Washington State Energy Code Roadmap

Issues, priorities and sequences that will lead to success in meeting legislated targets for the Washington energy code

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Introduction:

The purpose of this roadmap is to provide context for the policy and code performance goals for new residential and commercial buildings in Washington law and identify the mechanisms and cycles by which code provisions can evolve to meet these goals. These code improvements will occur in incremental steps and this document will help identify the order and priority that is needed to lay the groundwork for subsequent code and policy strategies to improve code language. The improvements can be mapped into the planned code cycles remaining between now and the target achievement date for Washington's policy goals for building stock. The *Roadmap* will also identify scope and policy barriers as well as opportunities that will need to be addressed to achieve the long-term goals identified.

Foremost among the needs to achieve long-term performance goals will be to identify strategies that address specific building type performance characteristics. The *Roadmap* will include opportunities and priorities based on building types and end uses that are anticipated to play a large role in state and regional development in the building sector.

The Washington State Energy Code (WSEC) goals for 2030 include both residential and commercial construction. However, the discussion in this roadmap is focused mostly on the commercial sector.

The *Roadmap* first provides background information, then moves to key issues and opportunities, and then concludes with additional analytical approaches and a summary.

Background:

Washington State Goals for the Building Sector

Many organizations and jurisdictions have adopted a range of building performance goals over the past decade that have significantly changed the conversation about energy codes and building energy performance. The primary policy driver for the Washington State Energy Code increases in stringency is the language adopted by the Washington State Legislature, which reads:

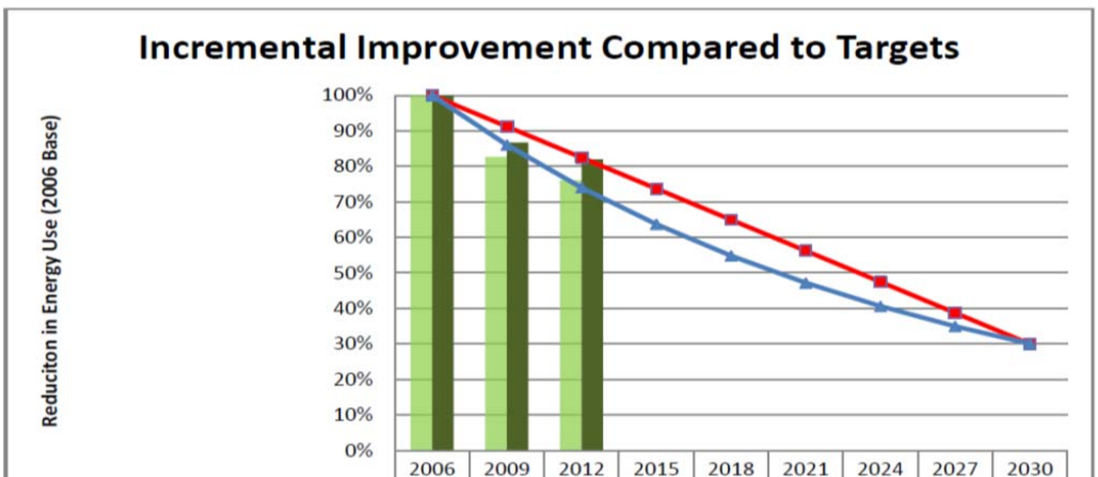
- *Residential and Nonresidential construction permitted under the 2031 state energy code must achieve a 70 percent reduction in annual net energy consumption (compared to the 2006 state energy code) (RCW 19.27A.160)*

  And—

- *Construct increasingly efficient homes and buildings that help achieve the broader goal of building zero fossil-fuel greenhouse gas emission homes and buildings by the year 2031 (RCW 19.27A.020)*

The WSEC is modified in three-year cycles. This means that there are six code modification cycles between now and 2031 when the building performance goals are to be achieved. (The nominal code date is 2030, with anticipated adoption in 2031.) Washington's Department of Commerce characterizes this pathway to building performance in the graph in Figure 1. This graph shows steady and equal incremental improvements over the course of the mandate. But in fact the improvements are linked to the adoption cycle, so the improvements could more accurately be represented as steps down to the goal. More importantly, these steps are probably not equal through the course of the policy and are also not the same magnitude for different building types, due to variations in use patterns. Although individual steps in the code adoption cycle may not be of the same magnitude each time, it is very important to recognize that significant progress must be made each cycle if the end goals are to be achieved. The stringency of each code cycle needs be tracked to make certain that long term goals will be met.

The progression in Figure 1, modified over time, forms the basis of the discussion in this roadmap of how to address sequential code cycles, different building types and end use types. These issues are addressed in later sections of this document.



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Residential	100%	82.7%	76.1%						
Commercial	100%	86.8%	82.0%						
Target: 8.75 % savings compared to the 2006 WSEC	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% savings compared to each previous code	100%	86%	74%	64%	55%	47%	41%	35%	30%

Figure 1: WSEC stringency progression: a representation of progressive energy code stringency. Two code cycles since 2006 are represented based on stringency achieved in these cycles.

One issue not clarified in the policy language is the role that building-scale renewable energy is to play in this progression. If building efficiency improves to the point that buildings are 70% more efficient than the 2006 WSEC baseline, it is conceivable that adding renewables to these buildings could come close to achieving net zero energy goals that are part of broader regional and national policy goals. This relationship is implied in RCW 19.27A.020, where "increasingly efficient homes and buildings… help achieve the broader goal of building ***zero***…***greenhouse gas emission*** homes and buildings by the year 2031" (emphasis added). Alternately, the language in RCW 19.27A.160 states: "…construction permitted under the 2031 state energy code must achieve a 70 percent reduction in ***annual net energy*** consumption…" (emphasis added). For the purposes of this paper, both provisions will be assumed to imply that the buildings constructed under the 2031 code will consume no more than 30% of the energy that was permitted under the 2006 energy code.

The Difference Between *Code Improvement* and *Energy Achievement*

A key issue in considering energy code progress is recognizing that setting energy code stringency improvement goals is not the same thing as requiring specific building energy performance outcomes. When we talk about *net zero annual energy use* or *greenhouse gas emissions*, we are referring to a specific, measurable outcome. The success or failure of policies targeting this outcome are dependent on actual building performance outcome, as measured at the utility meter or calculated based on annual consumption.

When we talk about a *percent increase in energy code stringency*, we are talking about an abstract evaluation of relative code building energy performance. Buildings with a wide range of energy use or greenhouse gas emission rates can all be said to meet energy code requirements, and while increased code stringency will push energy performance in the right direction, it will not determine the energy use outcome of the project nor can it assure meeting zero greenhouse gas emission goals.

This subtlety becomes very important in the context of policy goals that set criteria for specific building performance outcomes. The legislative language adopted by the State of Washington seems to refer to **both** goals, "a 70% improvement compared to 2006 code" and a "broader goal of zero emission buildings".

In the national and regional context, most policy goals focus on the specific outcome of "net zero annual energy use by 2030" as opposed to a percent improvement goal. This goal has important implications for energy code enforcement strategies, and code scope, as discussed in the section below.

Understanding the Starting Point for Policy Goals

Regional and national jurisdictions and organizations have adopted different starting points, or baselines, as the basis for tracking progress toward long term performance goals for their energy codes or building stock. Most of these goals are influenced by the 2030 Challenge, a policy goal developed by the Architecture 2030 organization to define a path to building performance improvement[1]. Though these baselines are similar and tend to be influenced by the Architecture 2030 goals, there are differences in the way these baselines are established.

- **Commercial Building Energy Consumption Survey (CBECS 2001) Baseline:** This is the baseline used by the 2030 Challenge as a starting point on the trajectory to net zero carbon emissions for

[1] http://architecture2030.org/2030_challenges/2030-challenge/

new construction by 2030. It is based on data collected by EIA about the broad characteristics of the national building stock, including buildings of all ages and types. Energy performance is measured in terms of energy use intensity (EUI) in kBtu/sf/yr. CBECS data has not been collected/released since 2001, so the data set is dated and does not include good representation of newer code and construction practices.

- **Percent Improvement Beyond Code:** Many utility and voluntary programs like LEED use a metric of comparing building performance to current or historic energy code requirements. This is also typically used in the private sector to describe building energy performance. Unfortunately the language seldom identifies specifically which version of the energy code is being exceeded, so it is virtually impossible to compare performance claims among different buildings.
- **ASHRAE Addendum BM:** ASHRAE has recently adopted a methodology to standardize evaluation and claims of performance beyond code. Instead of comparing projects to the code in force, projects will always be compared to the 2004 version of ASHRAE 90.1. As energy code stringency increases, projects will be expected to exceed 90.1-2004 by larger and larger margins, while meeting updated code requirements. Note that the WSEC 2006 energy code is very similar in stringency to ASHRAE 90.1-2004, so this metric can serve WSEC policy goals fairly well.
- **zEPI:** The Zero Energy Performance Index (zEPI) is a mechanism to recognize progress toward the ultimate goal of net zero annual energy use. Normalized building EUI is compared to similar project types to determine how far along the "net zero trajectory" a project is, and the zEPI score reflects this progress. The baseline score is 100, representing a normalized CBECS 2001 baseline. Both codes and individual buildings can be ranked on this scale to compare to each other. The ASHRAE 90.1-2004 energy code (the basis of Addendum BM) achieves a zEPI score of 75.

Code Improvements Proceed at Different Rates

Although we talk about the energy code increasing in stringency as a code, different components of the code are changing at different rates. Technology improvements in lighting (primarily LED's) have allowed for rapid improvements in lighting efficiency to be captured in code requirements. Steady increases in insulation requirements and cooling system efficiency have also contributed to energy code stringency increases. Figure 2 (from PNNL) shows how different building components have contributed to code stringency increases over the past 40 years, and anticipates continued improvements moving forward. But a key performance element of energy codes has not improved over the past 30 years, heating equipment efficiency.

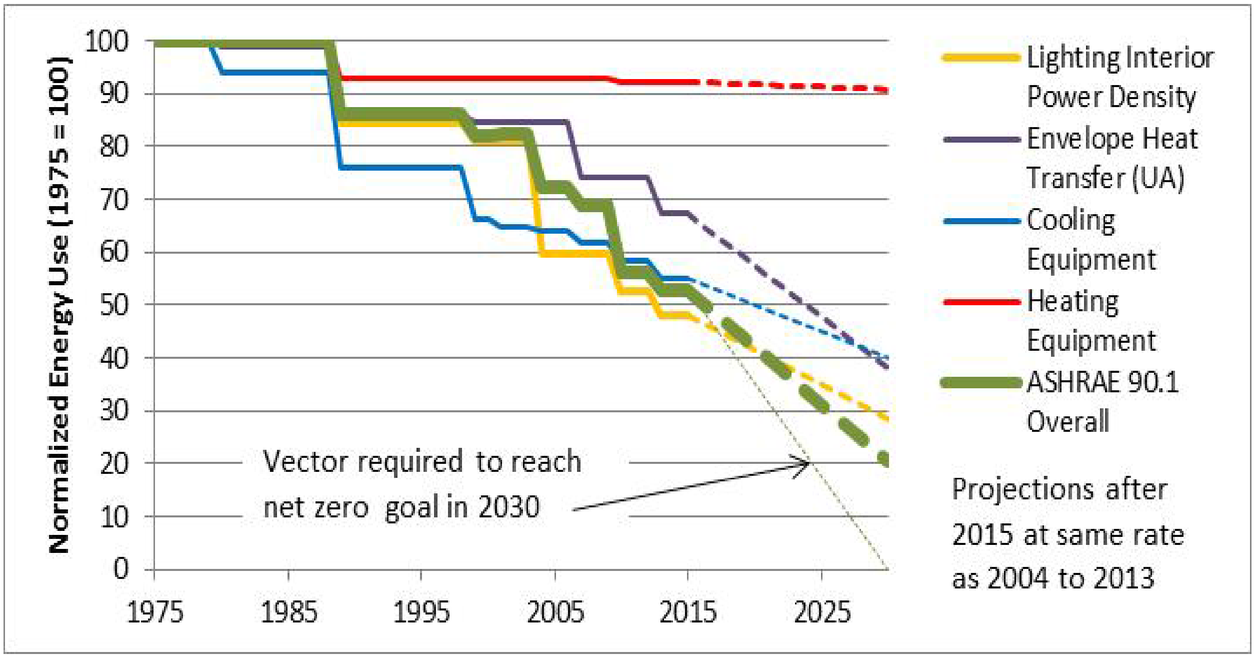


Figure 2: Efficiency progress of individual building components since 1975

Issues and Opportunities:

Federal Pre-emption on Heating Efficiency

Heating equipment efficiency performance has remained stagnant over the past thirty years in large part because there is a federal mandate that precludes the adoption of heating efficiency requirements in energy codes that exceed federal guidelines[2]. This federal pre-emption was adopted by Congress through efforts by the HVAC industry to prevent the "market confusion" represented by multiple requirements in code across the national market. The pre-emption also applies to most cooling equipment, but because the underlying statute allows ASHRAE to advance the national standard, cooling equipment codes have increased somewhat over time but still at a constrained rate in Washington because of the federal pre-emption.

While the issue of multiple regulations may have been valid for the industry, the outcome has been an ongoing resistance to updates to requirements that would lead to higher efficiency requirements and active legal battles by industry organizations to prevent individual states and jurisdictions from adopting efficiency upgrades. The industry continues to defend this pre-emption, precluding even modest improvements in heating equipment efficiency requirements in states and cities across the country. This pre-emption represents a significant barrier to achieving the performance goals that Washington has set for code stringency increases.

[2] Minimum efficiency standards for commercial products under EPCA are established in Section 6316. EPCA Section 6316(b)(2)(A) contains a general preemption provision: A "standard prescribed or established under section 6313(a) of this title shall . . . supersede any State or local regulation concerning the energy efficiency or energy use of a product for which a standard is prescribed or established pursuant to such section."

Note that while regulations on the efficiency of the heating equipment itself are restricted, there are other strategies to reduce heating energy use such as increasing envelope insulation, encouraging the selection of alternate heating systems, or reducing ventilation heat loss through heat recovery. Also, recent litigation on this issue affirmed the legality of the use of more stringent heating efficiency standards as options in the energy code, provided the more stringent standards are not universally required. This has led to the development of "option paths" in WSEC and other codes to develop improved efficiency standards.

Recommendations:

- Continue to develop option pathways that encourage the use of more efficient heating equipment while retaining an allowance for use of equipment subject to federal pre-emption. Multiple pathways and other structural modifications of the WSEC may enable further choices in compliance while not being pre-empted by federal regulation.
- Monitor potential changes in this policy for future efficiency opportunities and consider consultation with Washington's congressional delegation.

Progress Toward Building Performance Improvement is Uneven Among Project Types

Although we tend to represent energy code progress toward policy goals as a single linear value, in fact there is a great deal of variation across project types and even among individual building types with respect to how much energy they use at basic code compliance levels. Therefore the makeup of the building stock and the way these buildings use energy will affect the rate of progress of code performance improvements.

The commercial building stock is made up of a range of different building types. In Figure 4, the projected floor area of buildings in the Pacific Northwest over the next decade is represented[3]. This information demonstrates that warehouse, office and school projects represent the largest elements of the commercial building stock, comprising three-fourths of all commercial floor area.

[3] From Northwest Power and Conservation Council

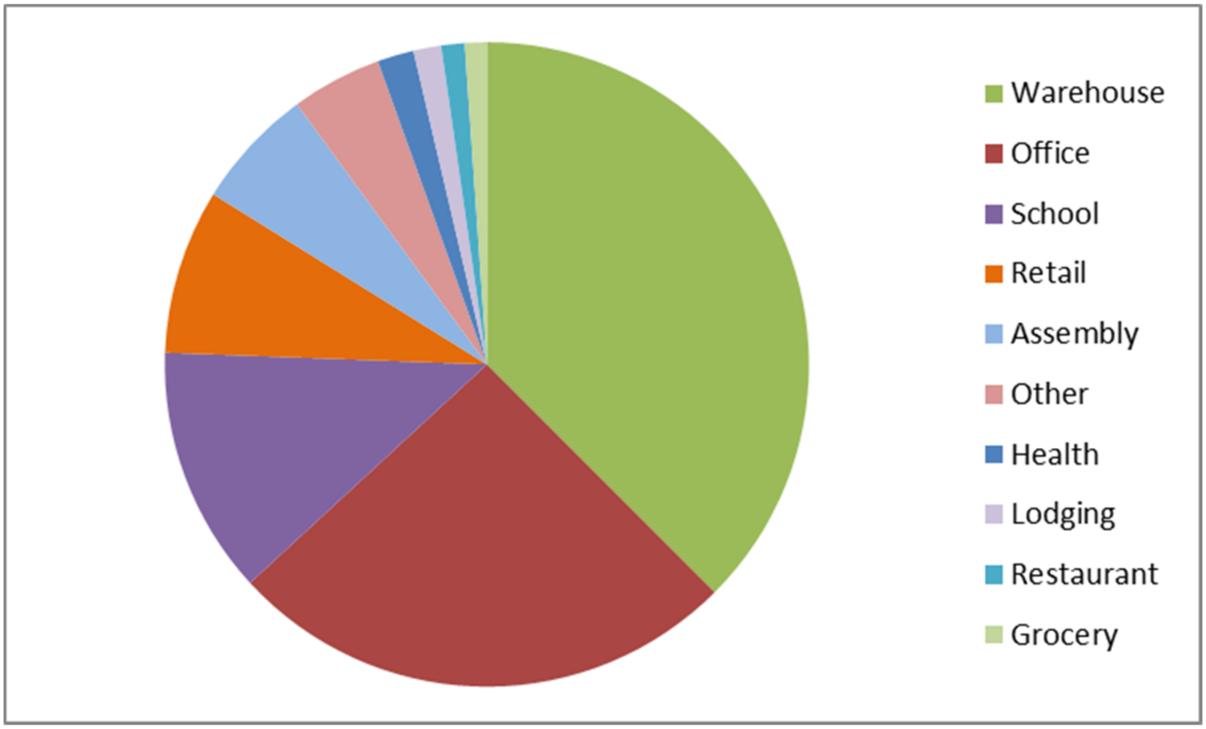


Figure 4: Total floor area by major project type

But different building types have very different energy consumption characteristics. Some building types are much more energy intensive than others. Figure 5 shows typical building energy use intensity for a range of project types. The data represents energy use of buildings meeting current WSEC 2012 requirements. This figure shows that restaurant buildings use about ten times as much energy per square foot as office and school buildings, while supermarket and health buildings use at least three times as much energy as office and school buildings. Warehouse buildings, which represent the single largest floor area category, use only about half as much energy per square foot as offices.

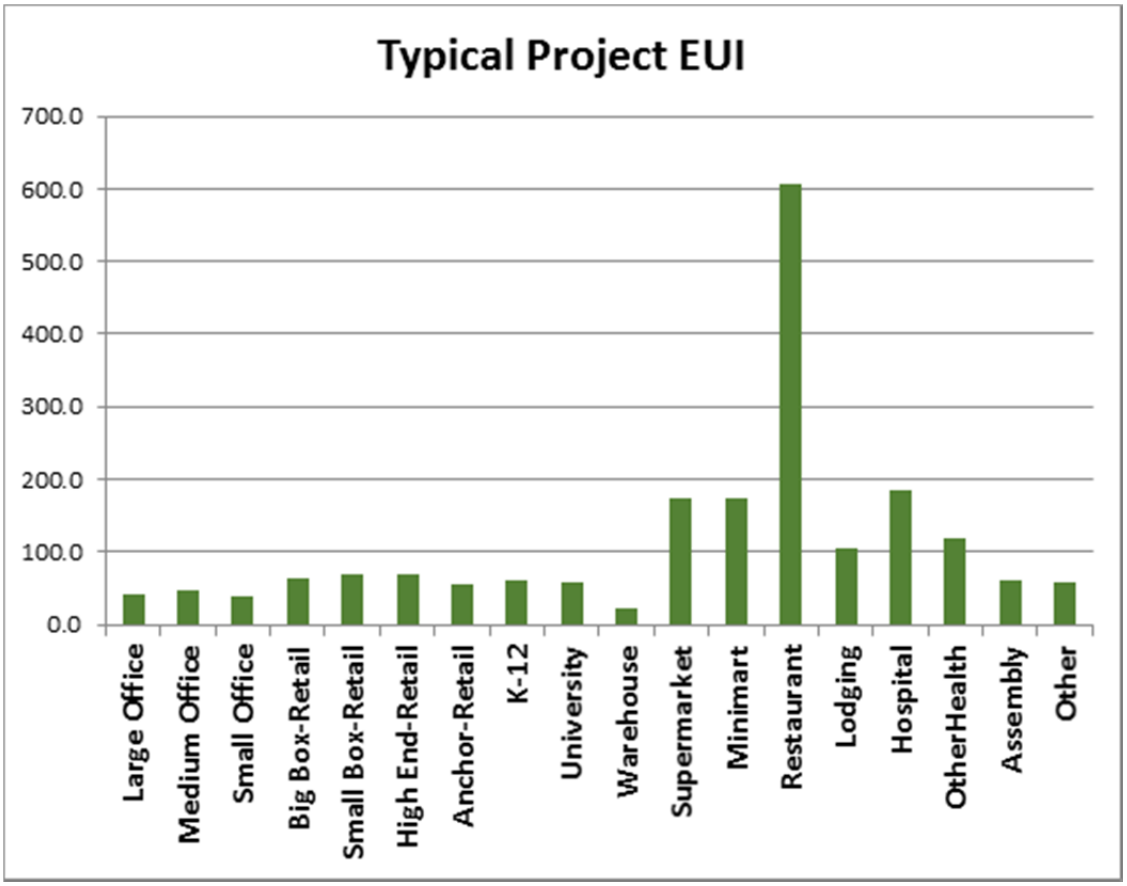


Figure 5: EUI by project type in the Pacific Northwest based on 2014 CBSA research

If we combine the impact of energy use intensity from Figure 5 with the relative floor area for each building type from Figure 4, the distribution of energy use among building types looks very different than a simple analysis of comparative floor areas. Figure 6 shows the area weighted energy use by building type of the commercial building stock. Compare the energy significance of health and restaurant building types in Figure 6 to the floor area distribution in Figure 4.

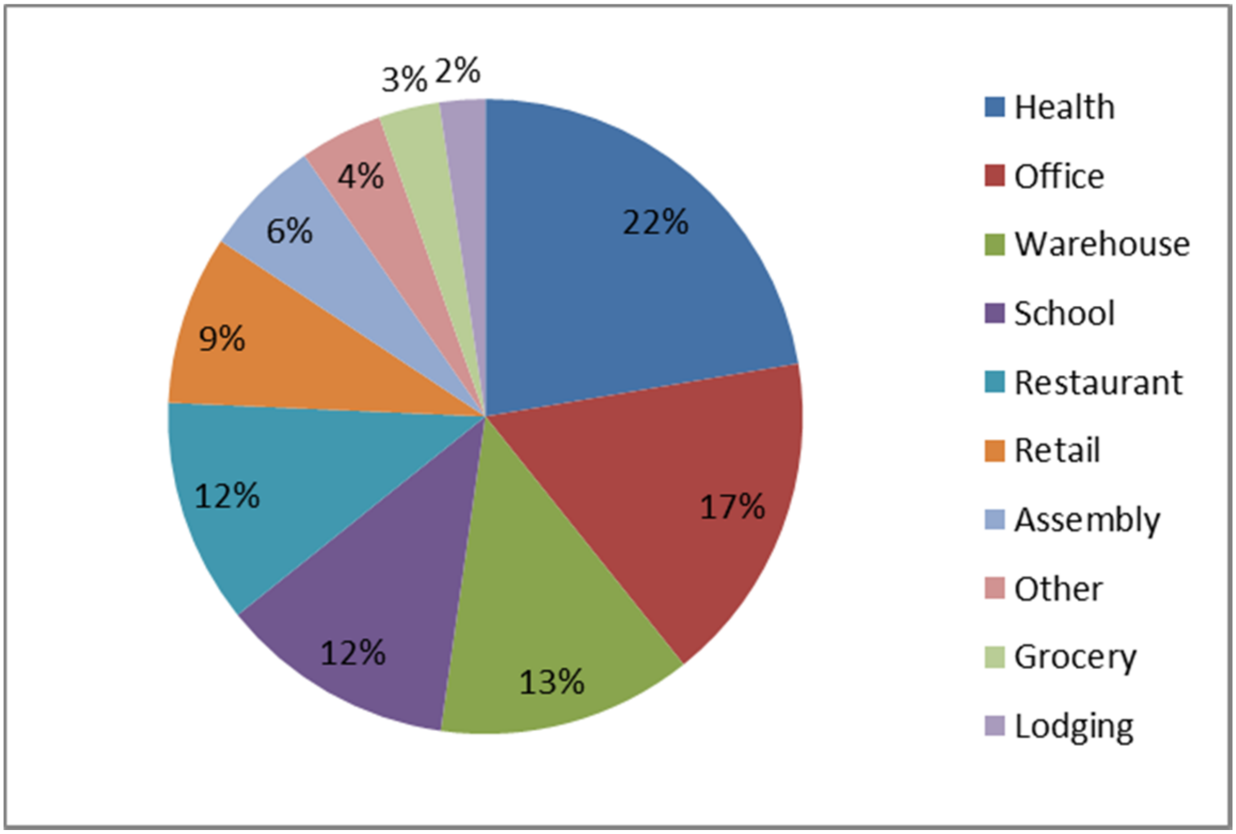


Figure 6: Commercial building energy use by project type (floor area and EUI combined)

Although restaurants represent a relatively small portion of the commercial building floor area, their significantly higher average energy use per building magnifies the impact of this project type on overall commercial building energy use. When floor area and energy use are factored together in accounting, restaurants represent 12% of the total of commercial sector energy use.

Recommendations:

- Energy code development should consider the project mix and relative energy use intensity of different building types. Evolving code strategies should recognize that code advancements have different impacts on different building types. Efforts should be made to develop code proposals that are targeted to ensure that these energy intensive project types are addressed effectively. There may also be implications in this area for energy code enforcement strategies and priorities.

Energy Code Scope Does Not Address Many Building Loads

Another clear challenge of the "2030" policy mandate is that a significant percentage of building energy loads are currently outside the scope of the energy code. The most significant components of these loads are plug and equipment loads, generated by computers, small appliances, printers and office machines, etc. Other unregulated loads in certain project types such as industrial process equipment, servers, cooking and refrigeration loads can also be significant. Taken together these loads make up nearly half of the current energy use of buildings in the commercial sector and a significant percentage of loads in the residential sector as well.

Figure 7 demonstrates how unregulated loads will increasingly impact progress toward building performance goals. As represented in this graph, to meet the 2030 goals of a 70% reduction in building energy use (if unregulated energy loads remain unchanged) regulated building loads must be completely eliminated by 2030 but of course this is not possible. Even with significant efficiency improvements, building loads like lighting, ventilation, heating, etc. will continue to consume energy. Therefore a meaningful long term energy code strategy must directly address plug and other unregulated loads while moving forward with the more conventional energy code improvements.

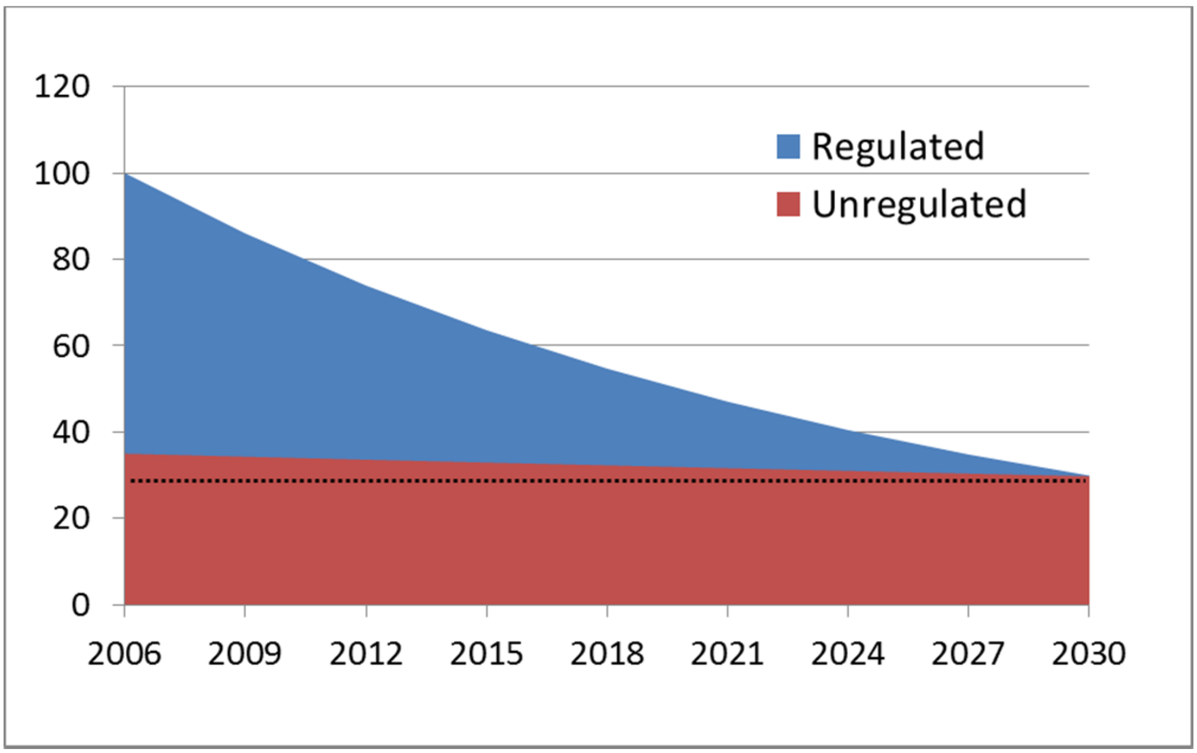


Figure 7: Relationship of regulated and unregulated loads under current energy code scope. Dashed line represents WSEC 70% reduction target.

Several levels of strategies to address plug and equipment loads exist. The State of California has adopted equipment efficiency requirements that support their net zero energy code goals. California appliance standards are regulated under the state's Title 20 requirements. This effort has led to significant efficiency improvements in key appliance types like televisions and computer monitors. Because California is such a large consumer market, the response of manufacturers to these requirements have rippled outward and significantly influenced the national market for these products. Many of these California appliance standards have also been adopted in Washington. In addition to appliance standards, certain other types of equipment efficiency such as refrigeration and vertical transportation is regulated under code provisions in the WCEC. Other provisions in the WCEC can require the ability to control the receptacles in buildings which can lead savings during times when equipment can be turned off. Some strategies, now voluntary, can address central building control or room-by-room control of plug loads by automated management systems.

End Uses

As with overall energy use intensity, building type also has a significant impact on the end use distribution of energy within a building. Plug and process loads outside the scope of current codes represent a much larger percentage of total building energy use for some building types compared to others. Figure 8 shows the distribution (by percentage) of different end uses in the same set of building types.

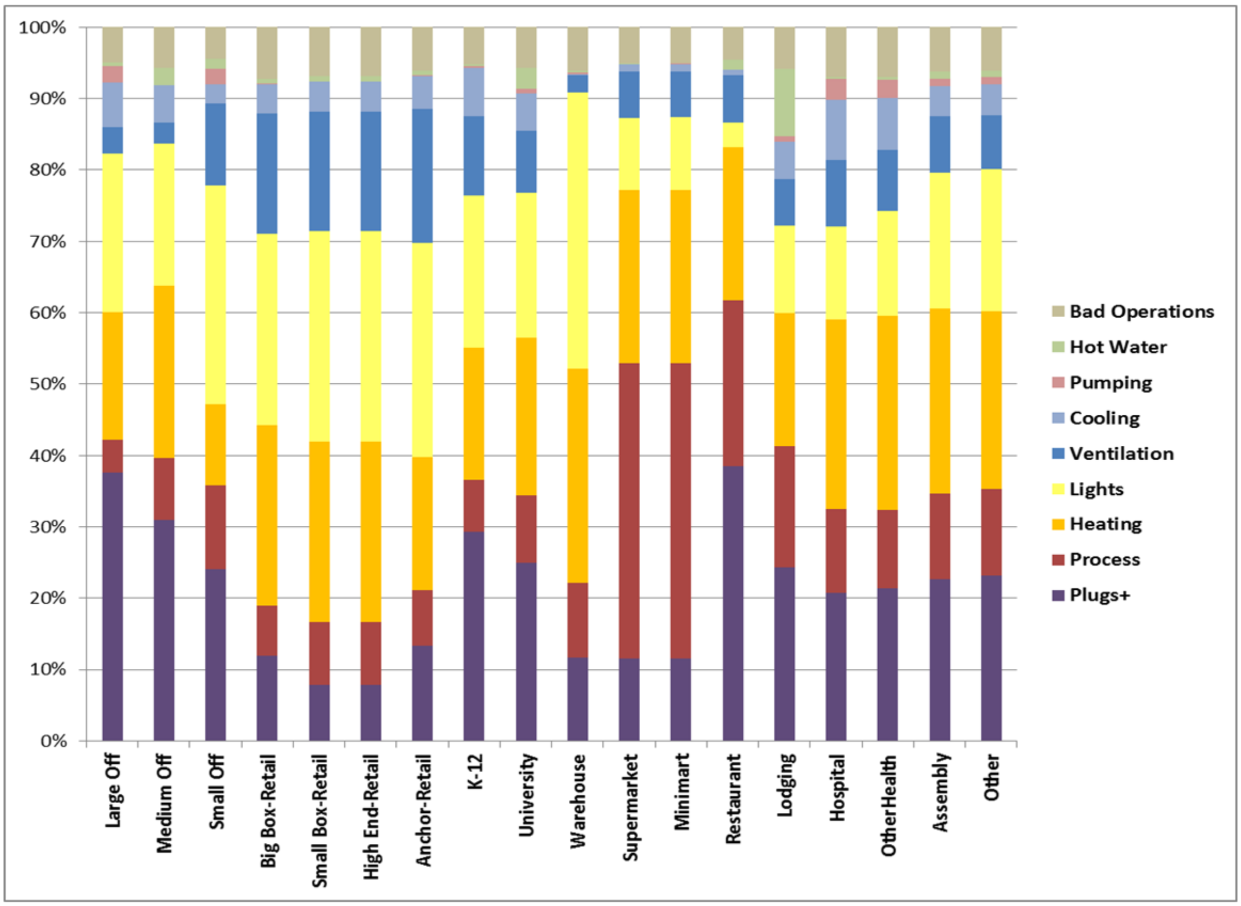


Figure 8: Distribution of energy end use by project type, shown as a percentage of total energy use.

In this representation, the bottom two categories in each bar (red and purple) represent the unregulated loads discussed above process and plug loads. In project types like supermarket and restaurant, unregulated loads already represent over 75% of total building energy use! It is clear that a

70% reduction in total building energy use or greenhouse gas reductions ***will not be possible*** for many building types without some mechanism to address loads currently unregulated by the WCEC.

Historically, the impact of the code on different project types has not been well integrated into policy level discussions about energy code development. The project/energy distribution shown in Figure 6 suggests that subsequent code development should focus more specifically on the impact of code updates on specific project types in order to achieve long term policy goals.

Another perspective that will be important to policy success is a more direct focus on key building end uses. Just as project type population and energy use intensity were aggregated in Figure 6, we can combine the weighted end use by population and energy use intensity. In Figure 7 the following three factors are combined:

- The magnitude of energy use in each end use category
- The total energy use associated with each project type
- The population of these project types in the building stock.

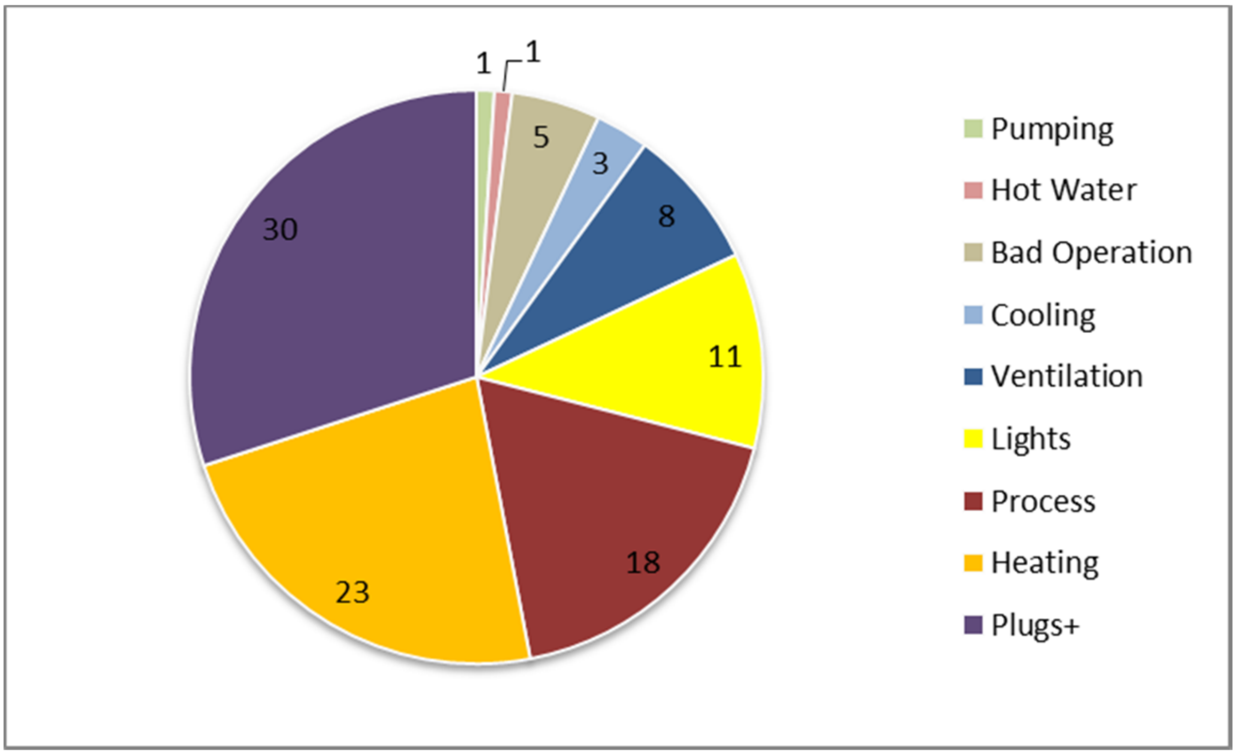


Figure 8: Combined energy end use across building type and population

In this graph we can see that the three largest categories of building energy end use across the commercial building stock are:

- Plug and equipment loads
- Heating
- Other process loads, which include refrigeration, cooking, elevators, etc.

Taken together these categories represent over 70% of commercial building energy use. ***But much of this energy use is for the most part outside the scope of the WCEC***, either because they are unregulated loads or because efficiency improvements are restricted by federal pre-emption. (Note that heating energy end use can also be reduced by managing heating loads, regardless of federal pre-emption. This is discussed further in the section below.)

To achieve the performance goals set by the legislature, modifications to energy code scope are likely to be necessary.

Recommendations:

- New code proposals for measures that directly impact plug and equipment loads should be developed and implemented.
- Code development should recognize that some specific end uses make up a disproportionate percentage of total building sector energy use. Targeting these end uses should a priority for code strategies and proposal development moving forward.
- Energy code development should be considered in a larger policy context that begins to address building operation and maintenance and occupant behavior as an integral part of building performance policy. Jurisdictions such as New York City can provide examples.
- Codes and policies must address a wider range of building energy performance issues to succeed in achieving long term policy goals.

Measures that Matter

The WSEC is a complicated document filled with requirements for major and minor elements of building characteristics. Although the development of the code considers the energy impact of each measure, it is not easy to tell from the language alone which aspects of the code have more or less significance. Determining this requires complicated analysis of how the language will play out in a wide range of building conditions. So how do we determine what the most significant opportunities for code improvement are?

Specific code proposals must be modeled across a range of building types to determine impact. In the absence of guidance or deep building experience, the process can be somewhat hit and miss. One way to consider code opportunities is to develop a sensitivity analysis of the impact of a range of efficiency strategies on building performance. An analysis of this type was conducted by NBI and Ecotope in 2012. Figure 9 shows the range of impacts of a series of efficiency strategies applied to a medium office building prototype in Seattle. This analysis was not conducted specifically to identify code opportunities but the "zero line" approximates the characteristics of a building that meets the WSEC 2006, which is the starting point for state code goals. The green bars below the zero line represent the magnitude of potential savings from a series of efficiency strategies applied to this prototype. (Orange bars above the zero line represent the adverse performance impact of less efficient strategies, as we might find in older buildings.)

Also shown on this graph is whether the efficiency strategies considered are within or outside the scope of the energy code. Columns with a light grey box at the bottom are fully regulated by energy code while darker boxes indicate strategies that are only partially regulated by code, or are completely outside the scope of code.

As an example, the analysis suggests that substantial savings opportunities remain from increased envelope insulation requirements and these are within the scope of code. (The analysis considers the impact of the insulation requirements contained in ASHRAE Standard 189). It is also clear that choosing better HVAC systems, in this case a ground source heat pump compared to rooftop packaged equipment) has the potential to generate significant savings. However, this strategy needs to be considered in the context of federal pre-emption constraints.

This type of analysis could be very important in planning and developing energy code language revisions through the cycles leading up to 2030.

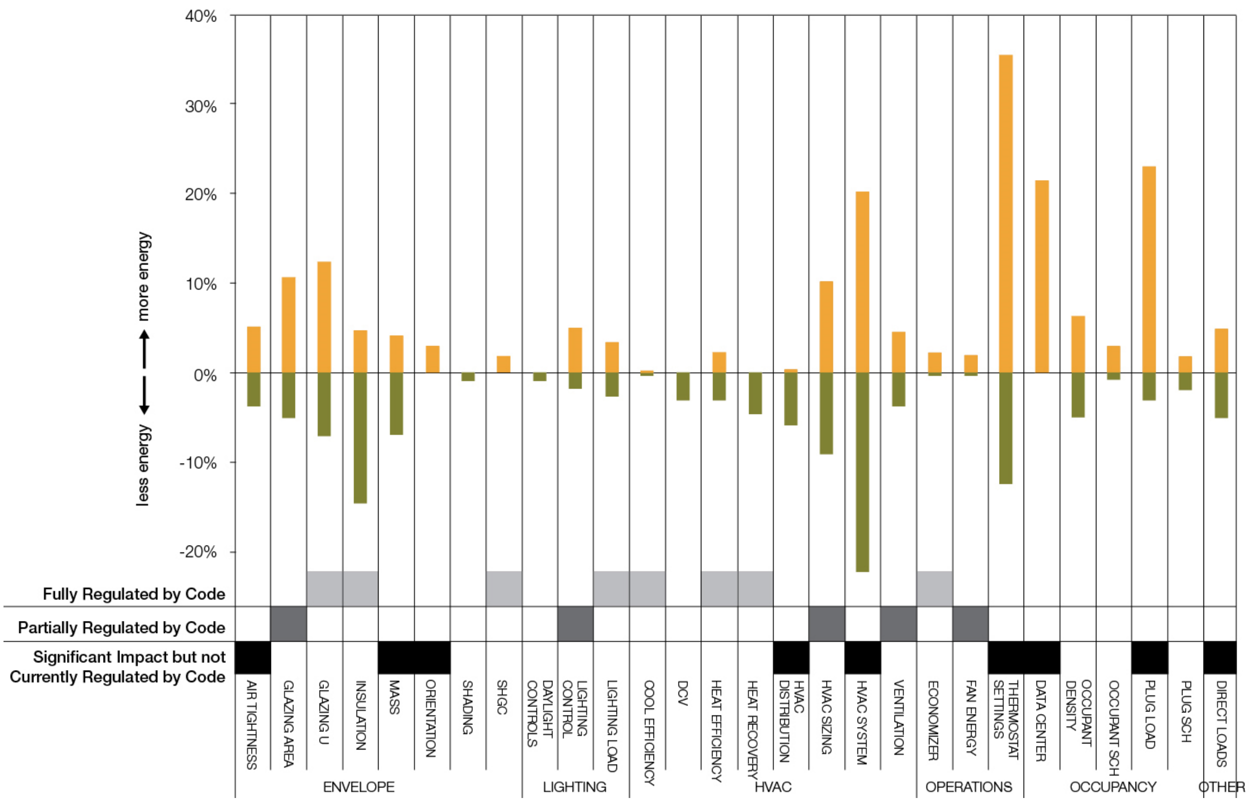


Figure 9: Relative magnitude of energy impact of individual efficiency strategies

Although the efficiency strategies in Figure 9 above are considered in isolation, in fact many strategies have interactive impacts across different building end uses. Envelope performance improvements can reduce heating and cooling loads. Light fixture efficacy and controls reduced lighting loads and cooling loads, but may increase heating energy needs. These interactive effects provide cost-effective energy savings opportunities but complicate energy code strategies that are focused on individual aspects of building performance. As buildings become more efficient, building systems need to be considered in a more integrated fashion. This becomes increasingly challenging as the code tries to capture more and more aspects of building performance with specific prescriptive requirements. Over time, new code strategies that focus on integrated system performance will be needed. Some examples of building systems that need to be better integrated include:

- HVAC system sizing, zoning and control strategies
- Building-wide system efficiency metrics
- Integrated lighting, control, daylighting and shading strategies
- Integrated ventilation , thermal mass, glazing and insulation strategies
- Occupant driven control strategies

These integrated systems are increasingly difficult to regulate and specify in component-based code language. Robust integrated design and evaluation protocols will be needed as a basis for a more integrated energy code approach to system performance.

Recommendations:

- Research and develop new code proposals that integrate measures between and among multiple building systems to be implemented.

Focusing on Thermal Loads as a Systems level measure

One strategy that has demonstrated effectiveness is a focus on managing building thermal loads. This approach was pioneered by the *PassiveHaus* program, and has now been adopted as a regulatory strategy in a number of European countries. It is also under consideration in several Pacific Northwest jurisdictions in the context of incentive programs.

This strategy has been also referred to as a Thermal Load Intensity (TLI) limit, where the total annual energy use that serves to maintain thermal comfort is limited. The limits play out as maximum allowed capacities for installed heating and cooling systems. These limits force the design and construction team to pay close attention to envelope thermal performance. Building envelopes must be well insulated and tightly constructed, glazing area must be managed and high performance glazing systems utilized. Typically these projects are highly focused on managing air leakage and controlled; heat-recovery ventilation is an important feature.

The *PassiveHaus* (PH) program has been in use for approximately 20 years and includes more extensive requirements and guidelines than described above. But the basic concept is gaining traction as a code strategy in various jurisdictions and several European Union jurisdictions have adopted it as a base code. Commercial-scale applications of this program are becoming more common in North America, and a number of jurisdictions on this continent are considering TLI and PH strategies as a basis for new code and policy strategies.

Aspirational (Reach) Codes

Washington legislation, in directing the Department of Commerce to develop a *Strategic Plan for Energy Efficiency* every three years, also stated that: "….the strategic plan must….consider development of aspirational codes separate from the state energy code that contain economically and technically feasible optional standards that could achieve higher energy efficiency for those builders that elected to follow the aspirational codes in lieu of or in addition to complying with the standards set forth in the state energy code."

Several states have a version of a Reach Code. These include California, Massachusetts, Vermont and Oregon. In implementing the recommendations of a roadmap that leads to success in meeting the legislated 2031 energy code goals, a Reach Code could serve several purposes:

1. A Reach Code allows the market to be exposed to standardized versions of advanced energy efficiency measures before they are adopted into the base code. This provides manufacturers, trades and suppliers with both market opportunities and with time to prepare for future code requirements.
2. A Reach Code provides standardized energy efficiency measures that can be included in utility and other voluntary programs across the state.
3. A Reach Code provides standardized energy efficiency measures that can be included in jurisdictional requirements, such as bonus Floor to Area Ratios (FAR).

Recommendations:

- After the effective date of each energy code cycle, the SBCC or Commerce in consultation with utility program managers should prepare a complimentary package of measures that could be ready for code implementation but were not included in the base code and offer those in some form of statewide Aspirational Code.

Outcome-Based Codes

Although the goals set for the WSEC represent a significant challenge within current energy code scope limitations, other strategies to achieve this level of performance have been proposed. For several years the term "*outcome-based codes"* has been used to describe a code regimen that regulates building performance outcome instead of or in addition to building physical features. In this model, the energy code is focused on a simpler set of requirements that insure that long life span components like insulation and window performance meet basic performance requirements but the nuances of lighting and HVAC system design and control strategies are left up to the design team. At the same time, the design/development team is responsible for delivering a building that uses no more energy than the performance targets set forth in the outcome-based code. This approach has been adopted by the most recent version of the IGCC and is likely to become more common as policymakers face the challenges implied by highly efficient and net zero building policy goals.

This approach has significant implications for both the design and enforcement process, with a number of challenges to be resolved. But it also has the potential to significantly simplify the code enforcement process at the front end.

Although some pilot implementations of outcome-based codes have been developed (including Seattle's), this approach to energy codes would take a number of cycles to develop and implement.

Recommendations:

- Review Seattle's experience with the outcome-based pilot. Formulate improvements and modifications to the program in order to offer an outcome-based compliance option to be considered in future WCEC code cycles.

Additional Analytical Approaches

Prioritizing Efficiency Strategies by End Use:

Another way to consider end use impacts of efficiency strategies is presented in Figure 10. This diagram recognizes that individual efficiency strategies can impact multiple building energy end uses. To the extent code work is prioritized based on end use impact, individual code strategies need to be mapped to the end uses they impact.

Current End Use Impacts (baseline 100):		30	23	18	11	8	5	3	1	1
Strategy Area:	End Use Category: Efficiency Strategies:	Equipment	Heating	Other	Lights	Ventilation	Bad Operation	Cooling	Pumping	Hot Water
Controls	controls	x	x	x	x	x	x	x	x	x
	occupancy sensors	x			x	x	x	x	x	x
	standby loss management	x		x			x	x	x	x
	off-hour management	x	x	x	x	x	x	x	x	x
	smart controls	x	x	x	x		x	x	x	x
Design	system sizing		x			x	x	x	x	x
	system selection		x			x	x	x	x	x
	fan efficiency		x			x		x		
	zone layout		x			x	x	x	x	x
Technology	equip/tech improvements	x	x	x	x	x	x	x	x	x
Operations	remote computing	x						x		
	server virtualization	x						x		
	acquisition policies	x								
Practice	insulation		x					x	x	
	infiltration		x					x		
Solar	daylighting				x					
	solar control				x			x		
	solar harvest		x							x
Technology/Practice	regenerative elevators			x						
Practice	commissioning		x	x	x	x	x	x	x	X
Potential End Use Impact (reduction to 53)		15	12	13	5	4	2	1.5	0.5	0.5

Figure 10: Comparing efficiency strategies to end-use impact categories

The table above also represents the total performance impact if the energy code is able to successfully reduce each end use by approximately 50%. Note that even this level of achievement does not meet the 70% reduction goal for WSEC.

Progression and Dependencies – Adding Specificity to the Roadmap

A number of issues have been identified which will impact long term progress on energy code development, and will need to be addressed. But many opportunities for code development remain available within the current scope and approach of the WSEC. The appendix that follows highlights a significant list of code strategy areas that can evolve toward higher performance goals over several code cycles.

In order to achieve the long term goals identified, earlier strategies must often set the stage for adoption in subsequent cycles. The anticipated progression of these strategies through multiple cycles is identified in the “immediate”, “mid-term” and “long-term” columns identified at the top of the table located in the appendix.

The strategies identified in the appendix anticipate that some of the scope and application issues identified earlier in this document will be resolved. However, most of the specific policy items in each cell can be implemented under existing authority and can serve as recommendation or markers for progress on the path to meeting Washington’s policy goals.

Summary and Conclusions:

Table of *Roadmap* Recommendations:

A series of recommendations have been presented in the discussion above to move forward with energy code development to achieve legislated goals. These recommendations are collected here as a summary:

- Continue to develop option pathways that encourage the use of more efficient heating equipment while retaining an allowance for use of equipment subject to federal pre-emption. Multiple pathways and other structural modifications of the WSEC may enable further choices in compliance while not being pre-empted by federal regulation. Monitor potential changes in this policy for future efficiency opportunities and consider consultation with Washington’s congressional delegation.
- Energy code development should consider the project mix and relative energy use intensity of different building types. Evolving code strategies should recognize that code advancements have different impacts on different building types. Efforts should be made to develop code proposals that are targeted to ensure that these energy intensive project types are addressed effectively. There may also be implications in this area for energy code enforcement strategies and priorities.
- New code proposals for measures that directly impact plug and equipment loads should be developed and implemented.
- Code development should recognize that some specific end uses make up a disproportionate percentage of total building sector energy use. Targeting these end uses should a priority for code strategies and proposal development moving forward.
- Energy code development should be considered in a larger policy context that begins to address building operation and maintenance and occupant behavior as an integral part of building performance policy. Jurisdictions such as New York City can provide examples for this.
- Codes and policies must address a wider range of building energy performance issues to succeed in achieving long-term policy goals.

- Research and develop new code proposals that integrate measures between and among multiple building systems to be implemented.
- Review Seattle's experience with the outcome-based pilot. Formulate improvements and modifications to the program in order to offer an outcome-based compliance option to be considered in future WCEC code cycles.
- After the effective date of each energy code cycle, the SBCC or Commerce in consultation with utility program managers should prepare a complimentary package of measures that could be ready for code implementation but were not included in the base code and offer those in some form of statewide Aspirational Code.
- Recognize that energy code development cycles must be used to build a foundation for subsequent efforts that cannot be undertaken in a single code change cycle. Progress in future cycles is dependent on steps taken in earlier code cycles to support long-term goals. Specific examples are identified in the following *Strategies Appendix*.

APPENDIX: WSEC PROGRESSION AND DEPENDENCIES Strategies Appendix

Opportunity Areas		General Interim Steps	Code/ Policy Increments			Barriers	Long Term Goals
			Immediate	Mid-Term	Long-Term		
HVAC							
	Equipment Efficiency Improvements	continuous technological advancement	alternate pathways with increased equip. efficiencies	federal efficiency standards improve	inherent low-efficiency system configurations phased out	Federal Pre-emption, manufacturer resistance	continuous improvement in equipment efficiencies
	Overall System Efficiency	evaluate system part-load performance, incorporate additional features into system performance analysis (part-load performance, fan and duct impacts)	whole system design/calculation criteria. Sizing and part-load performance criteria	integrated whole system performance criteria	increased overall system efficiency criteria	single-point efficiency ratings; lack of info about part-load performance and system interaction; modeling limitations	whole-system efficiency optimized in integrated fashion; load management to reduce capacity
	Control Effectiveness	acceptance testing or more robust commissioning (Cx); metering and feedback, expanding to include real-time occupancy information	specific acceptance testing criteria; metering requirements	feedback and retro-commissioning requirements	real-time performance requirements	poor Cx, undocumented design criteria, limited information about building use patterns, limited feedback from building systems	system operation continuously optimized and closely matched to building use patterns
	System Selection	increasingly dis-incentivize low-performing system types	alternate pathways with high efficiency equipment as alternate baseline; separate thermal and ventilation systems	increased baseline efficiency; incentivize non-air distribution	Specific low-efficiency system types dis-allowed; move away from air distribution	Federal Pre-emption; code neutrality on system selection, cost	allow only higher performing systems; phase out poor performers

Opportunity Areas		General Interim Steps	Code/ Policy Increments			Barriers	Long Term Goals
Lighting							
	Fixture Efficacy	continuous technological advancement	low-efficacy fixtures phased out in certain space types	low-efficacy fixtures phased out in many space types; increased efficacy requirements	fixture efficacy requirements for all applications	rate of technical change	continuous improvement
	LPD	continued reductions; better address exempted use types	better linkages between LPD and control strategies; fewer exempt space/application types; metering requirements	increasing linkages between LPD, efficacy, and controls; feedback requirements	lighting regulated on overall system operation	use-specific exemptions; design challenges; LPD not necessarily a proxy for overall efficiency	integrated lighting efficiency
	Controls Effectiveness	system-level efficiency metrics; broader control application guidance; acceptance testing or more robust Cx; metering/feedback	develop system level efficiency protocols; acceptance testing requirements; metering	require system-level efficiency; feedback and RCx linkages	lighting regulated on overall system operation	lack of design expertise; lack of alignment with actual building operations (building use patterns)	integrated lighting efficiency; direct response to occupancy characteristics
	Daylighting	increased daylit floor area requirements, better integration with lighting controls, better Cx	increased floor area requirements, or percent of lighting load requirements, shading requirements	daylight requirements incorporate fenestration strategies; effective solar control and glare management	daylighting becomes primary light source in daylight hours via control requirements	lack of design expertise; multiple systems must be coordinated (glazing, controls, lighting, etc.)	broad application of effective daylighting as a primary lighting source

Opportunity Areas		General Interim Steps	Code/ Policy Increments			Barriers	Long Term Goals
Envelope							
	Insulation	continuous improvement	increased insulation requirements; limitations on thermal bridging impacts	adopt Passive House or ASHRAE 189 envelope standards, envelope Cx	continued envelope performance improvements; envelope Cx requirements	cost effectiveness, thermal bridging; construction quality	super-efficient thermal envelope
	Glazing	increasing dis-incentives for over-glazing, continuous technological advancement	increasing dis-incentives for over-glazing, continued thermal and solar performance advancement	increasing dis-incentives for over-glazing, continuous technological advancement	increasing dis-incentives for over-glazing, continuous technological advancement	thermal limitations of frames, cost, desire to over-glaze	moderate glazing area, high performance glazing systems
	Infiltration	infiltration testing; increasingly stringent performance requirements; heat recovery ventilation.	broader testing requirements	specific performance criteria, demonstrated by testing	specific performance criteria, demonstrated by testing	poor practice on air sealing; real or perceived moisture concerns; HVAC pressurization strategies	tight building envelope with heat recovery ventilation
Plug Loads							
	Computers and other plug loads	regulate equipment efficiency; require automatic controls, engage occupants	require separate plug load circuits; metering; plug load circuit controls in increasing applications; occupant feedback	active plug management and control strategies; manufacturer equipment performance standards	continued equipment performance improvement; occupant engagement programs typical	outside scope of code; requires interaction with building users	more efficient equipment, operated only as needed
	Misc. Equipment	regulate equipment efficiency; require automatic controls	sector specific performance requirements (elevators, emergency lighting, security systems, etc.)	increasing sector specific performance requirements	broad sector specific performance requirements and equipment standards	outside scope of code; requires interaction with building users	more efficient equipment, operated only as needed

Opportunity Areas		General Interim Steps	Code/ Policy Increments			Barriers	Long Term Goals
Other Equip.	Refrigeration	continued efficiency improvements; integration with other building loads	larger equipment integrated, not stand alone	heat recovery incorporated, continued efficiency improvements	equipment broadly regulated and integrated	stand-alone equipment not integrated, lack of remote condensers, not in code scope	integrated loads, remote condensing, fully regulated, efficiency improved
	Elevators	continued efficiency improvements	regenerative technology required	design guidelines facilitate stair use	continued efficiency improvements	cost, outdated guidelines, lack of performance criteria	continued efficiency improvement
	Hot Water	reduced standby losses; continued efficiency improvements	incentivize instantaneous technologies; increased pipe insulation, restrict distribution loss	require instantaneous technologies and heat recovery or solar	continuous efficiency improvements	cost	continued efficiency improvement
	Cooking	continued efficiency improvements; add to code scope	incentivize efficient equipment selection	appliance standards for manufacturers	equipment broadly regulated and integrated in building systems	cost, lack of performance criteria, not in code scope, limited availability of better equip.	continued efficiency improvement
Renewable Energy	Solar-Thermal	increased incorporation of solar thermal to offset loads	pathway incentives for solar thermal inclusion	solar thermal required for specific applications	solar thermal contribution assumed in baseline	poor interface with low-end HVAC systems, cost	solar thermal offsets substantial portion of heating energy
	Photovoltaic (PV)	support infrastructure at building level; increased capacity	PV-ready requirements for many building types	PV-ready across spectrum; PV required for some project types	PV incorporated in most projects	cost, utility distribution issues	broad application of PV as part of regional utility infrastructure