Supporting analysis for proposed changes to the commercial provisions of the 2012 IECC: Reduce Threshold for Toplit Daylighting Area

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Proposal Description

This proposal modifies Section C402.3.2 of the 2012 IECC for the 2015 version. It reduces the area threshold for skylight daylit zones from 10,000 square feet to 2,000 square feet. It maintains 15 foot ceiling height requirement and the exception for climate zones 6 through 8.

Energy Impact

Based on average national energy prices[1] of $0.99 per therm and $0.1032 per kWh, the net savings are calculated with EnergyPlus™[2] from whole building energy savings that result from reduced lighting, and depending on climate zone, increased or decreased heating and cooling. The annual savings for gas, electric, and total is shown in Figure 1 by climate zone.

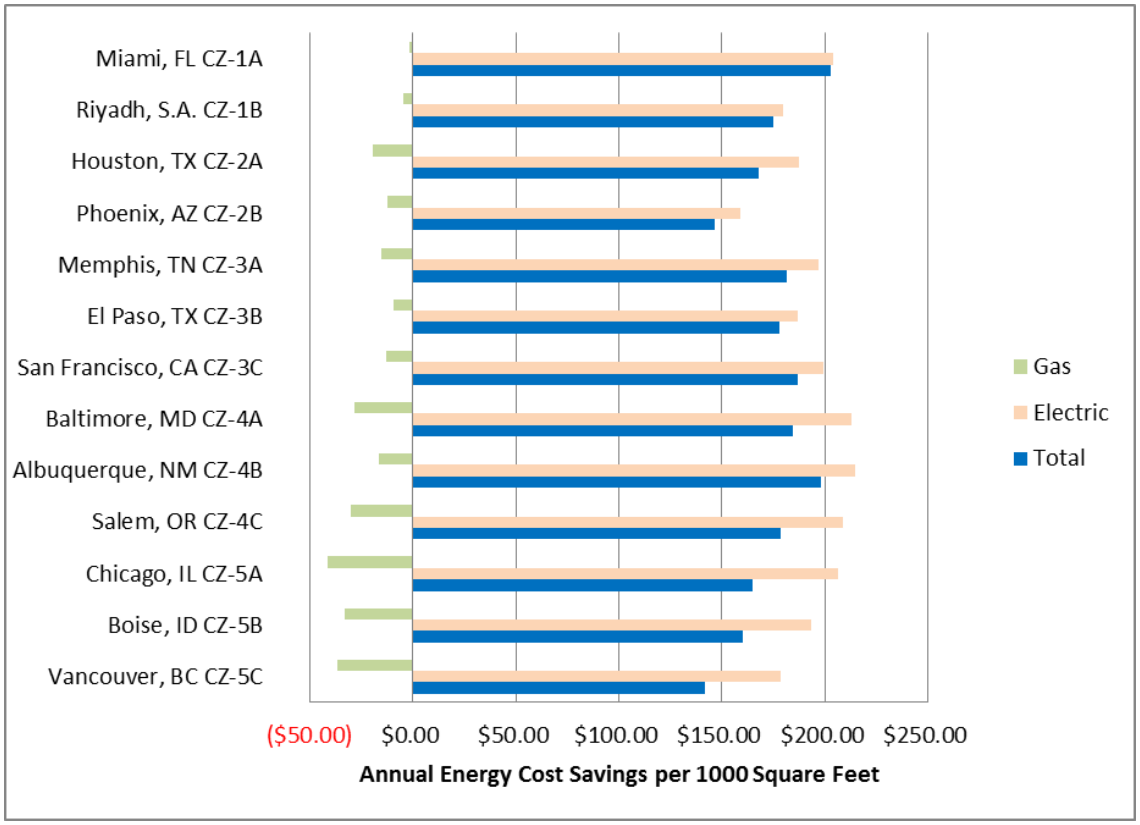

Figure 1: Annual Energy Cost Savings per Skylight with Daylighting Controls

Based on this analysis, there is demonstrated savings from skylights with daylighting controls in climate zones 1 to 5.

Basis for Analysis

PNNL conducted the analysis for this requirement using the Retail Standalone prototype building. This prototype includes both retail floor space and warehousing areas with an average lighting power density of 1.1 watts per square foot. Building parameters are based on 2012 IECC. The prototypes have been developed by PNNL to represent a typical building with typical

[1] Weighted commercial national average energy prices developed by the ASHRAE 90.1 standards committee for analysis of 90.1-2013 proposals; based on national data from the 2011 *Annual Energy Outlook* by US Energy Information Administration. www.eia.gov.
[2] EnergyPlus is an advanced building simulation model. More information online at: http://apps1.eere.energy.gov/buildings/energyplus/

loading profiles where savings measures are applied. The prototypes and parameters are documented at www.energycodes.gov.[3]

Gas heating and electric cooling has unitary equipment meeting minimum efficiency under 2012 IECC.

The savings is an average for the retail space of both sales and storage areas and is based on 1000 square feet of daylight controlled area. With the limit in SectionC402.3.2 reduced to 2000 square feet, for the minimum qualifying area, 1000 square feet of skylit and daylight controlled area would be required.

A single 4 foot by 4 foot skylight at 15 feet height can daylight 1156 square feet, so the cost was based on a single skylight and controls for daylighting a 1000 square foot area. The incremental skylight cost and wiring cost was estimated at $1400 with a 40 year life. The incremental controls for a multi-level (100%, 67%, 33%) daylight switching arrangement was estimated at $600 with a 15 year life. Skylight and photocontrol costs were compiled from online retailers. RS Means 2012 was used to gather other cost data. The component lives are based on consensus from the ASHRAE Envelope and Lighting Subcommittees.

Cost Effectiveness

Two different cost effectiveness techniques are applied:

- The ASHRAE 90.1 committee scalar method uses the economic factors to arrive at a discounted threshold or target simple payback based on the measure life. If the calculated simple payback is less than this target, it is deemed to be cost effective. This method accounts for tax impacts and uses a discount rate appropriate to commercial and private industry owners.
- The DOE/FEMP method uses an institutionally oriented discount rate to determine the net present value (NPV) for a particular measure. The discount rate considers the real time value of money, fuel escalation costs, and the measure life to arrive at an NPV. The NPV is the present value of savings minus the first cost. When that NPV is greater than zero, a measure is considered cost effective. This method does not include tax considerations or the opportunity value of invested capital.

Economic factors for the scalar method are those arrived at by the ASHRAE 90.1 committee for analysis of ASHRAE Standard 90.1-2013 measures. National average electric and gas rates are from EIA for 2011. The DOE/FEMP discount rate and electric and gas present value factors are from the NIST Life Cycle Cost 2011 supplement (NISTIR 85-3273-26).[4] The factors shown in Table 1 are used. The residual cost of controls at the end of 40 years is ignored.

Table 1: Economic Factors

	ASHRAE SPP Method	DOE/ FEMP NPV
Economic Life (skylight & wiring) - Years	40	40
Economic Life (photo controls)- Years	15	15
Fuel Escalation Rate - %	3.76%	N/A
Gas UPWF (present worth factor)	N/A	24.15
Electric UPWF (present worth factor)	N/A	21.82

[3] The prototype descriptions and models can be found at http://www.energycodes.gov/development/commercial/90.1_models

[4] Rushing, Kneifel, and Lippiatt, "Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – 2011."

	ASHRAE SPP Method	DOE/ FEMP NPV
Discount Rate - %	7.00%	3.00%
Replacement Discount Rate - %	5.00%	3.00%
Loan Interest Rate - %	6.25%	N/A
Federal Tax Rate - %	34.00%	N/A
State Tax Rate - %	6.50%	N/A
Gas Price - $/therm	$0.9900	$0.9900
Electric Price - $/kWh	$0.1032	$0.1032
Present cost including discounted controls replacement at 15 and 30 years	$2,427	$2,632
Metric for cost effectiveness	SPP	NPV
Metric threshold	< 21.851	> 0

The cost effectiveness results are shown in Figure 2 for net present value using FEMP economic criteria. The net present value is the present value of savings over the life of the measure minus the first cost and the present value of any replacement costs. In a net present value analysis, the project is cost effective when the net present value is greater than zero.

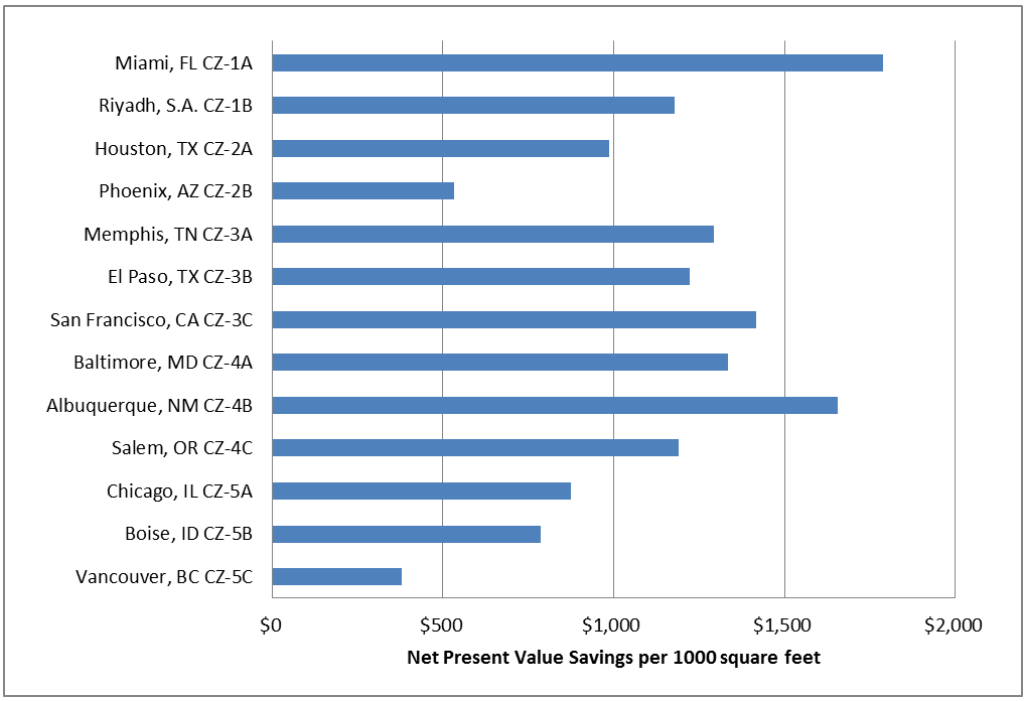

Figure 2: Net Present Value of Savings

The cost effectiveness results are shown in Figure 3 for simple payback compared to a discounted payback limit. The simple payback period (SPP) is the cost of the project, including the discounted cost of any replacements, divided by the annual energy savings in dollars. The discounted payback limit is calculated using a method and agreed to parameters developed by the ASHRAE 90.1 standard committee.[5] The discounted limit (also known as the scalar) accounts for discounting, tax impacts, and fuel escalation and a measure is cost effective when the simple payback is less than the discounted simple payback limit. For a skylight installation with daylight controls, the simple payback is below the discounted limit, and therefore cost effective, in climate zones 1 through 5.

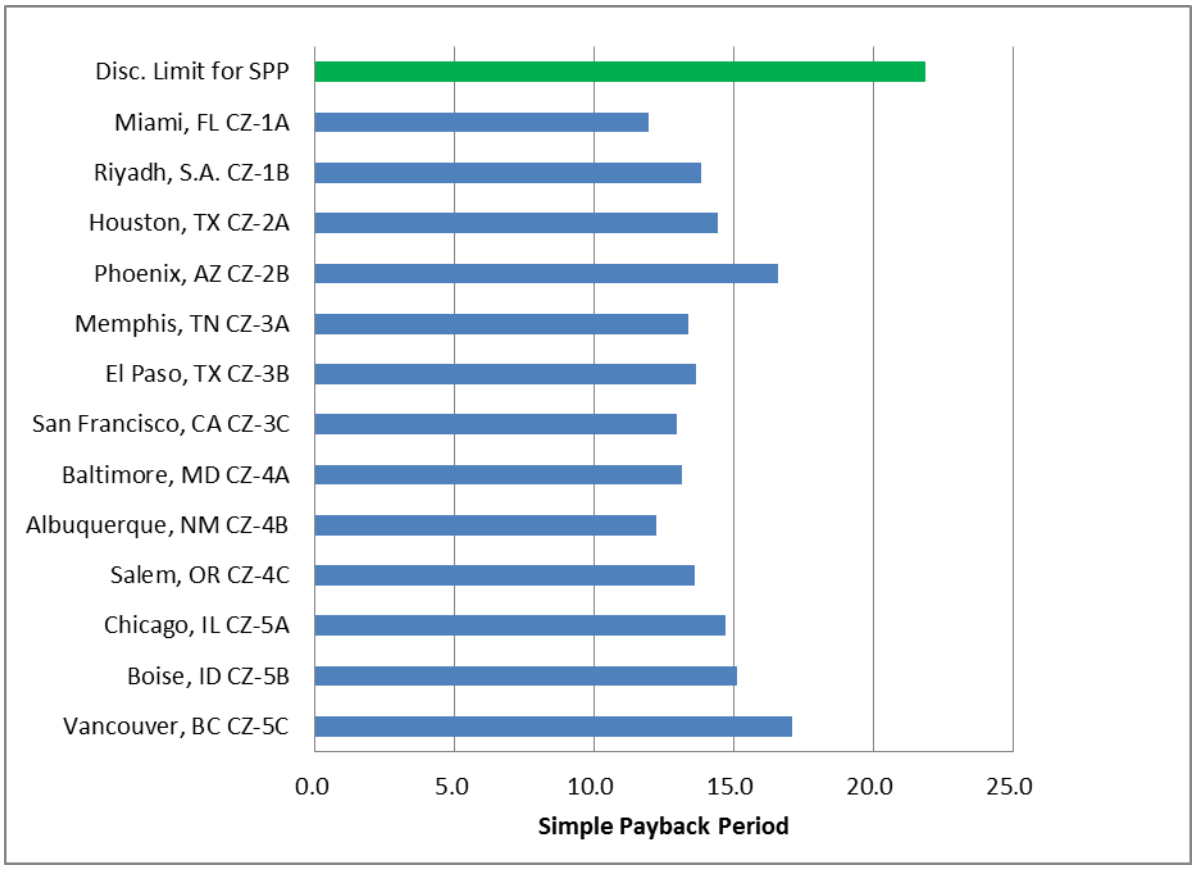

Figure 3: Simple Payback for Individual Skylight Daylighting

Under both cost effectiveness analysis methods, a single skylight with daylighting controls is cost effective in climate zones 1 through 5.

[5] M. F. McBride, "Development of Economic Scalar Ratios for ASHRAE Standard 90.1 R," in *Proceedings of Thermal Performance of the Exterior Envelopes of Buildings VI, ASHRAE* (presented at the Thermal Performance of the Exterior Envelopes of Buildings VI, ASHRAE, 1995), http://consensus.fsu.edu/FBC/2010-Florida-Energy-Code/901_Scalar_Ratio_Development.pdf.