Comparative Analysis of Prescriptive, Performance-Based, and Outcome-Based Energy Code Systems

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Alaska Housing Finance Corporation
www.ahfc.us

Mission Statement

To provide Alaskans access to safe, quality, affordable housing.

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Commercial-Sector Energy Efficiency Training Services

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I. BACKGROUND AND INTRODUCTION

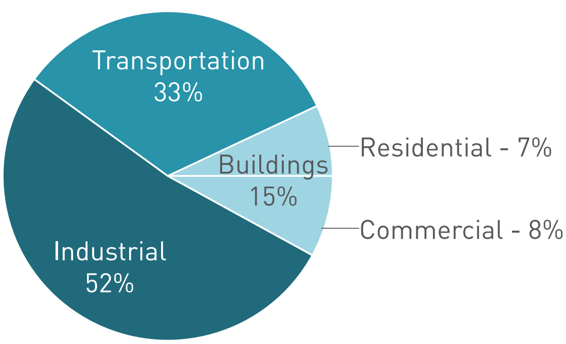
BACKGROUND

ENERGY USE IN ALASKA

Alaska is noteworthy when it comes to both energy supply and consumption. It is the second largest oil producing state, has the coldest temperatures, and uses the most energy per capita in the United States.[1] According to 2005 Department of Energy data, Alaska consumed 0.8% of all the energy used in the U.S. while only representing 0.2% of the total population. Alaska residents also pay some of the highest prices for their energy.

Residential and commercial buildings consume 15% of Alaska's total energy, though they account for 81% of the state's total electricity use.[2,3] Energy conservation and efficiency is the simplest and least expensive action Alaska can take to reduce utility bills and dependence on fossil fuels while subsequently shrinking carbon dioxide and greenhouse gas emissions.[4]

Alaska Energy Use



Source: US DOE, Alaska Energy Summary

STATE ENERGY POLICIES

In 2008, AHFC commissioned a report to identify energy efficiency opportunities in Alaska[5] which directly influenced the future adoption of the state's energy policies. Many of the report's recommendations were included in House Bill 306, passed in July 2010, outlining goals to improve statewide energy efficiency, decrease energy use in public buildings, protect public interest, and foster the state's economic prosperity.[6]

Senate Bill 220, signed into law June 16, 2010, calls for 25% of all public facilities to be retrofitted to meet or exceed current ASHRAE 90.1 standards. The bill authorized AHFC to develop a revolving loan

1 US Dept. of Energy, 2011

2 Information Insights, 2008

3 US Dept. of Energy, 2010

4 Ibid.

5 Information Insights, 2008

6 State of Alaska, 2010

ALASKA ENERGY EFFICIENCY REVOLVING LOAN FUND

In 2010, House Bill 306 set forth state energy policy to increase efficiency 15% by 2020.

Senate Bill 220 authorized AHFC to provide loans for energy efficiency improvements to public buildings including school district, university and municipal buildings. The loans are funded by the State Energy Program's American Recovery and Reinvestment Act (ARRA) of 2009.

The $250 million revolving fund will finance projects seeking energy savings. AHFC will require larger loans to set up Energy Performance Contracts to ensure that savings from energy efficiency improvements are used to pay back loans.

Loans will be structured to finance retrofits demonstrating a payback for building owners within 15 years. Interest rates will be locked-in at closing.

AHFC is currently evaluating the appropriate methodology for benchmarking energy performance requirements of buildings eligible for retrofit funding.

program to finance energy audits and energy efficiency retrofits to existing public buildings which include University of Alaska, state and municipal facilities, and regional educational attendance areas. SB 220 also requires the Office of Management and Budget to assist state agencies in developing a standardized method for collecting and storing building energy consumption data.

ALASKA'S ENERGY EFFICIENCY STANDARDS

In absence of a statewide energy code, Alaska relies on Building Energy Efficiency Standard (BEES) to guide efficiency requirements for new construction projects that receive state financing through AHFC. Residential BEES was adopted in 1992, but it was not until March 2011 that BEES was adopted for commercial buildings. The current version of BEES is based on the International Energy Conservation Code (IECC) 2009 and ASHRAE 62.2 2010 with Alaska specific amendments. It defines standards for thermal resistance, air leakage, moisture protection, and ventilation across Alaska's four distinct climate zones: Southeast, Southcentral, Interior & Western and Arctic Slope. AHFC will require commercial BEES as the minimum standard for all public facilities that receive funding through the revolving loan program. However, AHFC is interested in evaluating alternative code standards for benchmarking energy performance that may encourage even greater energy savings.

PURPOSE

The purpose of this report is to provide an overview of three different compliance pathways for energy codes: prescriptive, performance-based and outcome-based standards. This report is intended to serve as a resource for AHFC staff in the development of program policies and procedures for the retrofit revolving loan program. In addition to comparing the three code types and their implications for public buildings, it provides recommendations to AHFC in establishing benchmarks to best elicit maximum energy savings from retrofit funding.

Objectives

- Compare prescriptive, performance-based and outcome-based energy code systems and their ability to predict and measure actual building performance based on existing research and literature.
- Analyze various code systems as they relate to existing buildings.
- Provide recommendations for instituting a "code" standard for AHFC energy retrofit projects.

METHODOLOGY

The research methodology employed in the drafting of this report included an extensive literature review of the three different types of energy codes. Emphasis was placed on evaluating studies that have looked at measuring actual energy performance of commercial buildings approved under the various code systems and comparing expected and actual performance. Phone interviews were conducted with leaders in the field of energy codes and building performance which included staff from New Buildings Institute, Preservation Green Lab, the Cold Climate Housing Research Center and Cook Inlet Housing Authority. A list of interviewees can be found in Appendix A.

This report does not evaluate any specific local, state or national energy codes, but rather compares prescriptive, performance-based and outcome-based code systems and gives examples of each. The report summarizes findings from the literature review and interview process, and makes recommendations to AHFC on policy development for benchmarking performance of projects earmarked for retrofit funds. For the purposes of this research, the focus was on recommendations for commercial-scale public facilities (schools, government offices, convention centers, etc.), not residential sector development.

II. TYPES OF ENERGY CODES

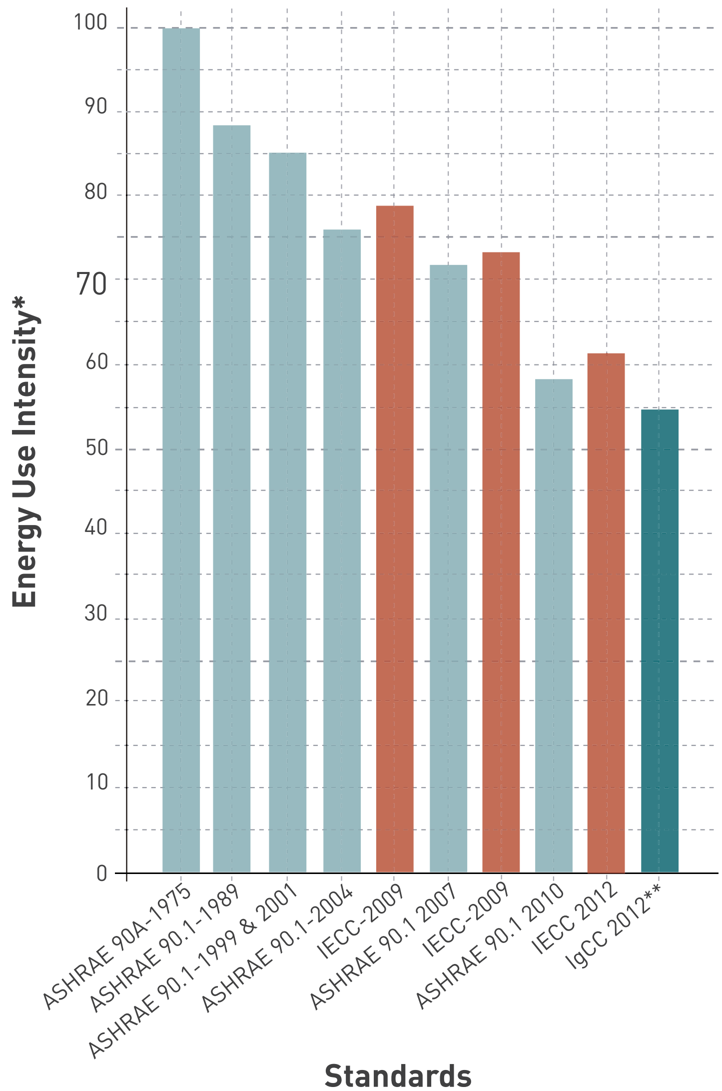
ENERGY CODE OVERVIEW

Codes define minimum requirements for reaching specified objectives. Energy codes are used by state and local jurisdictions to mandate and enforce standards for how a building's envelope, mechanical systems, and lighting should be designed and installed.

Most current code systems lack accountability for unregulated plug loads such as computers, monitors, kitchen appliances, water coolers, speakers, fans, space heaters and televisions. These loads can account for 25-30% of a commercial building's total energy use though they can be as high as 70% in some building types.[7]

Like other building codes, states have the authority to mandate and enforce energy codes. The U.S. Department of Energy (DOE) provides guidance for energy code adoption and implementation in the United States. The two models recognized and supported by DOE are the International Energy Conservation Code (IECC) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers 90.1 (ASHRAE 90.1). Each of these standards is updated in three-year cycles to integrate new technologies and incrementally move towards more stringent energy efficiency standards. As these codes are updated with more rigorous energy use reduction goals, they begin to align themselves with the far-reaching end goal of net zero energy. Some jurisdictions, like Austin, Texas and Albuquerque, New Mexico have recently adopted codes that align with the targets established by Architecture 2030 advocating for carbon neutral buildings by the year 2030. Efforts to enforce some of these codes have been stalled by legal action.

Energy Use Comparisons Across Code Standards



* Energy Use Index (EUI) is total energy consumption in BTUs divided by the gross square footage of the building.

**The IgCC 2012 bar is representative of the intended energy efficiency requirements currently being designed into the code.

The 2012 update of the IECC is expected to take a large leap toward energy reduction in commercial buildings. In October 2010, code officials approved a package of revisions targeted to provide an additional 30% in energy savings over commercial structures built to ASHRAE 90.1-2004 standards.[8] Specific upgrades include improvements to cooling and daylighting requirements, renewable energy standards, and the addition of a new section

7 New Buildings Institute, Summary Paper on Plug Loads, 2010

8 New Buildings Institute, 2010

that requires testing and verification. IECC 2012 will also serve as the baseline standard for the International Green Construction Code (IgCC)—a new national model green code currently under development by the International Code Council.

PRESCRIPTIVE, PERFORMANCE-BASED AND OUTCOME-BASED CODE SYSTEMS
Three methods exist for achieving compliance and enformence of energy codes: prescriptive, performance-based and, more recently, outcome-based code systems. Prescriptive and performance-based pathways are the current models used by most jurisdictions, with prescriptive being the most common and performance-based an accepted alternative. Ideally, both of these code systems would ensure energy efficiency in buildings, however, research reveals that they tend to be overly optimistic due to the fact that neither one takes into consideration how a building is operated and how it functions over time.[9] Further, a lack of code enforcement, or enforcement budget, can contribute to the difficulty of predicting how codes relate to actual building performance.

The following sections outline the pros and cons of the different code systems and provide examples of each.

PRESCRIPTIVE CODES

Prescriptive energy codes offer distinct and discrete actions to directly move a building project toward an end goal of higher efficiency. Prescriptive codes contain a menu of options describing minimum or maximum values for various elements in a construction project from which the designer or building owner can choose. Common prescriptive measures include minimum R-values for insulation or wall assemblies, acceptable infiltration rates, and efficiency requirements for mechanical systems such as water heaters and HVAC equipment. Inspectors and code officials are tasked with enforcing code compliance by verifying that items on the list have been included in the project.

BENEFITS

Prescriptive codes are often considered easy to follow because they clearly lay out what is acceptable and require little, if any, analysis on the part of the project designer. Inspectors and code officials also appreciate the predictability of this pathway as they can visually confirm compliance during plan review and site inspections.

Items required on prescriptive lists are usually common, off-the-shelf products that meet code compliance. In fact, increasingly stringent prescriptive codes can help instigate the manufacturing and market demand for higher-performance products that meet or exceed current code standards.

Items on a prescriptive checklist can offer various levels of energy savings. Bundling of items based on building type, age or location can allow designers to choose prescriptive measures that target optimum energy savings. Some codes or standards will bundle items on the list together to attempt to offer the largest return on investment for certain building types.

DRAWBACKS

Prescriptive codes, however, have several shortcomings. First, the process of selecting items off of a list does not encourage a whole building approach to achieving energy savings. As such, opportunities to maximize energy efficiencies are often missed. In cases where building owners are only interested in meeting minimum code compliance, short-term project budgets may drive the selection of prescriptive measures toward those that offer the least expensive initial investment rather than those that might achieve higher energy savings over time.

9 Frankel, 2010

Second, prescriptive codes do not require that a prescribed menu item actually function properly over time, nor do they typically require commissioning or testing of systems once installed. The code is set up to assume that all equipment is installed correctly and performs as specified by manufacturers. This is frequently not the case. As an example, economizers are one of the mechanical devices often in need of servicing. According to New Buildings Institute, economizers experience failure or improper functioning 64% of the time.

Prescriptive codes can also fall short simply based on efficiency strategies and energy end uses that are often overlooked. Few prescriptive codes provide credit for effective building orientation and daylighting, thermal mass, natural ventilation, or integration of appliances and mechanical equipment—all of which can contribute significantly to reducing a building's overall energy demand.

Lastly, as energy reduction goals become more stringent, prescriptive codes must be reviewed and updated continually. The updating process for prescriptive codes can be a time consuming and complicated venture for municipalities since the responsibility for evaluating the performance of new and existing prescriptive measures falls within the purview of the public agency. Many jurisdictions fall behind in reviewing and revising their prescriptive codes for this reason.

PRESCRIPTIVE CODES	
PROS	**CONS**
Familiar • Commonly used framework • Building owners and designers know what is expected	Incomplete • Plug and process loads not considered; these unregulated loads can be significant
Simple • Provides a clear description of accepted energy efficiency measures	Shallow • Does not utilize a whole building approach • Can encourage selection of items with the least initial cost over system efficiency
Easy • Compliance is simple to verify by inspectors	Reductive • Only includes items that are easily verified
	Overly Optimistic • Assumes equipment is installed and performs correctly
	Difficult to Update • As efficiency targets become more stringent, prescriptive codes must be reviewed and updated regularly

EXAMPLES OF PRESCRIPTIVE CODES

Most codes offer a prescriptive path for achieving energy efficiency in buildings.

Commercial BEES

The Commercial BEES, utilized by AHFC, provides a prescriptive compliance pathway for meeting energy efficiency as outlined by IECC 2009, Chapter 5. Alaska-specific amendments to Chapter 5 identify prescriptive measures tailored to the state's unique climate zones, addressing thermal and moisture control issues common in cold climates. IECC tables provide maximum U-factors and minimum R-values for the building envelope including roof and wall assemblies and fenestration. Further clarifications and descriptions are provided for mandatory practices for moisture control, ventilation, air quality, and equipment sizing.

Core Performance

Other energy standards also utilize the simplicity of prescriptive measures such as the New Buildings Institute (NBI) Core Performance protocol for commercial buildings less than 100,000-square feet. NBI took an integrative approach to defining prescriptive measures for achieving 25-30% greater energy efficiency than current model codes. After conducting an extensive analysis of building types and system configurations across various climate zones, NBI developed a bundled list of practical, achievable and affordable prescriptive measures that designers and building owners can use when targeting increased energy efficiency goals. The U.S. Green Building Council's Leadership in Energy & Environmental Design (LEED) for New Construction has adopted this prescriptive path as an alternative to modeling for energy credits.[10] The State of Massachusetts also references Core Performance as a prescriptive approach that local jurisdictions within the State can use to meet energy code compliance.

PERFORMANCE-BASED CODES

Performance-based codes contain broad, qualitative energy efficiency goals that require computer modeling to verify compliance. Performance-based codes are sometimes called "Modeled Performance" codes or paths within codes.[11] This distinction is made to clarify that building "performance" is not being guaranteed; rather it is predicted based on simulation by designers and energy modelers. Performance-based codes require that a reference building be defined in order to create a baseline energy budget for comparison. The modeling process provides a rating valuation demonstrating both the proposed and the baseline buildings' energy use. Performance-based codes require that new buildings are equal to, or lower than, the baseline reference building.

Performance-based codes are typically expressed in terms of "percent better than" energy use in comparison to a baseline. This is determined through the use of computer modeling software that forecasts building energy consumption based on inputs describing materials, systems, climate, and expected use (eg. occupancy schedules and internal gains). Building data is entered into the appropriate software and components and systems are manipulated until the desired efficiency goal is met. Code officials review energy efficiency results computed by preapproved modeling software to verify compliance.

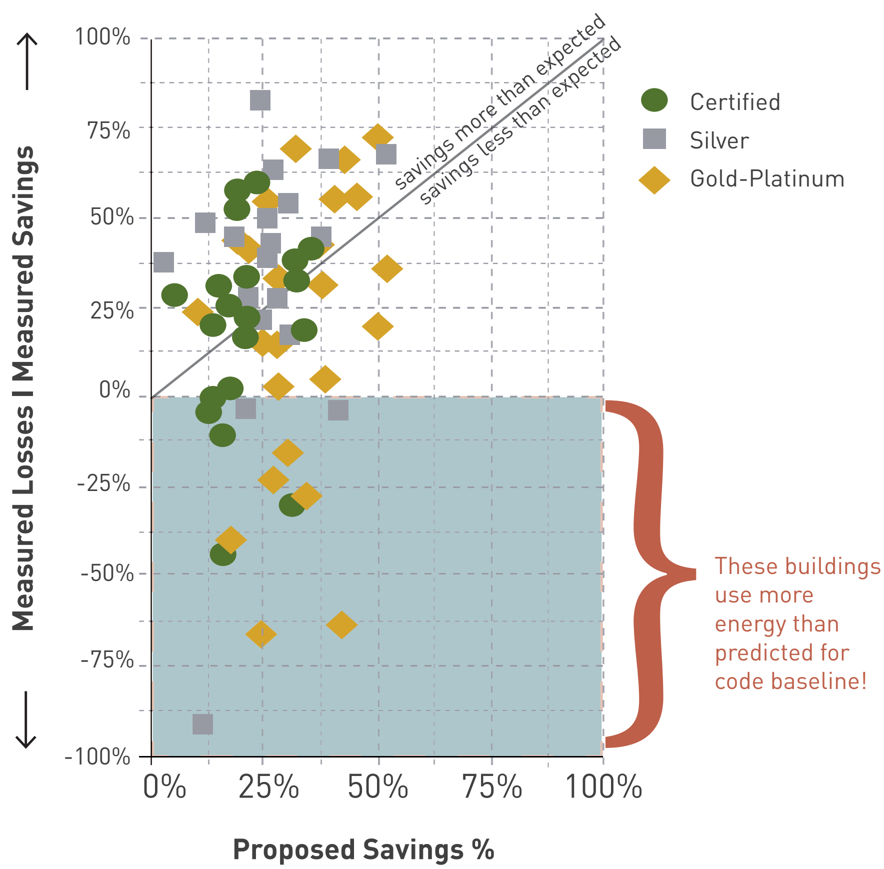
10 New Buildings Institute, 2007

11 Hewitt, Cohan, Frankel, 2010

BENEFITS
Performance-based codes are a common alternative method to prescriptive codes for creating flexibility within the compliance path. This pathway allows for design innovation and the integration of energy efficiency technologies. It is often perceived as a more expensive option over prescriptive codes due to the cost of energy modeling which frequently requires a trained energy specialist. However, once familiar with modeling software, design teams often prefer the performance-based path because the modeling tool allows them to evaluate various combinations of design strategies, components, and technologies until they arrive at a satisfying solution that provides the greatest energy savings for the least cost.[12] Once a project has been modeled, it is often possible for modeling results to be used concurrently for compliance with tax credits or beyond-code sustainability standards like LEED.

Communicating new targets for the "percent better than" standard is not as arduous or time consuming as updating lists of acceptable materials or efficiency measures. However, as performance-based codes are updated, confusion can arise as to the baseline from which the percent savings is achieved. For instance, early green building projects were recognized for being 40% more efficient than ASHRAE 90.1-1999, though years later these buildings would fail to comply with the most recent updates to ASHRAE standards.[13]

Measured vs Proposed Savings in LEED Buildings



Source: New Buildings Institute, Energy Performance of LEED® for New Construction Buildings, Turner, Frankel, 2008

DRAWBACKS
Performance-based codes usually incorporate prescriptive requirements as well, which can be time consuming to update. These mandatory measures are required so that basics such as insulation aren't completely left out of projects even though the modeling demonstrates that they are not necessary to achieve the targeted energy use.

Performance-based codes present a number of challenges related to how well they are able to predict actual building energy use. One consistent drawback is that modeling results are only as good as the data input. Even accurate data entry does not account for the likelihood that equipment will not always perform as specified by manufacturers, either because the system was faulty or because it was not properly installed.

Another challenge is that modeling software requires that the reference

12 Harris, et. al, 2010

13 Architectural Energy Corporation. 2009

building used in the comparison reflect the proposed building's design and equipment options. This can make it more challenging for a project that includes passive solar orientation or natural ventilation to demonstrate savings beyond code since these elements must also be modeled in the baseline building.

Like prescriptive codes, performance-based codes typically do not address plug loads. As a result, they also do not accurately account for how occupant behaviors and building management will impact energy use over time. This was reinforced by a 2008 study of LEED-certified buildings that compared actual versus modeled energy performance. The graph on the previous page, Measured vs Proposed Savings in LEED Buildings,shows that many projects, even those achieving the highest levels of LEED certification, are performing below their modeled targets and in some cases even below the levels projected by code baseline compliance. This is often the result of inconsistent building operation, unpredictable schedules, variable equipment performance, and other issues, like plug loads, not anticipated in the energy modeling.[14]

PERFORMANCE-BASED CODES	
PROS	**CONS**
Flexible • Takes a whole building approach • Supports evaluation of measures that yield the lowest cost and greatest energy savings	Incomplete • Unregulated loads are not considered • Requires significant staff expertise in the building department to review modeling submittals in a meaningful way • No enforcement mechanism to ensure building operates at the energy use level predicted by modeling software
Innovative • New technologies are integrated earlier • Allows more flexible approach to design strategies	Optimistic • Assumes equipment is installed and performing correctly
Transparency • Clearly stated goals and objectives	Limited • Modeled results are only as good as the data entered
	Expensive • Often requires specialty software and a trained energy modeler

14 Turner, Frankel, 2008

EXAMPLES OF PERFORMANCE-BASED CODES

There are many examples of performance-based codes.

AkWarm

BEES offers a performance-based compliance path as an alternative to the prescriptive path for meeting energy efficiency goals. AkWarm has been the software used by AHFC to analyze and rate energy efficiency of residential buildings. The recent adoption of IECC-2009 with Alaska specific amendments also approved AkWarm for simple commercial buildings. To make this software useful for energy audits the software has been updated to address commercial scale envelope construction techniques and materials, electrical loads, and commercial HVAC systems.[15]

ASHRAE 90.1 – Appendix G

ASHRAE 90.1 Appendix G is a whole building performance rating methodology designed to recognize performance above and beyond standard 90.1 requirements. This modeling method is designed to demonstrate that buildings using alternative strategies and systems can achieve equivalent energy costs to a building selecting typical prescriptive requirements. Appendix G now includes total energy consumption for all end uses and offers credit for mechanisms like better building orientation, automatic shading devices, occupancy sensors and timers for lighting, and better HVAC systems selection also receives appropriate credit. The results from the Appendix G modeling process can be used to document LEED and energy tax credits.

California Title 24

Another example is California's Energy Code, Title 24, which takes energy modeling a bit further. Known as one of the most advanced and complex performance-based codes, California developed a robust modeling and analysis tool (Alternative Calculation Method) for architects, builders, and code officials. The approved modeling programs simulate a building's thermal behavior by overlaying system impacts such as lighting, thermal mass, infiltration, solar gain, space conditioning, and occupant behavior. The Title 24 performance-based compliance path is especially unique because it considers the importance of when energy is demanded. This time dependent energy use is often referred to as Time Dependent Valuation (TDV). In addition, California's new statewide Green Building Standards Code (CALGreen)—which went into effect in January 2011—requires that a building demonstrate a 15% or greater reduction in energy use when compared to the State's mandatory energy efficiency standards.

Oregon State Whole Building Approach

The 2010 Oregon State Energy Code also offers a modeled compliance path with Section 506 of the Oregon Energy Efficiency Specialty Code (OEESC). The state's whole building approach offers more flexibility in how projects comply with the OEESC. The modeled building must ascertain that anticipated annual energy consumption will be equal to or less than energy consumption of a building following the prescriptive path approach. Energy consumption is measured in annual energy cost dollars in order to provide easy comparison across fuel types. A certified building analyst coordinates the permit process and design changes to comply with ASHRAE 90.1. If any building or system elements do not comply with the prescriptive requirements of the code the applicant must indicate and demonstrate how other system efficiencies will compensate.

15 Cold Climate Housing Research Housing Center, 2011

OUTCOME-BASED CODES

An emerging alternative to prescriptive and performance-based energy codes is outcome-based codes. This framework considers the whole building's energy use over a consecutive 12-month period including end uses that are currently unregulated. Outcome-based codes will require that buildings not exceed a maximum annual operating energy use. This pathway guarantees that actual energy efficiency is achieved by requiring a one-time reporting for compliance verification, though it may take a few years to obtain a consecutive 12-months of qualifying energy data.

While this pathway has the potential to help buildings achieve energy savings by assuring performance, it is still under development and has yet to be adopted by any jurisdiction. However, outcome-based paths appear well suited to federal, state, and local agencies that own their own buildings since they have long-term commitments to ensure that their buildings function properly over time.[16]

An inherent challenge with outcome-based codes is that within current code frameworks, a regulatory agency's power of authority typically ends at the time a certificate of occupancy is issued. To address this, DOE has suggested that a three-stepped fee structure could be useful as a compliance mechanism to inspire energy use reductions during the design and construction phases and to subsequently motivate the appropriate parties to maintain their energy efficient system:

1. a performance bond to keep the building / owner in compliance,
2. a utility cost-based fee to keep the tenant in compliance, and
3. a property tax-based fee to keep the owner / operator in compliance.[17]

Building energy disclosure ordinances, already gaining traction in several cities[18], will likely become an essential tool in the adoption of outcome-based code systems.

BENEFITS

Outcome-based codes offer a highly flexible regulatory pathway that will actually address energy use. Utilizing both prescriptive and energy modeling measures, designers can use the most appropriate means to predict and achieve maximum energy efficiency efforts. The use of both of these resources supports design innovation and evokes thoughtful planning so that energy savings are realized.

One of the most important aspects of this compliance path is its inclusion of all energy loads, including currently unregulated plug loads, in the equation for overall energy reduction. Management and maintenance of all systems and loads creates incentives for building operators and managers to understand how, when, and where energy is being used. Metering of all end uses by system[19], along with beneficial sub-metering, can provide guidance for initiating commissioning and calibration regimens, and identify energy offenders in a timely manner. If disclosure and reporting requirements are mandated, realistic energy use targets can be identified. Building labeling programs can also be instituted to reward responsible energy users and help create market-level awareness with potential tenants.

Whole-building metering and mandated disclosure requirements are likely to be helpful tools for maintaining energy efficient buildings over time. Reporting creates a positive feedback loop that encourages system upkeep. It compiles useful data that can be used by building managers in analyzing whole building performance while also providing

16 State of Alaska, 2008

17 ibid.

18 Disclosure requirements have been adopted by Washington DC, Seattle, New York City and Austin. Additionally, Washington and California have statewide disclosure requirements.

19 Hewitt, Cohan, Frankel, 2010

opportunities to educate building occupants about their energy use. In addition, tracking energy use provides essential data that can inform current and future energy codes.

DRAWBACKS

Outcome-based codes rely on regulatory authorities to set the allowable energy use quotient. As building owners and performance contractors adjust to a new set of guidelines for achieving energy efficiency compliance, they will likely offer conservative estimates for energy savings so as not to commit themselves to unattainable levels, thus choosing less risky, more reliable, energy saving strategies. Extra guidance for designers and building owners will be needed to ensure energy efficiency measures are met.

Commissioning and ongoing testing are key components to making sure a building is functioning as intended. Practical performance tests are readily available for cooling, dehumidification, hot water, distribution and envelope and duct leakage systems in larger buildings. However these tests, calibrations, and commissioning efforts are often perceived to be cost prohibitive from the standpoint of conventional code compliance paths. Further, insufficient budgets for managing ongoing systems operations may reduce potential energy savings over time.[20]

OUTCOME-BASED CODES	
PROS	**CONS**
Predictable • Guarantees energy savings • Metering and sub-metering links occupant behavior to energy use • Performance must be verified	Liability • Building owners, designers, and contractors may be unsure of the extent of energy efficiency savings for which they will be held accountable
Flexible • Encourages design innovation • Allows for the use of new technologies	Investment • Maintenance, commissioning, and systems calibration can be perceived to be expensive
Inclusive • Accounts for whole building energy uses including currently unregulated plug loads • Inherently considers all passive design strategies	New • Requires a fundamental shift in the way that energy codes function • Owners/developers will require extra guidance from regulatory agencies to ensure energy efficiency measures are met
Qualitative • Promotes higher performance design and construction • Offers feedback that can inform building energy improvements and future code revisions	
Ongoing • Calibrates energy codes to actual building performance • Informs new code development	

20 State of Alaska, 2008

EXAMPLES OF OUTCOME-BASED CODES

As of April 2011, no jurisdiction has adopted an outcome-based code as an alternative compliance pathway.

Outcome-Based Pilot Programs

The City of Seattle, WA, and Vancouver BC, Canada, are both studying how best to incorporate outcome-based compliance paths to achieve greater energy efficiency in buildings. The City of Seattle is running a pilot project that began in December 2009 and is intended for enactment in January 2013 in the Seattle Energy Code as an alternative compliance pathway. The City of Seattle's Priority Green Permitting Program partnered with New Buildings Institute and the National Trust for Historic Preservation's Green Preservation Lab to test how the flexibility of the outcome-based performance path can improve the energy efficiency of existing buildings by shifting the code's requirement to overall energy use reduction.

Seattle's outcome-based compliance will be based on meeting actual post-occupancy energy use targets instead of pre-occupancy prescriptive or modeled measures. The initial permit step will include the negotiation of pre-contracted energy rates with utilities, the identification of energy use targets, and the submittal of a compliance bond. Once the building owner demonstrates the ability to operate at or below the pre-negotiated energy use targets the compliance bond will be released. If energy efficiency targets are not met, penalties based on percentage variations from the established target will be applied. The time frame for demonstrating compliance will be flexible as it may take a while for building owners to figure out how to optimally run systems and to streamline tenant energy use.

Integral to the City of Seattle's outcome-based pilot program is a disclosure ordinance that requires commercial properties to reveal building energy consumption information. Ordinances will be instrumental in helping set appropriate targets and benchmarks. Ideally, public disclosure will allow the public to know how well buildings are performing and provide market reinforcement for energy efficient buildings while motivating conservation of occupant energy use. Tools such as metering and sub-metering will support these efforts and highlight which systems are most in need of improvement.

In January of 2011, Vancouver, BC outlined a number of green building objectives for meeting their 2020 carbon neutral goal for all new buildings. Included on their long-term list was an outcome-based energy code compliance path. The city will create financial incentives and support for contractors and building owners who want to adopt this path early.

The International Green Construction Code

The new International Green Construction Code (IgCC) is being developed by the International Code Council (ICC)[21] and is intended for publication in 2012. The IgCC is being designed to be at least 30% more efficient than IECC 2006. The code is written

THE BENEFITS OF AN ENERGY EFFICIENCY PORTFOLIO STANDARD

The Energy Efficiency Portfolio Standard is a useful tool for entities that own and operate numerous buildings, such as municipalities and universities.

Like outcome-based codes, portfolio standards intend to achieve actual energy savings. They set specific performance targets for the entire aggregate of buildings and often set maximum energy use limits for individual buildings as well.

This standard helps to focus energy efficiency efforts on achieving better overall building operation performance for each building while encouraging the identification of "worst offenders" for energy retrofits and upgrades.

21 In association with cooperating sponsors American Society for Testing and Materials (ASTM), International and the American Institute of Architects (AIA)

in mandatory language to be used by any level of regulatory or governmental agency but is currently used on a voluntary basis. It is hoped that the exposure that comes from the voluntary adoption of these aggressive codes will pave the way for broad adoption in subsequent code revisions.

IgCC Chapter 6 regulates the design, construction, commissioning and operation of buildings for the effective use of energy. The outcome-based compliance path sets maximum CO_2 emission limits and annual net energy use. It also sets peak energy demand limits and requires that the building's Energy Use Intensity (EUI) place the building in the top 10 percent of existing buildings in terms of energy performance. Compliance with this pathway for existing buildings requires verification of energy performance over a continuous 12-month period that will be compared to the 12-months of energy used before the alteration. Metering, monitoring, reporting, and a publicly accessible display will be required in an on-going basis to verify continued compliance.

Net Zero

Net zero energy is consistently referenced by outcome-based standards as the determinant for energy conservation success. Green building standards such as the Living Building Challenge seek substantial reductions of energy use and the negative environmental impacts from the use of fossil fuels.

The Living Building Challenge requires buildings to balance their annual energy use with the amount of energy they can generate onsite. Extreme conservation and system efficiency is essential in the design of these buildings. Buildings must demonstrate that they can achieve net zero energy over a consecutive 12-month period once occupied.

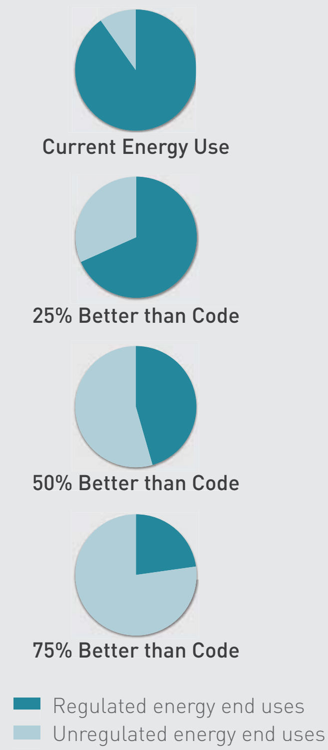
Net zero carbon is the goal of The 2030 Challenge. In June 2006, Edward Mazria authored The 2030 Challenge to call the building and design industry to action to reduce greenhouse gasses produced by commercial buildings. This challenge outlines a series of targets that will result in buildings that release no net carbon into the atmosphere by 2030.

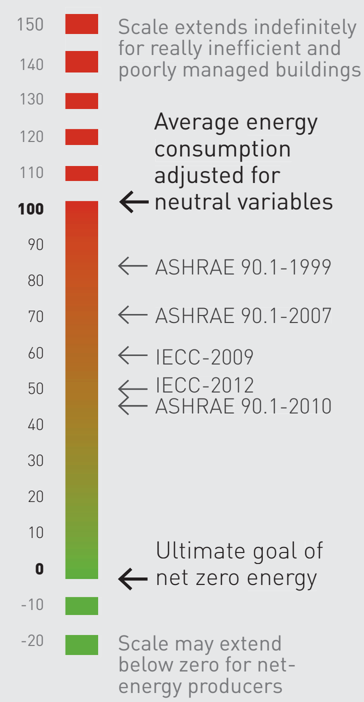
Metrics for Measuring Energy Use

The Problem with "Percent better than" Metrics

Many energy efficiency standards are measured in a relatively simple "percent better than" code metric. This approach selects a code baseline and then sets targets for further reducing energy use beyond that baseline. Confusion can arise over code update cycles and between different standards as it becomes unclear which baseline must be improved upon and which energy end uses are taken into account.

Additionally, this type of metric begins to yield diminishing returns since most codes don't account for the plug loads. As the regulated end uses are reduced, the unregulated plug loads become a larger portion of the building's total energy use.





Source: based on the recommended scale by Architectural Energy Corporation, 2009.

zEPI Scale

The Zero Energy Performance Index (zEPI) articulates a more comprehensive way of labeling energy use in real buildings, and provides logical labels for reducing building energy use.

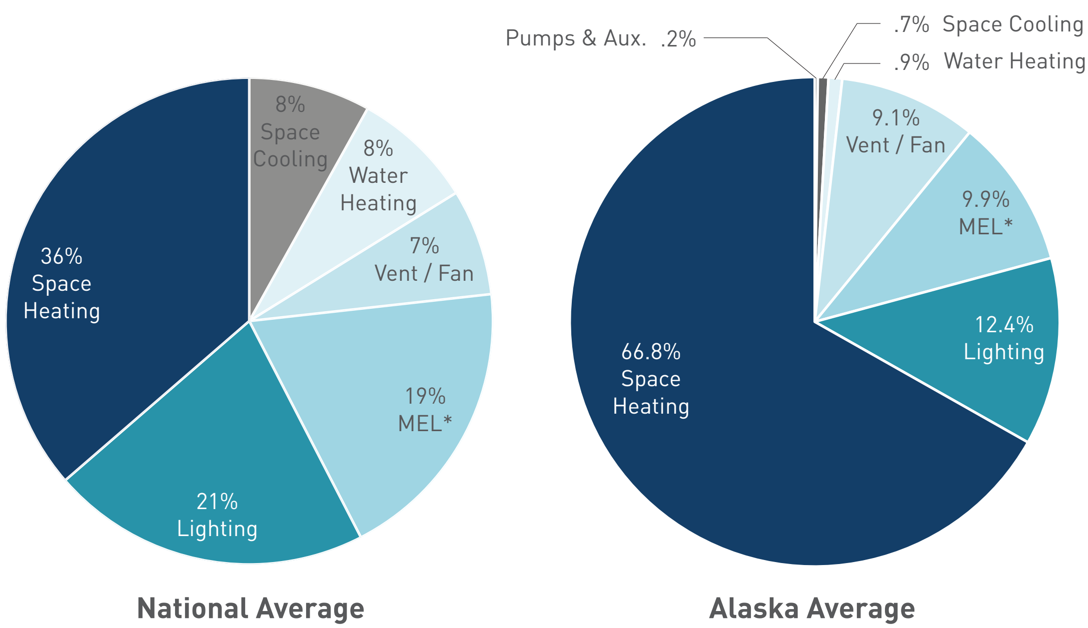
This metric utilizes a 100 point scale and names net zero energy as the ultimate goal. 100 equals the average energy use for that building type in a specific climate as established by national consumption data. A building's score represents how far it deviates from net zero.

III. CONSIDERATIONS FOR EXISTING BUILDINGS

Efforts to improve a building's energy efficiency will extend the life of the building, increase occupant comfort within the building, and reduce energy costs. While each existing building will have its own challenges and opportunities, some buildings will benefit more than others from energy efficiency retrofits.

CHALLENGES AND OPPORTUNITIES FOR ENERGY UPGRADES IN EXISTING PUBLIC BUILDINGS

Typical Energy Use for a Commercial Office Building



*MEL - Miscellaneous Energy Loads (Plug Loads)

Existing buildings offer unique challenges because they are already in place and because they are already occupied. Retrofits to existing buildings can also be more expensive than new construction due to difficulty accessing some parts of the building. It should be noted that in jurisdictions with energy and building codes, retrofit projects sometimes trigger other building code requirements, such as seismic and ADA upgrades. In these cases scope creep can prompt some building owners to abandon retrofit measures because of insufficient funds.[22]

Nationally, lighting and space heating consume the largest portion of commercial building energy use. In Alaska, however, space heating drives building energy use due to cold climate conditions.[23] Upgrading inefficient equipment (especially ventilation systems in a climate where the outside air is often bitter cold), calibrating controls, and improving occupant energy conservation practices are some of the most practical energy improvements existing buildings' owners can make in Alaska. Smaller buildings can also greatly benefit from building envelope maintenance.

22 Although Alaska currently has no state-wide building code this may be a consideration for the future as state-wide codes become established.

23 Alaska Energy Use data based on information provided by New Buildings Institute and Ecotope from a 2011 prototype modeling analysis.

Building owner reluctance provides one of the biggest barriers to initiating energy efficiency retrofits. First, the building owner knows that energy efficiency measures are much cheaper to incorporate as the building is being constructed. Second, scheduling building retrofits can be tricky as projects must accommodate or find alternative space for existing tenants as projects often overrun their schedule. Third, access to capital may be difficult for a building owner as many of the deeper retrofit strategies have high upfront costs. Many building owners are not aware of how much energy the building consumes and demonstrated savings for energy retrofits can be difficult to find. While the building owner finances most energy retrofits, it is the building tenants that reap the savings. This last barrier is often identified as a "split-incentive." Metering and sub-metering can help shift the responsibility to the appropriate party.

Code compliance pathways can create a variety of opportunities and challenges for motivating energy efficiency upgrades in buildings.

PRESCRIPTIVE CODES AND EXISTING BUILDINGS

- Prescriptive codes allow existing building owners to select from a menu of energy retrofits, but it can be difficult to choose the strategies that provide the best long-term investment for their building.
- Existing buildings often have physical constraints that can make prescriptive strategies difficult, such as shallower wall cavities that only allow minimum levels of insulation.
- Prescriptive codes don't offer guidance on how to schedule retrofit activities. For example, building owners should first insulate and seal their building in order to select the most appropriately sized heating system. Scheduling retrofits at the same time as other building renovations can reduce the overall costs involved in a project as well.

PERFORMANCE-BASED CODES AND EXISTING BUILDINGS

- The modeling tools of performance-based codes offer increased flexibility for existing building owners who want to identify the most cost effective energy efficiency retrofits. Modeling is the best tool we have for projecting energy use and analyzing various energy efficiency strategies.
- Performance-based projections require precise building data to model predicted energy use when testing various energy reduction strategies and systems. Even if a building has an as-built plan set, it is often outdated or inaccurate, and existing conditions like insulation levels can be challenging to assess without opening up the walls. It should be recognized that modeling tools are limited by the information and current understanding of building construction, operation, and tenant uses.
- Owners of existing buildings are in a unique position to collect actual energy use data and retroactively review it. Audits and pre-retrofit evaluations can fill in the gaps but they can be perceived as expensive and most building owners don't understand their value.
- Unless the existing building has been thoroughly audited and system performance accurately recorded, the projections from the modeling effort will not be reflected in the actual energy findings. This can indicate potentially faulty pathways for pursuing energy reductions and miss opportunities for deeper energy retrofits.

OUTCOME-BASED CODES AND EXISTING BUILDINGS

- Outcome-based energy codes are whole-building approaches to energy conservation efforts and use the best aspects of the prescriptive and performance-based tools for selecting the most appropriate energy efficiency improvement strategies for existing buildings.
- The National Trust for Historic Preservation, the City of Seattle, Pacific Northwest National Laboratory, Northwest Energy Efficiency Alliance, and New Buildings Institute are advocating for this energy reduction compliance path for existing buildings.
- Benchmarking and disclosure allow building owners to evaluate their building's performance and identify system problems in a timely manner; this compliance path makes the building itself the energy-use reference point. Metering and sub-metering are essential tools for this path; however, sub-metering can be challenging to install in existing buildings.
- Maintenance, commissioning and re-commissioning, as well as system calibration are important to all buildings once they exist. These maintenance and operation costs can be perceived as expensive but they offer sizeable energy and cost savings over the long-term.

IV. RECOMMENDATIONS FOR ESTABLISHING "CODE" STANDARD FOR AHFC RETROFIT FUNDING

It is recommended that AHFC take a whole building approach supporting energy savings for existing public buildings. Energy and financial savings can be achieved by setting up the AHFC loan program to optimize the most appropriate tools available in each of the compliance paths; prescriptive, performance-based, and outcome-based. Revolving Loan Fund success should be based on actual reductions of overall energy applied across the entire stock of public buildings.

Draw on the flexibility of the outcome-based approach
A whole-building approach allows designers to select the most appropriate and beneficial strategies to achieve actual energy savings. This flexible framework allows designers to accommodate a building's unique characteristics to achieve overall energy savings.

Require minimum prescriptive measures for energy efficiency
All public building owners should be required to implement a set of minimum requirements to ensure their building is operating at a baseline efficiency level. The prescriptive list should include strategies such as insulation, sealing, commissioning and re-commissioning, as well as metering and sub-metering to ensure systems are functioning correctly and to help track when and where energy is being used in the building. This requirement will also instill confidence with the parties backing the performance bond associated with the retrofit loan.

Initiate an energy use disclosure requirement
Documenting building energy use will be useful in informing retrofit activities. Ongoing disclosure across Alaska's public building stock can provide AHFC with meaningful data that can be used to set appropriate energy benchmarks and reveal energy use patterns across building type, use, and climate zones. Recurring annual disclosure educates building owners on their building's energy use patterns and reinforces good building operations and maintenance habits. Lessons learned can also inform future modifications to the loan program.

Incentivize ongoing energy use reduction through variable interest rates
Ongoing annual reporting can provide the data necessary to institute a tiered interest rate on retrofit loans. This incentive can be used to motivate building owners to maintain buildings at their optimal energy efficiency levels. Lower interest rates could be tied to energy reduction success. Monthly loan payments could remain the same but the lower interest rates would enable building owners to pay down the principal more quickly, putting energy savings dollars in their pockets sooner.

Use a portfolio standard to maximize savings across all public buildings
Effectively reduce energy use across all public buildings by setting an energy reduction target that increases over time and sets minimum performance levels for each building. Making the entire portfolio of buildings responsible for achieving the energy reduction goals prioritizes building operations improvements, allows each building to streamline energy efficiency of their equipment and systems, and improves tenant conservation efforts. Owners of public buildings reporting the largest energy use patterns should be urged to take on extensive energy efficiency retrofits to help reduce the overall energy use of the portfolio group.

V. ADDITIONAL RESOURCES/BIBLIOGRAPHY

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ADDITIONAL RESOURCES

ORGANIZATIONS

Alaska Conservation Alliance - http://www.akvoice.org

Alaska Energy Authority - http://www.akenergyauthority.org

Alaska Energy Efficiency- http://www.akenergyefficiency.org

City of Seattle, City Green Building - http://www.cityofseattle.net/dpd/GreenBuilding/

Cold Climate Housing Research Center - http://www.cchrc.org

New Buildings Institute - http://www.newbuildings.org

Northwest Energy Efficiency Alliance – http://www.neea.org

PikeResearch - http://www.pikeresearch.com

Preservation Green Lab - http://www.preservationnation.org/issues/sustainability/green-lab

Rocky Mountain Institute (RMI)– RetroFit Depot - http://www.retrofitdepot.org

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VI. APPENDIX A- INTERVIEWEES

INTERVIEWEES

Stuart Brooks, Weatherization Program Manager and a Building Inspector, Cook Inlet Housing Authority

Ric Cochrane, Policy and Research Project Manager, Preservation Green Lab

John Davies, Senior Researcher, Cold Climate Housing Research Center

Mark Frankel, Technical Director, New Buildings Institute

Scott Waterman, State Energy Programs Manager, Alaska Housing Finance Corporation