Comparison of 2021 IECC Residential Cost Effectiveness Analyses

This document is intended to provide a comparison of two reports the *2021 IECC Residential Cost Effectiveness Analysis* published for the National Association of Homebuilders (NAHB) by Home Innovation Research Labs (HIRL) in June 2021, hereafter referred to as the HIRL report[1]; and the report of the same name published by ICF in January 2022, hereafter referred to as the ICF report. The purpose of this document is to identify concerns and issues in the HIRL report, which were addressed in the ICF report.

Simplistic Economic Metrics

The HIRL report only evaluates cost effectiveness using a simple payback metric, which is easy to calculate and understand, however it is not appropriate to use for evaluating energy code changes. The U.S. Department of Energy's *Methodology for Evaluating Cost Effectiveness of Residential Energy Code Changes* (DOE Methodology)[2] concludes that "because simple payback ignores many of the longer-term factors in the economic performance of an energy-efficiency investment, DOE does not use [simple payback] as a primary indicator of cost effectiveness for its own decision-making purposes."

Instead, the DOE Methodology uses Life-Cycle Cost (LCC) as the primary metric to evaluate cost effectiveness, therefore the ICF report also uses this metric.

High Builder Profit Margins

The HIRL report stated that the total cost to the consumer included a builder's gross profit margin of 19%. Several issues were found with this, all leading to higher costs which would negatively impact cost effectiveness.

First, many code changes in Appendix A of the HIRL report were found to have a higher profit margin applied. For example, RE112 had a reported cost to the builder of $200 and a cost to the consumer of $247, which would be a profit margin of 24%.

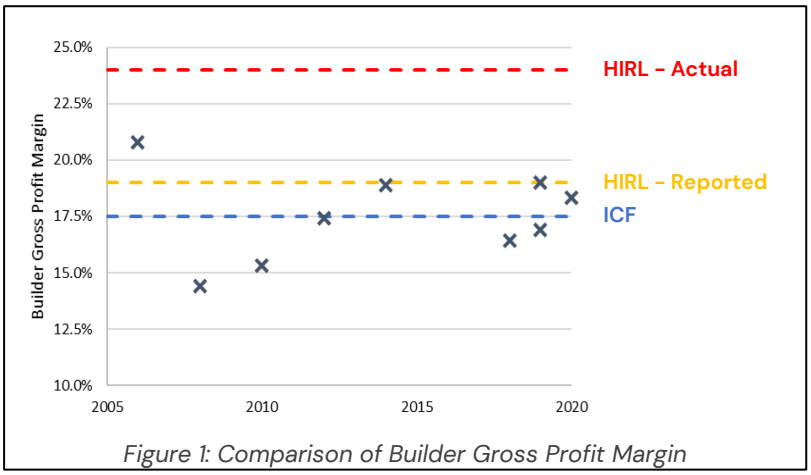

Figure 1: Comparison of Builder Gross Profit Margin

Additionally, the ICF report considered changes in builder profit margins over time and used an average value representing all data that was available. In figure 1, the data available for builder gross profit margin is shown by black X's, with their average – the value used in the ICF report - shown by the blue line. The profit margin used in the ICF report is a more representative value, as the value reported to have been used in the HIRL report is the highest profit margin seen since 2006, and the value that was actually used is higher than any reported historical profit margin.

Finally, the HIRL report assumed all construction was performed by subcontractors, so the excessively high profit margin of 24% was applied twice, once reflecting the subcontractor's profit and again to reflect the builder's profit. To reflect that the majority, but not all, aspects of homebuilding are subcontracted, the ICF report applied a factor of 79.3% to subcontractor markups to reflect the average share of construction costs that are subcontracted dating back to 2012.[3]

1 Source: https://www.nahb.org/-/media/NAHB/advocacy/docs/top-priorities/codes/code-adoption/2021-iecc-cost-effectiveness-analysis-hirl.pdf
2 Source: https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf
3 Source: https://www.nahb.org/-/media/NAHB/news-and-economics/docs/housing-economics-plus/special-studies/2020/special-study-average-new-home-uses-24-different-subcontractors.pdf

General High Cost

When reviewing the HIRL report, the high estimated incremental cost of code changes conflicted with other data sources, specifically Northwest national Laboratory's (PNNL's) *National Cost Effectiveness of the Residential Provisions of the 2021 IECC*, as shown in Figure 2.[4] After reviewing and updating cost data, the ICF report concluded costs were generally in line with the PNNL report, instead of 2 to 3 times higher as shown in the HIRL report.

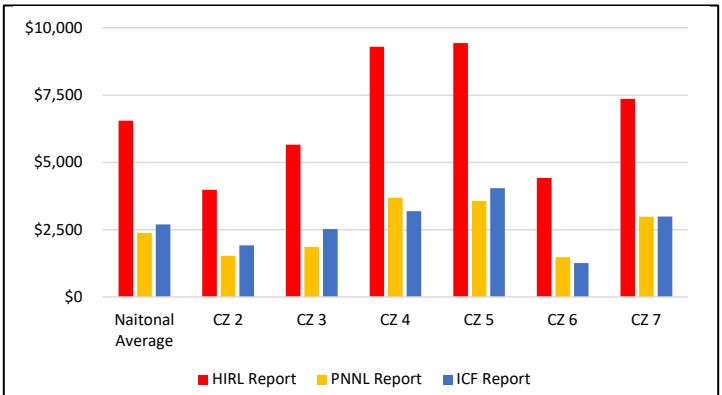

Figure 2: Comparison of 2021 IECC Code Change Costs

Costs for Negligible Administrative Changes

Some code changes in the 2021 IECC are administrative and technically are new requirements, but in practice require no, or negligible, incremental cost. They simply require reporting readily available information (e.g., RE18, 20, 21, CE40.2). The HIRL report included a cost of $114 for these code changes for every home, which was considered inaccurate and removed in the ICF report.

Costs Included for Code Changes that Save Energy but Not Modeled

Some code changes result in energy savings but were not able to be modeled due to limitations in energy modeling software. Therefore, energy savings for these changes are not included. Despite this limitation the HIRL report included costs for these code changes leading to an inaccurate accounting of costs and calculation of cost-effectiveness. These code changes include RE149 Lighting: exterior controls, and RE49 Baffles at attic access.

Outlier Energy Savings Estimates

Savings from the HIRL report and PNNL's savings estimates (*Energy Savings Analysis: 2021 IECC for Residential Buildings*[5]), were compared and national average savings were comparable (9.7% for HIRL and 8.7% for PNNL). However, some results in specific climate zones showed significant differences as shown in Figure 3 (i.e., climate zones 3 and 7). Due to the robustness of the methodology that PNNL's savings estimates used, it is likely that there is an issue with the modeled energy use in the HIRL report. However, this cannot be confirmed, nor could the potential impact on the cost-effectiveness be determined.

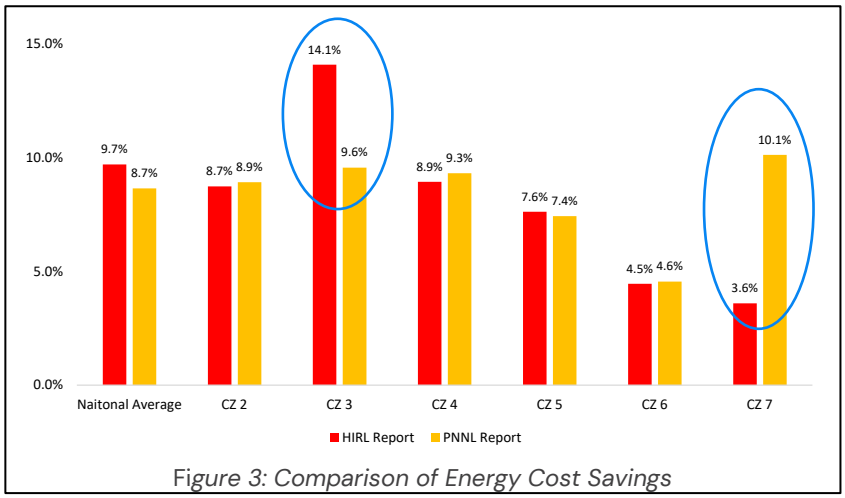

Figure 3: Comparison of Energy Cost Savings

Weighting Factors & Permutations

The HIRL report relies on a methodology developed in 2012 for the National Association of Homebuilders.[6] This methodology is notably simpler than the DOE methodology, last updated in 2015 based on a public process where stakeholders can submit comments on the methodology.[7] The methodology used in the

[4] Source: https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf
[5] Source: https://www.energycodes.gov/sites/default/files/2021-07/2021_IECC_Final_Determination_AnalysisTSD.pdf
[6] Source: https://www.nahb.org/-/media/NAHB/advocacy/docs/top-priorities/codes/codes-and-research/calculation-methodology.PDF
[7] Source: https://www.regulations.gov/docket/EERE-2015-BT-BC-0001

HIRL report has not been publicly vetted. It utilizes a smaller number of foundation types, fuel types, and locations than DOE uses to assess codes and leads to a less complete picture of the impacts of code changes.

The HIRL report also relies on weighting factors that differ from the DOE methodology. For example, the HIRL report uses data from the 2019 Annual Builder Performance Survey (ABPS) of approximately 1,500 home builders to estimate the amount of construction in each climate zone. The DOE methodology relies on the U.S. Census Builder Permits Survey which gathers permit data from over 20,000 permit offices. the Census data provides a larger statistical sample and presumably the better source for establishing weighted national averages.

Annual Energy Use / Costs Errors

Appendix E in the HIRL report presents annual energy use and costs for 153 modeled homes, 19 of which were identified as having a significant error where the reported energy use and energy rates did not result in the documented energy costs. See below for an example of the climate zone 7, crawlspace, 2018 IECC home which results in a discrepancy of over $40.

Reported Energy Use	Reported Energy Rates	Calculated Energy Cost	Reported Energy Cost
7,119 kWh 1,473 therms	$0.1301 / kWh $1.051 / therm	$2,474 (7,119 x 0.1301 + 1,473 x 1.051)	$2,515

To correct this issue, the ICF report applied a factor to correct the energy use to result in the reported energy cost. The reported energy cost could not have been used directly because the ICF report used a more robust economic metric which accounts for changes in future energy prices.

Dimmer Quantity Error

RE145 changes lighting requirements and adds lighting controls except for bathrooms, hallways, exterior lighting fixtures, and lighting designed for safety or security. The HIRL report includes a cost for a dimmer in a crawlspace, which would be an exempted for safety purposes. Including the crawlspace dimmer cost overstates the cost of the code change and negatively impacts cost-effectiveness, so the cost was removed in the ICF report.

Duct Option Analysis Omits Some Foundation Types

The HIRL report only considered slab and crawlspace homes for the more efficient thermal distribution system option (from RE209). This option could be used for any home and should have been evaluated for more foundation types (e.g., basements) to offer a complete picture of the savings and cost-effectiveness. For some foundation types, like conditioned basements, it is likely that ducts were already located in conditioned space before the 2021 IECC so there would be no change in requirements resulting from this code change.

Misleading Cost Effectiveness of Additional Efficiency Package Options

Table 21 in the HIRL report makes a misleading comparison of the cost-effectiveness of the additional efficiency package options against a baseline of the 2021 IECC (without the options). This is an odd comparison because the options, combined with the other code changes of the 2021 IECC, achieve savings against the 2018 IECC. Therefore the 2018 IECC would have been a more appropriate baseline and would show more savings and better cost-effectiveness. The table could be useful to make a comparison of which option is relatively more cost-effective, but should not be used to determine if these options are cost effective or not.