Bridging the Energy Performance Gap: Real-World Tools

Duane Jonlin, City of Seattle Department of Planning and Development

ABSTRACT

This paper examines how the influence of building energy regulations can extend far beyond the end of construction, to optimize a building's real-world performance and ensure that it realizes its potential. Seattle is enacting a suite of regulations aimed at accelerating the pace of efficiency improvements and empowering the "Three O's"– Owner, Operator and Occupants – to operate each building at its optimal performance level. Such rules address the persistent disparity between the designed capabilities of new buildings and their actual energy performance. These provisions constitute five categories that we have labeled as: Handoff, Autopilot, Awareness & Control, Proportionate Upgrade, and Future-Ready. Together, they are intended to ensure the best possible return on each building's energy efficiency investments. Some of these initiatives are controversial in that they seek to improve energy performance through influencing (but not mandating) the actions of the players involved. However, as buildings are constructed to increasingly stringent standards, the behaviors of the "Three O's" will come to dominate the pursuit of very high performance buildings. Seattle's new rules facilitate this cultural shift. Following descriptions of each of these regulatory provisions, the appropriate reach of regulatory control and the value of actionable performance data are discussed, and a roadmap leading towards "zero-carbon-ready communities" is presented.

Introduction

A new building's Certificate of Occupancy is finally signed, and the inspector's truck disappears down the road: What happens next? While the contractor's warranty remains in effect, the occupants move in and the maintenance staff starts figuring out how things work.

If you pay a visit three years later, how close to its optimal performance level will the building be running? What percentage of its systems will be operating as intended? Asking this question of an experienced building commissioning team provides a sobering reality check. Between the design team expectations on the one hand, and the actual performance of the occupied building on the other hand, there is a deep gap into which that building's performance can fall (NBI 2008, 16).

The City of Seattle has recently enacted a suite of energy code provisions intended to provide a safe bridge across that gap (SEC 2013). Our objective is to extend the code's influence well beyond the Certificate of Occupancy, while still allowing project participants to close out the project in a timely manner. A construction project eventually must have an end date, some point when the design and construction teams, not to mention the owner and the building department, can sign off that it's complete, releasing everyone to move on to other projects. The City doesn't have (and doesn't want) energy code enforcement powers beyond that point[1], and therefore our code provisions are intended to empower the Owner, Operator and Occupants to act as our future agents in operating the building as it was intended.

---

[1] Although we don't want enforcement powers to pursue "energy violators," we do want to track building energy use to evaluate the effectiveness of our programs and target additional measures.

Improvements to building envelope, lighting and mechanical systems have reduced building energy use significantly under recent codes (SBCC 2012, 4), leaving an increasing proportion of the remaining energy use dependent on the actions of the building operator and occupants. A common thread among Seattle's new energy code provisions is that they relate to human behavior, not just building physics. Some provisions automate energy-saving tasks that occupants would otherwise need to perform manually, while others provide actionable information allowing users to identify malfunctioning systems and savings potentials. They can be categorized in five categories that we have labeled as: Handoff, Autopilot, Awareness & Control, Proportionate Upgrade, and Future-Ready.

Seen in a timeline, the "Handoff" elements would begin during the construction period and extend a year or two into the future. Both the "Autopilot" and the "Awareness and Control" elements would take effect as soon as the building went into operation, while the "Proportionate Upgrade" and "Future-Ready" elements would come into play over the following years or even decades. In each case, conditions are created to increase the likelihood of energy-saving actions by those who own, operate and inhabit our buildings.

Handoff

Handoff procedures are critical for getting each of the systems up and running as intended, and letting the facility manager successfully take the reins of the new building. Advanced controls for lighting and HVAC systems in our buildings are increasingly complex and non-intuitive (Stluka and Foslien 2011). If a construction deficiency results in an occupant comfort complaint, it is likely to be remedied under the contractor's 12-month warranty period. If however the malfunctioning system simply consumes excess energy without causing any discomfort, there will likely be no call-back, and thus no correction. Furthermore, this higher level of energy use caused by malfunctioning systems would create a *de facto* benchmark, which would then be seen as the ordinary energy use baseline for the building. A handoff period ensuring that everything is integrated and operating optimally while the building is fully occupied should be imperative. Seattle addresses this issue with two sets of rules.

- As the most important "Handoff" procedure, we have instituted the optional Target Performance Path (TPP) (SEC 2013b), shifting the evaluation of the building performance from the theoretical (code compliance) to the real (measured energy use). Another session at the 2014 ACEEE Summer Study (Pinch et al. 2014) explores Seattle's TPP in more detail, but in essence it is a means of focusing design and construction attention on the building's actual energy performance during the initial years of operations. Project teams can set the energy code aside and instead use the TPP as an alternate compliance path, utilizing any means at their disposal to meet an assigned energy use "target." They must submit a believable energy model at the permit phase, and then operate the completed building below its assigned energy target for a full year of occupancy, or else pay a modest penalty.
- Seattle also strengthened its commissioning process (SEC 2013a) to increase the likelihood that all building systems are functioning properly as the building is turned over to the occupants and operators. Especially significant is the new "commissioning permit" that will be required just before issuance of the certificate of occupancy. This "permit"

simply lists the commissioning tests not yet completed and the identified deficiencies that have not yet been resolved. The owner is then periodically notified until the commissioning permit is closed out.

Autopilot

Autopilot is our term for a category of manual tasks that have been automated in order to obtain more reliable energy savings. Simply expecting occupants to manually dim their lights to correspond with each change in available sunlight is not likely to be a successful energy saving tactic, although it is an assumption built into most energy codes. Seattle's code requires daylight responsive controls and plug load controls, thus moving these loads into the Autopilot category.

- Almost all daylight zones are required to be provided with automatic daylight responsive controls so that electric lights will automatically dim when sufficient daylight is available (SEC 2013c). This is in addition to the occupancy sensors and automatic time clocks used to control the room lighting generally. Obviously, the presence of daylight does not save energy unless it results in the lights being turned down or turned off. HVAC systems have for decades responded automatically to exterior conditions, and lighting systems should now do the same.
- Half of all convenience outlets in offices and classrooms must be placed on circuits controlled by occupancy sensors or automatic time clocks, allowing computer screens and other non-essential accessories to remain completely off when no one is in the room (SEC 2013d). The same control system used for automatically turning off a room's lighting can often be used for its plug loads. Since plug loads represent over a third of energy use in recent buildings (McDermott 2011), and offices and classrooms sit empty for many more hours than they are occupied, these savings could have substantial impacts. This measure represents an important first step towards reducing unnecessary plug loads.

Awareness and Control

Awareness and Control strategies provide the building owner and tenant with detailed real-time data on the performance of their building systems, allowing them to benchmark and monitor energy use. Building systems tend to drift out of compliance. By some mysterious process, temperature setpoints and schedules change, control modules fail, and the building performance worsens over time. Traditionally, a facility manager or accounting office will get monthly gas and electric bills, long after the fact, by which time it is very difficult to sort out what might be causing increased energy use. To resolve these issues, Seattle has enacted several policies to empower owners and tenants with actionable data:

- The code requires the operator of a new building to be provided with a graphic screen displaying continually updated data over various time periods, for both the incoming gas and electric energy and the energy use of five major sub-systems: HVAC, water heating, lighting, plug loads and process loads (SEC 2013e). This is commonly referred to as "metering," but literally speaking it is the actionable information presented on graphic displays that will lead to energy savings, not the meters themselves. If for example a building's basement lights were to be left on all weekend, that energy use profile would show up prominently on that week's display, allowing quick discovery and correction of the problem.

- Individual full-floor tenants are required to be provided with dashboards that graphically display their electric use, allowing them to monitor their own lighting and plug loads over time and visually compare them to previous days, weeks or seasons (SEC 2013f). Such dashboards can be powerful energy reduction tools (GSA 2012), especially when combined with the plug load controls discussed above. In addition, those tenants can be billed directly for their actual energy use, which would further encourage (and reward) conservation actions.
- Building energy use reports are made available to prospective buyers and tenants through Seattle's Benchmarking and Reporting Ordinance (Seattle OSE 2014), and the City gives feedback reports to building owners showing how they're doing in comparison to their peers. This data has not been made publicly available in Seattle as it has in New York and Washington, DC (NEEP 2013, 12), due to privacy concerns. Those jurisdictions that do post energy data publicly have an additional tool in their arsenal, in that many businesses are highly sensitive to their public image, and may improve their energy performance in order to avoid potential criticism (IMT/NRDC 2011, 2).
- This year Seattle stakeholders may debate a requirement for periodic energy audits (or a subscription to an energy monitoring service) for larger buildings, in order to bring system deficiencies to light. Similar requirements already exist in San Francisco and New York City (NEEP 2009), but its acceptance in Seattle has yet to be decided. Since such an ordinance would apply to all large existing buildings, and not just new construction, its influence on the City's overall energy consumption could become substantial in a relatively short period of time. Energy audits are discussed in further detail under "Energy Use and Regulatory Control" below.

Proportionate Upgrade

Meeting Seattle's ambitious target of being fully carbon-neutral by the year 2050 (SEI 2011) will require significant energy use reductions in our existing building stock. Rather than requiring across-the-board upgrades to fully operational buildings, we have aligned energy upgrade requirements to be proportionate to the scale of other construction work that is already under way.

- Seattle employs a unique code concept known as "substantial alterations," most typically applied to remodeling projects that "substantially extend the useful physical or economic life of the building" (SEBC 2013). Substantial alteration projects in Seattle have long been required to upgrade seismic and life safety systems to contemporary standards. Last year a requirement was added to bring such buildings mostly, but not entirely, up to current energy code standards (SEC 2013g). This could potentially impact 2 percent of Seattle's building stock each year, resulting in very large energy use reductions over the next few decades. Although this adds construction cost to major remodeling projects, it may obviate the need for any future program of mandatory upgrades to occupied buildings, and would be far less expensive because it takes place while other major work is in progress. We can't wait another 30 – 50 years for the next substantial alteration.
- In general, new systems and equipment are required to meet current code requirements. When repair or replacement of lighting or mechanical systems exceeds certain defined

thresholds, additional requirements are triggered that bring the affected systems closer to full compliance (SEC 2013i). In this manner, lighting controls, lighting power density and economizer systems are incrementally brought up to current code levels.

Future-Ready

Future-Ready rules will enable uncomplicated upgrades in future years to the higher standards that will be required to meet Seattle's year 2050 zero carbon target, and to accommodate emerging technologies. This avoids situations where buildings constructed now would otherwise require expensive and invasive modifications in coming years.

- Photovoltaic (PV) arrays are on the cusp of becoming financially viable, even in cloudy Seattle (SEIA 2014), and the city already mandates a small renewable energy system on most buildings. Our "solar-readiness" provision requires that new buildings be constructed in a manner that removes most of the obstacles to future installation of a much larger rooftop photovoltaic system, literally clearing the way for a straightforward PV installation (SEC 2013h). When the cost of PV-generated electricity nears the cost of grid power, a building with extensive areas of clear, unshaded roof and a convenient connection to its electrical service panel will find the installation to be much more economical than will a similar building that has a cluttered roofscape and difficult connectivity, and thus the PV array is likely to be installed years earlier.
- Seattle City staff are now discussing with stakeholders what infrastructure might be needed in new buildings to accommodate battery charging for large numbers of electric vehicles in the future, and whether that can be accomplished without increasing a building's initial construction cost or electrical service size. Since battery charging is one load type that can be interrupted without significant consequences, it may be feasible to integrate load-shedding equipment that disconnects battery charging loads at those rare times when a building's electrical service is nearing capacity.
- An over-arching code philosophy that will guide the future development of our energy code is the concept of a "zero-carbon-ready community." This will represent the furthest reach of the code's influence into the future. Communities of buildings would be constructed now so that they could be conveniently enhanced with advanced systems to operate at zero net energy in the future, without having to demolish or replace significant building elements. The "zero-carbon-ready" concept is discussed in more detail below.

Energy Use and Regulatory Control

Many of the policies outlined above are highly unpopular (to say the least) with some members of the design, construction and ownership communities, who see the rules as a classic example of government overreach. This brings up a fundamental question of regulatory philosophy: Should owners and tenants be permitted to run their own buildings however they choose?

As a simplistic example, if a store's owners want to prop their front doors open all day and leave the air conditioning blasting, is it a city's place to interfere? One significant cornerstone of American culture holds that the government shouldn't interfere with citizens' private business, if those citizens are not harming or endangering anyone else. Thus, one aspect of the question is whether the hazards caused by one building's energy consumption are of sufficient severity to warrant restrictions on that consumption. Inspections of elevators and fire alarm systems easily pass this "severity" test because of the well-defined public hazards and specific tragedies that have already occurred. Vehicle emission testing, as another example, has been widely implemented due to the tangible and well-documented health impacts of local air pollution. However, carbon pollution, global warming and climate change are different from these examples in that their most severe consequences will occur far in the future, in a manner that is not directly observable or fully understood today. In addition, this topic has become so highly politicized that a very large proportion of our population (37%, as of 2013) firmly believes that no such problem exists (Public Policy Polling 2013). This attitude occurs partly because global warming concerns have been associated with "liberal" politics – anathema to political conservatives.

Nationally and locally, our energy codes grind along through a contentious and seemingly endless process of reducing the anticipated energy use of buildings. Opponents object to the disruption of their standard business practices and to additional costs of construction, and each code change cycle results in a difficult period of readjustment for designers and contractors alike. New code provisions generally must survive a determination of their having a reasonable energy savings "payback" period. This has generally been possible because the reduction of energy use usually does result in a reduction of operating costs. While high-level government policies are often based on carbon reduction, individual energy code provisions are more likely to be justified largely on energy dollars saved.

Once a building has been constructed according to code however, American society has rarely attempted to regulate the amount of energy consumed inside. We sometimes entice building owners to undertake efficiency upgrades by offering tax benefits or utility incentives, but this is purely on a voluntary basis. We've stopped short of actually requiring anyone to operate their building efficiently, or even to repair malfunctioning components. Thus, the shopkeeper can indeed leave her front door open all day, winter and summer if she thinks it will attract more customers. We don't hire "energy inspectors" to go out and red-tag buildings whose temperature settings are off or whose lights stay on after hours. In Seattle, such operational waste is exacerbated by the fact that the cost of natural gas and electricity are so extremely low that utility bills don't rise high in the priority list of busy building managers. Energy regulations under development continue to face the difficult task of balancing the principal of non-interference in the affairs of others with recognition of the serious consequences of energy waste and global warming.

The contribution of one building, or even one medium-sized city, to global warming is quite modest. However, Seattle's elected leaders have taken the position that it is our obligation to dramatically reduce carbon pollution, leading the way for other jurisdictions across the nation and beyond. An important consequence is that the economic impact of energy efficiency for the city and the region is and will continue to be quite positive. Washington State now spends 6 percent of its gross economic output to import fossil fuels from other states and nations (WA Commerce 2012, 64), plus some additional amount to mitigate the health and environmental consequences of burning all that fuel locally. Eliminating the natural gas we burn to heat buildings, while also redirecting a large portion of our hydroelectric power to replace the fossil fuels we currently consume in vehicles, would keep much of that money circulating in-state in the form of construction contracts, wages and company profits (Shuman, 2010). The necessary level of performance will require extremely efficient building operations.

The Bridge from Knowledge to Action

We have always demanded that our vehicles, appliances and computers function optimally, but have not applied this same standard to our buildings. One reason is that we rarely have a clear idea of what performance to expect from a new building. Retro-commissioning teams routinely find bizarre deficiencies even in high-end buildings (LBNL 2014). Also, buildings change hands, facility managers and building engineers come and go, and the institutional memory of how the building was intended to operate is lost. With all this, it is difficult to know whether a building is performing properly.

As mentioned under "awareness and control" above, one potential next step is something we will soon be debating in Seattle – an ordinance requiring larger buildings to either undergo periodic energy audits or to maintain an energy monitoring contract. This is predicated on the concept that repairs or upgrades to malfunctioning systems are much more likely to occur if the facilities manager already has a list in hand detailing the building's specific deficiencies and the cost estimates for correcting them (NEEP 2009 16, 22).

Marketing professionals have long understood this phenomenon. When they want us to purchase something, they remove every obstacle, so that we can simply drop a postcard in the mail or click on a box online. In the case of a rebate however, they impose a number of small and innocent-looking obstacles: find and address an envelope, buy a stamp, find the receipt, cut the UPC symbol from the packaging (which may involve finding the scissors), assemble everything, and get it to the mailbox, all before the coupon expires. Not surprisingly, nearly half of such rebate coupons go unredeemed (Grow 2005).

An especially large obstacle occurs when the task requires spending money upfront, even if the investment would pay attractive dividends in the long run. Mandatory periodic energy audits would require that several of those preliminary steps be taken, including paying for the audit, whereupon building owners would get a report detailing exactly what elements are running poorly in their buildings and what it would cost to fix them. In some cases, it might be something as simple as a software patch for the HVAC system economizer function. The bridge between reading the report and ordering the repairs is much shorter than the bridge from "I wonder why the electric bill is so high these days" to hiring a commissioning firm, ordering and paying for the audit, analyzing the report, and then ordering the repairs.

A small-scale demonstration of this phenomenon occurred last year in Washington State, where we had enacted a state code requirement to test ducts for leakage and seal the leaks whenever a residential furnace was replaced. However, this was later seen by some as being too onerous for homeowners, so a compromise was reached wherein the ducts would have to be pressure-tested for leakage, but the homeowner would not be required to have the leaks sealed (SBCC 2013). Reports from furnace installers since that time have indicated that some 85 percent of homeowners do elect to have their leaky ducts sealed. The mere existence of immediately actionable information appears to lead to energy-saving actions (NEEP 2009, 16, 22).

Zero-Carbon-Ready Communities

A concept intended to impact energy use further out on the timeline is a "zero-carbon-ready" building standard. Seattle has committed to a zero-carbon target for its entire "core energy" of buildings and vehicles – basically all of the city's energy use other than industry – by the year 2050. It is a somewhat outrageous ambition – that in a single generation and with a rapidly growing population, we will replace all of our current gasoline, diesel and natural gas (about 80 percent of our current energy mix) with hydro and wind-based grid power, distributed solar, and an unparalleled degree of efficiency and waste reduction.

Using current "state of the art" construction and available solar technology, a 3-story zero-net-energy Seattle office building, powered entirely with rooftop solar, is already feasible. However, the concept of individual "zero carbon *buildings*" is not especially relevant for Seattle due to the following:

- Most of our new buildings are taller than three or four stories, and therefore would not be able to provide enough rooftop PV to power the whole building, even assuming substantially more efficient future technologies.
- Some rooftops will be unsuitable for solar production due to heavy shading or competing uses such as plantings and roof decks.
- Buildings such as labs, restaurants, data centers and hospitals must power heavy process loads, while low-rise, low-intensity buildings such as schools, churches and warehouses will be able to generate surplus power (and perhaps some surplus income) to supplement some of the energy required by these higher-intensity buildings.
- Waste heat from data centers, industrial processes, commercial refrigeration and other sources is potentially available to serve space heating and water heating needs for other nearby buildings where connected by a district energy system.

For reasons such as these, it is important to think in terms of a "zero-carbon-ready community" (ZCRC) rather than a collection of individual zero-carbon buildings.

This can most expediently be accomplished by constructing new buildings and substantial alterations to a "ZCRC" standard today, so that they can be upgraded to full "zero-carbon" status 10 or 15 years later. It would place Seattle on a "carbon-neutral" timetable similar to that of the European Union in 2021 (EU 2010) and California in 2020 for residential and 2030 for commercial buildings (CPUC 2011, 6), so that Seattle designers and builders will be able to draw upon the technical knowledge and experience being developed by those two large economies. ZCRC buildings would be designed such that the envelope, lighting and major mechanical systems of all the city's new buildings viewed together would be capable of operating at a zero carbon level in the not-too-distant future, when PV arrays, energy recovery and storage systems, and other advanced technology are added. New and substantially renovated buildings would be required to provide enough physical space and infrastructure for these advanced components to be installed at a future date without significant disruption to the building envelope or major mechanical system components.

Conclusion

Seattle's emerging suite of codes and ordinances will protect the long-term interests of building owners and tenants, while providing a means of reaching the challenging 2050 "carbon-neutral" target set by the City's elected leaders. The owners of a new building will have paid a small fortune for that building to perform at the high efficiency level demanded by code, and will have paid a commissioning authority to ensure that everything works optimally. Ensuring that the building then works as advertised from the outset and continues to operate optimally well into the future is the least that owners should demand from such significant investments.

In so doing, Seattle intends to develop a building stock that will operate at a high level of efficiency, without imposing any post-construction "enforcement" mechanism on the owners or tenants. Under this suite of regulations, it will be in the *owner's* interest to make sure the commissioning process or Target Performance Path is successfully completed. It will be in the *tenant's* interest to monitor the energy dashboards and correct anomalies as they occur. And it will be in *both* of their interests to make cost-effective improvements to energy performance as conditions evolve in the future[2].

One future research area to consider will be the role of utilities and city governments in supporting and enhancing the effective use of the "Awareness and Control" tools that are provided for the building's owner, operator and occupants. It is likely that some program of advice, reminders, competitions, incentive payments or similar interventions could increase the effectiveness of the capabilities that are designed into our buildings.

There have been a number of objections to these regulations, primarily based on concerns about increased construction costs and complexity, but more philosophically due to constraints on how individuals are permitted to construct and operate their own properties. Recurring themes from those who oppose such code provisions include:

- "Nobody's ever going to pay any attention to those energy use dashboards."
- "Everyone's going to plug their equipment into the non-controlled outlets."
- "All this benchmarking and disclosure business is wasted time…"

While such claims may be exaggerations, full recognition should still be given to these concerns and the spirit driving them. While some feel that the environmental benefits make such restrictions worthwhile, these others remain intensely opposed. It will be important to seize every opportunity to mitigate the regulatory burden on our stakeholders and improve their financial rewards, while ensuring that progress towards Seattle's goals continues apace.

There is still plenty of good news in this for owners and occupants. High-performing buildings tend to lease up and retain tenants better than conventional buildings (CoStar 2011), are more comfortable for occupants (Abbaxzadeh 2006), and provide energy-savings dividends for the life of the building. They can also give building owners and their tenants the tools to protect themselves against energy price hikes, fuel shortages, carbon taxes, building labeling, and other potential future challenges. Perhaps basic "market forces" would bring about some of these changes over time, but Seattle's regulatory innovations will dramatically accelerate that progress towards a vibrant, clean energy future.

References

Abbaxzadeh, S. and L. Zagreus, 2006. Occupant Satisfaction with Indoor Environmental Quality in Green Buildings. *Proceedings, Healthy Buildings* 2006*,* Vol. III, 365-370, Lisbon, Portugal.

[2] Building operators and tenants do not necessarily share this viewpoint. Energy savings projected for future years, not to mention climate change mitigation on an even grander scale, is not generally on the radar of those charged with successfully managing the goals of a business or institution. This is especially true while energy costs remain low and climate change impacts are seen as distant or theoretical.

CoStar, 2011. Case for green buildings grows stronger for owners-occupants. March 9, 2011. www.costar.com/News/Article/Case-for-Green...Owners-Occupants/127092

CPUC (California Public Utilities Commission) 2011. *California Long Term Energy Efficiency Strategic Plan*. January, 2011 Update.

EU, 2010. *Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings*. Article 9, May 19, 2010

Grow, B. 2005. The Great Rebate Runaround. *Business Week Online*, Nov. 23rd 2005.

GSA (General Services Administration) Public Building Service. *Plug Load Control*. Findings, September, 2012. http://www.gsa.gov/graphics/pbs/PlugLoadControl_508c.pdf

IMT/NRDC (Institute for Market Transformation/Natural Resources Defense Council) 2011. *Empowering the Market: How Building Energy Performance Rating and Disclosure Policies Encourage U.S. Energy Efficiency*.

LBNL (Laurence Berkeley National Laboratories), 2014. *Hall of Shame*. Building Commissioning – A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions. http://cx.lbl.gov/hall-of-shame.html

McDermott, J., 2011. *Managing Plug Load is the Next Challenge for Energy Efficient Buildings*. AutomatedBuildings.com, May 2011. http://www.automatedbuildings.com/news/may11/articles/legrand/110425022303legrand.html

NBI (New Buildings Institute) 2008. *Energy Performance of LEED® for New Construction Buildings.* Washington, DC.

NEEP (Northeast Energy Efficiency Partnerships), 2009. *Valuing Building Energy Efficiency through Disclosure and Upgrade Policies – A Roadmap for the Northeast U.S.* http://www.neep.org/Assets/uploads/files/public-policy/building-energy-rating/NEEP_BER_Report_12.14.09.pdf

NEEP, 2013. *Building Energy Rating and Disclosure Policies: Update and Lessons from the Field.* http://neep.org/Assets/uploads/files/public-policy/building-energy-rating/BER%20Supplement_FINAL%20DRAFT_2-25-13.pdf

Pinch, M. et al, 2014. "Driving Innovation, Rewarding Performance: Seattle's Next Generation Energy Codes and Utility Incentives." Submitted to *Proceedings of the ACEEE 2014 Summer Study on Energy Efficiency*. Washington, DC: ACEEE.

Public Policy Polling, 2013. *Conspiracy Theory Poll Results*, April 2, 2013. http://www.publicpolicypolling.com/main/2013/04/conspiracy-theory-poll-results-.html

SEBC (*2012 Seattle Existing Building Code*) 2013, Section 303.1.1. Seattle Department of Planning and Development. *http://www.seattle.gov/DPD/codesrules/codes/existingbuildingcode/default.htm*

SBCC (Washington State Building Code Council) 2012. *2012 Washington State Energy Code Legislative Report.* https://www.google.com/#q=washington+state+commerce+energy+code+commercial+report+legislature.

SBCC (Washington State Building Code Council) 2013. *2012 Washington State Energy Code, Residential Provisions,* Section R101.4.3.1. https://fortress.wa.gov/ga/apps/SBCC/File.ashx?cid=2842

SEC (*2012 Seattle Energy Code*) 2013. Seattle Department of Planning and Development. *http://www.seattle.gov/DPD/codesrules/codes/energy/overview/*

Section References in the 2012 SEC

Citation	Section No.	Section Topic
a	C408	Commissioning
b	C402.1.5	Target Performance Path
c	C405.2.2 C405.2.2.3	Daylight Responsive Controls
d	C405.14	Plug Load Controls
e	C409	Metering
f	C409.5.3	Tenant Space Dashboards
g	C101.4.7	Substantial Alterations
h	C410.2	Solar Readiness
i	C101.4.3.1 C101.4.3.2	Lighting alterations Mechanical alterations

Seattle OSE (Office of Sustainability and Environment), 2014. *2011/2012 Seattle Building Energy Benchmarking Analysis Report.* http://www.seattle.gov/Documents/Departments/OSE/EBR-2011-2012-report.pdf

SEI (Stockholm Environmental Institute – US) 2011. *Getting to Zero – A Pathway to a Carbon-Neutral Seattle*. http://www.seattle.gov/Documents/Departments/OSE/CN_Seattle_Report_May_2011.pdf

SEIA (Solar Energy Industries Association), 2014. *Solar Energy Facts: 2013 Year in Review*. Figure 2.1. http://www.seia.org/research-resources/solar-market-insight-report-2013-year-review

Shuman, M. H. 2010. *The Competitiveness of Local Living Economies*. Post-Carbon Institute http://www.postcarbon.org/Reader/PCReader-Shuman-Economy.pdf

Stluka, P. and W. Foslien, 2011. *Control for Energy Efficient Buildings*, from *The Impact of Control Technology*. IEEE CSS. http://ieeecss.org/sites/ieeecss.org/files/documents/IoCT-Part4-07EnergyEfficientBuildings-LR.pdf

WA Commerce 2012 (Washington State Department of Commerce). *2013 Biennial Energy Report*. http://www.commerce.wa.gov/Documents/2013-biennial-energy-report.pdf