.0	87.5	86.5	87.5	86.5	84.0	86.5
5/3.7	87.5	85.5	87.5	87.5	87.5	87.5	85.5	87.5
7.5/5.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	88.5
10/7.5	89.5	88.5	89.5	89.5	89.5	90.2	88.5	89.5
15/11	90.2	89.5	91.0	91.0	90.2	90.2	88.5	89.5
20/15	90.2	90.2	91.0	91.0	90.2	91.0	89.5	90.2
25/18.5	91.0	91.0	92.4	91.7	91.7	91.7	89.5	90.2
30/22	91.0	91.0	92.4	92.4	91.7	92.4	91.0	91.0
40/30	91.7	91.7	93.0	93.0	93.0	93.0	91.0	91.0
50/37	92.4	92.4	93.0	93.0	93.0	93.0	91.7	91.7
60/45	93.0	93.0	93.6	93.6	93.6	93.6	91.7	92.4
75/55	93.0	93.0	94.1	94.1	93.6	93.6	93.0	93.6
100/75	93.6	93.0	94.5	94.1	94.1	94.1	93.0	93.6
125/90	94.5	93.6	94.5	94.5	94.1	94.1	93.6	93.6
150/110	94.5	93.6	95.0	95.0	95.0	94.5	93.6	93.6
200/150	95.0	94.5	95.0	95.0	95.0	94.5	94.1	93.6
250/186	95.4	94.5	95.0	95.4	95.0	95.4	94.5	94.5
300/224	95.4	95.0	95.4	95.4	95.0	95.4		
350/261	95.4	95.0	95.4	95.4	95.0	95.4		
400/298	95.4	95.4	95.4	95.4				
450/336	95.4	95.8	95.4	95.8				
500/373	95.4	95.8	95.8	95.8				

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Polyphase		
	Open motors (number of poles)		
	6	4	2
0.25/0.18	67.5	69.5	65.6
0.33/0.25	71.4	73.4	69.5
0.5/0.37	75.3	78.2	73.4
0.75/0.55	81.7	81.1	76.8
1/0.75	82.5	83.5	77.0
1.5/1.1	83.8	86.5	84.0
2/1.5	N/A	86.5	85.5
3/2.2	N/A	86.9	85.5

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Capacitor-start capacitor-run and capacitor-start induction-run		
	Open motors (number of poles)		
	6	4	2
0.25/0.18	62.2	68.5	66.6
0.33/0.25	66.6	72.4	70.5
0.5/0.37	76.2	76.2	72.4
0.75/0.55	80.2	81.8	76.2
1/0.75	81.1	82.6	80.4
1.5/1.1	N/A	83.8	81.5
2/1.5	N/A	84.5	82.9
3/2.2	N/A	N/A	84.1

A-7. Variable Frequency Drives

- For HVAC Systems - VFDs must be installed in a system that incorporates pressure sensors (or other applicable sensor devices) in the flow stream.

- For Boiler Systems – VFDs must be controlled by an automatic signal in response to modulating air/water flows.

A-8. Lighting - Fixtures

General:

- Applicant and/or partner shall be responsible for maintaining and confirming adequate light levels.
- Incentives will not be provided for the installation of screw-in or plug-in lighting measures in non-permanent fixtures. For example, screw-in or plug-in lamps installed in refrigerator, oven, floor or desk lamps are not eligible for incentives.
- Lighting measures installed for use as retail display lighting do not qualify for incentives (i.e. lamps/fixtures for sale).

LED:

- LED product must be listed on ENERGY STAR® or Design Lights Consortium (DLC)* qualified products list. Horticultural LEDs are listed on a discreet DLC product list.
- DLC qualified products must be installed in line with the Primary Use Category (For example, a fixture designated by DLC under the primary use category Outdoor Full-Cutoff Wall-Mounted Area Luminaires will not receive an incentive when installed in an interior space).
- Must replace existing incandescent/halogen, fluorescent or HID lighting only.

**Note*: DLC regularly releases updates to their list of qualified products. The impact is that some LED products will no longer be qualified once changes take place. Changes to the DLC Qualified Products List poses unique challenges for the P4P program. For instance, due to the amount of time between application approval, ERP approval, and Installation approval, the Qualified Products List may change several times. Additionally, many projects at the ERP stage do not know exactly what type of fixture will eventually be purchased. Therefore, in order to assist participants, the Pay for Performance Program will support approval of LED measures qualified either at the time of equipment purchase (so long as purchase does not pre-date submission of application to the program), or at the time of ERP submission. This assumes appropriate invoices, specification sheets, and DLC print-outs can be provided demonstrating that the delisted products in question were qualified at the time of purchase and/or ERP submission. DLC products can be searched by listed and delisted products, and the dates in which products were listed and delisted will be displayed. https://www.designlights.org/search/*

Other:

- Pulse Start Metal Halide (including pole-mounted parking lot lighting) must have a 12% minimum wattage reduction.
- Induction Lighting fixtures replacing HID must use 30% less wattage per fixture than HID system.

A-9. Lighting - Controls

General:

- Lighting controls, where installed, must control eligible energy efficient lighting fixtures.
- Occupancy sensors shall not be installed in a space where they are prohibited by state or local building or safety code.

Occupancy Sensor Wall Mounted (OSW):

- OSW sensors must not allow manual override to the "ON" position.

High-Low Controls (OHLC):

- Not eligible in spaces smaller than 250 square feet.
- "Low level" shall be no more than 60% of "high level."

Daylight Dimming Controls (DDC):

- Dimming shall be continuous or stepped at 4 or more levels.
- Daylight dimming control systems must be designed in accordance with IESNA practice as delineated in "IES RP-5-13, Recommended Practice of Daylighting."

A-10. Computers

Computers may only be considered as a measure if ALL of the following apply:

- Measure proposes to replace CRT desktop computers with new desktop computers and LCD and/or LED flat panel monitors.
- Installation of new computers must be in a facility where they will be permanent (e.g. school, public library, etc.) or as determined by Program Manager.
- Computer and monitor must be ENERGY STAR®.

A-11. Refrigeration Covers/Doors

- Doors must have either heat reflective treated glass, be gas filled, or both.

- Aluminum night curtains only applicable for refrigerated cases, used for non-frozen products which do not have doors or other means of full or partial closure to reduce cold air loss to ambient room air.

A-12. Food Service Equipment

Equipment must comply with performance requirements as outlined in the corresponding NJCEP SmartStart Food Service Equipment application:
https://njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/application-forms/application-forms

A-13. Envelope Insulation, Windows, and Doors

- Refer to ASHRAE Standard 90.1-2016 Tables 5.5-4 and 5.5-5. For example:
    - Attic insulation must be minimum R-49, or maximum U-0.021
    - Insulation of floors between conditioned and semi-heated spaces must be minimum R-19 / maximum U-0.051
    - Insulation of floors of conditioned spaces adjacent to exterior must be minimum R-30, or maximum U-0.033.

- Lower insulation levels may be permitted when existing conditions prevent from installing required insulation thickness, as described in 90.1 Section 5.1.3.

- For multifamily properties specifically, consistent with requirements for NJCEP Home Performance with ENERGY STAR and the NJ Rehabilitation Code N.J.A.C. 5:23-6, the following may be permitted:
    - If 7 inches of attic insulation is present, an upgrade is not required
    - If insulation is less than 7 inches, and additional 6 inches of insulation must be added
    - Where attic flooring is installed with existing insulation less than 7 inches and the gap between existing insulation and the flooring is greater than 2 inches, insulation upgrade must be installed to fill the cavity.
    - Where there is no existing attic insulation, R-49 attic insulation must be installed.

  In the above circumstances, any proposed insulation that does not meet ASHRAE 90.1-2016 prescriptive requirements will require submittal of a copy of the Building Permit prior to Energy Reduction Plan approval, which confirms that proposed insulation work has been approved by local code officials. Failure to provide this documentation will result in rejection of this measure from the project's P4P scope of work.

- Windows and doors shall be ENERGY STAR® rated where available and comply with current NJCEP Protocols to Measure Resource Savings.

A-14. Low-Flow Hot Water Fixtures

Low Flow Shower Head: Can be either a low-flow shower head or shower flow control valve. Cannot exceed 2 GPM (EPA Water Sense)

Low Flow Faucet: Can be either faucet aerator or flow control valve. Cannot exceed 1.5 GPM (EPA Water Sense).

A-15. Refrigeration Controls

Floating Head Controls: Baseline system must have a fixed saturated condensing temperature. Systems must have variable speed condenser fan controls. Temperatures must be reset based on ambient wet bulb temperatures for evaporative cooled systems, and dry bulb temperatures for air cooled systems.

Floating Suction Controls: Baseline system must have a fixed saturated suction temperature (SST) fixed to serve relevant suction groups (low, medium, high). Measure case SST must be rest higher for each applicable suction group (low, medium, high) based on the worse case load on that group.

A-16. Occupancy Controlled Thermostats

Limited to hotel/hospitality, with over 50 units. Thermostat must be controlled via one of the following occupancy-based methods

1. In-room occupancy sensors (single or dual technology)
2. Keycard-based system
3. Check-in/check-out system – requires door switch
4. and in-room occupancy sensor.

Appendix B

NJCEP Measure Lives

The measure lives listed below should be used for all recommended measures included in the Energy Reduction Plan, specifically in ERP Excel Tables, Measure Simulation tab. Deviation from the below stipulated measure lives must be supported by appropriate documentation. For example, if actual measure lives are available through nameplate information or other manufacturing specifications with proper documentation, those measure lives should be utilized to calculate lifetime savings.

NEW JERSEY STATEWIDE ENERGY-EFFICIENCY PROGRAMS
Measure Lives Used in Cost-Effectiveness Screening – October 2020

Measure	Measure Life (Years)
Residential Sector	
Lighting End Use	
CFL	5
LED	15
HVAC End Use	
Central Air Conditioner (CAC)	15
CAC QIV	15
Air Source Heat Pump (ASHP)	15
Mini-Split (AC or HP)	17
Ground Source Heat Pumps (GSHP)	25
Furnace High Efficiency Fan	15
Heat Pump Hot Water (HPHW)	10
Furnaces	20
Boilers	20
Combination Boilers	20
Boiler Reset Controls	10
Heating and Cooling Equipment Maintenance Repair/Replacement	10
Thermostat Replacement	11
Hot Water End-Use	
Storage Water Heaters	11
Instantaneous Water Heaters	20
Low Flow Showerhead	10
Solar Water Heater	20
Building Shell End-Use	
Air Sealing	15
Duct Sealing and Repair	18
Insulation Upgrades	25
Doors	30
Door Sealing Materials, Door Sweeps, and Spray Foam Sealant	15
Appliances/Electronics End-Use	
ES Refrigerator	14
ES Freezer	14
ES Dishwasher	11
ES Clothes washer	11
ES RAC	9
ES Air Purifier	9

Measure	Measure Life (Years)
ES Dehumidifier	12
ES Set Top Box	4
ES Sound Bar	7
Advanced Power Strips	8
ES Clothes Dryer	12
Refrigerator Retirement	5
Freezer Retirement	4
CO Alarm	7
Commercial Sector	
Lighting End Use	
Performance Lighting	15
Prescriptive Lighting	15
Refrigerated Case LED Lights	16
Specialty LED Fixtures (Signage)	16
Lighting Controls	8
HVAC End Use	
Electronically Commutated Motors for Refrigeration	15
Electric HVAC Systems	15
Fuel Use Economizers	15
Dual Enthalpy Economizers	10
Occupancy Controlled Thermostats	11
Electric Chillers	20
Gas Chillers	25
Prescriptive Boilers	20
Prescriptive Furnaces	20
Commercial Small Motors (1-10 HP)	15
Commercial Small Motors (11-75 HP)	15
Commercial Small Motors (76-200 HP)	15
Small Commercial Gas Boiler	20
Infrared Heaters	17
Programmable Thermostats	11
Demand-Controlled Ventilation Using CO2 Sensors	15
Boiler Reset Controls	10
Building Shell End-Use	
Air Sealing	15
Insulation	25
Doors	30
VFDs End Use	
Variable Frequency Drives	15
New and Retrofit Kitchen Hoods with Variable Frequency Drives	15
Refrigeration End Use	
Energy Efficient Glass Doors on Vertical Open Refrigerated Cases	12
Aluminum Night Covers	5
Walk-in Cooler/Freezer Evaporator Fan Control	16
Cooler and Freezer Door Heater Control	12

Measure	Measure Life (Years)
Electric Defrost Control	10
Novelty Cooler Shutoff	5
Vending Machine Controls	5
Food Service Equipment End-Use	
Electric and Gas Combination Oven/Steamer	12
Electric and Gas Convection Ovens, Gas Conveyor and Rack Ovens, Steamers, Fryers, and Griddles	12
Insulated Food Holding Cabinets	12
Commercial Dishwashers Commercial Refrigerators and Freezers	15 12
Commercial Ice Machines	10
Hot Water End-Use	
Tank Style (Storage) Water Heaters	15
Instantaneous Gas Water Heaters	20
Low Flow Faucet Aerators and Showerheads	10
Low Flow Pre-rinse Spray Valves	5
Pipe Insulation	11
Appliances/Electronics End-Use	
Computer	4
Printer	6

Appendix C

New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs

Lighting tables from the New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Appendix C can be used as a reference for baseline and retrofit lighting fixture wattages. The link to this document is provided below and document is also available on the Partner Portal.
https://www3.dps.ny.gov/W/PSCWeb.nsf/All/72C23DECFF52920A85257F1100671BDD

Appendix D

Metering Guidelines

D-1. Introduction

This Appendix contains guidelines for the metering individual energy conservation measures. Use the information in Section 4.3 to determine what equipment must be pre-metered. Results from the metering activities must be included in the ERP and will be used as inputs to the simulation model.

Option A – ***Partially Measured Retrofit Isolation****:* Savings are predicted using engineering or statistical methods that do not involve long-term measurement. This option will generally be accepted only where other methods are not cost effective and the savings are very predictable and reliable.

Option B – ***Retrofit Isolation****:* Involves short-term or continuous metering during the performance period to determine energy consumption. Measurements are usually taken at the device or system level.

Option C – ***Whole Facility***: Involves (1) comparing monthly billing data recorded for the whole building or project site by a utility meter or sub-meters, before and after project installation, and (2) analyzing that data to account for any variables, such as weather or occupancy levels. Energy savings can be determined once the variables are recognized and adjusted to match pre-installation conditions.

Option D – ***Calibrated Simulation****:* Involves using software to create a simulated model of a building based on blueprints and site surveys. The model is calibrated by comparing it with billing or end-use monitored data. Models of the project are typically constructed for (1) the existing base case, and (2) a case with the energy measures installed.

D-2. Lighting: Monitoring Hours of Operation

This method is based on the methodology of Option B in the FEMP M&V Protocols v4.0. The lighting projects covered by this standard M&V plan include:

- All retrofits of existing fixtures, lamps, or ballasts with more energy-efficient fixtures, lamps, or ballasts.
- Delamping with the use of reflectors.
- Installation of lighting control devices (such as occupancy sensors, daylight controls, automated lighting controllers, etc.) with or without changes to fixtures, lamps, or ballasts.

D-2.1 Overview of Metering Method

Surveys of existing and proposed fixtures must be documented in the ERP per Sections 3.3.1 and 4.6.3. Corrections or adjustments may be required for non-operating fixtures.

Pre-installation hours of operation will be determined by default building type (Section 4.6.3) or monitoring a statistically valid sample of fixtures/rooms (Section 3.3.1). The monitoring period must be reasonable and account for any seasonal variations.

If the Partner must measure fixture wattages, the following metering protocol should be used: The Partner must take 15-minute, true RMS wattage measurements from at least six identical fixtures of the type for which wattage data are required.[11] Readings will be averaged to determine the per-fixture wattage values. Meters used for this task must be calibrated and have an accuracy of ±2% of reading or better.

D-2.2 Adjustments to the Baseline Demand for Non-Operating Fixtures

Prior to installing new lighting fixtures, adjustments to the baseline demand may be required for non-operating fixtures. The Partner must identify all of the building's existing non-operating fixtures that will be retrofitted or replaced. Non-operating fixtures are those that are *typically operating*, but that have broken lamps, ballasts, or switches intended for repair. A delamped fixture is **not** a non-operating fixture, and thus delamped fixtures should have their own unique wattage designations. Fixtures that have been disabled or delamped or that are broken and not intended for repair should be noted, but *not included* in the calculation of baseline demand or energy use.

The baseline demand may include fixture wattages for up to 10% of the building's non-operating fixtures. *The inclusion of non-operating fixtures is limited to 10% of the total fixture count per building.* Therefore, if 10% or less of the existing fixtures in the building are non-operating, the Partner should include these fixtures and their functioning wattages. If more than 10% of the total number of fixtures is non-operating, the baseline demand needs to be adjusted. In this case, the number of fixtures beyond 10% should be included, but they will have a baseline and post-installation fixture wattage of zero.

D-2.3 Metering

The type of monitoring equipment and the length of the monitoring period should be documented in the ERP.

Monitoring is intended to provide an estimate of annual equipment operating hours. The duration and timing of the run-time monitoring strongly influence the accuracy of operating-hour estimates. Run-time monitoring should not be conducted during significant holiday or vacation periods. If a holiday or vacation falls within the run-time monitoring installation period, the monitoring should be extended for as many days as the usage aberration.

The amount of time required to monitor the operating hours of the lighting fixtures in the building (i.e., the monitoring period) is determined by the building's type and operating schedule. Buildings with variable schedules that change with the season or other factors require more monitoring than buildings with fixtures that have a constant operating schedule throughout the year. In all cases, the monitoring period should be long enough

[11] Actual values may vary by application.

to capture the operating schedule and any changes in the schedule. In most cases, operating hours will need to be monitored for three weeks. For buildings with seasonal schedules, such as schools and universities, longer monitoring periods are required. **Table D-2.1** specifies the minimum monitoring period required to determine hours of operation for lighting fixtures. Contact the Program Manager for required monitoring periods if the facility type is not in **Table D-2.1.**

If less-than-continuous monitoring is used, the lighting-operating hours during the monitored period will be extrapolated to the full year.

Table D-2.1. Monitoring Periods for Different Building Types

Building Type	Monitoring Period Required to Determine Operating Hours
Retail Stores	3 weeks
Office Buildings	3 weeks
Schools	3 weeks[a]
Hospitals	3 weeks
Industries with constant production	3 weeks
Industries with seasonal production	4-8 weeks[b]

a. If summer or out-of-session savings are greater than 20% of the total savings, then a minimum of 2 weeks if monitoring is required for both in-session and out-of-session periods.
b. Minimum of 2 weeks each season with a change in operating hours.

D-2.4 Usage Groups

Separate rooms or areas in the building(s) with similar use and operating schedules should be organized into usage groups. By applying usage groups, monitoring points can be allocated across buildings, reducing the total number of monitoring points required for a multiple-building project.

The rooms or occupancies included in the same usage group must have similar use and operating hours. For instance, even though a building's exterior lighting may have the same annual hours of operation as the hallway lights, the two lighting systems have different uses. In this case, a change in the operating hours of the exterior lights due to installation of a photocell would not be relevant to the hallway light operating hours. Therefore, the exterior and hallway lighting would be organized into two separate usage groups.

Refer to **Table D-2.2** to determine the suggested minimum number of usage groups for the building type. Six different usage groups for a normal office building might include private offices, shared offices, hallways, 24-hour lighting, rest rooms, and common areas.

Table D-2.2. Suggested Minimum Number of Usage Groups for Building Types

Building Type	Suggested Minimum Number of Usage Groups
Office Buildings	5
Elementary and Middle Schools	5
High Schools	6
Hospitals	10
Retail Stores	4
Light Industries	5
Heavy Industries	6
Manufacturing Plants	6
Other	10

Operating-hour estimates for each usage group should be reasonable and based on interviews with building personnel, observation of site conditions, and typical operating-hour estimates for the space use. Operating hour estimates will be reviewed by the Program Manager, and unrealistic estimates will be grounds for revising the ERP. The Partner would then be required to resubmit an updated ERP. Partners are encouraged to provide supporting documentation for their operating hour estimates.

D-2.5 Metering Equipment

Details on the equipment used to monitor the hours of operation should be included in the ERP. This includes type of equipment, manufacturer's name, model number, and summary specifications. Monitoring equipment for recording operating hours of lighting fixtures normally fall under one of the following categories:

- "Light Loggers" measure the operating hours of individual fixtures through the use of photocells. Only light loggers that store information translatable into actual load profiles of on and off times for fixtures (time-of-use-loggers) are allowed. Current sensitive loggers are also available.
- Current or power measurements of lighting circuits that, when calibrated to the total lighting load on the circuit, can be used to determine how many fixtures were operating in terms of elapsed time or actual time-of-use load profiles.
- Energy Management Systems can be used to record or trend usage of lighting equipment and/or lighting energy consumption.

The monitoring equipment used must measure and record data indicating operating hours in a downloadable electronic format. The monitoring device must also record status at frequent intervals (i.e., at least every 15 minutes). "Raw" as well as "compiled" electronic data from the monitoring devices must be submitted to the Program Manager for verification if requested.

If the Partner chooses to monitor electrical circuits to determine average operating hours, power-recording meters that record the circuit on/off status must be used. Only when lighting and non-lighting loads are separate may circuit monitoring be used.

D-2.6 Accuracy and Quality Assurance

The Partner should describe any information or steps taken to assure accuracy and quality of the metering results. The following is a list of common problems associated with lighting monitoring and analysis of data. The Partner should review these carefully to avoid erroneous results.

- **Undersampling:** If the lighting measure population after installation or during the Program year is different than that anticipated, the Partner should re-calculate the required sample sizes.
- **Box time:** Box time refers to the time a logger spends in a box as opposed to monitoring a fixture. There are two kinds of box time: before a logger starts logging, and after the logger is removed. The first type is the period between logger initialization and logger installation. Once a logger is initialized, it records "Light Off" until the sensor is properly installed. The second type is the period between logger removal and data downloading. The logger records "Off" when it is waiting for data to be downloaded. Data with significant box time decreases the average on-time and increases the coefficient of variation. Partners should identify box times for each logger file. Box time can be minimized by initializing the loggers as they are installed and downloading data from the loggers as they are being removed from the fixtures.
- **Malfunctions:** If a logger is damaged or malfunctions during the monitoring period, it should be identified as malfunctioning and the data should be disregarded. However, a logger with data significantly different from the average cannot be eliminated if both the metered equipment and the logger are functioning correctly.
- **Logger data error:** Although highly unlikely, a portion of the logger data may be erroneous due to computer error or transferring data files from one place to another. If justifiable and approved by the Program Manager, these data may be removed from the analysis.
- **Flickering:** If the fixture being monitored flickers during the monitoring period, any transition less than five minutes should be ignored. The presence of a large number of cycles with very short duration is a good indication the fixture was flickering.
- **Duplicate recording of hours of operation:** If two or more loggers collect data from the same circuit (on/off switch), the loggers will be treated as one sample point. The exception is loggers that were monitoring in-session and out-of-session periods for a school building, or a change in season for manufacturing buildings.
- **Multiple monitoring periods:** Some facilities, such as schools, may require multiple monitoring periods for each sampled point. In such cases, the same fixture must be monitored for all periods. Annual hours of operation for the sampled point are then determined by weighting each monitoring period's data by the applicable percentage of the year represented.

The Program requires that all meters, monitoring equipment, and transducers provide accurate readings. Reports should be submitted indicating equipment has been calibrated per manufacturer procedures within the past twelve months, if requested.

D-3. Lighting: Metering of Lighting Circuits

This alternate metering method for metering electric consumption of lighting circuits also follows the methodology of Option B in the FEMP M&V Protocols v4.0. The lighting projects covered by this method include:

- Retrofits of existing fixtures, lamps, or ballasts with more energy-efficient fixtures, lamps, or ballasts.
- Delamping with the use of reflectors.
- Installation of lighting control devices (such as occupancy sensors, daylighting controls, automated lighting controllers, etc.) with or without changes to fixtures, lamps, or ballasts.

D-3.1 Overview of Verification Method

This method involves measuring all, or a representative number of, lighting circuits to determine:

- Baseline and post-installation electrical energy consumption (kWh)
- Current flow (amperage) or power draw (wattage) per unit of time. The post-installation metering period may be continuous or for a reasonable, limited time period.

Depending on the specifics of the lighting retrofit and electric distribution system within the building(s) it may be more cost-effective to employ this method rather than that described in Section D-2 (where hours of operation at the fixture level are determined). In this alternate method, the quantity of metering points is typically lower. The retrofit type, inventory of available metering equipment, and accessibility to fixtures and/or lighting panels will also affect the method selection.

In a pre-installation equipment survey, the equipment to be changed and the replacement equipment to be installed for the buildings under the project are inventoried. The ERP should include fixture, lamp and ballast types, usage group designations, and counts of operating and non-operating fixtures. Data requirements for lighting and lighting control measures are presented in Section D-2.

D-3.2 Circuit Measurements

Circuit measurements determine either power draw or current flow (as a proxy for power draw) on one or more circuits that have only (or primarily) lighting loads. The circuits must be carefully selected to ensure that:

- Only lighting loads affected by the retrofit are on the measurement circuit(s) (typically 277-Volt circuits are used); or

- If other loads are on the circuit(s), the non-lighting loads should be minimal, well-defined, and not vary either before the retrofit is complete.

If only a subset of affected lighting circuits is metered, the following issues must be addressed:

- Define the lighting loads on each lighting circuit;
- Determining which lighting circuits represent the entire project site, certain areas, or certain lighting usage groups; and
- Determine appropriate lighting-circuit sample sizes.

Whether all or just a sample of circuits is metered, it is important to specify how long the metering will be conducted to determine a representative baseline operating profile.

The Partner should develop a sampling plan for monitoring circuits for each project site. The sampling plan may concentrate measurements in areas with the greatest savings. However, total circuits monitored must represent at least 70% of the energy savings.

D-3.3 Metering Equipment

The Partner must specify the meter(s) to be used. Circuit measurements are typically done with either:

- Current transducers connected to one or more legs of a lighting circuit. Current data measurements are taken over an extended period of time. Voltage and power-factor data are taken as spot measurements and then assumed to be constant during the time period of the current metering; or,
- True RMS current and potential (voltage) transducers are used to measure power continuously during the period. This type of metering can be more accurate than current measurement, but it is also more expensive.

The Partner should use a data logger that records status at frequent intervals (i.e., at least every 15 minutes). “Raw” as well as “compiled” data from the meter(s) must be made available to the Program Manager upon request. The Partner must maintain this data throughout the term of the project.

D-3.4 Metering Period

Metering is intended to provide an estimate of demand profiles and annual energy use. Duration and timing of circuit metering installation strongly influences the accuracy of energy-savings estimates. Metering should not be installed during significant holiday or vacation periods. If a holiday or vacation falls within the metering installation period, the metering should be extended for as many days as the usage aberration.

If less-than-continuous monitoring is used, the lighting operating hours during the monitored period will be extrapolated to the full year. Please refer to **Table D-2.1** to determine the minimum monitoring period for different project types.

D-3.5 Non-Operating Fixtures

Before installing new lighting fixtures, adjustments to the baseline demand may be required for non-operating fixtures. In addition, after the lighting controls installation, adjustments to baseline demand may be required because of remodeling or changes in occupancy. Methods for making adjustments must be specified in the ERP.

The Partner must identify all non-operating fixtures (i.e., those that typically operate, but have broken lamps, ballasts, or switches intended for repair). See Section D-2.2 for a discussion of how to account for and adjust the baseline for non-operating fixtures.

D-4. Constant-Load Motors

This method is based on the methodology of Option B in the FEMP M&V Protocols v4.0. Constant-load motor efficiency projects involve replacing existing (baseline) motors with high-efficiency motors that serve constant-load systems. These measures are called constant-load motor efficiency projects because the power draw of the motors does not vary over time. These projects reduce demand and energy use.

This method is appropriate only for projects where:

- Constant-load motors are replaced with similar capacity constant-load motors, or
- Baseline motors are replaced with smaller high-efficiency constant-load motors when the original motor was oversized for the load.

If motor changes are accompanied by changes in operating schedule or flow rate, or installation of variable-speed controls, other methods must be used.

D-4.1 Overview of Metering Method

Surveys are required to document existing (baseline) motors. The ERP should include for each motor:

- Nameplate data
- Operating schedule
- Spot and short-term metering data
- Description of motor application
- Location

Metering is required on at least one (1) motor of *each* horsepower size to determine average power draw for baseline and new motors. Demand savings are based on the average kW measured before, minus the proposed average kW. Allowances may be made for differences in motor slip between existing and new motors.

Operating hours for the baseline period will be determined with short- or long-term metering of at least a sample of motors. In addition, metering may be used to (a) confirm constant loading and (b) determine average motor power draw (if normalization is required).

D-4.2 Baseline Demand
Baseline conditions identified in the pre-installation equipment survey are defined by the Partner. Steps involved in establishing the baseline demand are:

- Pre-installation equipment survey
- Spot-metering of existing motors

The equipment survey is described in this sub-section. Spot metering measures instantaneous motor power draw and is discussed in Section D-4.4. The existing motors must also be short-term-metered to verify that the motor load is constant.

In the pre-installation equipment survey, the equipment to be changed and the replacement equipment to be installed must be inventoried. The ERP should include:

- Location
- Description of motor application
- Constant or variable loading
- Nameplate data
- Spot metering data (3-phase amps, volts, PF, kVA, kW and motor speed in rpm)
- Operating schedule

Non-Operating Motors. Prior to installing new motors, adjustments to the baseline demand may be required for non-operating motors that normally operate or are intended to operate. In addition, after installation, adjustments to baseline demand may be required due to factors such as remodeling or occupancy changes. Methods for making adjustments must be specified in the ERP.

Baseline Operating Hours. Baseline motor operating hours must be determined using short- or long-term metering and be described in the ERP.

D-4.3 Changes in Load Factor and Slip
Standard-efficiency and premium motors may rotate at different rates when serving the same load. Such differences in rotational speed, characterized as "slip," may lead to smaller savings than expected. Considerable slip-related savings impacts may be reflected in the load-factor difference between the existing motor and a new high-efficiency motor. Large differences in load factor between the existing motor and the replacement premium motor may also be symptomatic of other problems. The Partner must identify motors for which the difference in load factor between the high-efficiency and the baseline motor is greater than 10%.

In these cases, the Partner must provide an explanation, with supporting calculations and documentation. Acceptable reasons for changes in load factor greater than 10% may include:

- The high-efficiency motor is smaller than the original baseline motor. The Partner must document that the difference in load factor is due to differences in motor size.

- The high-efficiency motor exhibits less slip and is operating at a higher speed than the baseline motor. The Partner must document that the change in slip accounts for the difference in load factor. (On centrifugal loads, changes in RPM are governed by the "cube-law.") The Partner is encouraged to account for slip when selecting motors and preparing initial savings calculations or modifying motor-drive systems where appropriate.

D-4.4 Spot- and Short-Term Metering

For each baseline motor, spot-metering (i.e., instantaneous measurements) of volts, amperes, kVA, PF, and kW should be recorded. Such measurements should be made using a true RMS meter with accuracy at or approaching ±2% of reading.[12] Other factors that may be measured include motor speed in rpm and the working fluid temperature if the motor serves a fan or pump.

The Partner must conduct short-term monitoring to:

- Verify that motor loads are constant (baseline only)
- Normalize spot-metering kW measurement results
- Determine operating hours, as discussed in Section D-4.5

The Partner must conduct short-term metering on all motors or a randomly selected sample of motors with the same application or operating hours. Short-term metering should be conducted for a sufficient period to capture the full range of motor operation and all variances in the load it serves. Short-term metering should be summarized in a form. Sample selection and metering results for the entire sample should be summarized in a table.

Partners may conduct short-term metering using current transducers and data loggers. The equipment for short-term metering need only be accurate within ±5% of full scale, but must be calibrated against the spot-metering equipment specified above by taking spot-metering readings at the same time. Thus, short-term metering equipment must be installed at the same time spot-metering readings are being taken. Data loggers will record readings at intervals of 15 minutes or less.

<u>Verify Constant Load</u>. The Partner will verify that motor loads are constant by comparing the short-term metering period average amps to all hourly non-zero values. An application will be verified as constant if 90% of all non-zero observations are within ±10% of the average amps determined above. The Partner will record the number of non-zero observations, the number of observations within ±10% of the average amperes determined above, and the percent of observations within ±10% of the average amperes. If any application cannot be verified as constant load, the Partner will examine the collected data to determine whether the load for the motor varies on a systematic and

[12] Gordon, et al. (Gordon, F.M., et al. Impacts of Performance Factors on Savings from Motors Replacement and New Motor Programs. ACEEE 1994 Summer Study on Energy Efficiency in Buildings. American Council for an Energy-Efficient Economy. 1994) reported that, on average for all qualifying motors, the change in efficiency between a standard-efficiency and a high-efficiency motor, including an adjustment for slip, was 4.4%. As such, the resolution of meters used to measure instantaneous kW should be much smaller than 4.0%.

predictable basis, whether the constant load was changed during the test period, or whether there is some system anomaly.

If the load varies on a systematic basis, the motor will be treated as a variable load. If the load was changed during the short-term monitoring period, the spot-metering and short-term monitoring testing will be repeated. If a system anomaly is discovered, the Partner will investigate the anomaly to determine whether there is a logical explanation. Once the anomaly is understood, the Partner must either treat the load as a variable load or re-test as a constant load.

Normalize Spot-Metering kW Measurement Results. To determine the average power draw of the motors, the spot kW measurements must be adjusted and normalized using short-term measurement data with the following equation:

Normalizing factor = (average amps measured during short-term metering) ÷ (instantaneous amps measured with spot-metering)

For each motor replaced, the Partner must then calculate average or normalized kW, using the following equation:

Normalized kW = instantaneous kW x normalizing factor

For motors not subject to short-term metering, the normalizing factor is equivalent to the average normalizing factor developed for the motor sample of the same application.

D-4.5 Monitoring to Determine Operating Hours

Operating hours may be the same before and after the new motors are installed, or they may be different. Operating hours for the baseline period must be determined with short- or long-term monitoring on at least a sample of motors. If the post-installation operating hours differ from the baseline, then they must also be incorporated into energy savings calculations.

Monitoring is intended to estimate annual equipment operating hours. Duration and timing of run-time monitoring installation strongly influence the accuracy of operating-hour estimates. Run-time monitoring should not be installed during significant holiday or vacation periods. If a holiday or vacation falls within the run-time monitoring installation period, the monitoring should be extended for as many days as the usage aberration.

If less-than-continuous monitoring is used, the monitored period’s operating hours shall be extrapolated to the full year. A minimum monitoring period of three weeks is recommended for almost all usage-area groups. For situations in which motor operating hours might vary seasonally or according to a scheduled activity, such as in HVAC systems, it may be necessary to determine operating hours during different times of the year.

The ERP must specify the period and schedule used for monitoring.

D-4.6 Selecting Motors for Metering

Spot-Metering. The Partner must spot-meter all of the motors. However, the short- or long-term metering to determine (a) that the load is constant, (b) normalizing factors, and (c) monitoring operating hours may only be necessary for a sample of motors.

Sampling. Partners should begin their sampling analyses by classifying existing motors by applications with identical operating characteristics or expected operating hours. Examples of applications include, HVAC constant-volume supply fans, cooling water pumps, condenser water pumps, HVAC constant-volume return fans, and exhaust fans. Each application must be defined and supported with schematics of ductwork or piping, as well as control sequences to demonstrate that the application qualifies as a constant load.

Sampling Accuracy. For each application or usage group in the project, there must be at least one motor of each horsepower size that is short-term metered. Similar to the guidelines for lighting projects:

- Sampling of a single project site's motor operating hours must meet a precision and confidence level of 90/20 for the site as a whole.
- Sampling in usage groups across multiple facilities must meet a precision and confidence level of 80/20 for each usage group. Sampling across multiple facilities can only be done if the facilities have the same usage groups, occupancy and use, and energy use patterns.

D-5. Variable Speed Drives

This method is based on the methodology of Option B in the FEMP M&V Protocols v4.0. Variable-speed drive (VSD) efficiency projects involve replacing existing (baseline) motor controllers VSD motor controllers. These projects reduce demand and energy use, but not necessarily utility demand charges. VSD retrofits often also include installing new, high-efficiency motors. Typical VSD applications include HVAC fans and boiler and chiller circulating pumps.

This method is only appropriate for VSD projects with the following baseline motor conditions:

- Energy use is constant (i.e., constant-load motors), or
- Electrical demand as a function of operating scenarios (e.g., damper position for baseline or motor speed for post-installation) can be defined with spot measurements of motor power draw, and
- Operating hours as a function of different motor operating scenarios can be defined.

D-5.1 Overview of Metering Method

Surveys are required to document existing motors and motor controls (e.g., motor starters, inlet vane dampers, and VSDs). The ERP should include for each motor and control device:

- Nameplate data
- Operating schedule
- Spot metering data
- Description of motor application
- Location

Commissioning of VSD operation is expected.

Metering is required on at least a sample of the existing motors to determine baseline motor power draw. Constant-load motors may require only short-term metering to confirm constant-loading. For baseline motors with variable loading, the short-term metering is done while the motors' applicable systems are modulated over their normal operating range. For variable-load baseline motors, an average kW demand or a kW demand profile as a function of appropriate independent variables (e.g., outside air temperature) may be used for calculating baseline energy use. If independent-variable values are required for calculating the baseline, they must be monitored during the pre- and post-installation periods.

Post-installation metering is recommended on at least a sample of motors with VSDs.

Baseline demand and energy use are based on:

- Motor operating hours measured before the VSDs are installed, and
- A constant motor kW value determined from pre-installation metering.

Post-installation demand and energy use are based on:

- Estimated motor operating hours after the VSDs are installed, and
- Estimated motor kW

D-5.2 Determining the Baseline

The baseline conditions identified in the ERP must be defined by the Partner, and will be verified by the Program Manager during the pre-installation site inspection.

Baseline motor demand will either be:

- A constant kW value,
- A value that varies per a set operating schedule (e.g., 4,380 hours per year at 40 kW and 4,380 hours per year at 20 kW), or
- A value that varies as a function of some independent variables (e.g., outdoor air temperature or system pressure for a variable air-volume system).

Steps involved in establishing the baseline demand are:

- Pre-installation equipment survey, and
- Spot- or short-term metering of existing motors.

In the pre-installation equipment survey, the equipment to be changed and the replacement equipment to be installed are inventoried. The ERP must include:

- Location

- Description of motor application
- Load served
- Nameplate data
- Spot metering data
- Operating schedule

For each motor to be replaced, spot-metered 3-phase amps, volts, PF, kVA, kW, and motor-speed data should be recorded in a standard form. Such measurements should be made using a true RMS meter with accuracy at or approaching ±2% of reading. Other factors that may be measured include motor speed in rpm and the working fluid temperature if the motor serves a fan or pump.

The Partner will conduct short-term monitoring for constant-load baseline motors to:

- Verify that motor loads are constant, and
- Normalize spot-metering kW measurement results.

The Partner will conduct short-term monitoring for variable-load, baseline motors to:

- Develop a schedule of motor kW (e.g., 4,380 hours per year at 40 kW and 4,380 hours per year at 20 kW), or
- Define the relationship between motor kW and the appropriate independent variables (e.g., outdoor air temperature or system pressure for a variable air-volume system).

The Partner must conduct short-term metering on all baseline VSD-controlled motors or on a randomly selected sample of motors with the same application or operating hours. Short-term metering should be conducted and analyzed in the manner discussed in Section D-4.6 for constant-load motor applications.

<u>Operating Hours.</u> Baseline motor operating hours must be determined prior to installation. If post-installation operating hours are different from the baseline, then they must be discussed in the ERP. Short- or long-term metering will be used to determine operating hours as discussed in Section D-5.4.

<u>Adjustments to Baseline Demand and Energy Savings.</u> Prior to installing new motors, adjustments to the baseline demand may be required for non-operating motors that are normally operating or intended to operate. In addition, after measure installation, adjustments to baseline demand may be required because of factors such as remodeling or changes in occupancy. Methods for making adjustments must be specified in the ERP and Post-Installation Benchmarking Report, when required.

<u>Non-Operating Motors</u>. The Partner must also identify any non-operating motors. Non-operating equipment would be operating but for broken parts and is intended for repair.

D-5.3 Selecting Motors for Metering

<u>Spot-Metering.</u> The Partner must spot-meter all of the motors; however, short- or long-term metering may only need to be done for a sampling of motors.

<u>Sampling</u>. Partners must begin their sampling analyses by classifying existing motors according to applications with identical operating characteristics or expected operating

hours. Examples of applications include HVAC supply fans, cooling water pumps, condenser water pumps, HVAC constant-volume return fans, and exhaust fans. Each application will be defined and supported with schematics of ductwork or piping, as well as control sequences.

Sampling Accuracy. For each application or usage group in the Partner's project, there must be at least (1) motor of each horsepower size subject to short-term metering. Following the guidelines for lighting projects:

- Sampling of a single building's motor operating-hours, must meet a precision and confidence level of 90/20 for the project site as a whole.
- Sampling in usage groups across multiple facilities must meet a precision and confidence level of 80/20 for each usage group. Sampling across multiple facilities may be done only if the facilities have the same usage groups, ownership, occupancy and use, and energy use patterns.

D-5.4 Monitoring to Determine Operating Hours

Operating hours may be the same before and after the VSDs are installed, or the hours may be different. Operating hours for the baseline period will be determined with short- or long-term monitoring on at least a sample of motors.

Operating hours will be established for different operating scenarios. Examples include:

- For a baseline motor: 4,000 hours per year at 50 kW (control valve open) and 4,760 hours per year at 40 kW (control valve closed).
- For a motor with a VSD: 2,000 hours per year at 15 kW (50% speed), 2,000 hours at 30 kW (75% speed), and 4,760 hours at 50 kW (100% speed).

Monitoring is intended to provide an estimate of annual equipment operating hours and energy use. Duration and timing of run-time monitoring strongly influence the accuracy of operating-hour estimates. Run-time monitoring should not be conducted during significant holiday or vacation periods. If a holiday or vacation falls within the run-time monitoring period, the duration should be extended for as many days as the usage aberration.

If less-than-continuous monitoring is used, the operating hours during the monitored period will be extrapolated to the full year. A minimum monitoring period of *four weeks* is recommended for almost all usage groups. For situations in which motor operating hours might vary seasonally or according to a scheduled activity, such as in HVAC systems, it may be necessary to determine operating hours during different times of the year.

D-6. Chillers

This method is based on the methodology of Option B in the FEMP M&V Protocols v4.0. Measures included in this method include electric chillers, air conditioners, and heat pumps used for space-conditioning or process loads. For simplicity, the term "chiller" includes all of the applicable types of cooling equipment. Projects can include:

- Existing chillers replaced with more energy-efficient electric chillers; or
- Changes in chiller controls that improve chiller efficiency.

Two methods are described in this section. For the first, chiller electric energy use is continuously metered or metered at regular intervals. With the second method, chiller energy use and the cooling load are metered at regular intervals or continuously.

For projects that include the installation of non-electric chillers, a modified form of these approaches may be used.

D-6.1 Overview of Verification Methods

Surveys are required to document existing (baseline) and new (post-installation) chillers and chiller auxiliaries (e.g., chilled-water pumps, cooling towers). The surveys should include (in a set format) for each chiller and control device:

- Nameplate data
- Chiller application
- Operating schedules
- Cooling load profile
- Control sequence

When multiple chillers serve the same area, i.e. a chiller plant, a survey of all chillers must be provided.

Energy Use Metering Method. Pre-installation chiller energy use is continuously measured, or measured during set intervals to determined baseline energy use. Baseline energy use is based on:

- Measured or stipulated baseline chiller ratings (e.g., kW/ton, IPLV), and
- Cooling loads calculated from measuring pre-installation chiller energy use.

Energy Use and Cooling Load Metering Method. Pre-installation chiller energy use and cooling loads are continuously measured, or measured during set intervals, to determine baseline energy use. Baseline energy use is based on:

- Measured or stipulated baseline chiller ratings (e.g., kW/ton, IPLV), and
- Cooling loads measured during the post-installation period.

Metering of all chillers is required and commissioning of new chiller operation is expected.

D-6.2 Baseline Efficiency

Baseline conditions identified in the pre-installation equipment survey must be defined by the Partner and documented in the ERP.

Steps involved in establishing the baseline demand are:

- Pre-installation equipment survey, and
- Defining chiller efficiency or metering of existing chillers.

Pre-Installation Equipment Survey. In the pre-installation equipment survey, the equipment to be changed and the replacement equipment to be installed will be inventoried. The ERP shall include:

- Location
- Chiller and chiller auxiliaries' nameplate data
- Chiller age, condition, and ratings
- Load served
- Operating schedule
- Cooling load profile
- Control sequence
- Chiller application
- Equipment locations

Baseline chiller performance should be measured. If multiple chillers utilize a common header the baseline efficiency is calculated using a capacity-weighted average of all chillers in the plant, unless one chiller is used as a back-up. All methods for determining chiller performance/efficiency, as well as resulting values, must be included in the ERP.

Stipulated Chiller Efficiencies. The most common sources of chiller performance data are the manufacturer or the minimum efficiencies specified in Appendix A, Minimum Performance Standards. For existing chillers, the "nameplate" performance ratings may be downgraded based on the chiller's age or condition. Chiller efficiency may be presented in several formats depending on the type of load data that will be stipulated. Possible options include annual average kW/ton expressed as Integrated Part Load Value (IPLV)[13] or kW/ton per incremental cooling loads.

For electric chillers, manufacturer data or performance sheets that illustrate the actual baseline efficiency (full load and IPLV) must be provided. The ERP must document how baseline kW/ton values were obtained.

Metering Existing Chillers. The data collected to characterize the performance of the chiller depends on whether or not the chiller's efficiency is sensitive to condenser and chilled water temperature. Volume II of the Final Report for ASHRAE Research Project 827-RP, Guidelines for In-Situ Performance Testing of Centrifugal Chillers, provides detailed instructions for developing both a temperature-dependent and independent model of chiller performance. The models use linear regressions on metered data to characterize the chiller's performance over a range of conditions. The wider the range of conditions during the metering, the more accurate the models.

[13] For example, as per the appropriate standards of the Air-Conditioning and Refrigeration Institute.

For temperature-independent chillers (i.e., chillers whose condenser and chilled-water temperatures are close to constant), the following data must be collected:

- Chiller kW
- Chilled water flow, entering and leaving temperatures for calculating cooling load

For chillers subject to varying condenser and chilled-water temperatures, the data noted above must be collected, along with:

- Condenser water supply and return temperatures.
- Chilled-water supply and return temperatures.
- If other features of the cooling plant are also modified by the proposed measures, they will need to be metered as well. For instance, if the condenser water pumps, chilled-water pumps, or cooling-tower fans are affected, their demand [kW] should also be metered.

To the greatest extent possible, this data should be entered into standard forms. Such measurements should be made using a meter with accuracy at or approaching ±2% of reading for power measurements and ±5% for flow measurements. Multiple measurements should be made while the cooling systems are operating at different loads so the complete range of chiller performance can be evaluated. Baseline metering typically requires at least several weeks during a time when the cooling load is expected to vary over a wide range, and additional time is often required.

D-7. Generic Variable Loads

This method is based on the methodology of Option B in the FEMP M&V Protocols v4.0 and includes continuous post-installation metering. This method covers projects that improve the efficiency of end-uses that exhibit variable energy demand or operating hours. Examples of such projects include:

- Replacing motors that serve variable loads with high-efficiency motors.
- Upgrading building automated systems.
- Installing new industrial process equipment.

D-7.1 Overview of Method

The Partner must audit existing systems to document relevant components (e.g., piping and ductwork diagrams, control sequences, and operating parameters). The Partner must also document the proposed project and expected savings. All, or a representative sample, of the existing systems should be metered by the Partner to establish regression-based equations (or curves) for defining baseline system energy use as a function of appropriate variables (e.g., weather or cooling load).

Once the measure is installed, there are two general approaches for determining pre- and post-installation energy use:

- Continuously measuring pre-installation energy use and the appropriate variables.

- Continuously measuring only the appropriate pre-installation variables. With this approach, the Partner will use pre-metering to determine the post-installation relationship between input energy and the appropriate variables after the project is installed.

Commissioning of new equipment operation is expected.

D-7.2 Determining the Baseline

The Partner must audit system(s) that will be affected to document all relevant components, such as motors, fans, pumps, and controls. For each piece of equipment, documented information should include the location, manufacturer, model number, rated capacity, energy use factors (such as voltage, rated amperage), nominal efficiency, the load served, and a listing of independent variables that affect system energy consumption.

The Partner must meter system input energy (e.g., kWh) and demand (e.g., kW) over a representative time period before any efficiency modifications are made. Such metering will be applied to those devices directly affected by the proposed measures. The duration of input metering will be sufficient to document the full range of system operation. Typically, observations will be made of 15-minute intervals, unless the Partner demonstrates that longer intervals are sufficient and such intervals are approved by the Program Manager.

If multiple similar equipment components or systems are to be modified (e.g., 10 supply fans), the Partner may meter a representative sample.

Variable Measurements. Over the same period that input energy use is monitored, the Partner will meter:

- Independent variables that affect energy and demand use. Examples of such data are ambient temperature, control set points, and building occupancy;
- Dependent variables (system output) that indicate energy and demand use. Such monitoring will clearly quantify output in units that directly correspond to system input. Examples of dependent variables are tons of cooling and gallons of liquid pumped.

Baseline Model(s). The Partner will use the results of the energy-input metering and variable(s) monitoring to calibrate the simulation model.

The Program Manager will make a final determination on the validity of models and monitoring and may request additional documentation, analysis, or metering from the Partner as necessary.

The Partner must carefully investigate systems and select data input and output for monitoring that exhibit direct relationships to energy use. For example, some processes may use the same amount of energy regardless of the amount of units produced. In such cases, the Partner should carefully analyze systems to identify a quantifiable output that exhibits a direct relationship to the input energy.

Appendix E

Frequently Asked Questions

E.1 Eligibility

1. **What constitutes Program eligibility?**
   Pay for Performance is available to existing commercial and industrial buildings with a peak electric demand in excess of 200 kW in any of the preceding twelve months (100 kW for multifamily buildings) and to new construction buildings with 50,000 square feet or more of planned space. See Partner Guidelines Section 2.3 for complete eligibility requirements.

2. **Could gas consumption (therms) be combined with the kW to reach the minimum demand requirements?**
   No, only the electric demand can be used in determining eligibility.

3. **Is Pay for Performance available for both public and private customers?**
   The Program is available to all commercial, industrial, and institutional customers with a peak demand in excess of 200 kW in any of the preceding twelve months (100 kW for multifamily buildings), or 50,000 square feet or more of planned space, who contribute to the societal benefits charge (i.e. customers of at least one of New Jersey's investor-owned utilities). See Partner Guidelines Section 2.3 for complete eligibility requirements.

E.2 Incentives

4. **To whom are the incentives paid?**
   Incentives are paid to the Participant (customer) but can be assigned to the Partner by the Participant

5. **Can the incentive payments be assigned to partners?**
   Yes, but the Participant must indicate this on the Incentive Request forms.

6. **Under certain programs, the partner must be paid and documentation must be provided prior to the participant receiving an incentive payment. Will Pay for Performance work this way?**

The partner must ensure the contract structure with the participant covers this item.

7. **Are the incentives adjustable or fixed per project?**
   There will be three incentives. Incentive #1 is based on the size of the facility and Incentives #2 and #3 are based on the level of savings in kWh and/or therms. View the existing buildings incentive structure and the new construction incentive structure documents for details, also see Partner Guidelines Section 2.4.

8. **What if actual post-retrofit savings are higher than estimated?**
   Incentive Payment #2 represents 50% of the total performance incentive, based on estimated savings predicted by the simulation results. Savings in excess of (or less than) the estimate will result in a re-calculation of the total performance incentive. This will be "trued-up" with Incentive Payment #3. See Partner Guidelines Section 6.

9. **The payment per kWh and therm saved is for what period?**
   Incentive payments #2 is based on annual energy savings projected by calibrated simulation; incentive #3 is based on annual electric kWh and natural gas savings realized during post-retrofit period compared to pre-retrofit period, normalizing for difference in weather.

10. **What incentives can be expected for a multi-building (campus type) situation where there are only two meters?**
    The entire campus must be treated as one project, unless sub-metering has been established. The 15% savings will be achieved on a campus-wide level and one set of incentives will be paid out. Incentive Caps apply. See Partner Guidelines Section 2.3.2.

11. **How much of a reduction in kWh (or therms) is required to receive an incentive?**
    A minimum of 15% source energy reduction is required for existing buildings, which can be achieved through a combination of electric, gas and other fuel source reductions, but incentives will only be paid for electric and natural gas savings. For new construction, a minimum 5% energy cost savings for commercial and industrial, 15% for multifamily, compared to ASHRAE 90.1-2016 is required.

12. **What are the 15% savings based on?**
    For existing buildings, the 15% savings represents source energy savings (estimated Btu site energy savings converted to Btu source energy) and can include electric, natural gas and other fuels (i.e. fuel oil, steam, chilled water, etc.). For new construction, the 5% and 15% savings represents energy cost savings compared to ASHRAE 90.1-2016 compliant design.

13. **Can fuel oil reduction be included as savings?**
    Fuel oil (and other fuels) may be included in the savings to meet the 15% source reduction requirement, however no incentives are provided for these fuel types unless there is a fuel conversion project per Partner Guidelines Section 4.6.3.

14. Do other available incentives jeopardize Pay for Performance incentives?

Incentives will not be paid from multiple NJ Clean Energy Programs and/or SBC funded programs for the same energy efficiency measures, additionally projects enrolled in P4P may not enroll in other NJ Clean Energy Programs at the same time. Local Government Energy Audit participants may have their first Pay for Performance incentive reduced by 50% to acknowledge the value of the audit if the audit was completed within the past 3 years. See Partner Guidelines Section 2.4.

15. What is the average amount in incentives expected for a typical project?

The average total incentive per project is roughly 40% of the total project cost, or $350,000.

16. Do interruptible gas clients qualify for incentives for therms saved?

Yes, as long as the interruptible gas client has an active account for gas service and pays the Societal Benefits Charge they are eligible for incentives from the Program.

E.3 Energy Reduction Plan

17. What if the 15% source energy savings cannot be met after the audit is performed?

The Program will not provide Incentive #1 if the savings target cannot be met or the installation of measures does not move forward. The partner must inform the participant of this and should make certain that their contract covers this situation. Identified measures could then apply for NJ SmartStart Buildings incentives.

18. What is the reason behind the 15% savings not being allowed from a single energy conservation measure?

Pay for Performance is designed to be comprehensive in nature, thus savings are anticipated to be provided by multiple energy conservation measures. If savings are anticipated to be derived from a single measure (such as lighting), the participant should be referred to the prescriptive or custom tracks offered as part of the NJ SmartStart Buildings Program.

19. Can solar PV panels and other renewable projects contribute to the 15% savings?

No. Renewable measures that generate power cannot be included in the 15% savings. Solar water heaters and thermal storage are OK. See Partner Guidelines Section 3.4.1.

20. Once I complete my energy reduction plan, am I required to continue with the rest of the Program?

You are not required to continue with the Program, but you will not receive Incentive #1. Incentive #1 is distributed contingent on the installation of the energy efficient measures outlined in your energy reduction plan.

21. Is it a requirement that all energy conservation measures evaluated must be implemented?

The decision on implementation of energy conservation measures (EEMs) is to be determined by the participant with input from the partner. It is not a requirement that all EEMs be implemented as long as the ones selected meet Program requirements per Partner Guidelines Section 2.3. The ERP requires a list of recommended EEMs (with associated savings), and listing of non-recommended EEMs with an explanation as to why these are not included.

22. Can energy savings from operation & maintenance items be included (e.g. if economizers are not working)?

Retro-commissioning type items may be incorporated into the ERP, however savings estimates associated with these should be well documented. See Partner Guidelines Section 3.4.

23. What about electric demand reduction measures (e.g. thermal storage)?

Pay for Performance is designed for, and provides incentives for, energy efficiency measures. Electric demand reduction measures may benefit the participant and can be included in the ERP, however no incentive is specifically associated with demand savings.

24. Is the use of Portfolio Manager required?

Yes. See Partner Guidelines Section 3.8.

25. What effect would a change in operating hours have on the project?

If a substantial change in operating hours occurs during the construction and/or post-retrofit period, this change would be accounted for by documenting the changes and adjusting the hours of operation in the baseline model. See Partner Guidelines Section 6.5.

26. Since the Program is designed around utility billing history, how will the Partner get this when in many cases this goes to corporate management offices?

Partners will need to make arrangements with the participant to obtain the utility history.

27. Will utility release forms be available?

Yes, utility release forms can be obtained by contacting the Program Manager.

28. Is it a requirement to meter each piece of equipment?

Any existing equipment or recommended measure that cannot be incorporated into the simulated building model will require metering. See Partner Guidelines Section 4.3.

29. Can ASHRAE 90.1-2013 be used as the baseline for new construction projects?

If a project can provide proof of receiving permits under the prior energy code (i.e. ASHRAE 90.1-2013) then it will be allowed to meet energy targets reflective of this code.

30. Is the internal rate of return calculated on an individual energy conservation measure basis, or on a total project basis?

A 10% IRR is/was required for all applications received prior to July 1st, 2015. As of July 1st, 2015 all applications received will not have an IRR requirement. Although IRR that is very low, zero, or negative will be questioned as part of the review.

31. What can be included in total project cost?

Partner fees, equipment and installation costs, design fees, construction management, measurement and verification / commissioning fees are included. See Partner Guidelines Section 3.4.7.

32. What if another energy conservation measure is found during the construction phase?

This would be considered a scope change and may require re-submittal of the ERP. The performance incentives would be recalculated to include the additional estimated energy savings. See Partner Guidelines Section 5.4.

33. Can the participant choose a different partner after the energy reduction plan has been submitted and approved?

The participant can choose to change partners. Partners should make certain that their contract covers this situation so they are paid for their services. Should the participant choose not continue in the Pay for Performance Program, the funds associated with Incentive #1 may have to be returned by the participant.

E.4 Implementation

34. Some participants such as school districts may not be able to commit to the Pay for Performance process, due to New Jersey laws that require such entities to go out to bid.

Pay for Performance must comply with any state and local procurement laws, but will work with partners and participants in these particular situations on how best to proceed. Keep in mind that partner services are considered “professional services” and may be subject to alternative procurement requirements. If the physical installation of recommended energy efficiency measures is bid to a different company from the partner company, make sure that the partner remains involved to ensure installation is done per the energy reduction plan and to develop the post-construction benchmarking report.

35. What types of bid and/or construction documents are required?

The partner role is to perform services as necessary to ensure that the measures are bid, designed, and installed as presented and modeled in the ERP. Submission of these documents is not required.

36. What happens if construction costs are higher than those estimated, which would lead to a lower internal rate of return?

Pay for Performance only considers the initial estimated cost and internal rate of return provided in the ERP. Performance Incentive #2 and #3 will be capped at the lower of the estimated cost per the ERP or actual as-built cost. Partner may need to provide explanation if as-built costs are significantly higher than what was estimated in the ERP.

37. If a participant requires a multiple bid process and must select the low bidder, which is not the partner, is the applicant still entitled to Incentives #2 and #3?

The participant can only receive Incentives #2 and #3 if an approved partner remains with the project in some capacity. Partners should be aware of the procurement requirements of the participant to guard against this.

E.5 Post-Construction Benchmarking (Existing Buildings only)

38. What happens if the building becomes vacant, or if there is a shift in operation due to economic issues, after the baseline is developed?

This must be accounted for through a baseline adjustment. See Partner Guidelines Section 6.5.

39. What happens if the 15% source energy savings target is not met after the post-construction benchmarking?

Incentives #2 and #3 are designed as a single performance incentive that is split in order to provide up-front financial assistance in implementing the project. Incentive #3 will be “trued-up” based on actual achieved savings so that the total performance incentive (i.e. #2 and #3) is in compliance with the Program’s incentive structure. If savings are below the 15% minimum but at or above 5%, the project will still be eligible for an incentive, although at a reduced rate calculated at $0.005/kWh less and $0.05/therm less from the base incentive (i.e. $0.09/kWh and $0.90/therm) for each 1% savings below 15%. So long as the savings are at or above 5%, the minimum incentive paid is $10,000 or committed value, whichever is less, assuming all required data and documentation is submitted. If savings are less than 5% there would be no Incentive #3 paid. Incentives #1 and #2 are not required to be returned to the Program. The scaling down of incentives does not apply to high energy-intensity users, which are required to demonstrate at least 4% energy savings.

40. Certain programs allow payment in shorter time period if performance criteria are met (i.e. based on 6 months of billing history), will New Jersey's Clean Energy Program consider this?

No. Incentive #3 will be calculated based on 12 months of post-construction utility bills.

E.6 Building Simulation

41. Can tax incentives associated with EPACT be applied to a Pay for Performance project?

Yes. Information on EPACT tax incentives can be found at http://www.energy.gov/taxbreaks.htm

42. Do the simulation guidelines require modeling of the actual utility rate tariff?

This is recommended.

43. Can you provide tariff inputs for simulation?

Due to the number of approved simulation programs and wide variation in regulated tariffs and 3rd party energy provider contracts, the Program Manager cannot provide tariff inputs.

44. What is the purpose of calibrating the baseline model?

Calibration of the baseline model with actual utility bills is required to ensure that the model accurately represents energy use at the facility. This will result in higher accuracy of estimated savings. See Partner Guidelines Section 4.5.

45. Suppose weather conditions are an anomaly in the post-retrofit year?

Portfolio Manager, Model Calibration Tool, and Savings Verification Tool all normalize for weather. See Partner Guidelines Section 4.5 and 6.4.

46. Is there a method for ranking the energy conservation measures?

It is up to the partner and participant to determine the ranking of the measures. See Partner Guidelines Section 4.6.

47. What is the basis of the site to source conversion?

Site to source conversions are based on EPA's ENERGY STAR Portfolio Manager software. See https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?50cd-804b

48. The simulation software reports energy use in terms of site energy, will we need to convert it to source energy units?

The conversion is done automatically in Portfolio Manager and in the ERP Excel Tables provided.

49. Are Incentives #2 and #3 based on site or source energy?

Incentives are calculated based on site energy, in standard units (kWh and therms).

50. If a building is being brought up to code (e.g. more ventilation, etc.), will there be any allowance for this in the modeling?

This may be considered on a case-by-case basis by the Program Manager. See Partner Guidelines Section 4.6.3.

E.7 High Energy Intensity Customers - Industrial, Manufacturing, Water Treatment, Datacenters

51. What if achieving 15% savings in my building is impossible?

There is an exception to the 15% energy reduction requirement for the Existing Buildings component of Pay for Performance. See Partner Guidelines Section 2.3.4.

E.8 Multifamily Buildings

52. Should I enroll my multifamily building in the Home Performance Program or Pay for Performance Program?

Please refer to the multifamily flow chart in Partner Guidelines Section 2.3.3 to determine whether your multifamily building fits into the Residential Home Performance Program or the Commercial Pay for Performance Program. If you believe your project has fallen into the wrong category please contact Program Manager at 866-NJSMART.

53. What if my multifamily building consists of multiple garden-style buildings?

Garden style apartment complexes usually consist of multiple low-rise apartments, cooperatives, condominiums and/or townhouses surrounded by landscaped grounds. These types of complexes will be treated as one project under Pay for Performance. In other words, if there are 10 garden-style buildings that are part of one multifamily community, all 10 will be aggregated into one Pay for Performance application.

Exceptions to this rule may be considered by the Program Manager on a case-by-case basis where financial constraints prevent the entire complex from participating at once, or where parts of the complex are determined to be better suited for Home Performance with ENERGY STAR. The 100kW participation threshold will be met through this aggregation (including common area and in-unit billing). The 15% savings requirement (as well as all other Program requirements) will be achieved in aggregate, as well. Only one set of incentives will be paid per project, and all incentive caps apply. All other Program rules apply. See Partner Guidelines Section 2.3.3.

E.10 Other

54. Will Pay for Performance have a portal?

A partner portal is available for approved partners. See Partner Guidelines Section 2.2.

55. What is the estimated timeframe for approval of the Energy Reduction Plan?

- ERP Rev0 averages 3 weeks in review.
- Subsequent Revisions average 1-2 weeks.
- ERPs with Incentives <$500,000 are approved by Program Manager, but may require QA/QC ---adds 2weeks.
- ERPs with Incentives ≥$500,000 are approved by Program Manager and NJ Board of Public Utilities (BPU). BPU meets monthly to review projects---adds 4+ weeks depending on BPU schedule.

56. What is the estimated timeframe for receiving incentive money?

Between 45 and 60 days from incentive authorization.

57. Would a loan program help Pay for Performance to be more successful?

The Economic Development Authority provides supplemental financing for eligible New Jersey-based commercial, institutional or industrial entities (including 501(c)(3) organizations). Please see the “EDA Programs” page of the NJ Clean Energy website for more information.

58. Can an ENERGY STAR® rating be achieved through Pay for Performance?

Yes, the measures installed under Pay for Performance could result in the building being eligible for the ENERGY STAR® Label if the facility scores a 75 or higher. Please refer to ENERGY STAR® rules and requirements.

59. Can the partner seek work through the Program or must they wait to be contacted by a potential participant?

Partners are encouraged to seek participants and bring them into the Program.

60. When should we apply for SmartStart (SS) and when should we apply for Pay for Performance (P4P)?

If you have the option of pursuing either P4P or SmartStart, consider TWO things:

Scope of Work – SmartStart has a very specific equipment list for which it provides incentives, although the Custom Measure path is fairly open to a wide range of technologies. Through the SmartStart program a project can consist of as little as one measure or several measures. The P4P Program is open to a wide range of energy efficiency upgrades, but scopes of work must be comprehensive involving multiple measures that meet minimum performance requirements.

Budget - P4P is time intensive, which translates to a bigger investment. There really needs to be considerable savings involved to make P4P worthwhile - especially for smaller facilities.

Here are some cases where SmartStart would be a better option:

- The project consists of minimal upgrades, or a single upgrade OR
- You have a “tight” budget OR
- You have a “short” deadline.

Here are some cases where Pay for Performance would be better:

- The scope of work involves comprehensive lighting, HVAC, and envelope improvements OR
- You have complex technologies in the building OR
- You have time and budget to commit to investigating all potential energy opportunities in the facility.

When in doubt, have a Pay for Performance partner perform a free energy assessment and evaluate the results. If the results are not meeting your needs, then SmartStart may be a better route. Keep in mind that many Pay for Performance partners are also knowledgeable in SmartStart.