Comparison of the 2012 Seattle Energy Code with ASHRAE 90.1-2010

Final Report

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1 Executive Summary

This report compares the commercial, non-residential provisions of the 2012 Seattle Energy Code (2012 SEC) with those of the ASHRAE 90.1-2010 Energy Standard for Buildings (90.1-2010). A qualitative comparison is made of all differences, and a quantitative estimate of the major differences is made. This evaluation is limited to the code prescriptive compliance paths.

The City of Seattle adopted the 2012 SEC in November 2013. The code is an amended version of the 2012 Washington State Energy Code (2012 WSEC). In turn, the 2012 WSEC is a heavily amended version of the 2012 International Energy Conservation Code (2012 IECC). Both the state and city amendments are targeted at increasing code efficiency.

A textual analysis identified 91 code differences with sixteen 90.1-2010 provisions judged more stringent than the 2012 SEC and seventy-one 2012 SEC provisions judged more stringent than 90.1-2010. The primary differences all favor the 2012 SEC over 90.1-2010. The 2012 SEC has:

- much higher minimum insulation requirements for all envelope components
- requires building air leakage testing and compliance with a maximum leakage of 0.4 CFM/ft^2 at 75PA
- requires full commissioning with plan, preliminary and final commissioning reports
- requires hourly metering of all energy sources and major end uses

The quantitative estimate of the relative minimum efficiency level was made for 24 of the identified differences. The estimates were made using building energy simulation and engineering calculations on 14 building prototypes. Table 1 presents the difference in the 2012 SEC minimum performance relative to 90.1-2010 minimum performance. The 2012 SEC is more efficient than 90.1-2010 in all metrics in all building types. The commercial sector average result is determined from weighting the prototype savings by the projected new and addition floor area for the 10 year period 2015 through 2024.

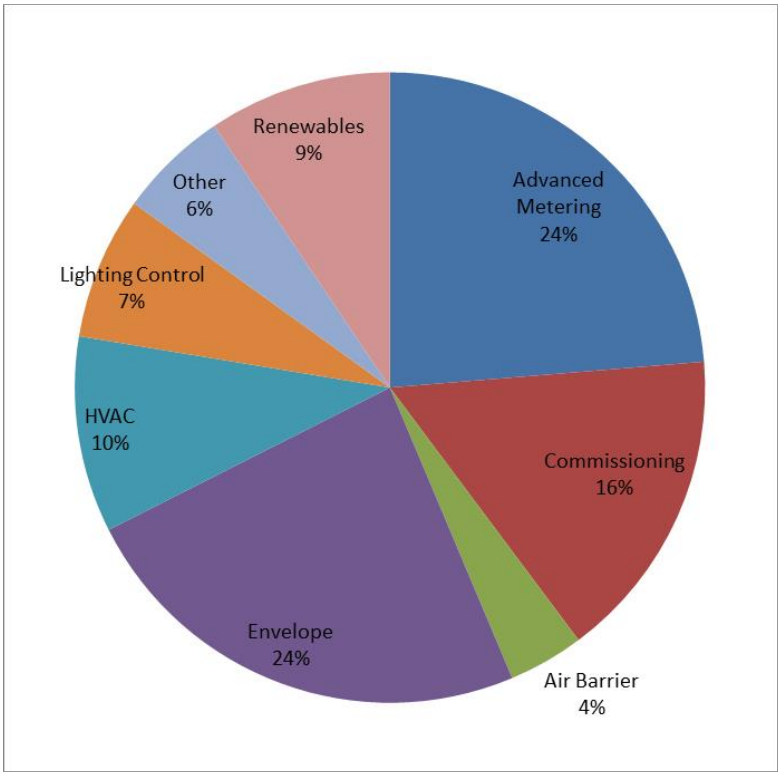
Table 1. Difference in Code Minimum Performance ((90.1-2010 – 2012 SEC) / 90.1-2010)

	Percent 2012 SEC more efficient than 90.1-2010				
Building Type	Site Electric	Site Gas	Total Site Btu	Energy Cost	Regional Carbon[1]
Grocery	3.9%	46.7%	17.3%	10.6%	11.8%
Hospital	6.0%	13.9%	8.8%	7.5%	7.7%
Lodging – Hotel	8.7%	16.8%	11.5%	10.1%	10.4%
Lodging – Motel	9.8%	20.6%	11.7%	10.7%	10.8%
Office – Large	9.4%	29.1%	10.7%	9.9%	10.1%
Office – Medium	10.7%	24.4%	12.3%	11.4%	11.6%
Office – Small	5.9%	24.4%	8.1%	6.9%	7.1%
Restaurant – Sit Down	3.5%	49.1%	16.0%	9.6%	10.7%
Restaurant – Fast Food	2.1%	20.8%	8.7%	5.5%	6.1%
Retail – Large	5.6%	25.0%	10.7%	8.1%	8.5%
Retail – Small	1.9%	22.5%	9.2%	5.7%	6.3%
School – Primary	10.8%	31.3%	15.5%	13.0%	13.4%
School – Secondary	10.8%	49.8%	18.9%	14.6%	15.3%
Warehouse	16.6%	30.8%	20.2%	18.3%	18.6%
Weighted Average	8.2%	21.5%	11.3%	9.7%	10.0%

1- Assumes 0.8 lbs. /kWh (NPCC 2008) and 117 lbs. /therm (EIA)

Figure 1 presents the contribution of each measure group to the energy cost savings. Envelope measures made up the largest block of savings, followed by advanced metering and commissioning.

Figure 1. Portion of Energy Cost Savings by Code Provision Type



2 Introduction and Purpose of Report

The City of Seattle has been a leader in the adoption of progressive commercial building energy codes. The City is in a unique position of being the electric energy provider as well as the enforcer of building codes. Over the last 34 years the City of Seattle has adopted energy codes above and beyond the Washington State code to increase minimum building energy efficiency, making it one of the nationwide leaders in commercial building energy efficiency.

This report compares the prescriptive minimum performance levels of the 2012 SEC with 90.1-2010 and estimates energy impacts for the major differences.

As with any work of this nature, there is significant uncertainty with the energy use difference estimates. By necessity, only the primary code differences – those expected to have the largest impacts – are evaluated in this work. Many other code provisions that differ between the codes have not been quantified due to limits in the available resources. Unevaluated differences are expected to have smaller impacts on minimum performance energy use but there are far more unevaluated items than evaluated items. Taken together these un-quantified provisions likely contribute significant additional savings, perhaps an additional 1-3%. As such, this work forms a conservative estimate of the 2012 SEC minimum performance energy use relative to 90.1-2010.

3 Methodology and Data Sources

This report estimates the change in minimum energy performance for moving from the 90.1-2010 to the 2012 SEC. The analysis method is designed to assess the impacts of the application of the code on typical northwest new construction and has been used by the Northwest Energy Efficiency Alliance and the Northwest Power and Conservation Council for more than 20 years to estimate regional energy savings potential from improvements in commercial building energy codes.

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The process is as follows:

- Estimate the minimum performance requirements for the base code (e.g. 90.1-2010) and the proposed code (e.g. 2012 SEC) for each building in a sample of recently constructed buildings. The current evaluation utilizes a data set with detailed information on approximately 350 buildings.
- Summarize the minimum performance requirements of each building for key traits (e.g. heat loss rate, lighting power) by building type. Do this for both codes.
- Estimate energy use for code minimum performance of both codes in fourteen representative prototype buildings using energy simulation software and, where needed, engineering calculations. Compare the predicted energy performance of the codes.
- To get an average savings for all buildings in the Seattle commercial building sector, results from each of the fourteen individual building types are weighted based on the expected new construction / addition floor area forecasts from the Northwest Power and Conservation Council (NPCC) 6th Power Plan[1] for Washington State adjusted to reflect the City of Seattle.

It is important to note that the minimum performance difference here is a direct code-to-code comparison. Current practice in new construction energy efficiency is not accounted for. Current practice is generally better than code so that actual energy savings from a code change are diminished from the code-to-code comparison. Therefore, relative performance reported here reflects code stringency and is larger than the realized utility energy savings.

There are two important areas not evaluated in this work. The code differences associated with remodel activity where triggers requiring code compliance differ between the codes, and, the impact of the code differences in midrise and high rise residential. These areas account for a very significant portion of the overall activity in the City of Seattle but are beyond the scope of this work.

3.1 Primary Data Sources

3.1.1 NEEA New Construction Survey Characteristics

The primary building characteristics data used in this work are derived from data collected as part of the Northwest Energy Efficiency Alliance (NEEA) Baseline Characteristics of the 2002-2004 Non-Residential Sector study (Ecotope 2008)[2]. This data was used to determine HVAC equipment type, performance, and associated minimum code performance, code maximum lighting power densities (LPD), code minimum building envelope characteristics, and average building geometry. The data is also used to determine the applicable of various code provision differences. For example, the percentage of cooling capacity required to have economizer in the 2012 SEC but not in 90.1-2010 is determined by looking at the size distribution of equipment found in the data base. The NEAA study buildings were built to the standards current during the 2001 code year. This data set is referred to as the NEEA Baseline.

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[1] Supporting data files from: Sixth Northwest Electric Power and Conservation Plan, Northwest Power and Conservation Council, Document 2008

[2] http://www.nwalliance.org/resources/reportdetail.asp?RID=134

3.1.2 NPCC Sixth Plan and Floor Area Forecast

The Northwest Power and Conservation Council (NPCC) has developed several key regional information sources. The NPCC Sixth Power Plan evaluates energy savings and cost of a full range of electric energy conservation measures. Savings factors have been borrowed from this work.

The NPCC also produces a regional floor area forecast. The most recent forecast is from September 2009 and estimates new nonresidential floor area to be built through 2029 by state and building type. This estimate is used to determine the overall new construction floor area in Washington State. The portion of state floor area occurring in the City of Seattle is determined for each building type from permit data.

3.2 Prototype Buildings

Fourteen prototype buildings were used in this evaluation to represent Seattle's commercial building sector. The prototypes are based on building type descriptions that have been used in regional codes work for the Bonneville Power Administration and NEEA. The prototype descriptions capture the building geometry, envelope component types, operating schedules and set points, and HVAC system types and characteristics.. The prototype descriptions were adapted by the Bonneville Power Administration (Kennedy 2011) from US Department of Energy prototypes used by Pacific Northwest National Laboratory (PNNL) to evaluate ASHRAE 90.1-2010 (Halverson, 2011).

The prototypes developed by PNNL were developed using the EnergyPlus building simulation software. The adaptation undertaken by BPA translated the descriptions to eQUEST. The translations attempted to model the buildings as close to the PNNL approach as possible, though they are approximate in many aspects, as the programs have differing capabilities and approaches. Documentation of the prototype characteristics can be found at the PNNL repository for the 90.1 evaluation work. In particular, the score card spreadsheets are useful, though in some cases the actual PNNL models deviate from the published scorecard descriptions.

3.3 Evaluated Code Differences

The first step was to identify all code differences between the 2012 SEC and 90.1-2010. In total, 91 differences were identified between the 2012 SEC and 90.1-2010. Sixteen of these are provisions where 90.1-2010 is judged to be the more stringent provision and 71 are provisions where the 2012 SEC is more stringent. Four differences were judged to be energy neutral.

The differences were then prioritized by anticipated magnitude of energy impacts and then decisions made as to which differences should have energy impacts quantified. Table 2 presents the energy code differences that were quantitatively evaluated. A complete listing of energy code differences is presented in Appendix B with an indication of whether it has been evaluated and, if not, the reasoning for exclusion.

This evaluation compares changes in the code prescriptive paths only. No attempt is made to compare performance paths, alternate compliance paths, or compliance tool (e.g. COMcheck) results.

Table 2. Evaluated Code Changes

Provision Differences Evaluated	Stronger Code	Evaluated
Minimum Opaque Envelope Insulation	SEC	Yes
Minimum Window Performance	SEC	Yes
Air Leakage Testing and Minimum Leakage Rate	SEC	Yes
Semi-heated Criteria and Insulation Requirements	SEC	Yes
Limits on Air Cooled Chiller Capacity	SEC	Yes
Economizer	SEC	Yes
Fractional HP Motor efficiency	SEC	Yes
Demand Control Ventilation Threshold	SEC	Yes
Lighting Controls – Automatic On	90.1	Yes
OS Receptacles in Classrooms	SEC	Yes
Lighting Controls – Secondary Daylight Zone Control	SEC	Yes
Commissioning	SEC	Yes
On-site Renewables	SEC	Yes
Grocery Heat Recovery	SEC	Yes
Energy Metering (whole building and sub-metering)	SEC	Yes
Energy Star Cooking Equipment	SEC	Yes
Hotel/Motel HVAC Occupancy Control	SEC	Yes
OS Control of Outside Air Damper or Local fan	SEC	Yes
Key Provision Differences Not Evaluated		
Exhaust Air Heat Recovery Thresholds	SEC	No
Walk-in Cooler and Freezer requirements	SEC	No
Optimum Start	SEC	No

Measures evaluated include both physical energy saving attributes (e.g. envelope insulation, equipment efficiencies, or lighting controls) and operational measures (commissioning and advanced metering). The physical attributes create a base building with energy saving potential (e.g. low U-Value, equipment rated to operate at certain efficiencies, or lighting that is only on when needed) while the operational measures provide the means to ensure that the physical attributes operate as intended.

The operational measures evaluated have been demonstrated to save energy over the life of the building. Northwest codes have included requirements for initial building commissioning for the last 10 years. Commissioning studies of new and existing buildings have reliably shown achieved energy savings through improved energy system operations (Mills, 2009). Advanced metering provides a means, short of continuous recommissioning, for discovery of operational problems. Both physical and operational measures are only effective if properly utilized and, from an energy saving point of view, operational improvements can be evaluated for projected savings similarly to equipment and control capabilities.

A large number of identified code provision differences have not been evaluated in this work. A majority of the unevaluated differences are items where the 2012 SEC is more stringent that 90.1-2010. For a much smaller number of unevaluated items, 90.1-2010 is more stringent. These unevaluated items typically impact a limited number of buildings or system types. Individually they are not important, but taken together they represent additional savings not captured in these estimates. As a result this evaluation likely underestimates the performance of the 2012 SEC relative to 90.1-2010. Together these unevaluated items likely would add an additional savings of 1%-3%.

3.4 Energy Difference Estimation

The difference in energy use from code provision differences are estimated using building energy simulation supplemented with engineering calculations. Differential energy use estimates are made on a unit area basis for each building type. Average differential energy use across all building types are developed by combining the unit area savings estimates with the new construction/addition floor area forecasts from the Northwest Power and Conservation Council (NPCC) Sixth Power Plan[3] and factors apportioning total state floor area to the City of Seattle.

The fourteen prototype buildings were modeled to determine differential energy use from changes in the primary performance variables (e.g., maximum lighting LPD, minimum equipment efficiency, and minimum envelope component efficiency). The simulations were also used to establish baseline energy use, which underlies all engineering estimates.

The savings estimates made here are a direct code-to-code comparison. They do not account for better than code behavior of early adopters. For example, if 50% of the current buildings already incorporate a technology being evaluated, this fact is not considered. As a result, savings estimates reflect code stringency not actual utility energy savings. A more complete discussion of why code-to-code estimates do not reflect actual energy savings can be found in the 2011 NEEA Energy Code Evaluation (Kennedy, 2011, Appendix E).

Details on the evaluated measures and individual savings calculations can be found in Appendix A and in the calculation spreadsheets.

3.4.1 Calculation Spreadsheet

All energy use calculations are processed through a spreadsheet that combines simulation results, engineering calculations, applicability factors, and population estimates. The workbook contains a worksheet for each evaluated code difference, and worksheets to aggregate the energy use differentials.

Unit area energy differentials for each code difference are calculated either through direct simulation or engineering calculations. Where measures are directly modeled, the calculation spreadsheets link to the simulation results, which are stored in a central simulation results spreadsheet. Where engineering calculations are used, the calculations are typically a function of simulation predicted end-use consumption.

Energy differentials are calculated per square foot of applied measure and also per square foot of all floor area in the Seattle commercial sector for the building type. For the sector floor area estimate, the applied measure energy differential is adjusted for applicability of the code provision to the given building, heating fuel, system types, or other factors.

The prototype building types and floor area forecast building types do not align perfectly. The worksheets include a crosswalk between the two building type systems. The savings calculations are done by prototype and then the savings are translated to the floor area forecast building types.

3.4.2 Simulations

Simulations were conducted using the eQUEST building energy simulation program and the prototype buildings described in 3.2. Table 3 lists the fourteen models utilized to represent the general building stock, along with their respective HVAC systems.. Table 4 presents the portion of the Seattle commercial building new construction represented by each prototype in terms or area, energy, and carbon.

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[3] Supporting data files from: Sixth Northwest Electric Power and Conservation Plan, Northwest Power and Conservation Council, Document 2008

Table 3. Prototype Buildings

Building Type	Baseline System/Fuel
Grocery	Package single-zone, gas heat
Hospital	VAV and CAV – Standard non-fan powered terminals. Gas boiler, hot water reheat.
Lodging – Hotel	Common areas: VAV; rooms: four pipe fan coils
Lodging – Motel	Common areas: package single-zone, gas heat; rooms: PTAC
Office – Large	VAV – fan-less terminals. Gas boiler, hot water reheat.
Office – Medium	VAV – fan-less terminals. Gas furnace, electric reheat.
Office – Small	Split system single-zone heat pump, gas auxiliary
Restaurant – Sit Down	Package single-zone, gas heat
Restaurant – Fast Food	Package single-zone, gas heat
Retail – Large	Package single-zone, gas heat
Retail – Small	Package single-zone, gas heat
School – Primary	VAV – fan-less terminals. Gas boiler, hot water reheat. Package single-zone with gas furnace for some common areas.
School – Secondary	VAV – fan-less terminals. Gas boiler, hot water reheat. Package single-zone with gas furnace for some common areas.
Warehouse	Package single-zone, gas heat. Unit heaters.

Table 4. Seattle Commercial Sector by Prototype Type

	Avg. Annual Floor Area - 10 yr. Avg.	Total Site Btu	Site Elec Btu	Site Gas Btu	Regional Carbon (lbs)
Grocery	0.6%	1.6%	1.5%	2.1%	1.6%
Hospital	9.7%	29.0%	23.6%	44.0%	27.0%
Lodging – Hotel	1.9%	4.1%	3.3%	6.3%	3.8%
Lodging – Motel	1.0%	1.0%	1.0%	1.2%	1.0%
Office – Large	30.6%	18.3%	23.2%	4.5%	20.1%
Office – Medium	17.0%	11.8%	14.1%	5.2%	12.6%
Office – Small	6.4%	4.3%	5.1%	2.0%	4.6%
Restaurant – Sit Down	0.3%	2.0%	1.6%	3.1%	1.8%
Restaurant – Fast Food	0.3%	3.9%	2.6%	7.3%	3.4%
Retail – Large	2.2%	2.1%	2.1%	2.1%	2.1%
Retail – Small	1.5%	1.6%	1.4%	2.2%	1.6%
School – Primary	2.1%	2.2%	2.2%	2.4%	2.2%
School – Secondary	6.2%	5.2%	5.3%	4.8%	5.2%
Warehouse	10.4%	3.0%	3.0%	2.9%	3.0%
Other	10.0%	10.0%	10.0%	10.0%	10.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

The base model characteristics for window-to-wall ratio for each prototype were updated based upon NEEA New Construction Survey data (See 3.1 Primary Data Sources).

Code specific characteristics are also developed from the NEEA New Construction Survey buildings. The code characteristic (e.g. maximum LPD, minimum envelope heat loss, minimum cooling efficiency) for each building in the data set is estimated based upon the lighting area types, envelope component types, window area, and equipment types found in the building. The resulting code characteristics are averaged by building type (e.g.

small office, large office, grocery). The prototype characteristics are then scaled so that the prototype averages match the NEEA Baseline averages.

For example, code insulation requirements are assigned to each component in each building in the NEEA Baseline data, and the code whole building steady state heat loss rate is calculated. Adjustments are made to the code heat loss rate for NEEA Baseline buildings exceeding code maximum window-to-wall ratio (WWR) based upon the 2012 SEC component performance equations. These equations calculate the code steady-state heat loss rate using the building WWR or the code maximum WWR whichever is smaller. Buildings with high glazing fractions are assumed to maintain their high glazing fraction but improve insulation to compensate. This calculation is exactly analogous to the SEC Component Performance compliance path and very similar to the trade-offs allowed in 90.1 through COMcheck. The average code heat loss rate per unit floor area is calculated for each prototype building type (e.g. small office). The prototype component heat loss rates are then scaled so that the prototype heat loss rate per unit floor area is the same as the calculated average. This calculation is done for each code. A similar process is followed for window SHGC, lighting LPD, and cooling efficiency.

Modeling the average characteristic derived from a large number of projects provides a truer assessment of the code impact than can be achieved by simply modeling the code prescriptive values in a specific prototype. The average for many buildings implicitly weights the various lighting area types, envelope component types, window area fractions, and equipment sizes so that the efficiency increase (or decrease) represents the sector response rather than that found for just the few situations represented in the models.

All NEEA New Construction Survey buildings are used to set code characteristics no matter whether the building is actually located in Seattle. The use of all buildings allows much better characterization of a given building type, which has a critical impact on energy savings. Items such as the average office area within warehouse and the amount of CMU wall versus other wall types are better determined using a large number of points rather than the small number occurring in the data base within the City of Seattle. To the extent that Idaho buildings are built with different materials or a different mix of spaces, this treatment will introduce error. This trade-off was deemed worthwhile.

Each prototype has a single heating fuel chosen to represent the most common fuel by building type. The final calculation spreadsheets calculate code differential use for buildings heated by electric, gas, and heat pumps from the default system consumption using simplified conversion factors. Average code differential energy use by building type is determined in the calculation spreadsheets by combining the consumption for each heating fuel case with the regional heating fuel type saturation found in the NEEA New Construction Survey data. Lost in this method is the impact of significant changes in system types or building configuration in the future. The world is seen through the lens of the audit data, which reflects the design choices of the past.

3.4.3 Engineering Method

Measures such as motor control and lighting control improvements were evaluated using a simplified engineering approach. This approach was chosen when modeling was difficult within the confines of eQUEST and the prototypes, or when modeling an “average” case was difficult and/or the model inputs would directly predict savings. For example, savings from a control strategy such as occupancy sensors are not modeled but are determined by applying a savings factor derived from field evaluations.

Engineering calculations are implemented in the calculation spreadsheets. Generally, savings are calculated using engineering calculations based upon the predicted total energy use or predicted energy use for a specific end use, as determined from the prototype simulations. If applicable, engineering calculations utilize lighting measure interaction with HVAC factors developed from the simulations.

As with the simulation results, the differential energy estimates are modified to account for heating fuel saturations and the applicability of the code language to given building or system type. To minimize double counting, end use consumption and interaction factors were taken from simulations that included the 2012 SEC LPD, UA, and HVAC performance improvements rather than the baseline 90.1-2010 models.

3.5 Efficiency Difference Metrics

Five metrics of efficiency have been generated in this work. All consider 90.1-2010 as the base code and the 2012 SEC as the proposed code. Each metric is the increase or decrease that results from the 2012 SEC relative to 90.1-2010. Positive numbers indicate increased performance by the SEC.

Table 5. Efficiency Difference Metrics

Metric	Calculation Method / Notes
Electric Use	Calculated directly by the methods of Section 3.3. All thermal consumption is assumed to be gas rather than oil or propane.
Gas Use	
Site Btu	Gas Use (Btu) + Electric Use (kWh) / 3.41214 * 1000
Energy Cost	Calculated assuming energy charges from general service rates only. PSE gas cost assumed to be $0.91/therm. SCL electric cost assumed to be $0.0764/kWh.
Carbon	Calculated using 11.7 lbs. of carbon per therm of natural gas (EIA) and 0.8 lbs. of carbon per kWh of electricity (NPCC 2008). The carbon associated with electricity assumes new electric use will contribute to regional marginal energy needs so uses an estimate of the average carbon content of the northwest marginal electric generation resources

4 Results

Comparing energy codes is a difficult exercise in language parsing and expected outcomes. Some things such as the LPD of office space might seem straightforward but when codes have alternate paths for lighting power it can be hard to determine what sort of impact a change in one path might make. Despite this uncertainty it is clear that the 2012 SEC meets or exceeds the requirements of 90.1-2010 in almost every aspect.

Only a few provisions are weaker in the 2012 SEC and these for the most part are estimated to be of minor importance. There are many provisions where the 2012 SEC exceeds 90.1-2010 with a few responsible for a majority of the estimated energy savings and a multitude of provisions with smaller impacts. Table 6 presents the increase in building efficiency of the 2012 SEC over 90.1-2010 for the evaluated provisions. Gas efficiency gains are substantially larger than the others due to the large impact of envelope measures and the predominance of gas heating. The overall building consumption used to calculate the percentages in this table includes all modeled energy use including plug loads plus additional energy use associated with operational inefficiencies not captured by the models. The additional energy from operational inefficiency is estimated to be the full 3rd party commissioning savings potential as discussed for the commissioning measure in Appendix A. The actual efficiency increase due to the 2012 SEC would exceed these estimates if the impact of the many smaller provisions, most of which favor the 2012 SEC, were factored in.

Table 6. Difference in Code Minimum Efficiency – All Measures

	Percent 2012 SEC more efficient than 90.1-2010 ((90.1-2010 – 2012 SEC) / 90.1-2010)				
Building Type	Site Electric	Site Gas	Total Site Btu	Energy Cost	Regional Carbon[1]
Grocery	3.9%	46.7%	17.3%	10.6%	11.8%
Hospital	6.0%	13.9%	8.8%	7.5%	7.7%
Lodging – Hotel	8.7%	16.8%	11.5%	10.1%	10.4%
Lodging – Motel	9.8%	20.6%	11.7%	10.7%	10.8%
Office – Large	9.4%	29.1%	10.7%	9.9%	10.1%
Office – Medium	10.7%	24.4%	12.3%	11.4%	11.6%
Office – Small	5.9%	24.4%	8.1%	6.9%	7.1%
Restaurant – Sit Down	3.5%	49.1%	16.0%	9.6%	10.7%
Restaurant – Fast Food	2.1%	20.8%	8.7%	5.5%	6.1%
Retail – Large	5.6%	25.0%	10.7%	8.1%	8.5%
Retail – Small	1.9%	22.5%	9.2%	5.7%	6.3%
School – Primary	10.8%	31.3%	15.5%	13.0%	13.4%
School – Secondary	10.8%	49.8%	18.9%	14.6%	15.3%
Warehouse	16.6%	30.8%	20.2%	18.3%	18.6%
Weighted Average	8.2%	21.5%	11.3%	9.7%	10.0%

1- Assumes 0.8 lbs. /kWh (NPCC 2008) and 117 lbs. /therm (EIA)

Table 7 presents the increase in building efficiency of the 2012 SEC over 90.1-2010 excluding savings for commissioning and advanced metering. These are presented separately to facilitate comparison to LEED v4 where commissioning and whole building metering are prerequisites and advanced metering is a distinct credit, and therefore these operational savings are not considered in the energy savings calculations. The overall building consumption used to calculate the percentages in Table 7 differs from that used in Table 6 in that energy use associated with operational inefficiency is not included.

Table 7. Difference in Code Minimum Efficiency – Excluding Operations Measures

Building Type	Percent 2012 SEC more efficient than 90.1-2010 ((90.1-2010 – 2012 SEC) / 90.1-2010)				
	Site Electric	Site Gas	Total Site Btu	Energy Cost	Regional Carbon[1]
Grocery	0.4%	50.3%	14.2%	7.1%	8.4%
Hospital	1.7%	9.6%	4.4%	3.1%	3.3%
Lodging – Hotel	3.4%	10.8%	5.7%	4.6%	4.8%
Lodging – Motel	5.6%	15.6%	7.2%	6.3%	6.4%
Office – Large	5.8%	30.2%	7.2%	6.4%	6.6%
Office – Medium	7.3%	24.2%	9.0%	8.0%	8.2%
Office – Small	5.0%	26.0%	7.3%	6.0%	6.2%
Restaurant – Sit Down	2.8%	53.8%	15.2%	8.7%	9.8%
Restaurant – Fast Food	1.5%	20.2%	7.4%	4.4%	5.0%
Retail – Large	1.0%	23.9%	6.5%	3.6%	4.1%
Retail – Small	0.7%	23.2%	8.0%	4.3%	5.0%
School – Primary	7.2%	31.9%	12.3%	9.6%	10.0%
School – Secondary	7.2%	54.8%	16.0%	11.2%	12.0%
Warehouse	13.6%	32.1%	17.7%	15.5%	15.9%
Weighted Average	4.8%	19.5%	7.8%	6.2%	6.5%

1- Assumes 0.8 lbs. /kWh (NPCC 2008) and 117 lbs. /therm (EIA)

Figure 2 through Figure 5 attribute the efficiency improvement by code provision category as measured by energy cost, total site Btu, electricity, and natural gas.

Envelope, commissioning, and metering provisions have the largest efficiency improvements and collectively account for 64% of the total improvement in energy cost. The envelope provisions of the 2012 SEC lead to a maximum envelope heat loss rates 20% lower than allowed by 90.1-2010. Every envelope component is required to have better thermal performance, with windows standing out as the most dramatic difference. The envelope portion of gas savings in Figure 5 is 40%.

One area with no evaluated efficiency change is lighting power. There are several provision differences between the SEC and 90.1, some favoring SEC and one favoring 90.1. However, because lighting power has two compliance options, and because of the general difficulty of determining the rate that the special allowances available in 90.1 can be utilized, no estimated savings are made. A complete discussion can be found in Appendix A.

Figure 2. Portion of Energy Cost Differential by Code Provision Type

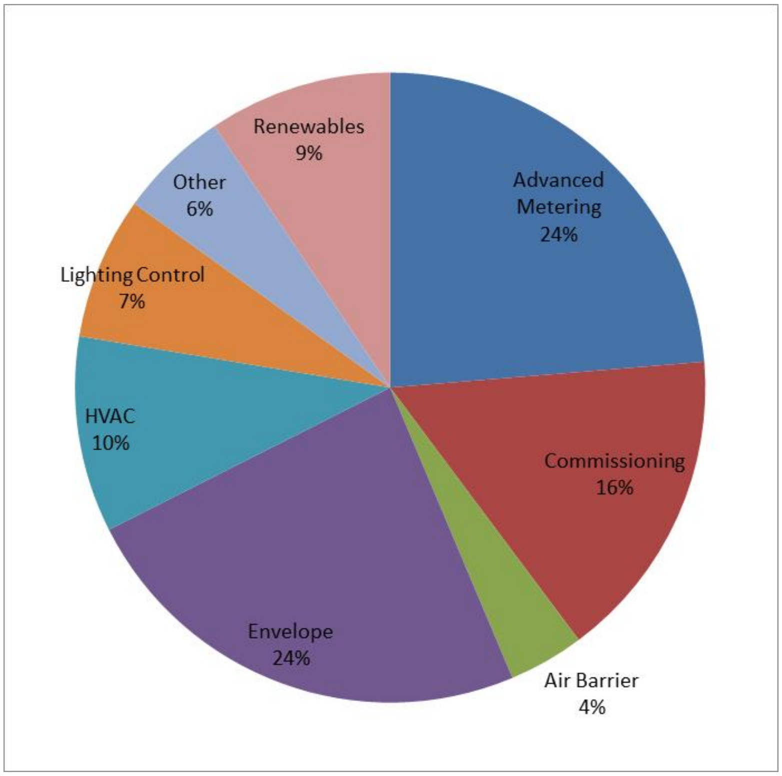


Figure 3. Portion of Total Site BTU Differential by Code Provision Type

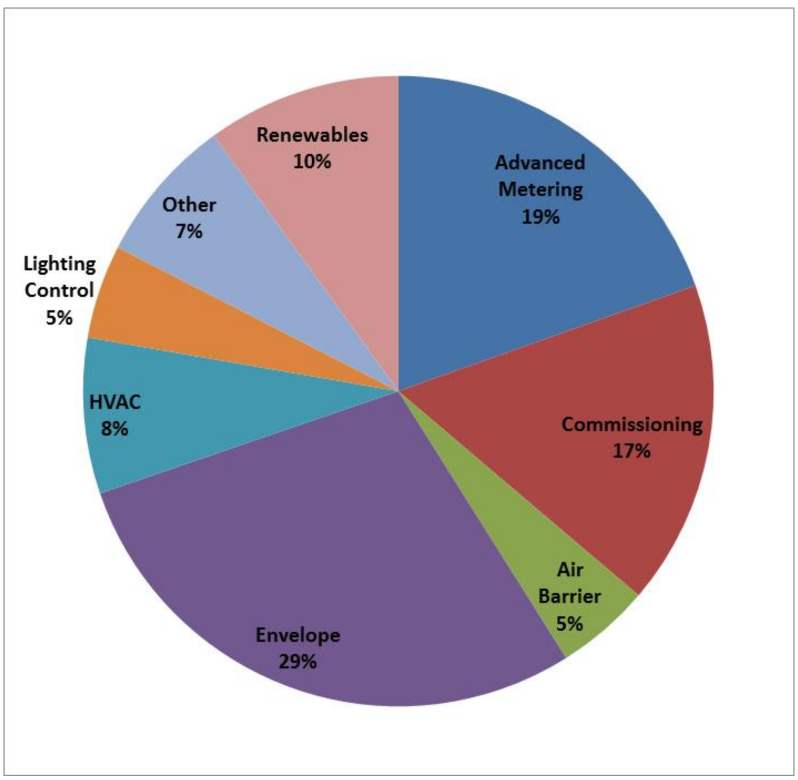


Figure 4. Portion of Electric Differential by Code Provision Type

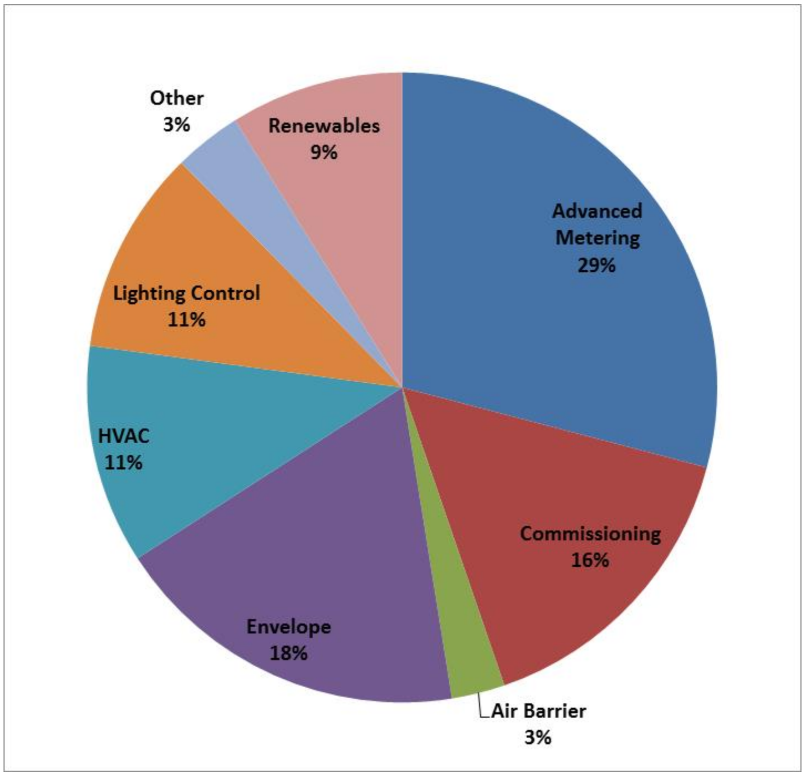
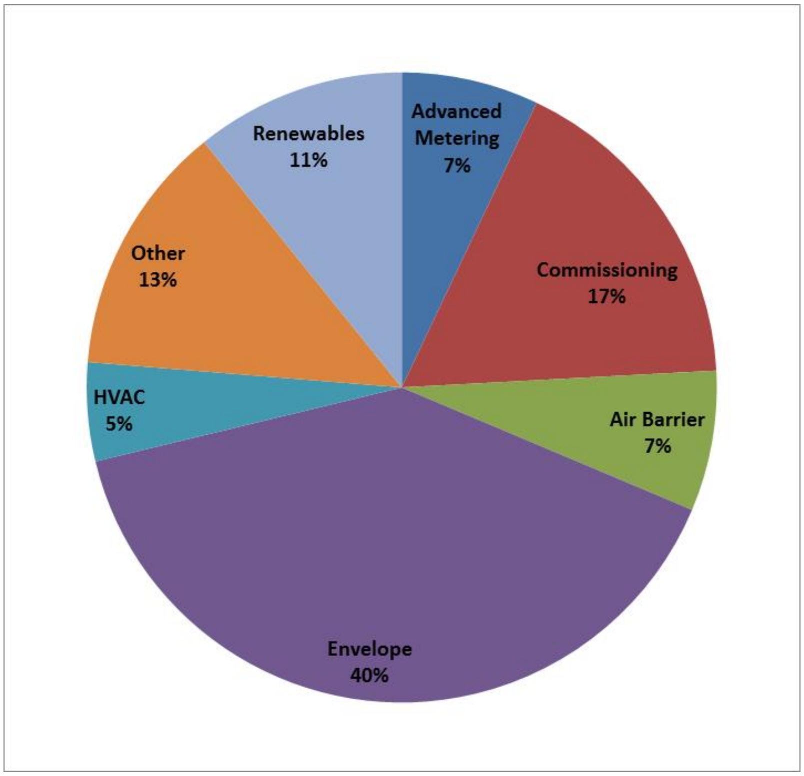


Figure 5. Portion of Gas Differential by Code Provision Type



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Appendix A. Measure Evaluation Details

A.1 Envelope

A.1.1 Envelope Insulation

The 2012 SEC has more stringent minimum thermal integrity for all building envelope opaque and fenestration components. Savings from envelope code changes were estimated by simulating the regional prototypes. Prototype insulation levels were adjusted so the prototype heat loss rate per square foot corresponded to the estimated code heat loss rate per square foot. The code heat loss rate was derived from the respective prescriptive codes and the NEEA New Construction Survey data. For each of the 350 NEEA New Construction Survey buildings, a code heat loss rate was calculated for the 2012 SEC and 90.1-2010 by combining audit data with the respective code prescriptive minimum efficiency requirements. The whole building code heat loss rate per square foot of conditioned area was calculated for each code.

Table 8 presents the resulting code heat loss rates for 90.1-2010, the 2012 SEC, and the 2012 WSEC. Prototype insulation values of the modeled prototype were adjusted to achieve the target heat loss rates for each building type.

Table 8. Envelope Data Summary (UA/ft^2). NEEA New Construction Survey

Energy Code	Code Heat loss Rate (UA/ft^2)
90.1-2010	0.1505
2012 SEC	0.1198
2012 WA Zone 4c/5b	0.1315

Semi-heated insulation requirements were applied when the buildings complied with the respective code thresholds. Both the 90.1-2010 insulation requirements and thresholds are less stringent than the 2012 SEC.

A.1.2 Maximum Glazing

The 2012 SEC prescriptive code limits WWR to 30% of gross above-grade wall area, with two exceptions: The first allows a 40% WWR if more than 50% of the conditioned floor area is in a daylight zone. The second allows a 40% WWR if the fenestration U-values are approximately 10% better than required by the prescriptive code. This second option is allowed to serve as the baseline for a target UxA tradeoff calculation, but not for a Total Building Performance calculation.

In calculating the 2012 SEC code heat loss rate, buildings that could achieved the 50% daylight zone threshold based upon the criteria below were assigned the lower code glazing performance values. For other buildings the SEC code values were calculated using the performance path equation with both sets of minimum requirements and associated WWR and the least stringent target adopted for the code heat loss.

Determining the percent of buildings that could qualify for 50% daylight zone is difficult. The NEEA New Construction Survey data has poor information on this point. Assuming a 14' floor-to-floor height, an optimally shaped building with a wall to floor ratio over 0.47 should be able to achieve 50% daylighting if they allow window head heights to rise to the maximum available height. This criteria was used to identify buildings that might achieve the 50% threshold in the NEEA Baseline data set. These candidates were then hand reviewed to determine whether the project could reasonably meet the threshold. Using this process a total of 3 buildings were determined to qualify for this exception

A.1.3 Air Barrier

The 2012 SEC code introduces explicit requirements for a building air barrier and requires all buildings to have an air leak test at 75 PA of less than 0.4 CFM/ft^2 of above-grade envelope. The building air barrier, materials and, assemblies are similar to those required by ASHRAE 90.1 – 2010 but 90.1 does not require testing.

Quantification of the SEC savings due to requiring air leakage tests is complicated by two major uncertainties. First, baseline leakage rates are poorly understood with the primary leakage set being from the whole country and dominated by east coast, particularly buildings in Florida. The data set also has very few new buildings though the data that is present shows no diminishment of leakage in new buildings. Second, the performance of the building air barrier path without testing in 90.1-2010 is highly uncertain.

The base building air leakage rate assumed in the savings evaluation of ASHRAE 90.1 - 2010 (Halverson 2011) was based upon building leakage data assembled by NIST (Emmerich et al. 2005). The data set characterizes leakage data on the basis of CFM per square foot of building surface area. The mean leakage rate of 1.8 cfm/ft^2 at 75 PA was used in the PNNL evaluation. Three extreme outliers in the data are responsible for moving the average from 1.0 cfm/ft^2 to 1.8 cfm/ft^2. The median is 1.0 cfm/ft^2. The 2005 NIST paper ("Airtightness of Commercial Buildings in the US" by Emmerich and Persily) has a mean of 1.54 cfm/ft^2 of building surface area, (excluding floor), with higher levels in warehouse and lower in office for all climates. The paper also shows a strong correlation between air tightness and heating degree days, with much lower leakage rates in colder climates . The data has an average of 0.99 cfm/ft^2 for climates with >2000 degree days, with the caveat that they have little data for the western US.

PNNL evaluated the 90.1 – 2010 air barrier language as part of the DOE Determination Quantitative Analysis (Halverson et. al. 2011). PNNL chose to use the mean value of the aforementioned data set (1.8 CFM/ft^2) as the baseline. They assumed that the 90.1 sealing language would reduce the infiltration 45% to 1.0 CFM/ft^2, and that a testing requirement would be needed to get lower. The basis for the assumption of the 45% reduction was based on direction from the 90.1 Envelope subcommittee rather than any analysis.

All regional analysis (BPA 2012, NEEA 2011) has assumed a baseline leakage of 1.0 CFM/ft^2 of exterior surface as a more reasonable baseline for Pacific Northwest buildings. The 90.1 air barrier language might not reduce this leakage much in northern buildings and certainly PNNL assumes that air barrier language only gets the building to a leakage rate equal to the rate assumed as the base condition in this evaluation. We assume the 90.1 air barrier language reduces leakage 20% to 0.8 CFM/ft^2, a smaller percentage savings but leaving overall building leakage below what was assumed in the evaluation of 90.1-2010. This is "conservative" in that the lower baseline assumption combined with assuming some remaining savings from air barrier language means the air testing requirement of 2012 SEC will be assumed to reduce infiltration by a smaller amount (0.4 CFM/ft^2) compared with the 0.6 CFM/ft^2 increment implicit in the 90.1 evaluation.

A.2 HVAC Efficiency

A.2.1 Limitation on Air Cooled Chiller Capacity

The 2012 SEC requires facilities with more than 500 tons of total chiller capacity and more than 100 tons of air cooled chiller capacity to have air cooled chillers 10% more efficient than code minimums for the capacity beyond 100 tons. The NEEA Baseline data indicates a small number of facilities will be required to improve chiller efficiency as a result.

In applying the 2012 SEC equipment efficiency values to the NEEA Baseline buildings, those impacted by the above language were assumed to install more efficient air cooled chillers and the code efficiency values were adjusted for this factor. Simulation runs were done using the average 90.1-2010 code cooling efficiency and separately using the average 2012 SEC code efficiency. The difference reflects the average impact of this single provision.

A.2.2 Economizer

The economizer provisions of the 2012 SEC and 90.1-2010 are quite complicated and determining the applicability and impact of the differences involves separate treatment of different HVAC system types. In general, 90.1-2010 requires an air or water economizer but allows an unlimited quantity of equipment to be installed without an economizer as long as its cooling capacity is less than 54 kBtu/hr. The 2012 SEC requires air economizer and allows up to 72 kBtu/HR of cooling as long as the unit cool capacity is < 33 kBtu, or 54 kBtu for split system where the air handler is not adjacent to the exterior. For Group R the 2012 SEC has the same size limits but does not have a site limit on the total amount of cooling without economizer.

In all cases the 2012 SEC economizer requirements are equivalent or more stringent than 90.1-2010. The economizer analysis was divided into distinct pieces.

The Group R provisions impact lodging and high rise residential. Inspection of the NEEA Baseline hotel and motel buildings found that all buildings had equipment small enough to not require economizer in either the 2012 SEC or 90.1-2010. However, the 2012 SEC requires this equipment to be 15% more efficient. In this analysis, the lodging room cooling was modeled as 15% more efficient in the 2012 SEC runs. In addition, based upon NEEA Baseline data about 50% of room systems were heat pumps which are credited with heating savings as well. These savings are applied to all hotel and motel floor area.

Single zone package equipment and fan coils were assumed to install economizer in all cases where 2012 SEC required economizer and 90.1-2010 did not. The impact of economizers was modeled in several building types. These savings were applied to the percentage of floor area served by systems less than 54kBtu excluding up to 72 kBtu of units smaller than 33kBtu. This percentage was estimated for each building type from the NEEA Baseline data.

The 2012 SEC requires water source heat pump loops to have economizer except for up to 72 kBtu of units less than 33 kBtu, which covers nearly all water source heat pumps. Alternatively, there is a special exception that allows a 60% economizer if the equipment is 15% more efficient than the code tables. 90.1-2010 exempts 76% of water source heat pumps based upon capacity.

Buildings are assumed to utilize the SEC heat pump loop exemption which requires equipment to be 15% better rather than install an economizer. Savings are calculated as 15% of heating and cooling energy for all water source heat pumps with cooling capacity <=54 kBtu/hr. The heating and cooling energy for heat pumps is estimated using simple multipliers from each prototypes system energy use.

The more efficient water source heat pumps will also be required to have partial airside economizer. In these systems, the economizer will save less than an economizer in other systems because reduced cooling from the economizer in the core of the building will be partially offset by decreased loop temperatures and a resulting increase in heating energy needs in the exterior zones. There will be additional savings from this partial economizer but they are suspected of being small and have not been quantified, as a heat pump loop system was not modeled.

Differences in computer room economizer requirements were not evaluated. This is a small amount of overall floor area so will have little impact. Differences in water side economizer which is allowed in 90.1-2010 but not the 2012 SEC are not evaluated and this likely has a bit larger impact. In the Seattle climate the air side economizer saves more energy than a water side economizer.

A.2.3 Fractional HP Motors

The SEC requires that fractional horse power fan motors be over 70% efficiency fans with speed control for balancing or dynamic control. The code exempts fans that only operate during heating and also those in certified equipment listed in the HVAC equipment efficiency tables. This exempts all roof top units, unit heaters, most furnaces, and parallel VAV boxes. Applicable equipment includes small heat/cool fan coil units, series fan powered VAV terminal fans, exhaust fans, and possibly heat units that have fans operating continuously to deliver ventilation. 90.1-2010 has no efficiency requirements for these fans. This measure is evaluated in two significant situations. Not evaluated is the impact of this provision on small central station air handlers common in schools and exhaust fans.

A.2.3.1 ECM Motors in Series Terminals

The biggest impact of this fractional motor requirement will be on series fan powered terminals which are very common in Seattle. Unfortunately the prototypes as currently developed do not have a system with series fan-powered terminals. The application of ECM motors to series fan-powered terminals was evaluated previously (NEEA 2011) with a very similar simulation methodology utilizing a suite of prototypes which did include series fan powered terminals based upon the assumptions below.

The floor area served by systems with series-fan powered terminals is derived from the NEEA Baseline data. The percentage floor area served by VAV system for each building type is determined for all buildings in the database. The saturation of series versus parallel and fanless VAV was determined separately for buildings in each state. While this is statistically less desirable there are clear differences in preferred VAV type between Oregon and Washington.

The savings estimate determined in the NEAA 2011 evaluation modeled series fan powered terminals in the perimeter of the large office prototype and savings were normalized per square foot of area served by the VAV system including both the area with fanless VAV core terminals in the core and series-fan powered terminals in the perimeter. The model assumes the standard fan-powered box motor consumes 0.35 W/CFM and the ECM motor consumes 0.2 W/CFM. This savings value was applied to the systems and terminal saturations across all building types. Estimated electric savings were 0.105 kWh/ft^2 and gas savings were -0.12 kBtu/ft^2. This estimate is used directly here for the impacted systems.

A.2.3.2 ECM Motors in Fan Coils

The large hotel prototype has a fan coil system which was modeled using assumptions taken from the 90.1-2013 preliminary determination (Halverson 2013). In that work baseline PSC motor efficiency is assumed to be 29% and ECM motor efficiency to be 70% with a fan efficiency of 55% and total pressure of 1.08 in. The saturation of this system type in new construction is uncertain. Savings are only claimed for the hotel sector.

A.2.4 Demand Control Ventilation (DCV)

The 2012 SEC reduces occupancy threshold for DCV from 40 people / 1000 ft^2 to 25 / 1000 ft^2. Space types requiring DCV by 2012 SEC but not by 90.1-2010 include school class rooms for age 9 and above, office reception areas, health club aerobics and weight rooms, museums, mall concourses, bowling alleys, and correctional facility day rooms. The combination of the system outdoor air and multizone DDC exceptions limits applicability to spaces served by very large single zone equipment (>20tons) and to spaces served by multizone systems with DDC. The number of spaces meeting all these criteria will be limited with school classrooms served by central VAV air handlers being the largest impacted group.

This provision was modeled in the schools prototypes and applied only to the schools sector.

A.2.5 Grocery Refrigeration HR

2012 SEC provisions require most grocery buildings to install equipment to recover refrigeration condenser heat and use it for water *and* space heat. If the facility has food service and > 500kBtu remote refrigeration then refrigeration condenser heat recovery to water or space heat is required. If facility > 40000 ft^2 and has > 1000kBtu of remote refrigeration then refrigeration heat recovery to both space and water required.

This is a very effective technology but does have some interactions between the heat recovery and compressor energy due to limits on the head pressure control. In this evaluation grocery heat recovery was treated briefly. Heat recovery was assumed to save 90% of the water heat and 50% of the space heat. Estimates of space and water heating energy were derived from the simulations. Applicable floor area was derived from the NEEA Baseline. Eighty-eight percent of the NEEA Baseline floor area would be required to have heat recovery to water heat and 65% would be required to have heat recovery to space heat.

A.2.6 Occupancy Controlled HVAC - Hotel / Motel

SEC requires Hotel / Motels with over 50 rooms to have OS or card key activated thermostat set back or set up. PNNL studied 6 installations (USDOE, PNNL 2012) and found savings varied from 11% to 26% of HVAC energy use. BPA has conducted a few case studies and found savings of 12% (BPA 2011) and minus 48% (BPA 2010). Studies in other areas of the country have found savings of 13% to 62%. Many of these control schemes include fan deactivation and outside air shut off which the SEC language does not require but will often be included as part of code compliant controls. Savings are assumed to be 10% of the HVAC energy.

A.2.7 Occupancy Controlled HVAC – Classroom, Conference room, Gyms, and Auditoriums

The SEC requires classrooms, gyms, auditoriums and conference rooms > 500ft2 to have OS control to close outside air dampers or shut off the HVAC equipment. Shutting local dampers on multi-zone systems will save fan, heating and cooling energy. In single zone systems, closing the dampers will save only heating and cooling energy but many projects will find the easiest response is to shut the system off and so will save fan, heat, and cooling energy.

Savings depend upon the baseline assumptions of impacted floor area, hours of operation, outdoor air flow, and the control response. One factor is the spaces where this control is required are also required to have demand control ventilation with the exception of classrooms served by single zone equipment.

There have not been significant field studies of this control. Simulation studies of office buildings (Zhang et. al. 2013) found 7.5% savings of whole building energy use in Salem from occupancy control of VAV boxes in private offices and conference room which made up just 33% of the building floor area. This equates to 23% of building energy use if the whole building were made up of conference rooms and private offices. The VAV terminal application saves fan, heating and cooling energy and so represents the high end of savings.

We have assumed 10% savings of HVAC energy use in the applied floor area. This is very conservative for multi-zone systems and where single zone systems are shut down and high for situations where single zone system dampers close but the fan continues to run. The applied floor area has been calculated from the NEEA Baseline data.

A.3 Interior Lighting Power Allowance

There are several differences between the 2012 SEC and 90.1-2010 maximum lighting power allowances. Both codes have separate building-area and space-by-space prescriptive lighting power paths, and buildings must comply with one of these paths. The ability of buildings to choose the alternate path complicates what would otherwise be a straight forward comparison. After considering the differences this analysis treats the lighting power regulation of the two codes to be equivalent. The differences are discussed below.

The 2012 SEC has building-area maximum wattage allowances considerably below those of 90.1 for 7 building types. However, the 2012 SEC space-by-space method allowances for these building types are more lenient than the building-area values. Warehouse is the most glaring example. The 2012 SEC building-area allowances are 0.5 W/ft^2. The 2012 SEC space-by-space values for warehouse are 0.58 W/ft^2 for medium/bulky material and 0.95 W/ft^2 for fine material. In almost any conceivable warehouse, the allowed lighting power allowance of the 2012 SEC space-by-space method is higher than the building area method allowance.

This is the result of the 2012 SEC space-by-space maximum allowances not being calibrated with their respective building-area allowance values. In the push to adopt space-by-space values, the 90.1-2010 space-by-space values were adopted without adjustment. The ASHRAE 90.1-2010 space-by-space allowances are derived from the same building models as the 90.1-2010 building-area allowances and as such can be considered equivalent for typical buildings. The 90.1-2010 building-area allowance for warehouse is 0.66 W/ft^2, a much more reasonable value in comparison to the space-by-space values.

It is unrealistic to compare 2012 SEC building-area values with 90-1-2010 building-area values since any building having trouble with code will try the SEC space-by-space path which is equivalent to 90.1-2010. Assuming the effective SEC building-area method allowance is equivalent to the 90.1-2010 allowance is likely to be a better representation of the new codes impact. This will not account for buildings configured such that the space-by-space path results in a very low allowance and where under 90.1-2010 the building area allowance would be used. (for example, a warehouse that is 100% medium storage space). So the SEC2012 is slightly stronger in this aspect but exactly how much is uncertain.

Another factor in favor of the 2012 SEC is that under the space-by-space path it does not allow extra wattage for spaces with a high room-cavity-ratio while 90.1 offers 20% more lighting power to these spaces. On average this means the 2012 SEC space-by-space path is more stringent than 90.1-2010. As a result, under the 2012 SEC some buildings will opt for the building-area path but for many types the 2012 SEC is especially tough here so that will not offer relief.

Another factor in favor of the 2012 SEC is that 90.1-2010 increases lighting power allowance if lighting controls are installed beyond the minimum requirements. From a 90.1-2010 perspective these control credits have been designed as energy neutral ways of getting more lighting power. However, in some percentage of buildings the controls would be specified anyway. Under 90.1-2010 these buildings would be allowed more lighting power; under 2012 SEC they are not.

A factor in favor of 90.1-2010 is that the proposed fixture wattage for ballasted fixtures is based upon the maximum lamp rather than the installed lamp. For example, can lights are a common fixture group whose ballast and fixture allow a wide range of lamps. It is common to have fixture/ballast combinations that accommodate a 42W triple-tube CFL but that have 26W or 32W triple-tube CFL lamps installed. In 90.1-2010 this fixture would count 42 watts against that allowed while under the SEC it would count for 26 or 32 watts. Other fixture types are less prone to this kind of variation. A mitigating factor that lessens the impact of this difference is that if 90.1-2010 were strictly enforced and the lighting budget were an issue, a designer would simply need to install a ballast that only allowed the installed wattage and nothing more. This response would not save energy but would result in code compliance. Still this factor will result in a slight increase in the calculated proposed wattage under 90.1-2010 in comparison to the 2012 SEC.

A.4 Lighting Controls

The lighting control requirements are very similar between the 2012 SEC and 90.1-2010. The primary differences that favor the 2012 SEC are that automatic daylight control is required in the secondary day light zone and occupancy sensor controls are required in warehouse. Neither is required in 90.1-2010. The differences favoring 90.1 are a smaller room size for the threshold for requiring minimum skylight area and that automatic sweep/time clock controls must be manual or automatic on to 50% for several space types while the 2012 SEC has no requirements so that automatic on to 100% is possible.

Lighting control measures are difficult to assess, as most involve levels of occupant interaction as well as interacting with each other. Simulation models do not model these controls. Rather, they model the impacts of assumed changes in the fraction of lighting on. This fraction of lighting on-time is generally determined from field studies. Therefore this analysis has taken a simplistic approach to calculating savings for most lighting control measures. A fractional savings factor is applied to the model-predicted lighting energy use and adjusted for model-predicted lighting interactions.

OS control of warehouse lighting and manual-on of automatic-off lighting code differences are evaluated on a single worksheet. The secondary daylight zone control is evaluated separately. The difference in the room size threshold for the minimum skylight requirements is not evaluated because of the small number of impacted spaces.

A.4.1 Warehouse Occupancy Sensors

The 2012 SEC requires all warehouse and storage areas to have occupancy sensors where 90.1-2010 requires only storage areas less than 1,000 ft^2 to have OS control. The 2012 SEC requirement has a key exception for lighting in spaces considered industrial and manufacturing spaces "as may be required for production". The analysis here assumes that 90.1-2010 requirement for automatic shut off is met using automatic time clocks. The NPCC 6th plan estimated warehouse occupancy sensor savings of 35% for the controlled fixtures with 80% of the fixtures controlled. These numbers are assumed here.

A.4.2 Side Daylight Control

The 2012 SEC provisions are more stringent that 90.1-2010. Both codes require primary side daylight zones to have separate controls for general area lighting and to have automatic harvest controls. Only the 2012 SEC requires these controls in the secondary daylight zone.

In addition, the 2012 SEC requires small side daylighted spaces to have automatic daylight controls while 90.1 exempts spaces smaller than 250 ft^2. The 2012 SEC also has slightly more stringent requirements for continuous dimming controllers, minimum turn down of 20% power versus 35% in 90.1-2010.

Savings were estimated for the 2012 SEC primary and secondary control zone requirement but not the better requirements for continuous dimming devices. The savings estimate is based upon an engineering calculation. The NPCC 6th plan estimates side daylighting saves 50% of the lighting energy in the primary and secondary daylight zones. For this evaluation the savings are distributed unevenly between the primary and secondary zones with the primary zone savings estimated to be 66.6% and the secondary zone savings estimated to be 33.3%.

An estimate of the floor area within the primary and secondary daylight zones was derived from the NEEA Baseline data. An adjustment is applied for retail and small rooms which are exempt from the controls. This factor is estimated based upon general impressions from the NEEA Baseline building. Table 9 presents the factors used to calculate floor area in the primary lighting zone required to have automatic daylighting controls in the SEC but not 90.1. This calculation assumes small offices are equally distributed through the building. Table 10 presents the factors used to calculate floor area in the secondary daylight zone.

Table 9. Primary Daylight Zone Side Daylight Calculation Assumptions

Building Type	Applicability - Fraction of Floor Area	Fraction of Building Not Exempt	Fraction of Floor Area in Rooms < $250ft^2$	Fraction of Perimeter with Windows	Fraction of Floor Area in Primary Perimeter zone
Grocery	0.00	1.0	0.04	0.23	0.168
Hospital	0.012	0.1	0.8	0.75	0.204
Lodging	0.0	0.05	0.02	0.83	0.243
Office – Large	0.04	1.0	0.22	0.96	0.192
Office – Medium	0.04	1.0	0.22	0.96	0.192
Office – Small	0.03	1.0	0.12	0.73	0.359
Restaurant	0.0	0.0	0.02	0.49	0.480
Retail – Large	0.0	0.0	0.04	0.17	0.108
Retail – Small	0.0	0.0	0.04	0.41	0.330
School - Secondary	0.005	1.0	0.04	0.66	0.180
School – Primary	0.005	1.0	0.04	0.66	0.180
Warehouse	0.004	1.0	0.04	0.28	0.359

Table 10. Secondary Daylight Zone Side Daylight Calculation Assumptions

Building Type	Applicability - Fraction of Floor Area	Fraction of Building Not Exempt	Fraction of Perimeter with Windows	Fraction of Secondary Perimeter Zone Compromised by Interior Partitions	Fraction of Floor Area in Secondary Perimeter zone
Grocery	0.000	0.0	0.23	0.0	0.15
Hospital	0.010	0.1	0.75	0.3	0.19
Lodging	0.000	0.0	0.83	0.3	0.23
Office – Large	0.124	1.0	0.96	0.3	0.186
Office – Medium	0.124	1.0	0.96	0.3	0. 186
Office – Small	0.155	1.0	0.73	0.3	0.304
Restaurant	0.000	0.0	0.49	0.0	0.34
Retail – Large	0.000	0.0	0.17	0.0	0.10
Retail – Small	0.000	0.0	0.41	0.0	0.26
School - Secondary	0.110	1.0	0.66	0.0	0.165
School – Primary	0.110	1.0	0.66	0.0	0.165
Warehouse	0.059	1.0	0.28	0.3	0.304

A.4.3 Manual On or Automatic to 50%

90.1-2010 requires manual-on up to 50% and automatic-on for all lighting except lobbies, public corridors & restrooms while the SEC 2012 limits this requirement to lighting controlled by occupancy sensors thus letting sweep controlled lighting utilize full automatic-on. There is little information quantifying savings based upon different types of lighting-on control methods.

Full automatic shut off is assumed to save 20% over manual control. SEC 2012 Baseline control is multi-level switch which has been previously estimated as saving 5%. So full automatic shut off saves 15% over the space baseline. Evening performance is deemed more important to overall savings since the number of hours from lights being on all night are significant. The manual-on requirement in 90.1 is assumed to be responsible for 33% of the automatic shut off savings. The SEC 2012 will utilize 5% more lighting power in areas not required to have OS control.

A.5 Other

A.5.1 Classroom Occupancy Sensor (OS) Receptacles

SEC 2012 extends electrical outlet automatic control requirements to all classrooms. This same provision has been adopted by 90.1-2013 and power reduction factors from table 5.19 of the 90.1-2013 Preliminary DOE Determination are used to evaluate the SEC 2012 savings. The power reduction factors listed below are used to modify equipment schedules in the primary and secondary school prototypes. Classrooms in other building types are not evaluated, and the frequency of classroom area within schools is assumed to be the same as presented in the prototypes.

Power Reduction Factors

Prototype	Standard 90.1- 2010		SEC 2012 (90.1-2013)	
	Occupied	Unoccupied	Occupied	Unoccupied
Primary School	0.9952	0.9816	0.9306	0.7797
Secondary School	0.9983	0.9919	0.9512	0.8446

A.5.2 Energy Star Kitchen Equipment

The SEC requires commercial fryers, hot food holding cabinets, steam cookers, and dishwashers to meet the energy-efficiency and water-efficiency criteria required to achieve the Energy Star label. Energy savings for Energy Star fryers, steamers, and dishwashers were determined using the Energy Star Commercial Kitchen Equipment calculator. The equipment saturation in new floor area was determined from the *Energy Savings Potential and Research, Development, & Demonstration Opportunities for Commercial Building Appliance (US DOE 2009).*

A.6 Commissioning

Table 11 details the commissioning requirements of the two codes. The 2012 SEC has extensive, explicit building commissioning requirements for the mechanical equipment and controls, hot water controls, and lighting systems. The requirements specify building commissioning, specific items to be functionally tested, requires a commissioning plan and preliminary and final commissioning reports, and establishes a “commissioning permit” that tracks the progress of commissioning from initial occupancy through completion of the final commissioning report.

90.1-2010 requires commissioning of mechanical controls and lighting systems. The mechanical requirements provide no details on the commissioning required, while the lighting system requirements are more complete. 90.1-2010 requires testing requirements to be addressed in the plans and specifications but does not require a commissioning plan and does not require a HVAC commissioning report.

Table 11. Commissioning Requirements

Item	2012 SEC	90.1-2010	Comment
Test and Balance	Required on all air and water systems with written report except for buildings that are exempt from HVAC commissioning. Requires test ports on all pumps.	Required on all air and water systems. Requires written TAB report for systems servings over 5000 ft^2.	2012 SEC requires test port on pumps while 90.1-2010 does not. SEC exception is incredibly limited so TAB will be required in most buildings including those under 5,000 ft^2.
HVAC Commissioning Requirement and Threshold	Required for HVAC systems, equipment, and controls if system has economizer, is complex system, or simple system with heating capacity > =600kBtu or cooling cap > =40 tons.	All HVAC control systems.	Economizer is mostly required by the 2012 SEC so commissioning is effectively required in all projects. 2012 SEC provides specific details on the types of testing required.
DHW Commissioning Requirement and Threshold	Required for all DHW systems, pools and spas when the largest DHW system has a capacity > 200,000kBtu or when there are pools or spas present.	No requirements	
Lighting Commissioning Requirement and Threshold	All lighting control systems if connected lighting load is > 20kW or the amount of lighting controlled by occupancy sensor controls is > 10kW.	All lighting control systems must be functionally tested to verify proper operation. Must provide "documentation" to certify performance.	The 2012 SEC threshold means commissioning generally will only be required in buildings over 20,000ft^2. Specifics of required testing are very similar but the documentation difference is substantial (see plan and report requirements).
Commissioning Plan	Required if commissioning required. Delineates several specific items that must be in plan.	If building over 50000 ft^2 then requires "detailed instructions for commissioning" to be part of plans and specifications. There is reference, presumably for guidance on what detailed instructions might look like, to informative ASHRAE Guideline 1-1996 *The HVAC Commissioning Process.*	2012 SEC requires commissioning plan with specific detail about what is included. 90.1-2010 does not.
Preliminary Report	Required	Not required	2012 SEC requires preliminary commissioning report, 90.1-2010 does not.
Final Report	Required	Not required, except lighting commissioning must have documentation certifying proper operation.	2012 SEC requires preliminary commissioning report, 90.1-2010 does not.
Post-occupancy	Commissioning permit required to see commissioning finalized.	Not required	This 2012 SEC requirement is a substantial step forward in confirming the completion of building commissioning

The 2012 SEC makes a major attempt to require full commissioning of the project while 90.1 sets the bar very low especially for mechanical controls and doesn't have a bar for mechanical equipment. This evaluation considers the lighting system commissioning requirements of the two codes to be equivalent. However, the mechanical and DHW system requirements are much stronger in the 2012 SEC. The 90.1-2010 language says you will commission the HVAC controls but does not define what that will entail leaving a very low bar. This evaluation considers the 90.1 language to be ineffective but ascribes energy savings to the 2012 SEC HVAC commissioning requirements.

The potential energy savings for code-required commissioning are very large but also highly uncertain. The relevance of commissioning studies to date is questionable. A key issue, how code-driven commissioning in all buildings compares with incentivized third-party commissioning in complex buildings, is crucial since most of the cost and savings data are dominated by incentivized commissioning of complex buildings.

Quantifying savings for code driven commissioning is essentially a very significant guess, and the result has an outsized impact on overall savings because it is applicable to nearly all floor area. The basic approach here follows the same approach used in the NPCC Sixth Plan (PC-HVACControls-6P-D4.xls, Notes & Sources 2008). Estimated savings from commissioning is documented in various studies, and this value is taken to be representative of third-party and/or owner-driven commissioning in complex buildings.

A significant review of commissioning studies was conducted as part of the NPCC Sixth Plan. This included studies by NEEA, PECI and LBNL. Since then, LBNL has published a second commissioning evaluation that is based upon an expanded sample. Unfortunately the LBNL sample increase includes very few additional new construction projects, and the savings data made available is much less detailed than previous work, making the new data difficult to use. This is particularly true since the original data has significant shortcomings, and there is no reason to assume the same issues are not present in the new data. Therefore the NPCC Sixth Plan savings estimate of 6.0% of total electric and 2.1 kBtu/ft^2 gas will be used for the full potential of commissioning savings. These are conservative values.

These whole building savings numbers were transformed into savings fractions for the HVAC and lighting end uses. This allows savings to be better allocated to various building types and heating fuel types. The transformation requires estimates of end use fractions. The California End Use Study (CEUS) provides a detailed estimate of California building end use splits. Since the whole building savings estimates are heavily dominated by California buildings, this was used to transform the whole building savings estimates to end uses savings estimates.

HVAC is assumed to dominate electric savings, as one key study attributed only 6% of savings to lighting. The lighting end use was assumed to account for 15% of the electricity savings. From CEUS the average end use fraction for HVAC gas is 0.36 and for HVAC electricity is 0.325. These calculations lead to an estimated savings of 22.4% of HVAC gas use, 15.7% of HVAC electric use, and 3.1% of interior lighting electric use. These savings primarily represent owner chosen third-party commissioning of complex buildings.

Applicability

The 2012 SEC Section C408.2 has a three part exception for mechanical commissioning that is prone to confusion. This evaluation assumes a literal reading which requires mechanical commissioning in: all systems with economizer; all systems in buildings with mechanical equipment cooling capacity more than 480,000 Btu/h (140,690 W); all systems in buildings with mechanical equipment heating capacity greater than 600,000 Btu/h (175,860 W); and all complex systems (which includes all hydronic systems). This means all buildings except those with only very small HVAC equipment exempt from economizer in the simple path are required to be commissioned. This evaluation has assumed 95% of all floor area is required to have mechanical commissioning.

Savings from 2012 SEC HVAC code-driven commissioning is assumed to achieve 25% of the full savings for third-party commissioning as estimated by the NPCC Sixth Plan. These savings are applied to all building types in the size ranges this code provision is applicable to.

A.7 Advanced Metering

The 2012 SEC requires buildings over 20,000 ft2 with at least 10,000 ft2 on the building/owner meters to have an energy meter on each building energy source with hourly ability, 1 year history, and dashboard. Sub-metering is required for HVAC and lighting end uses. Additional sub-metering is required for water heat, plug load, and process where the total load for the end use is greater than 50 kVA. 90.1-2010 has no metering requirements.

Metering equipment is required to record hourly data and have local display or automatically connect to a data acquisition system with local display. Local display systems must be able to record 12 months of data, and data acquisition systems must record 36 months. Almost all buildings over 20,000 ft^2 have some sort of data collection and display systems installed. This code provision requires energy meters to be installed and connect to the EMS, typically requiring four or five data points: pulse output from gas and electric utility meters, and sub-metering for lighting and HVAC. The HVAC could require sub-metering for both gas and electric. Buildings with HVAC components distributed in multiple locations may require additional sub-meters and associated wiring.

Advanced metering saves energy by bringing awareness of and facilitating understanding of energy use patterns. Having meters installed significantly decreases the effort involved in diagnosing high energy use or energy use changes. Advanced metering does not save energy directly. Rather in helps initiate and target energy saving activities that might otherwise not be undertaken for lack of information. From a code perspective, requiring advanced metering is similar to setting a minimum operational efficiency requirement.

Energy savings from metering are highly uncertain. The US Department of Energy (2006, 2010) has published information for federal facilities managers trying to implement federal regulations requiring cost-effective metering. Savings are estimated to be 0%-2% for the “Hawthorne Effect”, 5%-15% for building tune-up, and 15%-45% for continuous commissioning. The Hawthorne effect describes behavior change when the subject knows they are being observed. The DOE recommends that federal facilities use at least 2% savings for evaluating the cost-effectiveness of installing metering (FEMP 2006).

An evaluation of the 2012 Washington State energy code (Kennedy, 2014) estimated savings from a form of advanced metering of 2% of whole building energy use. The WSEC language only requires sub-metering of HVAC loads. SEC metering requirements are more extensive and are assumed to save 3% of whole building electric use and 2% of whole building gas use. The electric savings are assumed to be larger due to the more extensive sub-metering requirements (lighting and plug load).

Metering Energy Savings Ranges – (FEMP 2006)

Action	Observed Savings
Installation of meters	0 to 2% (the "Hawthorne effect")
Bill allocation only	2-1/2 to 5% (improved awareness)
Building tune-up	5 to 15% (improved awareness, and identification of simple O&M improvement)
Continuous Commissioning	15 to 45% (improved awareness, ID simple O&M improvements, project accomplishment, and continuing management attention)

In this report advanced metering and commissioning are both evaluated for their impact on operations. Energy savings claimed in this work for both provisions combined are around 50% of the savings documented in several studies of new and retro-commissioning (Mills, 2009).

A.8 Renewables

The 2012 SEC requires buildings over 5,000 ft^2 to install PV capacity of $70W/1000ft^2$ of building (only counting 5 largest floors) or 240 kBtu of annual solar water heating energy production per 1,000 square feet. Alternatives are allowed including 10% beyond code HVAC equipment or beyond code heat recovery producing the equivalent amount of energy. In addition, buildings are required to be solar ready with extensive requirements.

The installed cost of $0.07W/ft^2$ PV is estimated to be ~$0.46/sf. (Federal tax credits or state incentives may reduce the effective cost.) At this cost it is likely that some projects would opt to install more efficient HVAC equipment. This would be a particularly attractive option for facilities whose primary HVAC is a boiler/chiller combination, heat pumps, or unit heaters which can easily be acquired in higher efficiency increments. Condensing combustion roof top package equipment is still a rarity.

The analysis of this provision assumes photovoltaic cells (PV) are installed in 50% of buildings and more efficient HVAC is installed in the other 50%. The 5 story height limit significantly reduces applicable floor area in the city; the minimum 5,000 ft^2 threshold reduces applicable floor area to a lesser degree. The PV load factor is assumed to be 16% and the area in the first five floors of buildings over 5000 ft^2 is estimated from the NEEA Baseline data. PV generated electricity is treated as savings.

Appendix B. Differences: 2012 Seattle Energy Code to ASHRAE 90.1-2010

The structural and categorization differences between the 2012 Seattle Energy Code (SEC) and ASHRAE 90.1-2010 result in a large number of changes between the codes. The changes involve dropped and diminished requirements in addition to strengthened requirements typical of same-code transitions. An attempt has been made to capture all changes that result in differences in energy use but due to the number of changes, many small aspects may be missing from this compilation. The organization is based upon 2012 SEC section numbers except where no 2012 SEC Section exists. Requirements of the 2012 SEC that are weaker than ASHRAE 90.1-2010 or where 90.1-2010 requirements have no parallel in the 2012 SEC are colored in rose. Areas where the 2012 SEC likely saves energy are marked in green.

Code Changes 2012 SEC to ASHRAE 90-2010				
2012 SEC Chapter 1 Requirements				
Section	**SEC**	**90.1**	**Comment**	**Evaluation Method**
Unconditioned Space Threshold & Treatment	C101.5.2 specifies building with peak heating and/or cooling capacity < 3.4Btu/h-sf as unconditioned and exempts them from envelope requirements.	Chapter 3 defines unconditioned as having <3.4 kBtu/h-sf heat and <5 kBtu/h-sf cool. Exempts these spaces from envelope requirements	Criteria are very similar.E62+E70	Not Evaluated
Change in occupancy or use (F, S, U)	C101.4.4 requires spaces changing from F, S or U occupancies to non-F, S, or U occupancies to comply with code. Allows project envelopes to be 10% above maximum code requirements as calculated using C402.1.3.	No requirement unless envelope changed	Unsure how often F, S, or U space is changed to a non-F, S, or U space. When it does the SEC will have a large impact while 90.1 will only impact envelope items changed.	Not Evaluated
Change in occupancy or use, lighting	C101.4.4 requires spaces changing use in the lighting tables to comply with the lighting code.	No requirement unless lighting is changed	In most cases the lighting will be changed when a space changes in use so this will only impact a small number of projects.	Not Evaluated
Change in space conditioning	C101.4.5 specifies building changing conditioning level from unconditioned to semi-heated or heated and those changing from semi-heated to heated must comply with the entire code. Allows project envelopes to be 10% above maximum code requirements as calculated using C402.1.3.	4.1.1.5 requires buildings changing conditioning level from unconditioned or semi-heated to conditioned to comply with the envelope code. Buildings moving from unconditioned to semi-heated are not required to comply.	90.1 requires unconditioned buildings to be insulated to semi-heat levels so buildings built as unconditioned would comply with the semi-heat requirements anyway. However, a majority of existing unconditioned floor area has not been insulated, therefore SEC is more comprehensive.	Not Evaluated
Miscellaneous Activities Called out.	HVAC equipment changes must comply with alternate economizer table, roofs being reroofed must be insulated.	None	SEC forces projects to comply with code items they might otherwise ignore.	Not Evaluated
Lighting Alterations Triggering Lighting Code	C101.4.3.1 specifies space must meet LPD requirements if 20% or more of the fixtures are replaced or have their lamps plus ballast replaced.	9.1.2 specifies space must meet LPD requirements if 10% or more of the fixtures are replaced or have their lamps plus ballast replaced.	SEC amended state code to move from a 50% threshold to 20%. ASHRAE is very strict in this regard. Number of spaces between the two thresholds is likely small.	Not Evaluated
Historic Buildings	C101.4.2 building official may modify specific requirements for specific buildings	4.2.1.3 exempts historic buildings completely	ASHRAE is very weak here.	Not Evaluated
Unconditioned Space Threshold & Treatment	C101.5.2 specifies building with peak heating and/or cooling capacity < 3.4Btu/h-sf as unconditioned and exempts them from envelope requirements.	Chapter 3 defines unconditioned as having <3.4 kBtu/h-sf heat and <5 kBtu/h-sf cool. Exempts these spaces from envelope requirements	Criteria are very similar.E62+E70	Not Evaluated

Code Changes 2012 SEC to ASHRAE 90-2010				
2012 SEC Chapter 4 Envelop Requirements				
Section	**SEC**	**90.1**	**Comment**	**Evaluation Method**
Opaque Component U-Values	Table C402.1.2	Table 5.5-4	The SEC requirements are substantially stronger for most all opaque components.	Evaluated with other envelope provisions. Code requirements applied to NEEA Baseline buildings and average code heat loss and SHGC modeled.
Fenestration U	2012 SEC Table C402.3 requirements are based upon overall building glazing level, the window frame material, and whether the window are fixed or operable. For buildings with WWR ≤ 30% or WWR ≤ 40% with 50% of floor area in daylight zones the requirements are: non-metal windows: U0.30, metal fixed frame: U0.38, metal operable: U0.40, metal entrance door: U0.60. For WWR up to 40% without 50% of floor area in daylight zone the non-metal windows are: non-metal windows: U0.28, metal fixed frame: U0.34, metal operable: U0.36, metal entrance door: U0.60.	90.1-2010 Table 5.5-4 requirements are based upon window type: Nonmetal U=0.4, Storefront U=0.5, Door U=0.8, Other metal U=0.55	The SEC window requirements are substantially stronger.	Evaluated with other envelope provisions. Code requirements applied to NEEA Baseline buildings and average code heat loss and SHGC modeled.
Fenestration SHGC	2012 SEC Table C402.3 requires vertical fenestration SHGC to be ≤ 0.35, and requires skylight SHGC to be ≤ 0.32.	90.1-2010 Table 5.5-4 requires vertical fenestration SHGC to be ≤ 0.40, and requires minimum skylight SHGC to be between 0.77 and 0.39	The SEC window requirements are substantially stronger.	Evaluated with other envelope provisions. Code requirements applied to NEEA Baseline buildings and average code heat loss and SHGC modeled.
Fenestration Orientation	No Requirement	5.5.4.5 requires East and West glazing to be less than South	Some energy savings here from reduced cooling and somewhat reduced peak load requirements.	Not evaluated.
Continuous Air Barrier	C402.4.1 requires continuous air barrier and air leakage test demonstrating maximum leakage of 0.4 cfm/ft2 at 75PA.	5.4.3.1 requires continuous air barrier but no testing.	Leakage test is generally considered much stronger	Model differing leakage rates.
Vestibule	C402.4.7 requires vestibules on building entrance doors but "not employee doors" if room is > 3000ft2 and building is > 10000ft2 or taller than 3 stories	5.4.3.4. requires vestibules on "building entrance" doors if building > 1000ft2 and on other doors if room is>3000 ft2. Defines building entrances as any doorway to gain access to a building by its users and occupants. Only excludes fire exits from the sound of it.	90.1 has much more stringent language, but with building leak testing required SEC is likely to get vestibules in areas beyond the code minimum.	Not evaluated
Rigid Insulation Rating	C402.1.2 requires foam insulation R-value be determined based upon the long-term thermal resistance (LTTR)	Standard Rating	It looks like industry mostly publishes the LTTR so this likely has no effect.	Not Evaluated

Continuous Rigid Insulation Penetrations	Allows up to 0.04% penetrations for fasteners. If between 0.04% and 0.08% then can comply with alternate requirements that require minimum foam R-values that are ~25% higher. Above 0.08% penetration then not considered continuous.	Allows up to 1% penetrations on roof. No mention for walls.	Limits which fastening systems can be used. Will increase insulation quality though marginal savings in highly insulated components are small. Calculated heat loss rates assume insulation is truly continuous.	Not Evaluated
Threshold for Semi-heated	C402.1.4: hcap<8Btu/sf and not cooled.	heated cap<=15 Btuh/hr-sf & cooling cap <=5Btuh/sf	90.1 allows a much wider range to projects to qualify as semi-heated. Some retail warehouse stores might qualify.	Evaluated as part of Envelope
Treatment for Semi-heated	C402.1.4 exempts walls from insulation requirements.	Table 5.5-4 has lower opaque requirements for all components, R0 mass walls, and single glazing.	90.1 is much more lenient except for very small framed buildings where the 90.1 requirement to insulate frame walls might be better than the SEC requires.	Evaluated as part of Envelope
Street Level Retail Glazing Allowance	C402.3.1 allows WWR up to 75% for street level retail wall up to 20' tall. This is extra glazing beyond the standard 30% allowance.	5.5.4.4.1 Exempts from SHGC if WWR less than 75% of retail wall below 20'- not tradable.	SEC allows more glass. For downtown areas the total added glass is small. Other retail typically does not exceed normal glazing limits.	Not evaluated
Minimum Skylight Requirements	C402.3.2 requires skylights in rooms >10000sf with >15ft ceiling height within single story buildings	5.5.4.2.3 requires skylights in rooms > 5000sf which are under a roof with a ceiling height >15' and in a building less than 5 stories tall.	90.1 requires skylights in smaller rooms and in more buildings (up to 4 stories rather than limited to 1). Number of rooms between thresholds is very small portion.	Not evaluated
Refrigerated Walk-in Storage Boxes	C402.5. Frozen-R32 wall, ceiling, door & R 28 floor. Refrigerated-R25 wall, ceiling & door.	No special requirements so if covered would have typical building insulation values	SEC considerably better but very small number of applicable spaces in the city.	Not evaluated
Refrigerated Warehouse Insulation	C402.6. Frozen-R38 wall, ceiling, door & R 28 floor. Refrigerated-R38 wall, ceiling & door.	No special requirements so if covered would have typical building insulation values	SEC considerably better but very small number of applicable spaces in the city.	Not evaluated

Code Changes 2012 SEC to ASHRAE 90-2010				
2012 SEC Chapter 4 Mechanical System Requirements				
Section	**SEC**	**90.1**	**Comment**	**Evaluation Method**
Modulation or Stage combustion	C403.2.3 requires unit heaters over 225 kBtuh and boilers over 500 kBtuh to have modulating burner or to be staged	No requirements	Modulation is good. Savings heavily dependent upon particulars. In larger sizes, may not be possible to even buy non-modulating equipment.	Not evaluated
Limit on Air Cooled Chiller Cap	C403.2.3: If plant or building chilled water >500 tons the max air cooled is 100 tons unless air cooled chiller is 10% higher eff	No requirements	Very small number of projects meet requirement and then only a small portion of the total chilling capacity is air cooled. Easy to evaluate as part of equipment efficiency.	Evaluated. Code requirements applied to NEEA Baseline buildings and average code EER for each code.
VFD Drives	C403.4.2: required on VAV fan motors>= 5 hp with variable loads. C403.2.12 requires VSD on ALL motors>=5hp driving fans or pumps no matter the load unless package equipment without option. C403.2.12 limits the VFD requirement for cooling towers to those serving "comfort cooling".	6.5.3.2.1 requires VSD on VAV fan motors>=10hp, 6.5.4.1 requires them on chilled water pump motors over 5hp (unless less than 4 control valves). 6.5.5.2 requires multi-speed or VFD for cooling tower fans > 7.5hp	There are only a small number of motors between the differing code size thresholds for variable flow systems so the lower SEC threshold will have a minor impact. The SEC also requires VFD in non-variable volume systems. This will lead to significant savings where air flow is adjusted down during the test and balance phase, but where no adjustment is made the usage will be slightly increased. The SEC cooling tower exception for non-comfort cooling applications will erode savings. SEC likely to have positive savings here but savings for this are very hard to determine.	Not Evaluated
Economizer	C403.3.1 and C403.4.1 require air economizer on most equipment. Air handling equipment >33,000 Btuh must have economizer, DX and chiller water equipment below 33,000Btuh can avoid an economizer if they are 15% and 25% more efficient, respectively, with a total capacity without economizer of 72,000 Btuh and 240,000 Btuh. Up to 500 tons of water economizer is allowed for chilled beams.	6.5.1 requires air or water economizer in all fan coils >54,000Btuh with no limit on capacity without economizer.	SEC is much more aggressive. Significant quantities of equipment in the 33 kBtu to 54 kBtu range and also a fair number of projects with more than 72 kBtu of less than 33 kBtu equipment. Modeled as adding economizer for all but water source heat pumps where are assumed to follow water source heat pump path that requires heat pumps to be 15% better.	Evaluated
Economizer Group R	Unlimited capacity exempt if efficiency is 15% better than minimum and "cooling unit" capacity < 20,000 Btuh (or 54000 Btuh for units not adjacent to the outdoors)	systems with capacity < 23tons	SEC will achieve significant efficiency gains in lodging and high rise residential sector.	Evaluated in Lodging.
Systems with condenser heat recovery.	Not exempt though have special paths for heat pump loop and VRF systems	Exempts all.	SEC extracts increased minimum efficiency for water source heat pumps, but otherwise requiring economizer is not likely to save much if any energy in these systems.	Not Evaluated

Economizer Computer Room	Exempts up to the larger of 20 tons or 10% of computer room cooling if 1) equipment is listed in package DX minimum efficiency tables and is 15% more efficient than the minimum efficiency, or 2) DX equipment with water side economizer and 5% better eff, or 3) Std 127 rated equipment with waterside economizer.	Exempts computer room HVAC where total CR load in building is < 250 tons and not served by central plant, the room design load is < 50 tons and there is a central plant.	SEC is significantly tougher. In typical rooms SEC will extract some added efficiency from the required efficiency premium and water side economizer requirements. In larger rooms where Seattle would require economizer and 90.1 wouldn't, there will be huge savings. Very hard to determine applicability. Floor area is small but savings are potentially large.	Not Evaluated.
Fraction HP Motor Efficiency	C403.2.13 requires ECM motors in series terminals, C403.2.10.3 requires ECM or 70% for all fractional hp motors except those in the airstream in heating only units or for operation only during heating and those in rated equipment.	No requirements	SEC has large advantage here. Main application will be series fan powered VAV terminals (very common in Seattle), hydronic fan coils (schools and hotels), and exhaust fans.	Partially Evaluated
Single Zone VAV	C403.2.12.2 requires single or multiple fan systems serving a zone with total supply > 10000 CFM to have vfd to reduce flow to 75% of peak or have designated cooling units that shut fans off in non-peak cooling conditions, or DOAS with HR. C403.3.2 All AHU/FC unit with chilled water cooling and SF motors >=5hp shall have 2-speed or VSD control to 50% when cooling <50%. All DX equip. with cap>110kBtu shall have controls to reduce air flow to 67% at 50% cooling.	6.4.3.10 All AHU/FC unit with chilled water cooling and SF motors >=5hp shall have 2-speed or VSD control to 50% when cooling <50%. All DX equip. with cap>110kBtu shall have controls to reduce air flow to 67% at 50% cooling.	SEC C403.3.2 and 90.1 6.4.3.10 requirements are identical. The SEC C403.2.12.2 requirement is significantly overlapped here. Impact will be limited to rooms with more than 25 tons of cooling from units of <110kBtu capacity which will have to make some changes – likely installing larger equipment that will come with the proper controls. Impact of addition provision is small.	Not Evaluated
Air System Heat Recovery	C403.2.6.1: any system with outdoor air flow > 5000cfm outside air but exempts cold deck systems unless min OA >70%. Also, exempts labs with VAV all around, systems serving spaces with <60F setpoints, and type 1 kitchen exhaust hoods. A key additional requirement is that for rooms or spaces served by multiple units, the threshold will be combined outside air flow.	any system with supply air flow >5000cfm with >70%OA for zones 4C and 5B. Exempts labs & fume hoods & the possible huge swath "where the largest exhaust source is less than 75% of the design outdoor flow."	SEC requires all non-"cold deck" systems with 5000 CFM of OA to have heat recovery. 90.1 has a slightly expanded requirement that will required HR is based upon supply cfm. A 5000 CFM system with 70% OA will have an OS flow of 3500 CFM. This are very few systems captured in this range. The primary difference is the SEC requirement that does not set a percent OA threshold and applies the combined flows to determine the requirement when multiple systems serve a single room. Box retail and warehouse will likely have to have Heat recovery.	Not Evaluated
Grocery HR	C403.4.6 If facility has food service and > 500kBtu remote refrigeration then HR required. If facility > 40000sf and > 1000kBtu remote refrigeration then HR to space and water required.	requires 24hr facilities with heat rejection cap greater than 6mmBtu, and h2o heating capacity greater than 1mmBtu.	SEC has large impact on grocery though the smaller store requirement for HR is likely met in most current practice with Ref to DHW HR The larger store requirement is a big deal though new grocery construction in the city is small.	Evaluate
Condenser HR	C403.4.6 requires HR if 24hr facility with water cooled system heat rejection > 1500 kBtuh and design service hot water loads > 250kBtuh	requires 24hr facilities with heat rejection cap greater than 6mmBtu, and h2o heating capacity greater than 1mmBtu.	SEC has smaller thresholds for this measure. Hospitals are main target here and SEC language will impact smaller facilities which are not so common in Seattle. Unsure how much additional floor area will be required to have HR.	Not Evaluated
Steam Condensate HR	C403.2.6.2: must return or have HR	No requirement	This SEC requirement is unlikely to have impact in completely new facilities but probably has some effect in remodel activities.	Not Evaluated

Steam Condensate HR	C403.2.6.2: must return or have HR	No requirement	This SEC requirement is unlikely to have impact in completely new facilities but probably has some effect in remodel activities.	Not Evaluated
Duct Leak Testing	C403.2.7.3.3 requires high pressure ducts (sp>3") to be tested and have a leakage class of 6. Leak testing also required for all ductwork outside the building envelope of small residential style buildings are likely impacted make this more stringent than 90.1-2010 and state code for that group.	Requires high pressure ducts to be tested to a leakage class of 4	SEC allows 50% more leakage than 90.1-2010 in high pressure ducts. The leak testing of ductwork outside the heated envelope is good but likely impacts a small number of projects as exterior duct work is uncommon in commercial buildings.	Not Evaluated
Hydronic Loop Design	C403.4.3.4: Hydronic loops >3 HP providing heated or chilled water for comfort conditioning are required to be designed for variable flow with capability to reduce flow by 50%. Condenser water systems not included.	6.5.4.1. Loops with bhp>10 and step control values shall be designed for variable flow. Totally exempts systems with 3 or less control valves and systems with total hp<75 with equipment required minimum flow > 50%.	SEC requires all hot and chilled water loops to be designed for variable flow. This combined with the VFD requirement on 5hp motors will lead to savings. Difficult to quantify the impacted floor area.	Not evaluated.
Heatpump Controls	C403.2.4.1.1: Thermostat must minimize auxiliary on startup. Must also have outdoor temperature lock out above 32F.	Thermostat must minimize Auxiliary on startup & set up but equipment <=65kBtu exempted	SEC requirements are much better. Floor area served by small air source heat pumps is limited. May have larger impact in retrofit if enforced at equipment replacement.	Not Evaluated
Supply Air Temperature Reset	C403.4.5.4: required in complex multizone systems	6.5.3.4 required in multizone systems. Design air to zones expected to have relatively constant loads must be sized using the reset temperature.	90.1 requirement that sizing be done assuming temperature reset is important though applicability is difficult to assess since the application is left up to the practitioner. Likely fairly limited number of zones and systems.	Not Evaluated.
Optimum Start	C403.2.4.3.3 requires optimum start for all systems.	Optimum start is limited to systems with supply air flow greater than 10,000 cfm	Optimum start saves energy by automatically adjusting the system start up time so the space is just warm when the thermostat indicates the space is occupied. The alternative is setting the thermostat to warm the space a fixed number of hours ahead of time. Savings are small and dependent upon the assumption of the amount of lead time required in the baseline. Also, optimum start is common in programmable thermostats that commonly small equipment so baseline saturation of this control reduces savings.	Not Evaluated
0% OA during night cycle	C403.2.4.4. Required.	6.4.3.4.2 required but if OA CFM>300	SEC is stronger here. Lots of smaller package equipment impacted. Savings are small and mostly gas.	Not Evaluated
OS control of HVAC	C403.2.5.2. Requires OS control of OA dampers (or system operation) in classrooms, gyms, auditoriums, and conference rooms > 500 SF. Exempts spaces with some other way to reduce outdoor air flow based upon occupancy (CO2).	No requirements	SEC is much stronger here. Saves energy for the same reasons OS control of lighting saves energy. Mechanism will vary from direct damper control to simply turning single zone equipment on and off. These space types, except classrooms with single zone systems, are also required to have DCV control of OA. So savings will be somewhat limited for those systems that only control the damper. Where the system fan is also shut off there will still be large savings.	Evaluated

DCV	C403.2.5.1 requires DCV in spaces >500SF with occ density>=25 per 1000sf with systems having economizer or OA >3000cfm. Exempt are: systems with ERV, multizone systems without zone level DDC; systems with design OA<1000CFM, systems with net supply <1200CFM	6.4.3.9 required in spaces >500SF with occ density>40 per 1000sf with systems having econo or OA >3000cfm. Exempt are: multizone systems without zone level DDC; systems with design OA<1200CFM, systems with net supply <1200CFM and spaces with HR	Space types covered by SEC but not by 90.1 include school class rooms for age 9 and above, office reception areas, health club aerobics and weight rooms, museums, mall concourses, bowling alleys, and correctional facility day rooms. The combination of the system outdoor air and multizone DDC exceptions limits applicability to spaces served by large single zone equipment (~>10tons) and to spaces served by multizone systems with DDC. Likely very low applicability, mostly middle and high schools with central VAV air handlers.	Evaluated
VAV OA Measurement	C403.2.10.5 required except if no spaces required DCV or if fan powered vav. Will require OA measurement if DCV required or fanless VAV even if system does not have zone DDC - BUT to implement this DDC is more or less required.	No requirements	Fairly common and is more of less required by requirement in both codes to reset minimum air flows based upon the ventilation efficiency.	Not Evaluated
VAV Turndown Criteria for Reheat	C403.4.5. Maximum of 30%, or 300CFM if <10% of system flow, minimum IMC ventilation rate, or flow rates required by applicable health and safety codes - but doesn't mention pressure.	6.5.2.1: Maximum of 30% of design flow, OR maximum of 20% in dead band with up to 50% at maximum heat. Allows over 30% where flow required 62.1 or by health and safety codes.	Very similar path except where small zones (<1000CFM) are allowed in SEC to be more than 30%. Alternate “reversible action” VAV terminal provision in 90.1 is likely more efficient than 30% criteria	Not Evaluated
VAV Turndown Pressurization Exception	C403.4.5 allows minimum flow to be larger than 30% as "required by applicable codes or standards for occupant health and safety".	6.5.2.1 allows minimum flow over 30% where flow required "to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates."	Similar language. Both better than IECC which simply exempts spaces with pressure relationships from variable operation. Really depends upon enforcement. If designers say 100% flow is required to maintain pressure relationships and the Seattle language is interpreted to not include pressure relationships then this is big difference in hospital/lab heavy Seattle. I would interpret both to have the same impact.	Not Evaluated.
Parking Garage Vent	C403.2.5.3 requires loading docks, motor vehicle repair garages, and parking garages to have gas sensor or occupant detection controls. Gas sensor with staged or modulating fan required if >8,000 CFM	6.4.3.4.5 requires enclosed parking garages to have gas sensor controlled 50% staging or modulation if >30,000SF and vent motor HP > 0.667 HP per 1000SF	SEC requires gas sensor control in garages larger than 10,000ft2 so impacts many more areas and also garages below the 90.1 fan power limit. If looking at garages in isolation this is a huge measure. For whole building it is less important.	Not Evaluated
Motorized Dampers	C402.4.5.2 requires motorized dampers for most opening types in all systems in all buildings. Exceptions for type 1 grease hoods exhaust, combustion air intakes, continuous operation and for "relief, outside air and exhaust openings” in building if equipment has less than 300CFM total supply flow!	Motorized inlet dampers required. Motorized relief dampers required in buildings over 2 stories if OA is > 300CFM	Code language is very different but equipment impacted by these requirements is manufactured and generally comes the way it comes. 90.1 allowing non-motorized dampers in many situations has little impact because economizer requirements cause most outdoor air dampers to be mechanical. For relief air, mechanical dampers are never installed, it is not clear this is an option in much equipment, and the impact of motorized over barometric is very unclear. Main impact is likely increase in infiltration when unit is not running. SEC language may not be realistic.	Not Evaluated.
Isolation Zone	No requirements	6.4.3.3.4 requires zone isolation capability in intended to operate non-simultaneously. Exempts zones intended for 24 hour ops or intended to operate when the rest of the building does.	90.1 is great, it might have captured the radio room in city hall, but most buildings that intend to do this likely have separate systems or dampers. Limited applicability as specified.	Not Evaluated.

Heating Unenclosed Spaces	C403.2.11 requires radiant with OS or time switch control	6.5.8.1 Requires radiant	SEC control requirement is great addition for most applications. Limited applicability.	Not Evaluated
Hotel / Motel Guest Room Controls	C403.2.4.7 requires lodges with more than 50 guest rooms to have automatic setback required via door entry or OS	No requirements	Great measure.	Evaluated
Heat Pump required	C403.2.3.3 requires heat pump heating in package/split electric heat/cool unit with DX>20kBtuh OR "cooling only equipment with electric heat in the main supply duct before VAV boxes"	No requirements	Fairly unusual	Not Evaluated
Refrigerated Walk-in Storage Box Fans	C403.5: Evaporator fan motors < 1HP must be ECM or 3ph, condenser fan motors <hp must be ECM, PSC, or 3ph.	No special requirements so if covered would have typical building insulation values	SEC considerably better but change from standard practice may be small and fan energy use while important, is small relative to overall consumption.	Not Evaluated
Refrigerated Walk-in Storage Box Controls	C403.5: anti-sweat heaters shall be <= 7.1W/SF of walk-in freezer door and <= 3W / SF of walk-in cooler door, or shall have controls to limit heater operation based upon room RH or condensation on inner pane.	No special requirements so if covered would have typical building insulation values	SEC considerably better but may not be change from standard practice. Not sure what baseline condition should be used.	Not evaluated
Refrigerated Warehouse Fans and Controls	C403.6 evaporator motors<1hp shall be ECM or 3ph and have variable speed control. Condenser fan < 1hp shall be ecm, PSC, or 3ph. Compressor must be designed for minimum condensing temp of 70F. Compressor > 50hp must be variable speed or staged.	No special requirements so if covered would have typical building insulation values	SEC considerably better but very small number of spaces in the city and change from standard practice may be small.	Not evaluated
Test and balance of air and water systems	C408.2.2: requires TAB on air and water systems and test port on pumps except where HVAC commissioning is exempt. (heating only spaces < ~30000SF). Requires air and water be balance to minimize throttling losses	6.7.2.3 requires TAB everywhere. Requires written TAB report for systems serving >5000SF. Requires air and water be balance to minimize throttling losses.	90.1 is more complete and should lead to outdoor air being better controlled in smaller, simple buildings but savings uncertain. Could be more or less efficient.	Not Evaluated
Mechanical System Commis-sioning	C408.2 Required for HVAC systems and controls if system has economizer, and qualifies as a simple system with heating capacity > =600kBtu or cooling cap > =40 tons. Also required for buildings where largest DHW system is >= 200,000Btu/h. Commissioning plan and report required.	6.7.2.4 requires testing for ALL HVAC and controls but provides no details. For projects >50,000SF (not warehouse or semi-heated) designer must provide detailed instructions for commissioning HVAC in the plans and specs.	Hard to compare. 90.1 requires systems to be tested and requires a plan in buildings > 50000SF. SEC does not require testing in small economizerless buildings but where it does require commissioning it requires plan and reports and it elucidates reporting requirements. SEC also sets up a commissioning permit to insure tests and report are completed	Evaluated

Code Changes 2012 SEC to ASHRAE 90-2010				
2012 SEC Chapter 4 DHW & Pool Requirements				
Section	**SEC**	**90.1**	**Comment**	**Evaluation Method**
DHW Additional Tank Insulation	C404.5 requires electric tanks to be placed on R10 pad.	No requirements	Good provision though energy savings are limited	Not Evaluated
DHW Circulation/Heat Tape Controls	C404.8 requires manual or automatic controls	7.4.4.2 requires automatic time switches or other controls (implies automatic). 7.4.4.4 limits pump operation between heater and storage to time that heater is on.	90.1 requirement for automatic control is much better though energy savings highly dependent upon the details of the control. Savings likely small.	Not Evaluated
Pool Heat Fuel	C404.10.1 bans electric resistance heat in pools over 2000 gallons. (~100ft2 assuming 3 feet deep.)	No requirements	Good provision but size threshold eliminates many pools in lodging sector leaving small applicable population. Also electric resistance heat would be crazy so likely not much of a change from standard practice.	Not Evaluated
Pool Insulation	C404.10.3 requires pools over 90F to have R12 sides and bottom.	No requirements	Good measure with impacts in lodging and assembly.	Not Evaluated
Pool Heat Recovery	C404.10.4 requires exhaust air heat recovery in spaces with pools > 200ft2.	No requirements	Very good measure but size threshold eliminates many pools in lodging section leaving small applicable population. In larger pools this is likely standard practice	Not Evaluated
DHW System Commissioning	C408.3. Required for all pool and in ground spas, and all service water heating systems in buildings where the largest service water heating system has a capacity greater than 200,000 Btu/h.	No Requirements		Evaluated

Code Changes 2012 SEC to ASHRAE 90-2010				
2012 SEC Chapter 4 Lighting System Requirements				
Section	**SEC**	**90.1**	**Comment**	**Evaluation Method**
Maximum Lighting Power Allowance – Building-area Method	SEC building area maximum lighting power allowances are the same or lower than 90.1		Lighting power can optionally comply with the building area or space-by-space. 90.1 levels for these two paths were calculated for a particular suite of buildings and so can be considered equivalent for the average building. The SEC building values are better but it has adopted the 90.1 space-by-space values. It is assumed that buildings not complying with the SEC building area values will explore space-by-space compliance before changing the lighting. Therefor the better building-area values are for not.	Not evaluated. (see Appendix A lighting power discussion)
Maximum Lighting Power Allowance – Space by space Method	SEC space-by-space allowances are the same as 90.1 except for allowing 500 watts more display light per building. However, 90.1 allowed adjustments for room-cavity ratio (RCR) are not included.		It is assumed that buildings not complying with the space-by-space method will explore other calculation options before changing the lighting system. One option in 90.1 is to use room-cavity ratio adjustment to increase space-by-space allowances up to 20%. Generally this is limited to rooms that are smaller than assumed in the models used to set the code lighting power limits. The SEC does not allow RCR adjustment. The other option is to try building area method where the SEC is more aggressive. The display light allowance difference is trivial. Will assume a small increase in average allowed light for the RCR adjustments	Not Evaluated (see Appendix A lighting power discussion)
Group R	Exempts dwelling units from all requirements provided 75% of permanent fixtures have high efficacy lamps.	No requirements – all dwelling unit lighting exempt from all requirements	SEC language is much more aggressive but impact may be very limited. Dwelling units typically do not have extensive permanent lighting on the assumption occupants will utilize plug-in lighting. Also, with the new federal lighting standards, high efficacy lamps may be the least cost option. The only lamp that might be an issue is MR16 down lighting which might be somewhat common in high end.	Not Evaluated
Industrial	Exempts general area lighting power in industrial and manufacturing occupancies dedicated to the inspection or quality control of goods and products from power requirements and industrial or manufacturing process areas, as may be required for production and safety from control requirements.	Mostly not exempt though have exceptions to automatic off controls for if they endanger safety.	Major weakness in SEC (and state code). Many manufacturers may claim they inspect at every step in the process and claim the whole space as exempt. Applicability depends upon what DPD accepts as spaces needing light for inspection or quality control. May be hard to estimate floor area that would qualify for this, and significant uncertainty about how much less light will be driven by this. Old code had ceiling height adjustment which allowed significantly more light in places like aircraft manufacturing facilities. New code does not have this adjustment.	Not Evaluated

Professional sports	Exempts professional sport arena - field lighting but not audience areas.	No exemptions but allows lots of light.	Small applicability. 90.1 allowance levels are ample so likely no real change in the allowed lighting.	Not evaluated
Egress			Very hard to characterize and compare the codes. There are differences. Applicability depends upon a complicated overlap of emergency, egress, lights required for safety, and light required to have 24 hour operation.	Not evaluated
Exterior Lighting	Implements same table as 90.1 except highest allowance column for "high activity commercial districts in major metropolitan area".	Implements table establishing 4 lighting zones with allowances for various lighting types. Each zone is for a different exterior lighting environment from zone 1 (developed areas in national parks) to zone 4 (heavy activity commercial districts in major metropolitan areas) and has a different allowance for a given type of light, higher allowances for the higher zones.	Odd comparison as 90.1 allows the jurisdiction to choose whether a building is located in a zone 4 area or not, so the SEC choice can be seen as just complying with 90.1. However, most cities the size of Seattle would likely use lighting zone 4 allowances in most commercial areas, therefore the SEC change is significant. However there is uncertainty about the baseline and whether current lighting levels are above the new code zone 3 allowances.	Not evaluated
Automatic Control Startup	C405.2.2.2 requires manual or up to 50% automatic on for lighting required to be controlled by occupancy sensor. Lobbies, public corridors & restrooms are exempt.	9.4.1 requires manual or up to 50% automatic on for all lighting except lobbies, public corridors & restrooms	SEC limit on manual or partial-on startup to OS control is major oversight. Lighting controlled with sweep controls will not have to be manual on.	Evaluated
Occupancy Sensor	C405.2.2.2: required in ALL classrooms, meeting, conference, lunch, break rooms, private offices, restrooms, warehouse spaces, storage rooms and other enclosed spaces <300sf.	9.4.1.2 required in all class, conference, meeting, copy, rest, dressing, locker, & break rooms, and offices <250sf, storage rooms >50sf & <1000sf.	SEC list of spaces requiring OS control is more extensive, most notably requiring OS control in warehouses.	Evaluate
Supplemental Task Light Controls	C405.2.3, item 4: OS and wall mounted switch	must be switched, either integral or on wall	SEC requirement of OS control is great though how exactly code impacts task lighting is a bit unclear	Not evaluated
Side Day Light Controls	C405.2.2.3: Required in Primary and Secondary daylight zones but exempts restaurant dining and retail sales spaces adjacent to sidewalks.	9.4.1.4 requires automatic multi-level control of primary daylighting zone only. Exempts enclosed spaces with primary daylight zone area < 250sf, spaces with an effective aperture less than10%, retail areas, and where the top of existing adjacent structures are twice as high above the windows as their distance away from the windows.	SEC requires daylight controls in the secondary daylight control zone and in small spaces.	Evaluated
Daylight Control Dimming Minimum Power	SEC requires step dimming to off or continuous dimming to 20%.	90.1 requires step dimming to 35% or continuous dimming to 35%.	SEC has better requirement for continuous dimming though unclear there are many control choices between the two minimum power levels. For step dimming the better code depends upon configuration.	Not Evaluated
Guest Room Lighting	C405.2.3: requires each room to have master switch. If rooms>50 then must have automatic control to turn all lights and switched outlets are off.	requires each room to have master switch and automatic off of bathroom light except 5W night light	90.1 allowance for a 5W night light will allow a reduction in bathroom light use. SEC requirement for automatic control is big step though applicable only to small percentage of overall Seattle new floor area. Savings in comparison to 90.1 limited to small degree by the OS requirement for the bathroom light and master switch by door.	Not Evaluated

Parking Garage lighting control	C405.2.3, item 9 requires automatic shutdown but likely would be claimed to be hazardous so next control requires OS to reducing lighting 30%	9.4.1.3 requires automatic shutdown but likely would be claimed to be hazardous so next control requires OS to reducing lighting 30% unless lamps are HID < 150watts or induction.	SEC does not limit lamp type. HID is less common in new garages so most of the time the two codes will be the same	Not Evaluated
Exterior Lighting Controls	C405.2.4: lighting not designated dusk to dawn shall have photocell + time switch OR astronomic time clock. Dusk to dawn, astronomic time switch or photocell. Building façade must be off from 12am-6am and other lighting must be reduced by 30% - allowance is made for building open for longer hours	Automatic time switching or photocell with night off schedule.	SEC gets detailed about the night off schedule. Likely results in some energy savings as features of the control system have to actually be implemented. Average baseline operation is extremely uncertain.	Not Evaluated.
Luminaire Wattage Determinations for Ballasted Fixtures	C405.5.1.3: wattage of lighting equipment	Wattage for maximum lamp. Does allow the use of the selected ballast factor for ballasts that allow that (as long as users can't select the ballast factor).	Many fluorescent fixtures can accommodate a range of lamps. By allowing lighting power to be calculated using the installed lamp rather than the maximum lamp, the SEC is increasing the amount of allowed light. Very difficult to quantify, could be 5 or 10% reduction in lighting budget but if people are running afoul of the LPD limits they might try to find a fixture is more tailored to the wattage they are trying to deliver which would not result in savings.	Not Evaluated (see Appendix A lighting power discussion).
Walk-in Cooler and Freezer Lighting	C405.10: requirement for lighting to have 40+ lumens per watt or to have 15 minute timer or OS	No requirements unless enforced as storage area	Lighting is mostly off so change in efficacy if of limited use. Timer control is more important, though for situations where the lighting is turned off regularly a time switch would increase the number of hours on. Very small applicable floor area.	Not Evaluated
Lighting Commissioning	C408.3 functional testing required unless light system <20kW and light with OS or daylight controls is < 10kW. Also, requires commissioning plan and report.	9.4.4 Functional testing of all lighting control devices required to confirm placement, sensitivity, adjustment, and operation of automatic controls. Requires documentation "specific enough to verify conformance" but no requirements for general commissioning report.	Hard to compare. 90.1 requires all lighting systems to be tested. SEC elucidates reporting requirements.	Not Evaluated

Code Changes 2012 SEC to ASHRAE 90-2010				
2012 SEC Chapter 4 Other Requirements				
Section	**SEC**	**90.1**	**Comment**	**Evaluation Method**
DDC Required	C403.2.4.10: DDC capabilities (trending, demand response set point adjustment) required for all buildings with total cooling capacity > 780kBtu	No requirements	Most buildings in this class will already have a DDC system though may not have the demand response. For anyone without DDC this will force issue – likely a small number of projects.	Not Evaluated
Whole building metering	C409.1 requires buildings over 20,000ft2 with at least 10,000ft2 on the building/owner meters to have an energy meter on each building energy source with hourly ability, 3 year history, and dashboard.	No provisions	Metering savings are very uncertain. Will be estimated as a percent of whole building use. All metering provisions evaluated together.	Evaluated
Sub-metering	C409.3 requires submetering of HVAC (excluding 120v and 208/120 when main service is 480/277) and lighting energy use, and also water heat, plug load, or process end uses when the building power provided for the particular end use is >50kVA.	No provisions	Metering savings are very uncertain. Will be estimated as a percent of whole building use. All metering provisions evaluated together.	Evaluated
Escalators	C405.12: requires variable speed or power factor control voltage escalators. Must have regenerative ability if down only or reversible.	No requirements	Good provision but small number of impacted units	Not Evaluated
Compressed Air	C403.7 requires no loss drains and bans timed unheated desiccant air driers. Requires rotary screw air compressors to not rely on modulation control and to have VSD, ample receiver, or staged compressors with VSD, or ample receiver on lead unit.	No requirements	Good provision but small number of impacted units	Not Evaluated
Commercial Cooking Equipment	C403.8 requires energy star label for commercial fryers, hot food holding cabinets, steam cookers, and dishwashers	No requirements	Good provision but small amount of floor area impacted though very significant within restaurant and possibly grocery.	Evaluated
Automatic Receptacle Shutoff	C405.14 Sweep or OS control required for at least 50% of all 15A and 20A receptacles in offices and classrooms. Includes those in partitions. Must be located within 72inches of each uncontrolled fixture.	8.4.2 Sweep or OS control required for at least 50% of all 15A and 20A receptacles in offices and computer classrooms. Includes those in partitions.	Very similar. SEC location language is good improvement.	Not Evaluated
On-site Renewable	C410 requires PV capacity of 70W/1000ft2 of building (only counting 5 largest floors). Exempts buildings with HVAC 10% more efficient than otherwise required, but uses standard reference systems rather than the installed system as the base efficiency for heat pumps is pretty easy. HR is allowed if shown to be equivalent savings.	No requirements	Small savings but impacts all buildings	Evaluated
Wire Sizing	No requirements	8.4.1 requires maximum voltage drop of 2% across feeders and 3% across branches.	Uncertain of baseline here. Appears to be standard practice.	Not Evaluated