Cost-Effectiveness of Improved Fenestration U-Factors

DOE Proposal: R-2; ICC proposal: TBA

For 2018 IECC residential code

Pacific Northwest National Lab

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T. Taylor, V. Mendon and M. Zhao

PURPOSE

Determine whether proposed U-factor improvements are cost effective.

BASIS

The proposed U-factors are based on the previous version of ENERGY STAR (version 5.0) introduced in 2010.[1] Targeting efficiency levels from an older specification of ENERGY STAR is intended to provide adequate consideration for the time required for sufficient market penetration of higher efficiency window products. Because the fenestration U-factor mainly affects heating loads, the proposal is limited to zones 3 and above. The current (2015 IECC) and proposed fenestration U-factors are as follows:

	Fenestration U-factor	
Climate Zone(s)	2015 IECC	Proposed
3	0.35	0.32[2]
4 except Marine	0.35	0.32
5 and Marine 4	0.32	0.30
6	0.32	0.30
7 and 8	0.32	0.30

The energy savings and cost-effectiveness potential of these window U-factors were evaluated using DOE's cost-effectiveness methodology.[3]

ENERGY PRICES

DOE's cost-effectiveness methodology specifies that for climate zone-level and national-level analyses, energy prices and escalation rates will be taken from the Energy Information Administration's latest estimates. The anticipated 2018 prices and escalation rates[4] are as follows:

Fuel	Price (2018$)	Effective[5] Escalation Rate (per year, real)
Electricity	$0.137/kWh	0.69%
Natural Gas	$1.154/therm	1.74%
Fuel Oil	$2.299/therm	1.84%

[1] See ENERGYSTAR version 5.0 at https://www.energystar.gov/sites/default/files/specs//private/Windows,_Doors_and_Skylights_Program_Requirements%20v5_0%20current.pdf

[2] Although ENERGY STAR 5.0 did not include the 0.32 U-factor in climate zone 3, it is cost effective in that zone and is included in the proposal.

[3] DOE Cost-Effectiveness Methodology available at https://www.energycodes.gov/development/residential/methodology

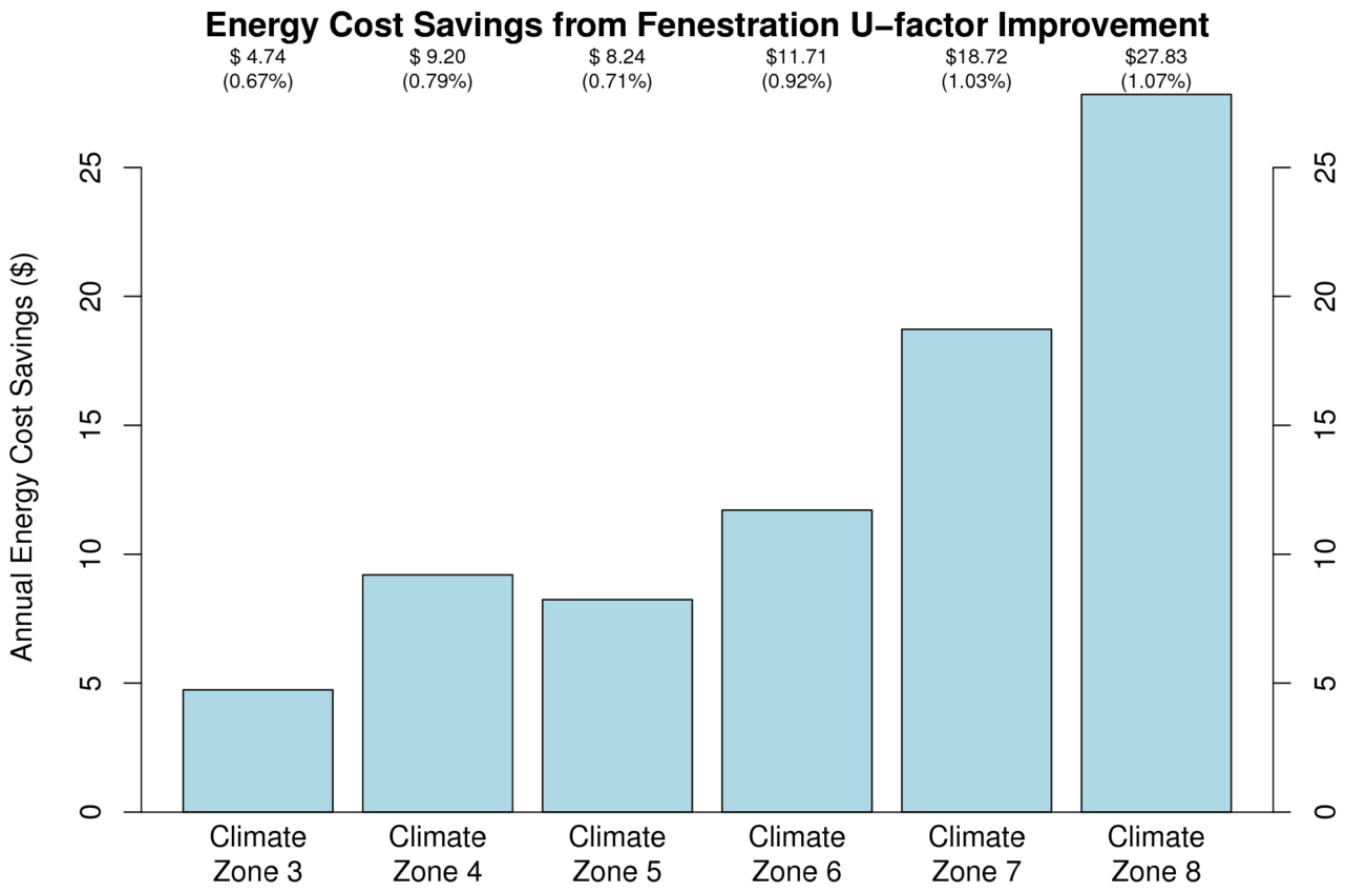
[4] EIA, Annual Energy Outlook 2015, table accessed 2 Dec 2015 from http://www.eia.gov/beta/aeo/#/?id=3-AEO2015&cases=ref2015; nominal 2018 prices.

[5] LCC calculations are based on year-by-year fuel price ratios derived from price estimates published by EIA (table accessed 2 Dec 2015 from http://www.eia.gov/beta/aeo/#/?id=3-AEO2015&cases=ref2015; 2013$ price estimates converted to ratios relative to 2018); the effective rates shown in the table are the uniform annual escalation rates that would give the same present value of energy as the estimated year-by-year price ratios.

ENERGY COST SAVINGS

As per DOE's cost-effectiveness methodology, improved window U-factors were simulated in one location for each unique combination of IECC climate zone and moisture regime, including an additional zone-1 location for semi-conditioned homes in the Tropical Climate Zone. Simulations covered two building types (single- and multifamily), four heating system types (gas furnace, oil furnace, heat pump, and electric furnace), and four foundation types (slab, crawlspace, heated basement, unheated basement). Each scenario was simulated with and without the propose window U-factors. In all, 1056 EnergyPlus simulations were conducted and the results were weighted based on housing starts (based on code permits data) and other data reflecting the shares of residential buildings and dwelling units having the various foundations and system types.

The proposed U-factors result in zone-average energy cost savings as shown in the figure:



MEASURE COST

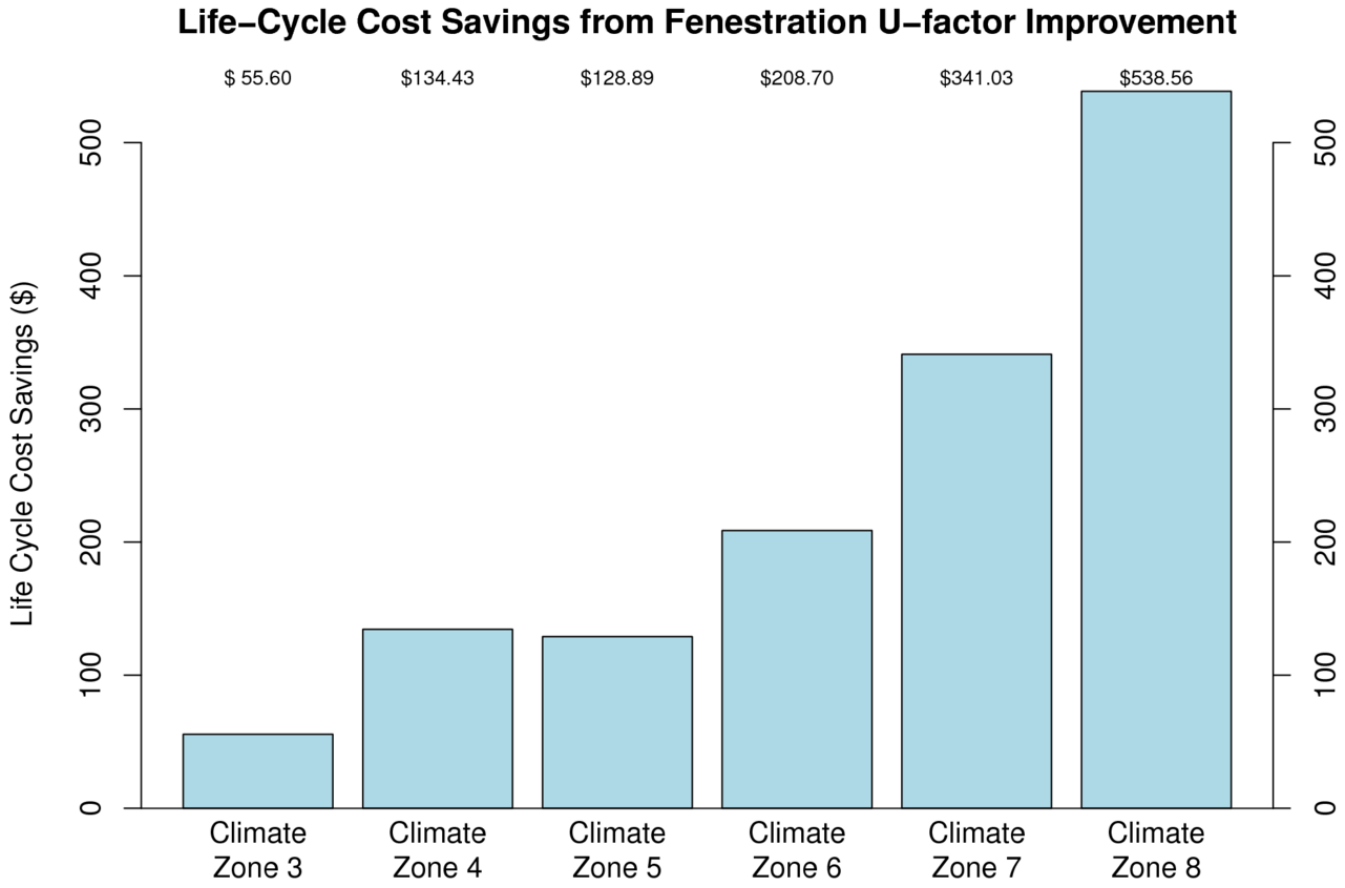
Data collected by DOE indicates an incremental cost of $0.18/ft^2 for a window with a U-factor of 0.30 compared to a window with a U-factor of 0.35.[6] Because the data source does not provide costs at the granularity needed for this proposed change, the present analysis conservatively assumes the same incremental cost of $0.18/ft^2 for

[6] Residential Energy Efficiency Measures – Prototype Estimate and Cost Data available at http://bc3.pnnl.gov/sites/default/files/Residential_Report.pdf

windows with a U-factor of 0.32 compared to windows with a U-factor of 0.35, as well as for windows with a U-factor of 0.30 compared to windows with a U-factor of 0.32.

COST-EFFECTIVENESS

Assuming windows have a useful life of 30 years, an evaluation of the life-cycle cost savings of these improved levels over the 2015 IECC requirements using the established DOE cost-effectiveness methodology shows positive life-cycle cost savings in climate zones 3 through 8.



CONCLUSION

The proposed U-factor changes, when analyzed according to the established DOE cost-effectiveness methodology and using conservatively high measure costs, are cost-effective in climate zones 3 through 8.