Home Upgrade Calculator Testing Procedure

The following testing procedure is primarily to confirm that the Home Upgrade calculator is functioning as expected both on a functional level (i.e. for a given set of inputs the spreadsheet tool produces the proper outputs given the work paper methodology) and an expectations level (i.e. the outputs appear reasonable when compared to participant energy use). Technical inaccuracies indicated during the testing procedure will be identified and corrected. Unexpected results that are not the result of a technical inaccuracy (ex: limitation of underlying regression equation) will be documented, explained, and will be determined if further calculator modification needs to take place.

# Confirm Documented Changes

Walk through all documented changes in the Log tab align with what has been modified in the work paper documentation and calculator.

# Collect and Confirm Measure Outputs

For all measures and measure combinations detailed below, the following outputs will be collected for analysis:

|  |
| --- |
| **Outputs** |
| Baseline - kWh Energy Use |
| Baseline - kW Demand Use |
| Baseline - Therms Energy Use |
| 1st Baseline - kWh Energy Savings |
| 1st Baseline - kW Demand Savings |
| 1st Baseline - Therms Energy Savings |
| RUL |
| 2nd Baseline - kWh Energy Savings |
| 2nd Baseline - kW Demand Savings |
| 2nd Baseline - Therms Energy Savings |
| EUL-RUL |
| Gross Cost |
| Incremental Cost |
| IR |
| EUL |

## Individual Measures (IM)

Collect individual measure results from the updated calculator and check the following:

1. Ensure all measures produce complete outputs where they should and not where they shouldn’t (ex: Furnace measures not allowed for homes with wall furnaces). When available, ensure that measure impacts are consistent with those documented in latest associated approved workpaper.
2. More efficient inputs produce greater energy savings outputs (ex: A SEER 16 AC produces more electric savings than a SEER 15 AC). When available, ensure that measure impacts are consistent with those documented in latest associated approved workpaper.

The individual measure analysis will consider all measures, including those not involved in direct regression calculation such as the measures for water heaters, hot water pipe wrap, and thermostatic shut-off valves. The following table describes each input variable manipulated accompanied by the number of “levels” or options available.

|  |  |
| --- | --- |
| **Inputs** | **Levels** |
| Climate Zone (limit to Climate Region) | 6 |
| Vintage | 3 |
| Floor Construction | 2 |
| Air Conditioning | 2 |
| Heating | 2 |
| Water Heating | 2 |
| Number of Stories | 2 |
| Measures | 22 |
| **Total Possible Combinations\*** | 12,672 |
| \*Home characteristic input rules will reduce total combinations | |

The climate regions with their associated climate zones and primary DEER climate zone are summarized in the table below:

|  |  |  |
| --- | --- | --- |
| **Climate Region** | **DEER Climate Zones** | **Primary DEER Climate Zone** |
| North Coast (NC) | 1,3,5 | 3 |
| Coast Ranges (CR) | 2,4 | 4 |
| Central Valley & Sierra (CVS) | 12,16 | 12 |
| Central Valley & Desert (CVD) | 11,13,14,15 | 13 |
| South Coast (SC) | 6,7,8 | 7 |
| Inland Southwest (IS) | 9,10 | 9 |

## All Measure Combinations (AMC)

Collect full combination of measure package results from the updated calculator and ensure logical sense for all scenarios. The full combination analysis will be restricted to only measures that directly impact regression calculations to reduce overall combinations and excludes the measures for water heaters, hot water pipe wrap, and thermostatic shut-off valves. The analysis will also be restricted based on program rules, where at least three measures must be selected, one of which must be either Reduce Building Leakage, Reduce Duct Leakage, or Insulate Attic. The excluded measures are tested as part of the Individual Measure analysis and can be manually tested in combinations to ensure their implementation works correctly in the calculator. The following table describes each input variable manipulated accompanied by the number of “levels” or options available.

|  |  |
| --- | --- |
| **Inputs** | **Levels** |
| Climate Zone (limit to Climate Region) | 6 |
| Vintage | 3 |
| Floor Construction | 2 |
| Air Conditioning | 2 |
| Heating | 2 |
| Water Heating | 2 |
| Number of Stories | 2 |
| Measures (see below) |  |
| **Measure Group Inputs** | **Levels\*** |
| Reduce Building Leakage (No, 15%, 30%) | 3 |
| Insulate Duct (No, R-8) | 2 |
| Reduce Duct Leakage (No, 10%, 5%) | 3 |
| Insulate Attic (No, R-30/38, R-44) | 3 |
| Insulate Floor (No, R-19) | 2 |
| Insulate Wall (No, R-13) | 2 |
| High Performance Windows (No,U-0.32 SHGC-0.25) | 2 |
| Efficient Air Conditioner (No, SEER15) | 2 |
| Efficient Furnace or Wall Furnace (No, AFUE92, AFUE95, Wall Furnace) | 4 |
| **Total Possible Combinations\*\*** | 1,990,656 |
| \*Levels include selection of "No" | |
| \*\*Note home characteristic input rules and program rules will reduce combinations | |

The full combination analysis produces a large number of combinations, and it will not be possible to review each result individually. Instead, we will use a two-stage approach towards analysis. First, we will use graphical and statistical measures to test whether results are in expected ranges. Second, we will check individual results that fall outside of expected ranges and a random selection of 0.01%. The former check will ensure anomalies are investigated and the latter will identify whether there are other issues that did not show up in the first stage of the analysis.

## Analysis

Stage 1 analysis will include, but is not limited to, the following:

* Distribution analysis of all calculator outputs for the whole set and additionally group by home characteristics.
* Plots and statistics for 1st Baseline vs. 2nd Baseline savings on the same measure package (kWh, kW, and Therms). All 1st Baseline savings are expected to be greater than or equal to 2nd Baseline savings.
* Plots and statistics of Gross Cost and Incremental Cost by Energy Savings (kWh, kW, Therms)
* Plots and statistics of energy savings and costs by number of Measures in a package
* Group by measures that have multiple levels of efficiency gain and plot savings by measure package. All higher efficiency measures are expected have savings greater than or equal to lower efficiency measures.

Stage 2 analysis will include:

* Review potential anomalies detected by stage 1 analysis to determine if there is a calculator error. If there is an error, prescribe a solution.
* Review random selection of 0.01% of measure combinations to assess if there are additional anomalies. If there are, investigate, diagnose, and prescribe a solution.