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A New Era of Performance-Based Code Compliance and Beyond Code Programs

GBCI

KARPMAN CONSULTING

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Learning Objectives

1. Learn about the new performance-based code compliance path in ASHRAE 90.1-2016 (Appendix G Performance Rating Method)
2. Understand the benefits of using the new Appendix G baseline
3. Learn how to apply the Appendix G method to document LEED Energy Performance
4. Demonstrate how the new Appendix G method was used to develop performance targets for above code programs in the Northeast

Outline

- The new Appendix G in ASHRAE 90.1-2016
- Creating custom performance targets for Appendix G
- Benefits of the new Appendix G method for LEED projects
- LEED Pilot Alternative Compliance Path
- Developing performance targets for above-code programs in the Northeast

Appendix G: A New Path to Comply with ASHRAE Standard 90.1-2016

Michael Rosenberg

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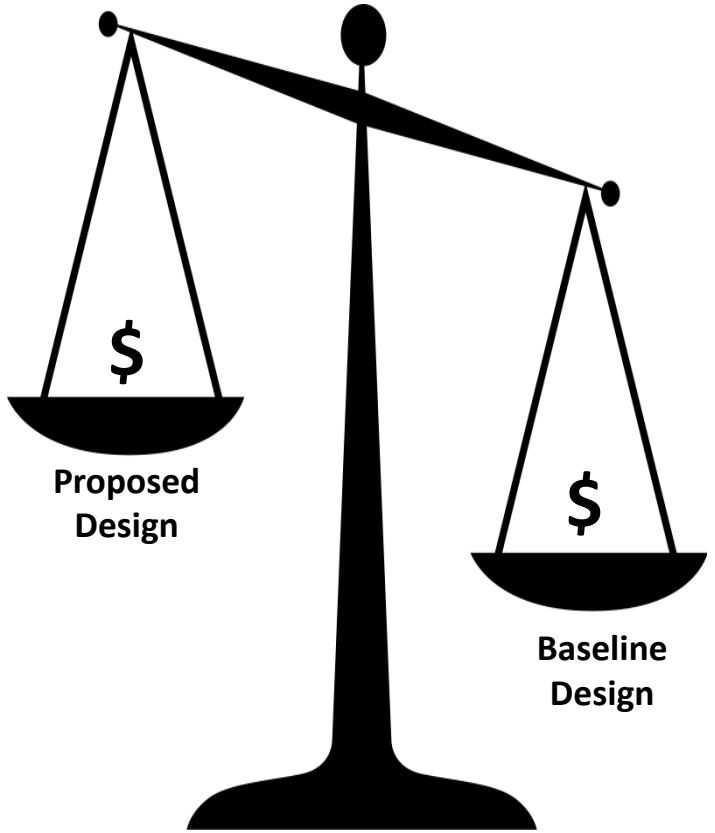
Performance Paths before 90.1-2016

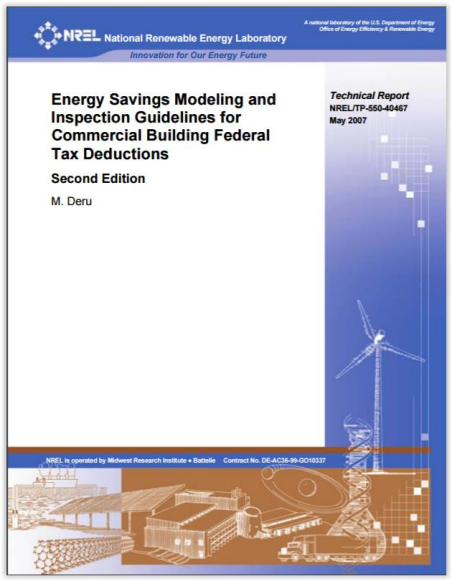
Chapter 11 – Energy Cost Budget (ECB) Method

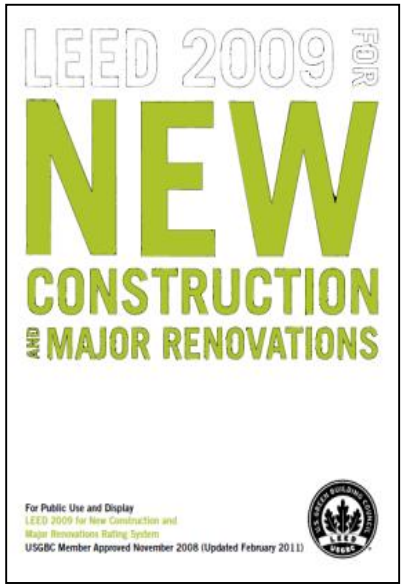
- Used for code compliance

Appendix G – Performance Rating Method

- Historically used for “beyond code” programs like LEED, IgCC, and federal tax credits

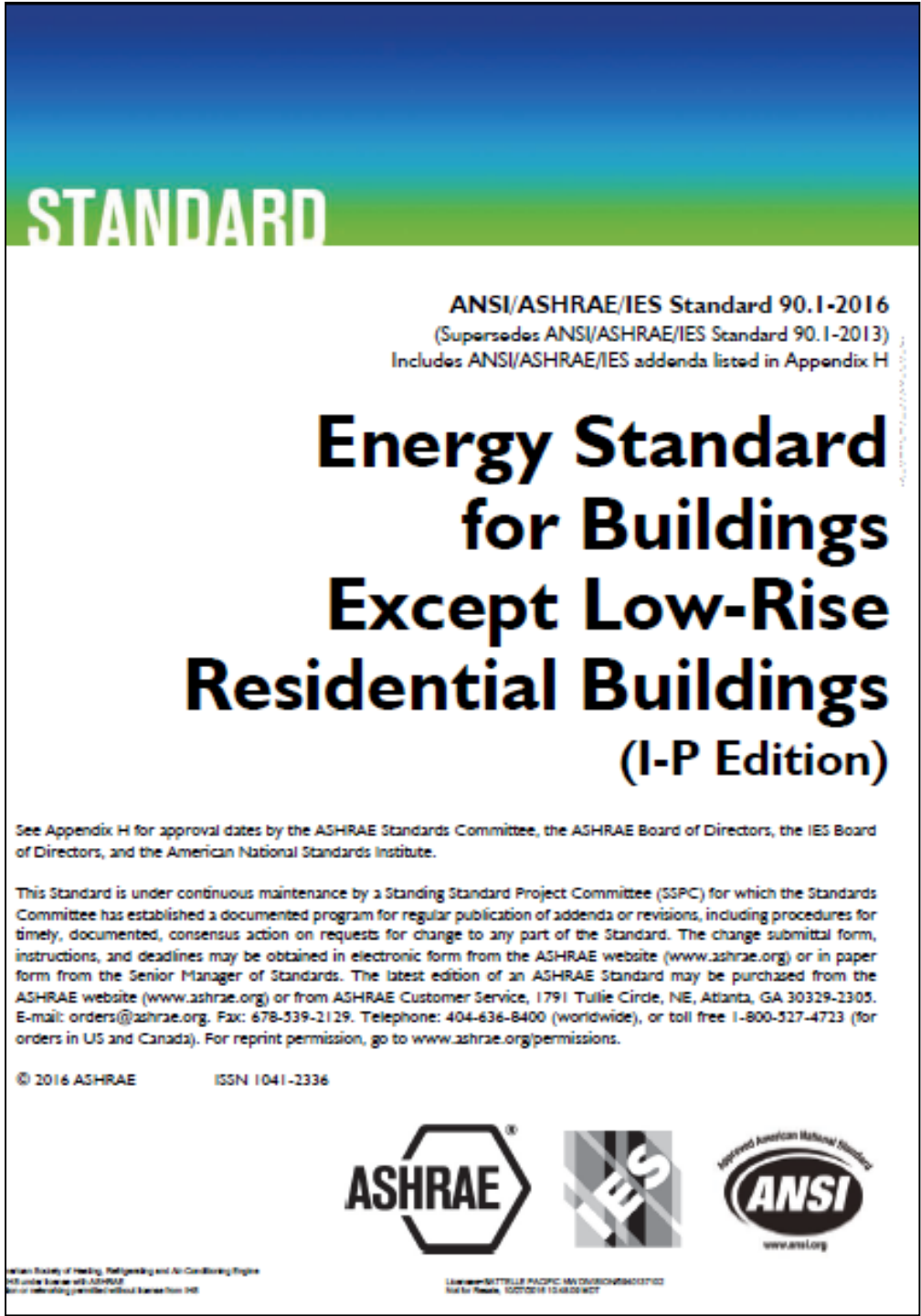






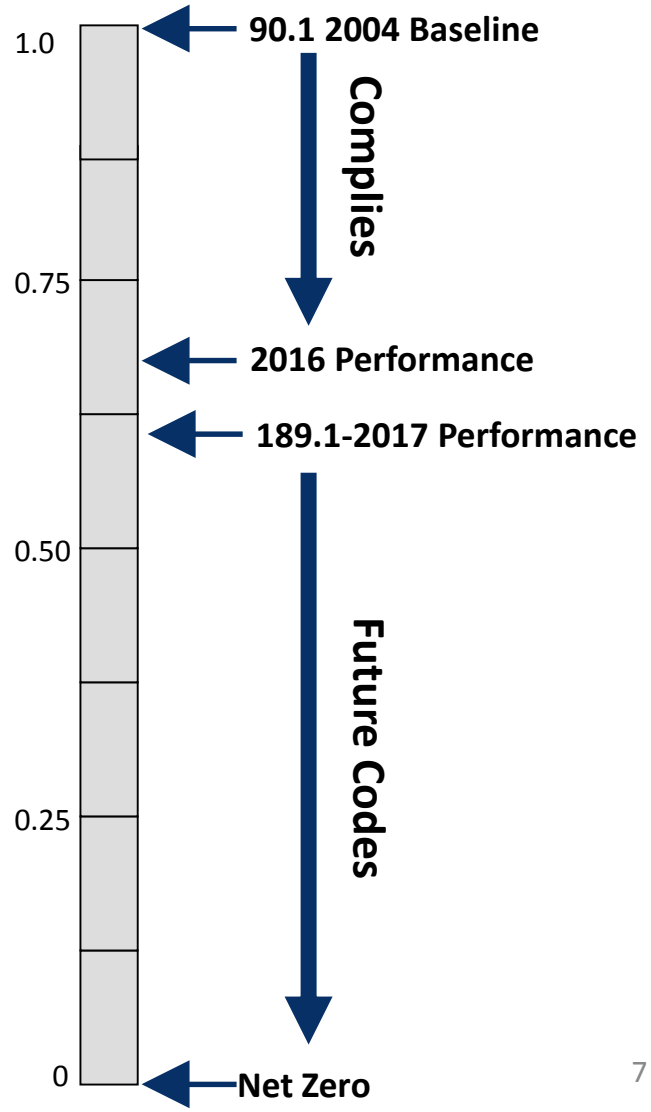
New Appendix G in Standard 90.1-2016

- Appendix G is now approved as a performance path for code compliance (in addition to ECB)
- Baseline is now “stable” at stringency level similar to Standard 90.1-2004



From “Moving” Baseline to Stable Baseline

- Intent is that the baseline remains at 2004 stringency levels
- Compliance requires meeting a performance target below the baseline
- Specific targets created for any code or beyond code program



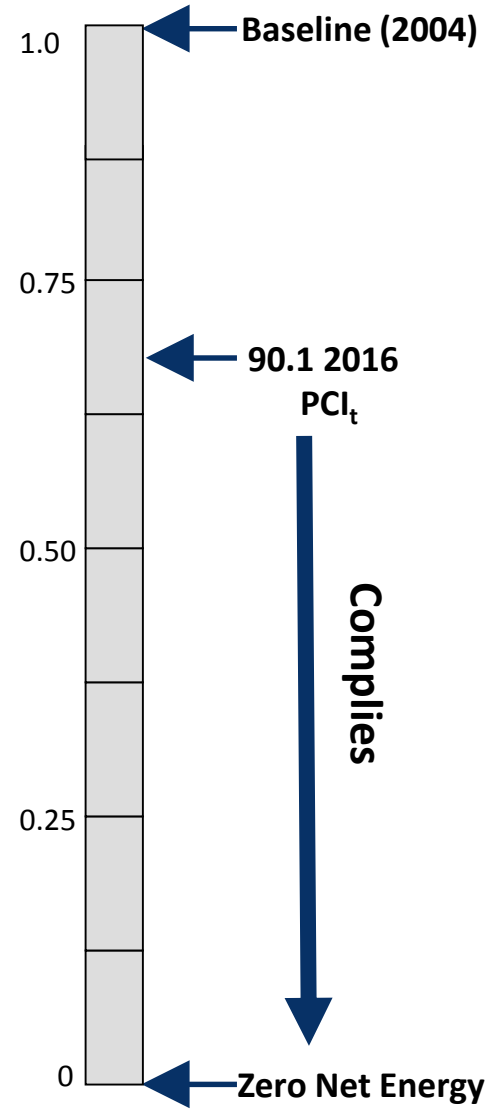
Stable Baseline: Performance Cost Index

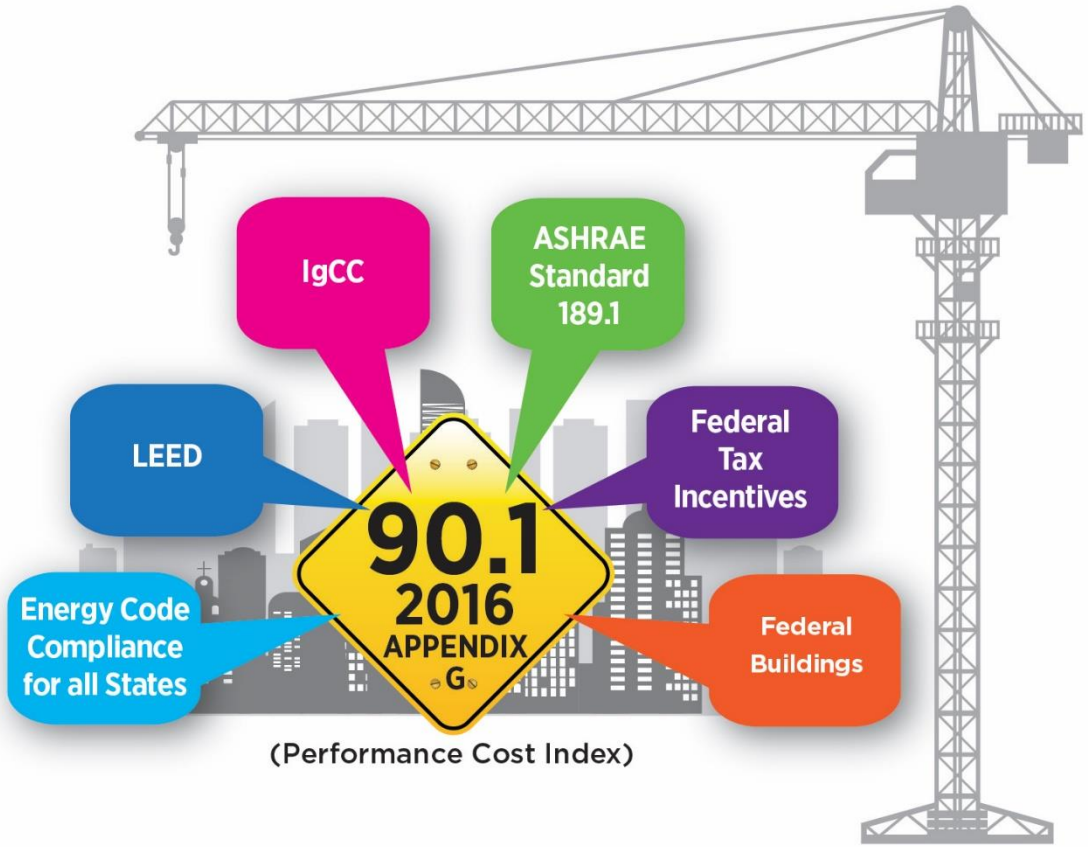
$$PCI = \frac{Proposed\ Building\ Energy\ Cost}{Baseline\ Building\ Energy\ Cost}$$

- PCI of 1.0 = baseline building
- PCI of 0.0 = zero net energy
- For compliance, PCI < PCI_t
- PCI_t specific for building type, climate zone, and proportion of regulated loads : unregulated load

$$PCI_t = \frac{(BBUEC + (BPF \cdot BBREC))}{BBP}$$

$$BPF = Building\ Performance\ Factor$$





Benefits of Appendix G with Stable Baseline

- Same model used for multiple purposes
- Encourage the creation of tools that automate the simulation process as the market is increased
- Simpler, cheaper, more likely to be accurate

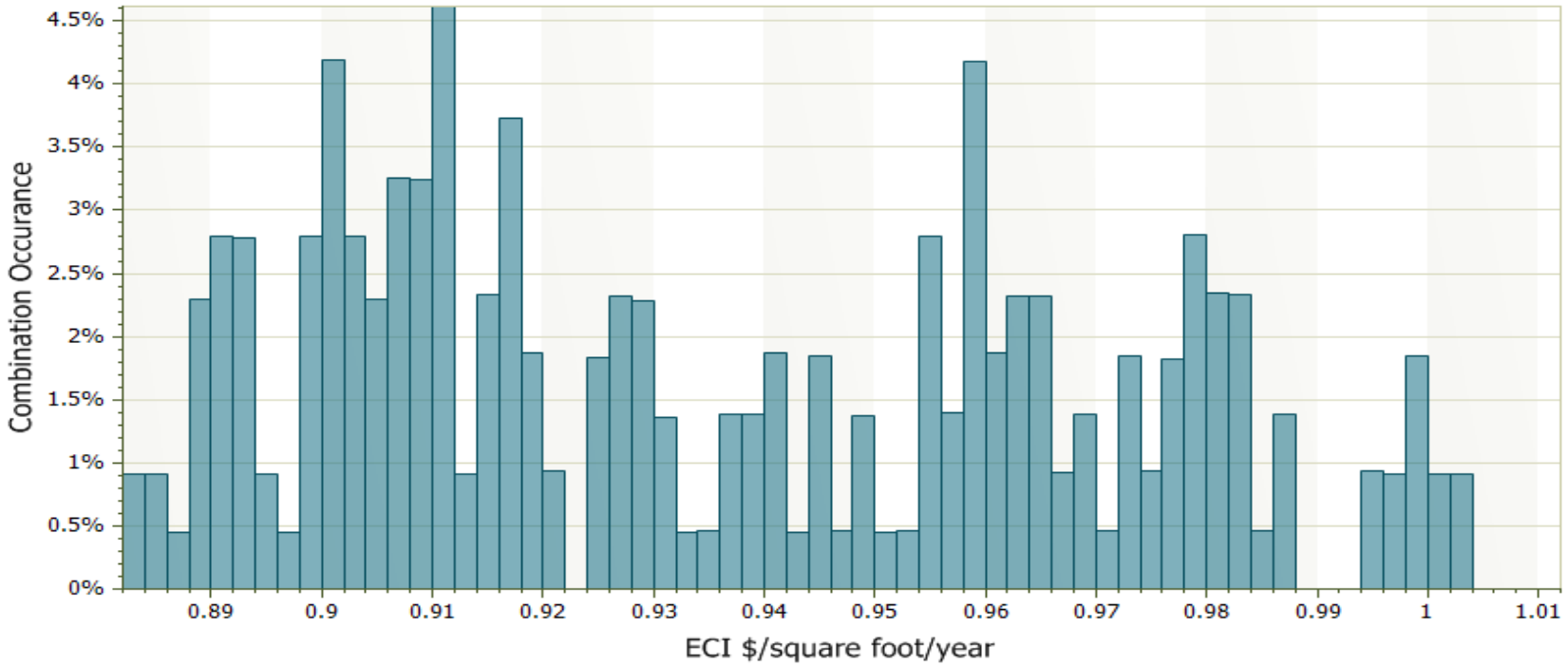
Creating Custom Performance Targets

1. Identify standard designs (primary package) for each building type and climate zone
2. Create building energy models based on the primary package
3. Apply the rules of ASHRAE Standard 90.1 Appendix G to create baseline models
4. Determine performance targets based on the difference between the primary package and the baseline building models

1. Identify Standard Design for Each Building Type and Climate zone

Prescriptive Options Allow Variation in Energy Use

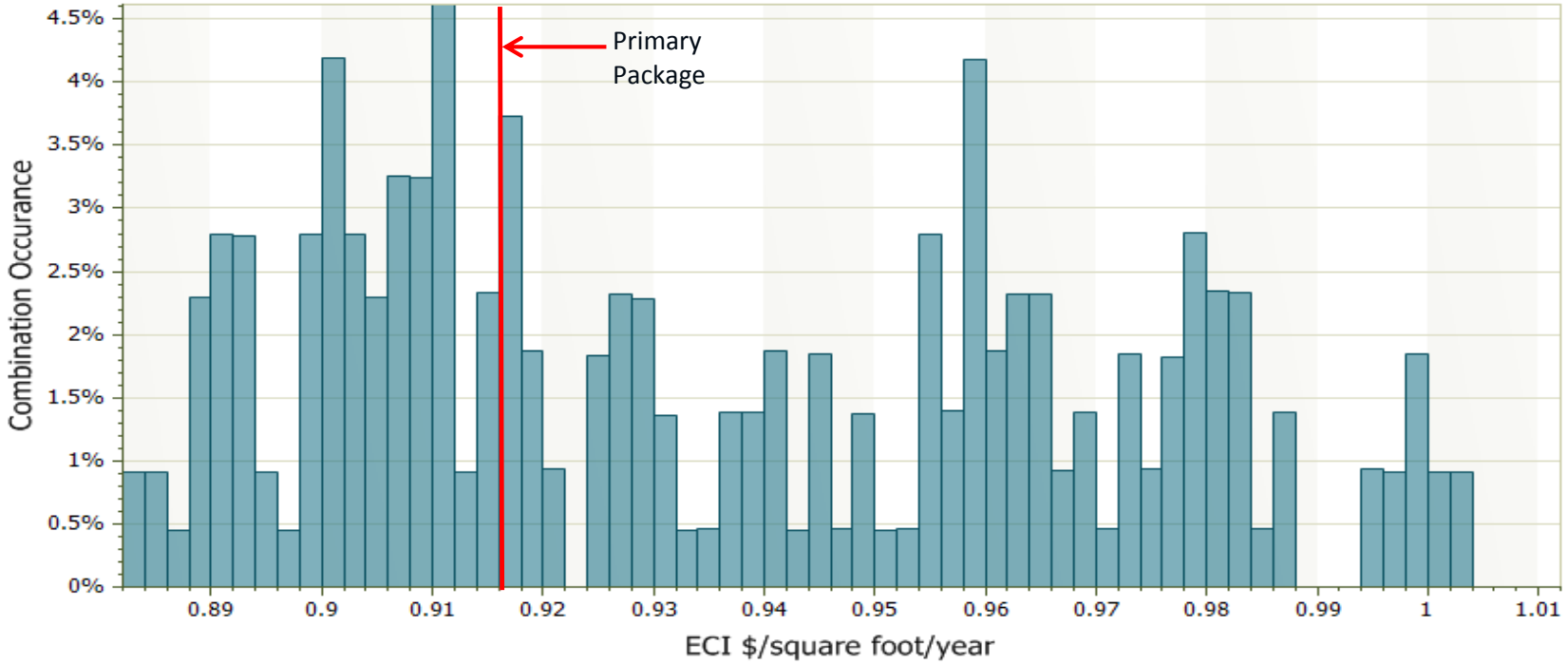
- Medium office in climate zone 4C
- 14% variation in annual energy cost



Example:

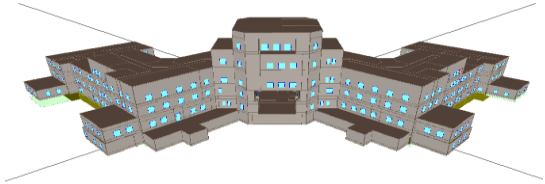
Primary Package for Medium Office in CZ 4C

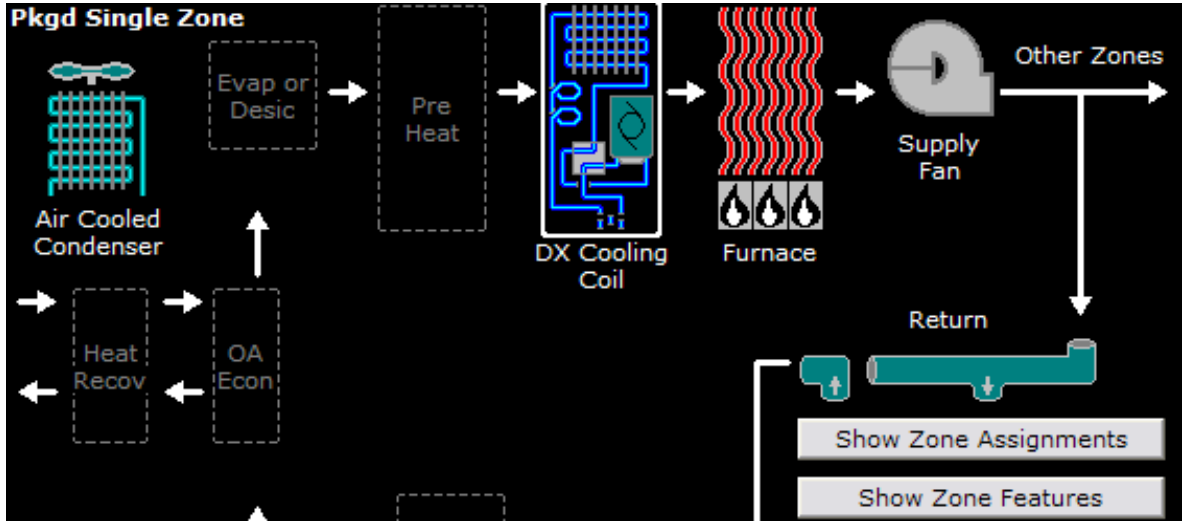
- HVAC - VAV air handler, 80% gas boiler, pumping @21 W/gpm, economizer, 11.0 EER DX cooling, ERV
- Lighting - 0.86 W/ft^2, 50% occupancy sensor coverage, 20% daylighting coverage
- Envelope - Wall U-factor = 0.055, Window U-factor = 0.38, WWR= 30%



2. Create Building Energy Model of Primary Package

- Determine energy cost of primary package ($/ft^2-yr)
  - Could be other metric such as:
    - Site energy use (kBtu/ft^2-yr)
    - Source energy use (kBtu/ft^2-yr)
    - Greenhouse gas emissions (lb CO_2e/ft^2-yr)



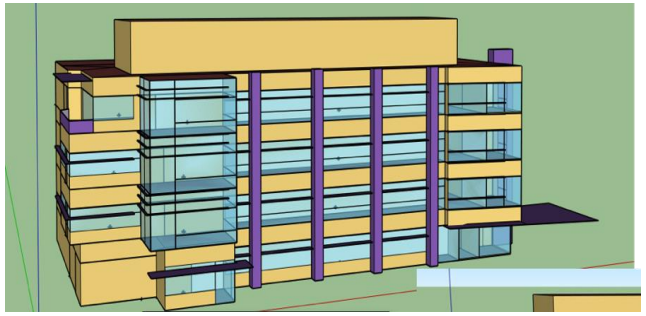


3. Apply the Rules of ASHRAE Appendix G to Create Baseline

Appendix G includes detailed methodology for creating the baseline building model

- Baseline building is a “clone” of the primary package design
- Except; systems and efficiency levels modified from the primary package based on the modeling rules

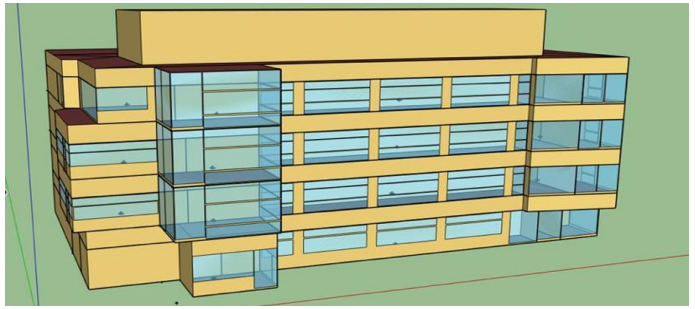
Primary Package
(Proposed Building)



Appendix G

Rules

Baseline Design



4. Create PCI Target for Compliance

- PCI of primary package used to develop Performance Cost Index target (PCI_t)
- Any design complies with code if PCI < PCI_t

$$Building\ Performance\ Factor\ (BPF) = \frac{Priamry\ Package\ Energy\ Cost\ (regulated\ loads\ only)}{Baseline\ Building\ Energy\ \ Cost\ (regulated\ loads\ only)}$$

$$PCI_t = \frac{(BBUEC + (BPF \cdot BBREC))}{BBP}$$

LEED Alternative Compliance Path

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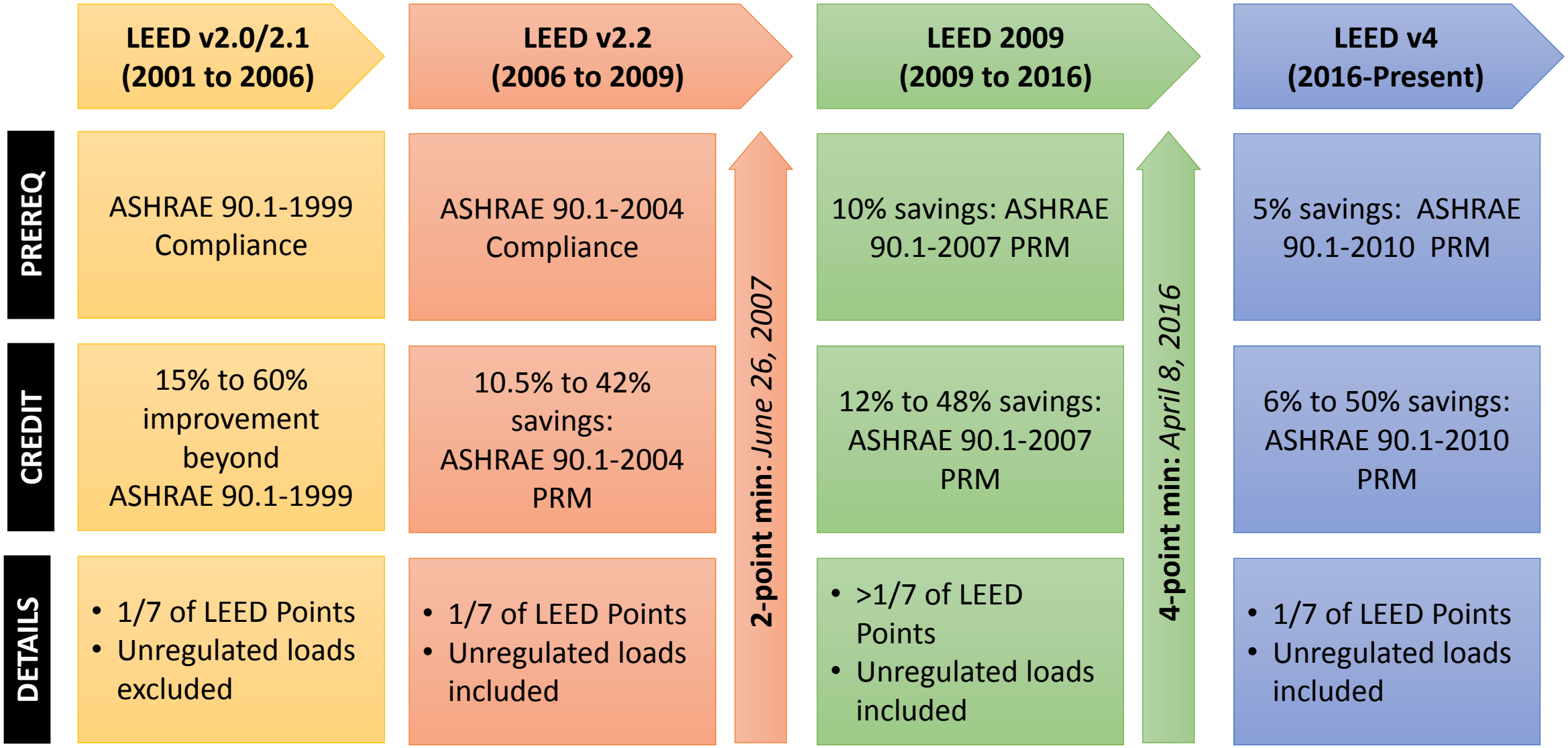
History of LEED Energy Requirements



Historical Transition difficulties – LEED Energy Efficiency

BASELINE CHANGES EACH VERSION OF THE STANDARD

DIFFICULT TO TRACK PROGRESS

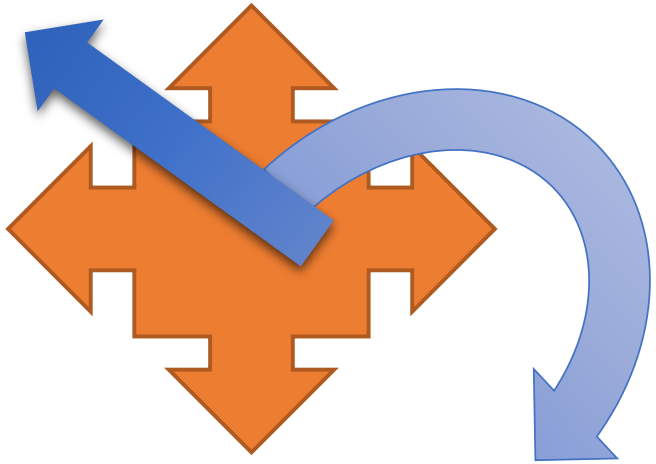
COMPLIANCE ISSUES

TIME

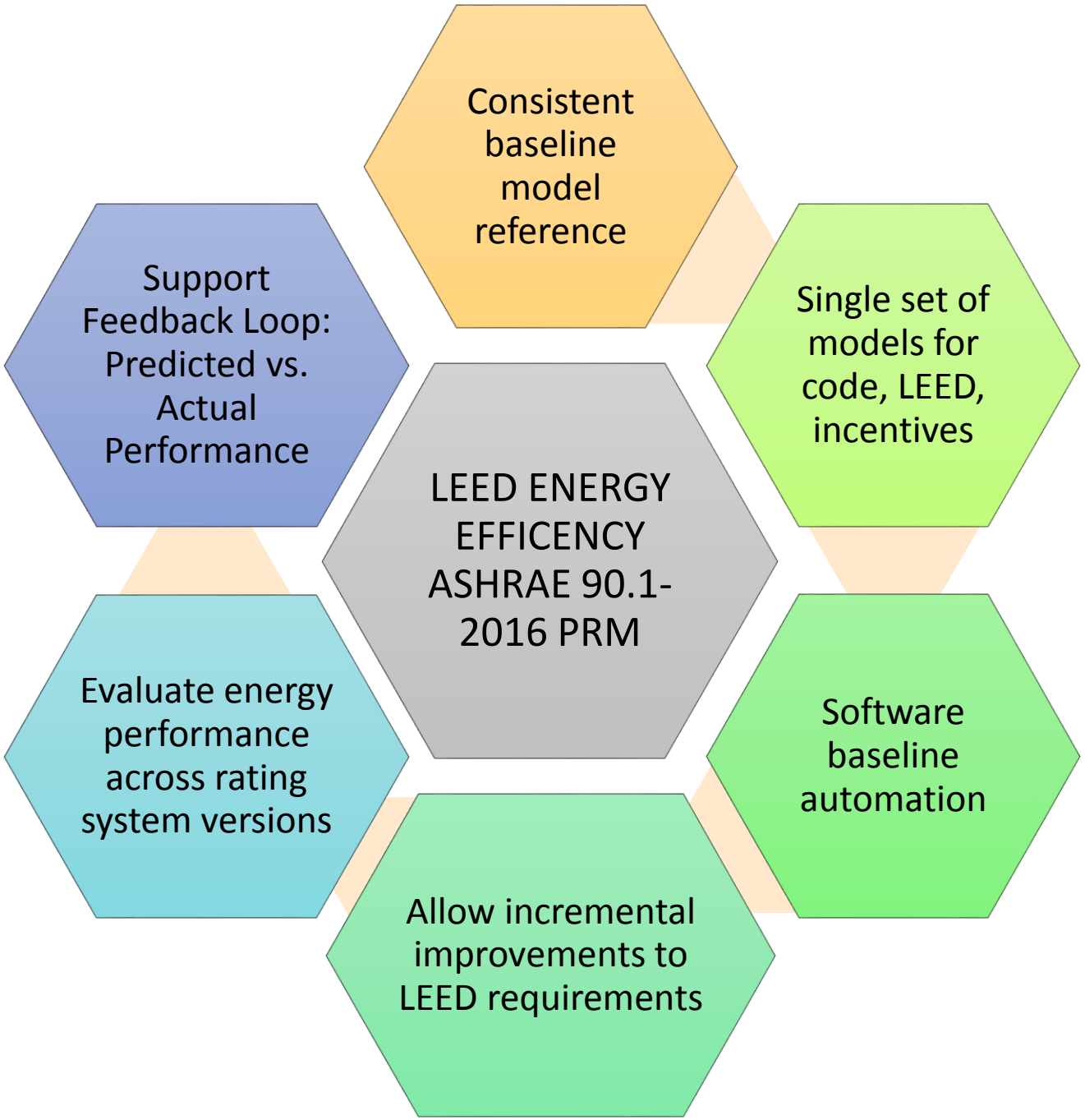
Learn Baseline Requirements

Inform Design Process

NET ZERO



Process-Intensive projects



LEED Application ASHRAE 90.1-2016 PRM

LEED Pilot Alternative Compliance Path (EApc111)

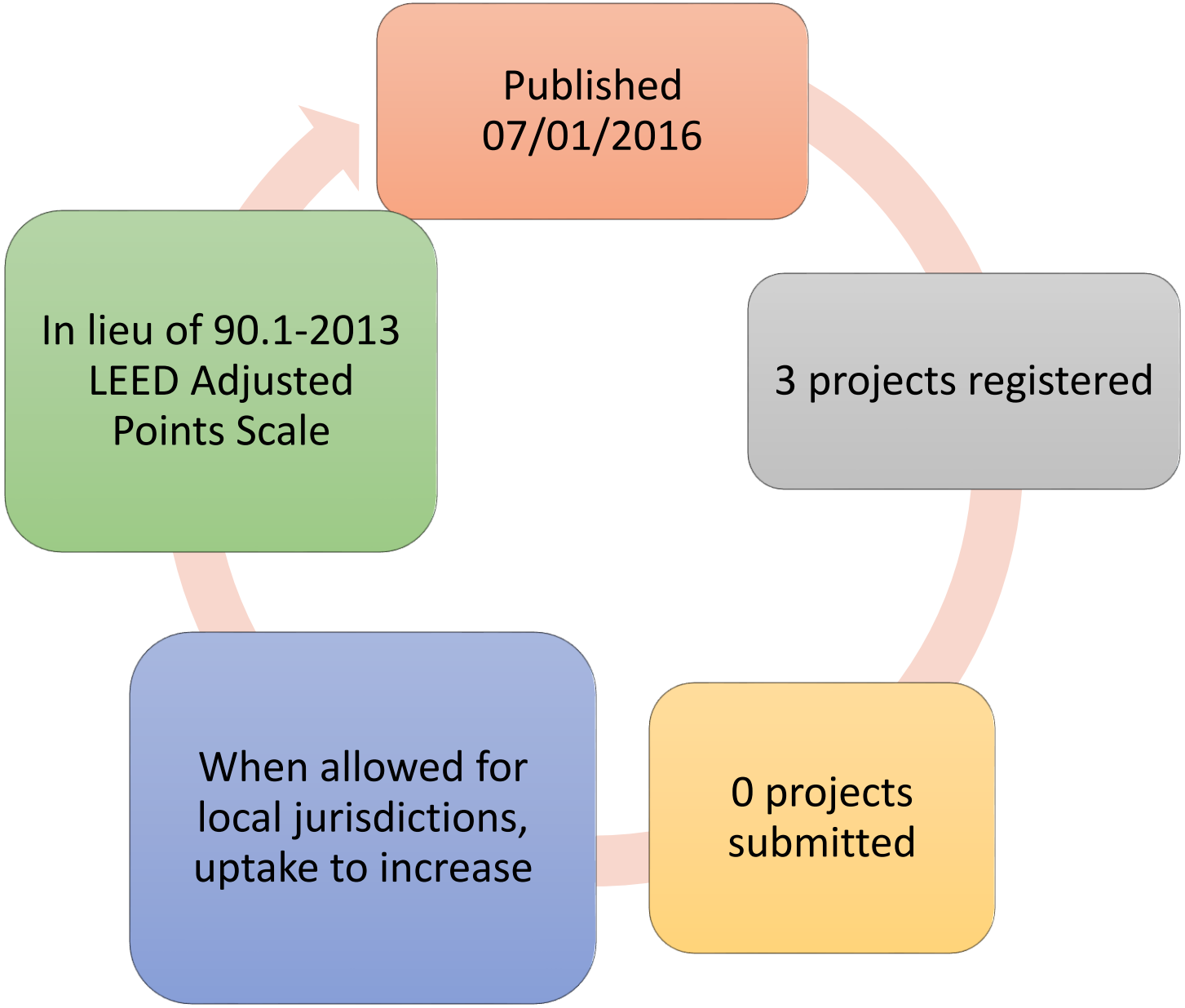
Allows research/evaluation/refinement before formal adoption into a future version of LEED.

- Mandatory measure compliance: 90.1-2010
- Building Performance Factors set per rating system
- Percent reduction in the Performance Cost Index (PCI) below the Performance Cost Index
- Target (PCIt) matches LEED Prereq / Credit requirements for percent improvement beyond ASHRAE 90.1-2010 Appendix G

Rating System Adaptation	Building Performance Factor (BPF)
New Construction (Except High-Rise Res)	0.72
Retail (Incl. Restaurant)	0.72
School	0.65
Healthcare	0.69
Hospitality	0.76
Warehouse	0.70
Multifamily Res (4+ floors)	0.89

Sample Applications: LEED Pilot ACP

Building Type	**Office**	**Elementary School**	**25-story Condominium**
LEED Rating System	LEED-NC v4	LEED-Schools v4	LEED-NC
LEED BPF	0.72	0.65	0.89
Base Bldg Performance	$125,000	$50,000	$400,000
Base Unregulated $	$25,000	$6,500	$80,000
PCI_T Equation	$\frac{\$25K + 0.72(\$125K - \$25K)}{\$125K}$	$\frac{\$6.5K + 0.65(\$50K - \$6.5K)}{\$50K}$	$\frac{\$80K + 0.89(\$400K - \$80K)}{\$400K}$
PCI_T	0.776	0.696	0.912
Proposed Building Performance	$75,000	$30,000	$240,000
Performance Cost Index (PCI)	$75K/$125K = 0.600	$30K/$50K = 0.600	$240K/$400K = 0.600
Percent Improvement	1-.600/.776 = **22.7%**	1-.600/.696 = **13.7%**	1-0.600/0.912= **34.2%**
LEED v4 Points	9	4	13



LEED Pilot ACP Status

Developing Performance Targets for Above Code Programs

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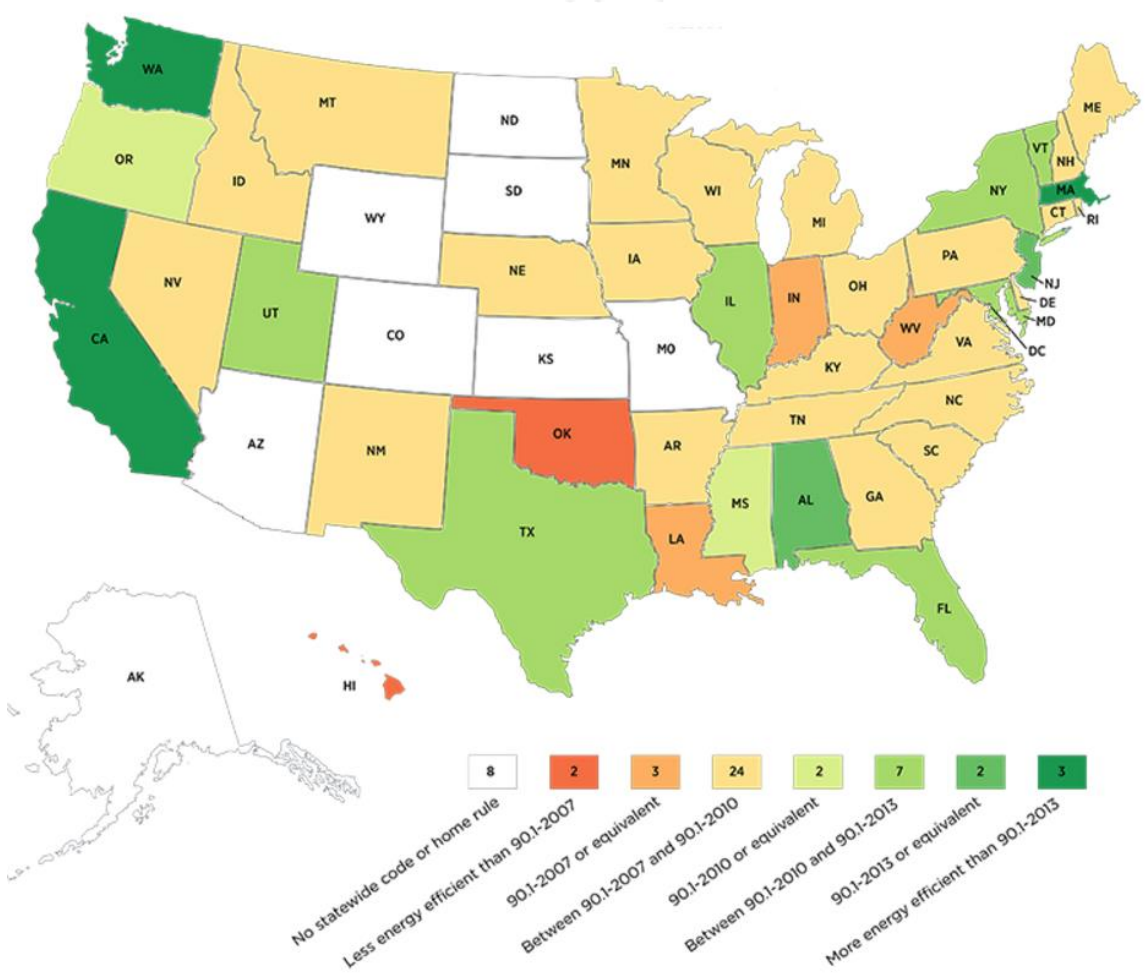
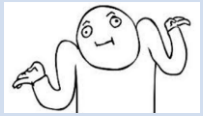
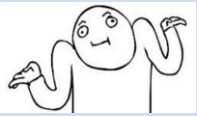
Juggling Multiple Baselines



- Utility incentive programs and national programs for high performance buildings set targets relative to state codes
- Most modelers work on projects in multiple states, participating in different programs

NJ Pay for Performance Program (P4P NC)

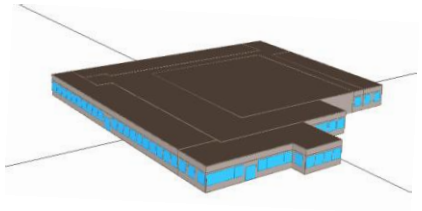
- Methodology based on 90.1 Appendix G, with the baseline tracking state code

Base Code	Methodology	Performance Target
90.1 2004	90.1 2004 Appendix G	15%
90.1 2007	90.1 2007 Appendix G	15%
90.1 2013		

- Most participating projects showed 18% - 20% improvement over 90.1-2007 using Appendix G methodology.
- **What is an appropriate performance target for the new program?**

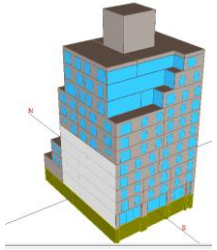
Increase in Stringency from 90.1 2007 to 2013

Office Renovation CZ5A



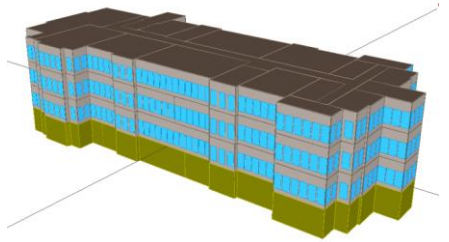
~25%, including 10% due to new modeling rules for envelope of retrofit projects

New Multifamily CZ4A



~25%, including ~14% due to over-ventilation penalty, and ~8% due to change in baseline heating fuel source for projects with electric space heating

New College Building CZ6A



~21%, including ~7% due to change in the baseline window area

- Modeled 90.1 2007 and 90.1 2013 Appendix G baseline for three sample projects`
- Changes in Appendix G rules have greater impact than the vintage of 90.1 used for the baseline.
- Performance target or modeling rules may have to be customized to support projects such as major renovations, or with purchased heating & cooling

New P4P NC Rules

OPTION 1

- Minimum 15% improvement over 90.1 2013 for multifamily buildings; 5% for other buildings in scope of 90.1
- Use 90.1 2013 with 90.1 Appendix G Excerpts 2015

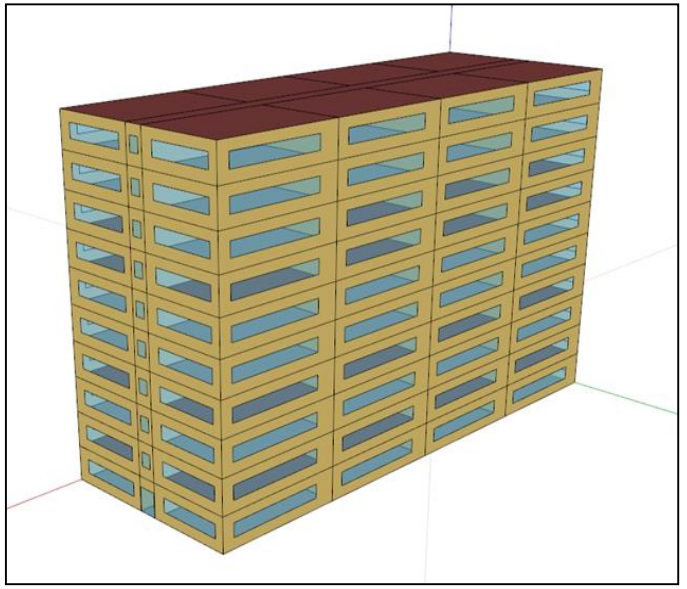
  Chose the “stable baseline” version of Appendix G to reduce future maintenance, simplify modeling, and align with LEED Pilot Credit

OPTION 2

- bEQ As-Designed score of 68 or less
- Baseline EUI based on EPA Target Finder (the ultimate “stable baseline”)

NYSERDA Multifamily New Construction Program

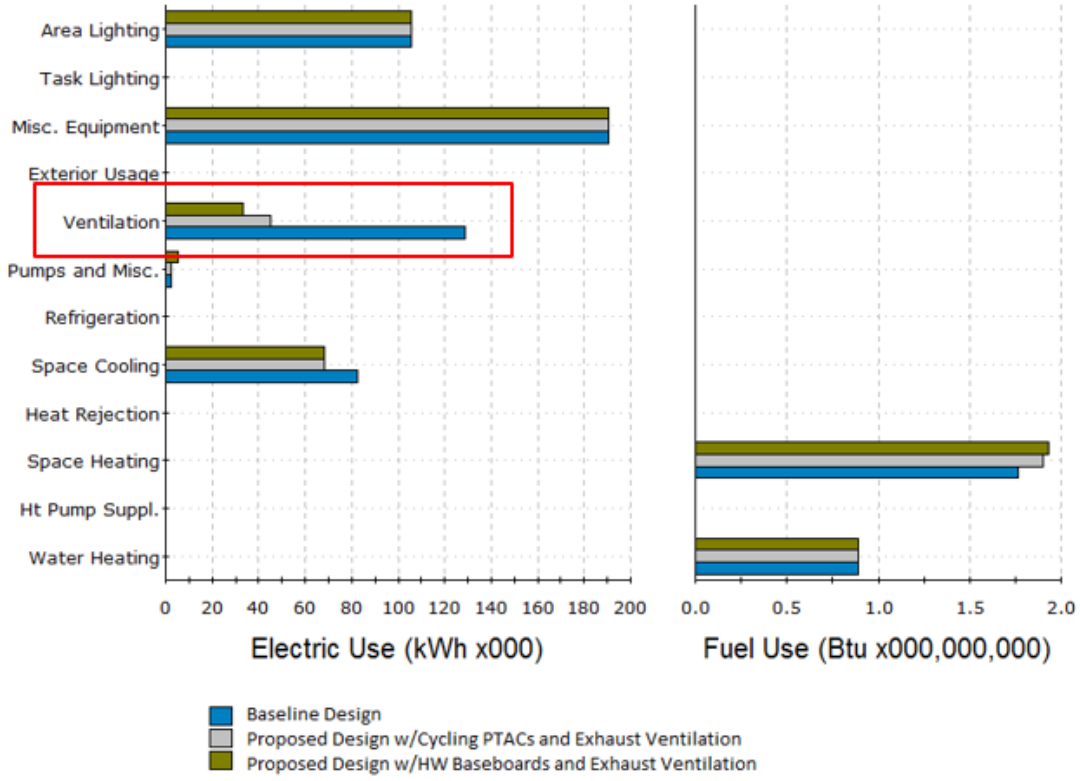
- Rolled out in 2005 as EPA Energy Star Pilot, with the methodology based on 90.1 Appendix G
- Tiered incentives with the minimum 15% improvement over NYS ECCC
- 2016 NYS ECCC adopted the “stable baseline” version of Appendix G
- The new target was evaluated in a modeling study based on PNNL high-rise apartment prototype model



Findings of the Modeling Study

- NY standard practice design minimally compliant with 90.1 2013 is **~8%** better than Appendix G baseline
- High electricity costs penalize projects with electric heating (e.g. VRF HP)
- There are impactful ambiguities in Appendix G, and the target must be set based on the adopted interpretations

Energy Savings of NY Standard Design versus Appendix G Baseline



Aligning Reporting Requirements

- To reap the full benefits of applicability of Appendix G methodology to both code and above code programs, adopters should share the reporting template
- Incentive programs in NY, NJ, and CT use LEED Energy and Atmosphere Credit 1 template, which allows directing some of the program implementation funding to enhance the template.
- The template has built-in QC tab, to streamline and automate submittal review

Quality Assurance Checks

Issue	Project Team Response
The total building area reported in the General Information tab differs from the total building area reported in the Lighting tab (Interior Lighting section) by more than 10%. Please check for consistency and verify that the building areas reported are accurate.	
The vertical glazing areas in the baseline differs from what is required in Table G3.1.1-1. Please correct or provide justification.	
The baseline vertical glazing area is greater than 40% (as reported in the Shading and Fenestration tab, Shading section), which is inconsistent with the requirement of Table G3.1.5(c) (baseline). Please correct or provide justification.	
The baseline and/or proposed interior lighting equivalent full load hours (determined by dividing the total annual lighting consumption by the total lighting power as reported in the Performance Outputs tab) is greater than 4,000 hours/year, which is unexpectedly high. Ensure that the lighting models reflect all mandatory controls from Section 9 and reflect the anticipated schedule of operation for the building.	
The baseline and/or proposed interior lighting equivalent full load hours (determined by dividing the total annual lighting consumption by the total lighting power as reported in the Performance Outputs tab) differs by more than 10%, which is unexpected.	

Process Loads | Service Water Heating | General HVAC | Air-Side HVAC | Water-Side HVAC | Results from eQuest | Performance_Outputs_1 | **Quality Assurance Checks** | ...

Takeaways

- **Customize performance targets** based on the technologies that the program wants to promote, and the standard practice
- **Test simulation rules** using popular modeling tools
- **Document technical policies in the Simulation Guidelines** to address ambiguities in Appendix G, and describe deviations from the standard rules
- **Align reporting requirements** with other prominent programs that use Appendix G, to reduce reporting overhead for participants, and to streamline submittal reviews.

Questions and Discussion

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