

Home Efficiency Rebates (IRA Section 50121): Single Family Software Verification Procedures

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Background

The Inflation Reduction Act (IRA) Section 50121.b.1 states that the Home Efficiency Rebates program shall:

...use procedures, as approved by the Secretary, for determining the reductions in home energy use resulting from the implementation of a home energy efficiency retrofit that are calibrated to historical energy usage for a home consistent with BPI (Building Performance Institute) 2400, for purposes of modeled performance home rebates.

Per that requirement, the U.S. Department of Energy, working with experts at the National Renewable Energy Laboratory, developed a test procedure to verify that home energy modeling software meets the requirements for the modeled pathway for single family homes in IRA Section 50121. To be approved, interested software providers must complete a series of tests and meet performance measures that confirm ability to:

- Perform calibration in accordance with BPI-2400 (Building Performance Institute 2015).
- Meet other specific requirements for data collection.

To allow verification of these capabilities, software providers must:

- Submit test results and test runs of prescribed buildings.
- Provide access to the software tool used to complete these tests.

We will strive to review and approve your request within 2 to 3 weeks; however, questions or follow-up items may extend this timeline.

Software providers interested in having software approved for modeling single-family homes under the Home Efficiency Rebates program (IRA Section 50121) should follow the process and requirement described below. All required documentation (as well as questions) should be submitted to homes.rebates.software@nrel.gov.



Energy Modeling Software Tests

Section 3.1 of BPI-2400 (Building Performance Institute 2015) requires that software must pass the software tests in Residential Energy Services Network (RESNET) Publication No. 06-001, published Nov. 7, 2011. That publication is no longer available, having been superseded by the updated RESNET Publication No. 001-20 (RESNET 2020). As described below and shown in Figure 1, the software tests in Section 3.2 of RESNET Pub. 001-20, with the exception of Section 3.2.2, will be required.

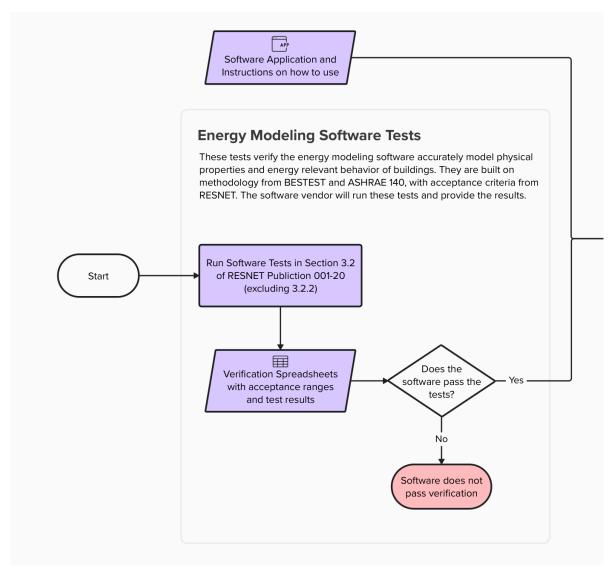


Figure 1: Energy Modeling Software Tests (created by NREL for this document)

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ASHRAE Standard 140

As specified in Section 3.2.1 of RESNET Pub. 001-20, the ANSI/ASHRAE Standard 140, Class II, software providers must perform and pass Tier 1 Tests (ASHRAE 2017). The acceptance criteria are listed in Appendix B of RESNET Pub. 001-20. After running the tests, the results should be submitted to the U.S. Department of Energy and the National Renewable Energy Laboratory (DOE/NREL)¹ using the ASHRAE 140 Results Form. The tests require the use of typical meteorological year 3 (TMY3) weather data from Las Vegas ("Las Vegas-McCarran Intl AP 723860," n.d.) and Colorado Springs ("Colorado Springs-Peterson Field 724660," n.d.) in place of those specified for those weather stations in ASHRAE 140.

Submit to DOE/NREL:

- ASHRAE 140 Results Form with test results.
- Building energy model test files so DOE/NREL can rerun the ASHRAE 140 tests.

RESNET HVAC Tests

Appendix D of RESNET Pub. 001-20 specifies a series of heating, ventilation, and air conditioning (HVAC) tests, based on modified models and acceptance criteria provided in ASHRAE 140. Software providers are required to perform the tests using TMY3 weather files specified for the ASHRAE 140 tests and document the results. Test results shall be submitted to DOE/NREL using the HVAC Results Form.

Submit to DOE/NREL:

- HVAC Results Form with test results.
- Building energy model test files so DOE/NREL can rerun the HVAC tests.

Duct DSE Tests

Appendix E of RESNET Pub. 001-20 specifies a series of Distribution System Efficiency (DSE) tests, based on modified models and acceptance criteria provided in ASHRAE 140. Software providers are required to perform the tests using TMY3 weather files specified for the ASHRAE 140 tests and document the results. Test results shall be submitted to DOE/NREL using the DSF Results Form.

Submit to DOE/NREL:

- DSE Results Form with test results.
- Building energy model test files so DOE/NREL can rerun the DSE tests.

¹ For the purposes of this document, the term "DOE/NREL" refers to the DOE and NREL team charged with reviewing and validating software for modeling single-family homes pursuant to IRA 50121.



Model Input Constraint Verification

Figure 2 below shows the process for model input constraint verification. Section 3.4 of BPI-2400 specifies value constraints for 20 model inputs. For each model input, DOE/NREL will check whether the value is directly editable, and if so, whether the constraints in Table 3.4.i are enforced either with error or warning messages or are otherwise constrained by the user interface to only allow inputs within the constraints. If an input is not directly editable but is calculated from other user inputs, such as assembly U-factors, they shall be displayed so the user can verify the input and confirm the constraint is being enforced. For cases where an exception to an input constraint is allowed (e.g., equipment efficiencies), a warning should be displayed but the user should be allowed to override the constraint.

Model outputs will also be checked by DOE/NREL to ensure that the tool is "capable of reporting energy consumption separately, by fuel type, for the following end uses at a minimum: space heating, space cooling, water heating, lighting, and other appliances" as specified in Section 3.1 of BPI-2400 (Building Performance Institute 2015).

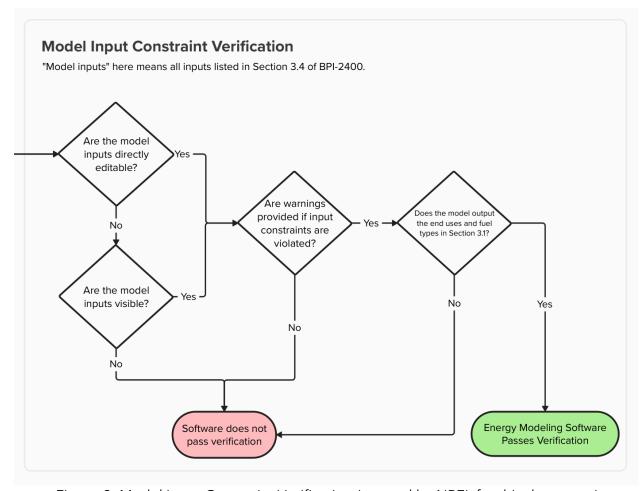


Figure 2: Model Input Constraint Verification (created by NREL for this document)

Submit to DOE/NREL:

- Access to use the software.
- Instructions, training, and/or documentation on how to use the software.

Calibration Procedure Verification

DOE/NREL will provide a sample of Home Performance XML (HPXML) files² that describe homes in several climate zones with monthly utility and/or bulk fuel consumption information. For each of the sample files, DOE/NREL will perform either a detailed or simplified calibration as described in BPI-2400 using the tool according to the documentation and instructions provided by the software vendor. For software tools that do not include fully automated calibration capability, the software provider must include documentation, training, and external calculation methods (e.g., spreadsheets) that will be used in concert with the software tool to fulfill calibration consistent with BPI-2400.

DOE/NREL will consider the following questions in reviewing a software provider's submissions. For each sample building, the software provider's submissions must result in affirmative responses to the following questions:

- 1. Based on the utility bill data available, is the correct calibration method (simplified or detailed) selected?
- 2. For detailed calibration:
 - a. Does the utility bill regression nearly match a reference utility bill regression of the same data from a known implementation of ASHRAE Guideline 14 (ASHRAE 2014)?
 - b. Does the utility bill regression enforce the utility bill criteria in Section 3.2.2 of BPI-2400?
 - c. Is there a way to calculate and report the acceptance criteria in Section 3.2.3 of
 - d. Is a "systematic approach" as described in Section 3.2.1.C.a.v.1 of BPI-2400 applied to adjust inputs to achieve the calibrated model?
- 3. For a simplified calibration:
 - a. Is there a way to calculate the estimated annual energy use according to equation 3.3.2.C.i of BPI-2400?
 - b. Is there a way to calculate and report the acceptance criteria in equation 3.3.2.A?

² The software isn't required to directly import the HPXML files. The information about the building characteristics and utility bills can be manually entered into the user interface.



4. Was it possible to calibrate the model to meet the acceptance criteria using the tools and methods provided?

Savings Calculation Verification

Test results must include recommended energy conservation measures for test homes 2 and 4. DOE/NREL will consider the following questions in reviewing the recommended measures. For each sample building, the software provider's submissions must result in affirmative responses to the following questions:

- 1. Are the savings calculated using historical weather data (e.g., TMY2 or TMY3)?
- 2. Are the pre- and post-retrofit models identical in inputs and assumptions except for the proposed energy upgrades?
- 3. Is the total equivalent energy use calculated according to equation 4.3.1.i in BPI-2400?
- 4. Is it possible to specify a different fossil fuel factor to accommodate different states' program requirements?
- 5. Is the total equivalent energy savings percentage calculated and displayed in accordance with Section 4.3.3 of BPI-2400?

HPXML Generation Verification

Figure 3 below shows the process for HPXML generation verification. Each project file from the sample set must be exported to HPXML v4. DOE/NREL will validate that each file meets minimum data requirements of the HPXML v4 schema (or HPXML v4-rc4 as of this writing). Each file will also be required to pass a minimum dataset verification. These data requirements include:

- <Building> element for calibrated pre-retrofit home with all recommended data points in the data and tools guide.
- <Building> element for the proposed upgrades with all recommended data points in the data and tools guide.
- <Project> element describing the measures to be installed.
- <BPI2400Inputs> sub-elements with details about the calibration.
- Utility billing data used in the calibration.



Full details of the minimum data requirements are still being developed, including a Schematron (ISO, n.d.) file to validate an HPXML file. That Schematron file will be posted when it is available.

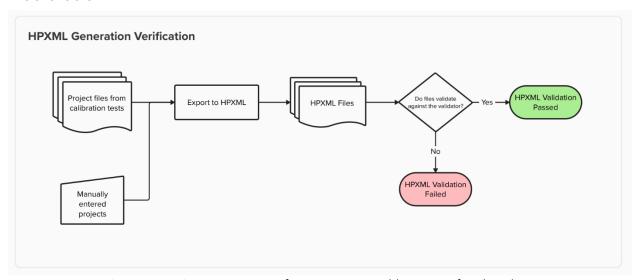


Figure 3: HPXML Generation Verification (created by NREL for this document)

Summary of Findings and Determination

DOE/NREL will provide a report of the results of its review to the software provider. This will include a determination of whether the software is compliant. For approved software, the report will reference the specific conditions that must be applied when using the software (e.g., calibration documentation) for the purposes of the rebates. In instances where software capabilities are not approved, the report will document where insufficiencies were found.

To appeal a decision, a software provider may resubmit required test results and information for reevaluation, and/or documentation of justification or remedies for insufficiencies identified in the report.

If substantive changes to this verification procedure are required due to revised BPI test procedures or other relevant updates, DOE/NREL will contact approved software providers to submit information for rereview. DOE/NREL does not anticipate such changes and will provide a grace period of at least 4 months for software to meet new testing criteria.

References

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