



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

Preliminary Energy Costs and Savings Estimates: 2018 IECC Residential Requirements

April 2019

ZT Taylor

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service
5301 Shawnee Rd., Alexandria, VA 22312
ph: (800) 553-NTIS (6847)
email: orders@ntis.gov <<http://www.ntis.gov/about/form.aspx>>
Online ordering: <http://www.ntis.gov>



This document was printed on recycled paper.

(8/2010)

Preliminary Energy Costs and Savings Estimates: 2018 IECC Residential Requirements

April 2019

ZT Taylor

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This report provides preliminary estimates of the incremental costs and savings associated with the residential provisions of the 2018 International Energy Conservation Code (IECC). The analysis is provided to the U.S. Department of Energy (DOE) to help quantify the costs and savings impacts of the latest published edition of the IECC, the 2018 IECC. The resulting information aids in understanding the net costs and economic impacts associated with updated energy codes, which is typically of interest to adopting states and localities.

The current analysis characterizes the incremental costs and savings associated with the residential provisions of the 2018 International Energy Conservation Code (IECC), and is being provided in addition to the analyses that the DOE traditionally provides and which DOE anticipates continuing to provide in the future.¹

Preliminary review of the 2018 IECC identified two key changes that are expected to have a significant and measurable impact on energy efficiency in residential buildings.² These changes are expected to increase energy savings, impact a significant fraction of new homes, and can be reasonably quantified through the established methodology. More information on these two changes and their expected energy savings impacts are presented in a separate technical analysis, *Preliminary Energy Savings Analysis: 2018 IECC Residential Requirements*. Technical details about the changes included in the 2018 IECC, the evaluation of those changes, and the energy simulations associated with those changes may be found in that document.

Table ES.1 provides a summary of expected net cost savings associated with the 2018 IECC. Savings are displayed on a national average basis and by climate zone. Life-cycle cost savings range from a low of \$398 in climate zone 1 to a high of \$1071 in climate zone 8. Expected payback ranges from 0.0 years (immediate payback) in climate zones 1 and 2 to 1.8 years in climate zone 3. National average savings are \$480 with a payback of 1.1 years.

Table ES.1 Net Energy Cost Savings by Climate Zone (2018 IECC vs. 2015 IECC)

Climate Zone	Life-cycle Cost Savings (\$/residence)	Payback Period (years)
1	398	0.0
2	427	0.0
3	431	1.8
4	633	1.5
5	595	1.5
6	668	1.4
7	890	1.2
8	1071	1.0
National	480	1.1

¹ Past residential energy and cost savings analysis is available at https://www.energycodes.gov/development/residential/iecc_analysis

² DOE's Preliminary Energy Savings Analysis may be found on DOE's Building Energy Codes Program (BECP) website at <https://www.energycodes.gov/development/determinations>.

Acronyms and Abbreviations

CFL	compact fluorescent lamp
DOE	U.S. Department of Energy
EUI	energy use intensity
FY	fiscal year
ICC	International Code Council
IECC	International Energy Conservation Code
IRC	International Residential Code
LED	light emitting diode
LF	linear fluorescent
PNNL	Pacific Northwest National Laboratory

Contents

Summary	iii
Acronyms and Abbreviations	v
1.0 Introduction	1
2.0 Overview of DOE Preliminary Savings Results.....	2
3.0 Preliminary Energy Costs and Savings Estimates	3
3.1 Measure Energy Cost Savings by Climate Zone.....	3
3.2 Net Cost Savings by Climate Zone	3
4.0 References	9

Tables

Table 2-1. 2018 IECC Code Changes Affecting Energy Use	2
Table 3-1. Measure Energy Cost Savings Percentage by Climate Zone (2018 IECC vs. 2015 IECC)	3
Table 3-2. Net Energy Cost Savings by Climate Zone (2018 IECC vs. 2015 IECC).....	3
Table 3-3. Measure Energy Costs and Savings in Climate Zone 1.....	4
Table 3-4. Measure Energy Costs and Savings in Climate Zone 2.....	5
Table 3-5. Measure Energy Costs and Savings in Climate Zone 3.....	5
Table 3-6. Measure Energy Costs and Savings in Climate Zone 4.....	6
Table 3-7. Measure Energy Costs and Savings in Climate Zone 5.....	6
Table 3-8. Measure Energy Costs and Savings in Climate Zone 6.....	7
Table 3-9. Measure Energy Costs and Savings in Climate Zone 7.....	7
Table 3-10. Measure Energy Costs and Savings in Climate Zone 8.....	8

1.0 Introduction

The current report provides preliminary estimates of the incremental costs and savings associated with the residential provisions of the 2018 International Energy Conservation Code (IECC). The analysis was performed by Pacific Northwest National Laboratory (PNNL) and provided to the U.S. Department of Energy (DOE) to help quantify the costs and savings impacts of associated with the latest published edition of the IECC, the 2018 IECC. Estimates of net costs—incremental costs of construction and resulting energy savings—aid states and localities in understanding benefits and economic impacts associated with adopting updated energy codes.

The current analysis characterizes the incremental costs and savings associated with the residential provisions of the 2018 International Energy Conservation Code (IECC), and is being provided in addition to the analyses that the DOE traditionally provides and which DOE anticipates continuing to provide in the future.³

Preliminary review of the 2018 IECC identified two key changes that are expected to have a significant and measurable impact on energy efficiency in residential buildings.⁴ These changes were identified as increasing energy savings, impact a significant fraction of new homes, and can be reasonably quantified through the established methodology. More information on these two changes is presented in a separate technical report, *Preliminary Energy Savings Analysis: 2018 IECC Residential Requirements*, which contains technical details and estimated impacts associated with specific changes.

³ Past residential energy and cost savings analysis is available at https://www.energycodes.gov/development/residential/iecc_analysis

⁴ DOE's Preliminary Energy Savings Analysis may be found on DOE's Building Energy Codes Program (BECP) website at <https://www.energycodes.gov/development/determinations>.

2.0 Overview of DOE Preliminary Savings Results

Preliminary review of the 2018 IECC identified two key changes that are expected to have a significant and measurable impact on energy efficiency in residential buildings.⁵ These two changes, as designated by the International Code Council (ICC) during the 2018 IECC development process, include:

- RE31 (fenestration)
- RE127 (lighting)

These changes are expected to increase energy savings, impact a significant fraction of new homes, and can be reasonably quantified through the established methodology.

Table 2-1 provides an overview of the changes and their expected impact on energy efficiency, with additional discussion on each change presented following the table.

Table 2-1. 2018 IECC Code Changes Affecting Energy Use

Proposal Number ^(a)	Code Section(s) ^(b)	Description of Change(s)	Impact on Energy Efficiency	Discussion
RE31-16	Table R402.1.2 (IRC Table N1102.1.2), Table R402.1.4 (IRC Table N1101.1.4)	Lowers (improves) fenestration U-factors in climate zones 3-8	Decreases Energy Use	Reduces heat loss/gain through windows and doors, thereby decreasing energy use. This change affects all residences in 6 of the IECC's 8 climate zones.
RE127-16	R404.1 (IRC N1104.1)	Increases high-efficacy lighting requirements from 75% to 90% of permanently installed lighting fixtures	Decreases Energy Use	The increased percentage of high-efficacy lighting results in a clear reduction in energy use. This change is applicable across all homes complying with the IECC.

The RE31 code change reduces the heat transfer coefficient (U-factor), and thus the building heating consumption, for fenestration in climate zones 3 through 8. Specifically, it reduces the U-factor from 0.35 in the 2015 IECC to 0.32 in the 2018 IECC in Climate Zones 3 and 4 (except 4C), as well as 0.32 in the 2015 IECC to 0.30 in the 2018 IECC in Climate Zones 4C and 5 through 8.

The RE127 code change reduces the lighting energy consumption in homes by increasing the requirement of high-efficacy lighting from 75 percent of permanently installed lighting fixtures to 90 percent. It also eliminates the option of calculating percentages based on lamp counts instead of fixture counts.

⁵ DOE's Preliminary Energy Savings Analysis may be found on DOE's Building Energy Codes Program (BECP) website at <https://www.energycodes.gov/development/determinations>.

More detail on the expected energy savings impacts associated with each change is presented in a separate technical analysis, *Preliminary Energy Savings Analysis: 2018 IECC Residential Requirements*.

3.0 Preliminary Energy Costs and Savings Estimates

This section presents a preliminary estimate of expected energy costs and savings, both nationally and by climate zone.

3.1 Measure Energy Cost Savings of the 2018 IECC

Energy cost savings are driven by the two key changes that are expected to have a significant and measurable impact on energy efficiency in residential buildings, as outlined in the previous section. These measures include RE31 (fenestration) and RE127 (lighting). Table 3-1 presents the energy cost savings associated with each measure, as well as their combined effects, nationally and by climate zone.

Table 3-1. Measure Energy Cost Savings Percentage by Climate Zone (2018 IECC vs. 2015 IECC)

Climate Zone	Energy Cost Savings (%)		
	RE31 (fenestration)	RE127 (lighting)	Combined
1	0.00	1.69	1.69
2	0.00	1.35	1.35
3	0.87	1.31	2.18
4	1.10	1.12	2.22
5	0.91	1.10	2.01
6	1.06	1.04	2.10
7	1.19	0.74	1.93
8	1.22	0.41	1.63
National	0.76	1.21	1.97

Note that RE31 (fenestration) impacts only climate zones 3 through 8, while RE127 (lighting) impacts all climate zones.

3.2 Net Cost Impacts of the 2018 IECC

Table 3-2 estimates the cost savings and payback periods associated with the 2018 IECC (compared to the previous 2015 edition). Life-cycle and simple payback cost perspectives are provided in accordance with the established DOE methodology (Taylor et al. 2015). A brief discussion of the expected cost impacts associated with change is also presented following the table.

Table 3-2. Net Energy Cost Savings by Climate Zone (2018 IECC vs. 2015 IECC)

Climate Zone	Life-cycle Cost Savings (\$/residence)	Payback Period (years)
1	398	0.0
2	427	0.0
3	431	1.8
4	633	1.5
5	595	1.5
6	668	1.4
7	890	1.2
8	1071	1.0
National	480	1.1

The remainder of this section outlines the expected cost impacts for the two identified changes 2018 IECC, RE31 (fenestration) and RE127 (lighting), compared to the previous 2015 IECC. Table 3-3 through

Table 3-10 detail the expected incremental costs of construction and related savings impacts for each climate zone. For each table in this series, key measures impacting energy efficiency are highlighted, and an incremental cost is assigned to any measure that varies from the 2015 IECC to the 2018 IECC. Regionally-adjusted costs are provided for each measure based on prominent and publicly available construction cost data sources (e.g., RS Means).

In some instances, measures were found to have significant prevalence in the marketplace and are available at little or no incremental cost compared to lower-efficiency alternatives. Trends toward higher efficacy lighting have been driven heavily by the continued emergence of LED technology. Similarly, federal standards⁶, which are outside of the purview of the IECC, have also contributed to high-efficacy lighting becoming the typical choice in the market. Therefore, this analysis assumes no incremental cost associated with RE31 (lighting).

Table 3-3. Measure Energy Costs and Savings in Climate Zone 1

Climate Zone 1 (Miami FL)	Measure Description		Incremental Costs and Savings (2017\$)
Efficiency Measure	2015 IECC	2018 IECC	2018 IECC
Wall	R-13	R-13	\$0.00
Ceiling	R-30	R-30	\$0.00
Floor	R-13	R-13	\$0.00
Window U-factor	NR	NR	\$0.00
Window SHGC	0.25	0.25	\$0.00
Envelope Leakage (ACH)	5	5	\$0.00
Duct Leakage (cfm25/100 ft ² CFA)	4	4	\$0.00
Lighting (% high-efficacy lamps)	75	90	\$0.00
Total Incremental Cost			\$0.00
Total Annual Energy Bill Savings			\$17.09
Simple Payback Period			0.0

⁶ For more information on federal lighting standards, see <https://www.energy.gov/eere/buildings/standards-and-test-procedures>.

Table 3-4. Measure Energy Costs and Savings in Climate Zone 2

Climate Zone 2 (Houston, TX; Phoenix, AZ)		Measure Description		Incremental Costs and Savings (2017\$)
Efficiency Measure	2015 IECC	2018 IECC	2018 IECC	
Wall	R-13	R-13		\$0.00
Ceiling	R-30	R-30		\$0.00
Floor	R-13	R-13		\$0.00
Window U-factor	0.40	0.40		\$0.00
Window SHGC	0.25	0.25		\$0.00
Envelope Leakage (ACH)	5	5		\$0.00
Duct Leakage (cfm25/100 ft ² CFA)	4	4		\$0.00
Lighting (% high-efficacy lamps)	75	90		\$0.00
Total Incremental Cost				\$0.00
Total Annual Energy Bill Savings				\$18.34
Simple Payback Period				0.0

Table 3-5. Measure Energy Costs and Savings in Climate Zone 3

Climate Zone 3 (Memphis, TN; El Paso, TX; San Francisco, CA)		Measure Description		Incremental Costs and Savings (2017\$)
Efficiency Measure	2015 IECC	2018 IECC	2018 IECC	
Wall	R-13	R-13		\$0.00
Ceiling	R-30	R-30		\$0.00
Floor	R-13	R-13		\$0.00
Window U-factor	0.35	0.32		\$36.41
Window SHGC	0.25	0.25		\$0.00
Envelope Leakage (ACH)	5	5		\$0.00
Duct Leakage (cfm25/100 ft ² CFA)	4	4		\$0.00
Lighting (% high-efficacy lamps)	75	90		\$0.00
Total Incremental Cost				\$36.41
Total Annual Energy Bill Savings				\$20.31
Simple Payback Period				1.8

Table 3-6. Measure Energy Costs and Savings in Climate Zone 4

Climate Zone 4 (Baltimore, MD; Albuquerque, NM; Salem, OR)		Measure Description		Incremental Costs and Savings (2017\$)
Efficiency Measure	2015 IECC	2018 IECC	2018 IECC	
Wall	R-13	R-13	\$0.00	
Ceiling	R-30	R-30	\$0.00	
Floor	R-13	R-13	\$0.00	
Window U-factor	0.35	0.32	\$42.75	
Window SHGC	0.25	0.25	\$0.00	
Envelope Leakage (ACH)	5	5	\$0.00	
Duct Leakage (cfm25/100 ft ² CFA)	4	4	\$0.00	
Lighting (% high-efficacy lamps)	75	90	\$0.00	
Total Incremental Cost			\$42.75	
Total Annual Energy Bill Savings			\$29.31	
Simple Payback Period			1.5	

Table 3-7. Measure Energy Costs and Savings in Climate Zone 5

Climate Zone 5 (Chicago, IL; Boise, ID)		Measure Description		Incremental Costs and Savings (2017\$)
Efficiency Measure	2015 IECC	2018 IECC	2018 IECC	
Wall	R-13	R-13	\$0.00	
Ceiling	R-30	R-30	\$0.00	
Floor	R-13	R-13	\$0.00	
Window U-factor	0.32	0.30	\$40.29	
Window SHGC	0.25	0.25	\$0.00	
Envelope Leakage (ACH)	5	5	\$0.00	
Duct Leakage (cfm25/100 ft ² CFA)	4	4	\$0.00	
Lighting (% high-efficacy lamps)	75	90	\$0.00	
Total Incremental Cost			\$40.29	
Total Annual Energy Bill Savings			\$27.55	
Simple Payback Period			1.5	

Table 3-8. Measure Energy Costs and Savings in Climate Zone 6

Climate Zone 6 (Burlington, VT; Helena, MT)	Measure Description		Incremental Costs and Savings (2017\$)
Efficiency Measure	2015 IECC	2018 IECC	2018 IECC
Wall	R-13	R-13	\$0.00
Ceiling	R-30	R-30	\$0.00
Floor	R-13	R-13	\$0.00
Window U-factor	0.32	0.30	\$42.62
Window SHGC	0.25	0.25	\$0.00
Envelope Leakage (ACH)	5	5	\$0.00
Duct Leakage (cfm25/100 ft ² CFA)	4	4	\$0.00
Lighting (% high-efficacy lamps)	75	90	\$0.00
Total Incremental Cost			\$42.62
Total Annual Energy Bill Savings			\$30.82
Simple Payback Period			1.4

Table 3-9. Measure Energy Costs and Savings in Climate Zone 7

Climate Zone 7 (Duluth, MN)	Measure Description		Incremental Costs and Savings (2017\$)
Efficiency Measure	2015 IECC	2018 IECC	2018 IECC
Wall	R-13	R-13	\$0.00
Ceiling	R-30	R-30	\$0.00
Floor	R-13	R-13	\$0.00
Window U-factor	0.32	0.30	\$46.91
Window SHGC	0.25	0.25	\$0.00
Envelope Leakage (ACH)	5	5	\$0.00
Duct Leakage (cfm25/100 ft ² CFA)	4	4	\$0.00
Lighting (% high-efficacy lamps)	75	90	\$0.00
Total Incremental Cost			\$46.91
Total Annual Energy Bill Savings			\$40.57
Simple Payback Period			1.2

Table 3-10. Measure Energy Costs and Savings in Climate Zone 8

Climate Zone 8 (Fairbanks, AK)	Measure Description		Incremental Costs and Savings (2017\$)
	Efficiency Measure	2015 IECC	2018 IECC
Wall	R-13	R-13	\$0.00
Ceiling	R-30	R-30	\$0.00
Floor	R-13	R-13	\$0.00
Window U-factor	0.32	0.30	\$49.32
Window SHGC	0.25	0.25	\$0.00
Envelope Leakage (ACH)	5	5	\$0.00
Duct Leakage (cfm25/100 ft ² CFA)	4	4	\$0.00
Lighting (% high-efficacy lamps)	75	90	\$0.00
Total Incremental Cost			\$49.32
Total Annual Energy Bill Savings			\$48.46
Simple Payback Period			1.0

4.0 References

Mendon VV, RG Lucas and SG Goel. 2013. *Cost-Effectiveness Analysis of the 2009 and 2012 IECC Residential Provisions – Technical Support Document*. Pacific Northwest National Laboratory, Richland, Washington. Available at

http://www.energycodes.gov/sites/default/files/documents/State_CostEffectiveness_TSD_Final.pdf

Mendon VV and ZT Taylor. 2014. *Development of Residential Prototype Building Models and Analysis System for Large-Scale Energy Efficiency Studies Using EnergyPlus*. 2014 ASHRAE/IBPSA-USA Building Simulation Conference, Atlanta, Georgia.

Mendon VV, A Selvacanabady, M Zhao, and ZT Taylor. 2015. *National Cost-Effectiveness of the Residential Provisions of the 2015 IECC*. Pacific Northwest National Laboratory, Richland, Washington. Available at https://www.energycodes.gov/sites/default/files/documents/2015IECC_CE_Residential.pdf.

Taylor ZT, VV Mendon, and N Fernandez. 2015. *Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes*. Pacific Northwest National Laboratory, Richland, Washington. Available at

https://www.energycodes.gov/sites/default/files/documents/residential_methodology_2015.pdf

Wilson E, C Engebrecht Metzger, S Horowitz, and R Hendron. 2014. *2014 Building America House Simulation Protocols*. National Renewable Energy Laboratory, Golden, Colorado. Available at

http://energy.gov/sites/prod/files/2014/03/f13/house_simulation_protocols_2014.pdf



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99352
1-888-375-PNNL (7665)

U.S. DEPARTMENT OF
ENERGY

www.pnnl.gov