

# Building America *Technical Highlight*



## NREL Improves Building Energy Simulation Programs Through Diagnostic Testing

Researchers at the National Renewable Energy Laboratory (NREL) have developed a new test procedure to increase the quality and accuracy of energy analysis tools for the building retrofit market.

The Building Energy Simulation Test for Existing Homes (BESTEST-EX) is a test procedure that enables software developers to evaluate the performance of their audit tools in modeling energy use and savings in existing homes when utility bills are available for model calibration. Similar to NREL's previous energy analysis tests, such as HERS BESTEST and other BESTEST suites included in ANSI/ASHRAE Standard 140, BESTEST-EX compares software simulation findings to reference results generated with state-of-the-art simulation tools such as EnergyPlus, SUNREL, and DOE-2.1E.

The BESTEST-EX methodology:

- Tests software predictions of retrofit energy savings in existing homes
- Ensures building physics calculations and utility bill calibration procedures perform to a minimum standard
- Quantifies impacts of uncertainties in input audit data and occupant behavior.

BESTEST-EX includes building physics and utility bill calibration test cases. The diagram illustrates the utility bill calibration test cases. Participants are given input ranges and synthetic utility bills. Software tools use the utility bills to calibrate key model inputs and predict energy savings for the retrofit cases. Participant energy savings predictions using calibrated models are compared to NREL predictions using state-of-the-art building energy simulation programs.

A diagram and description of the building physics test cases can be found on NREL's BESTEST-EX website at [www.nrel.gov/buildings/bestest\\_ex.html](http://www.nrel.gov/buildings/bestest_ex.html).

NREL and industry stakeholders collaborated to develop the first generation of this test suite. A working group of software developers and other industry experts actively participated in regular technical meetings and field trials of preliminary test cases and documented eight software revisions.

### Key Research Results

#### Achievement

NREL developed a Building Energy Simulation Test for Existing Homes (BESTEST-EX), which allows software developers to evaluate their audit tools' performance in modeling energy use and savings in existing homes when utility bills are available for model calibration.

#### Result

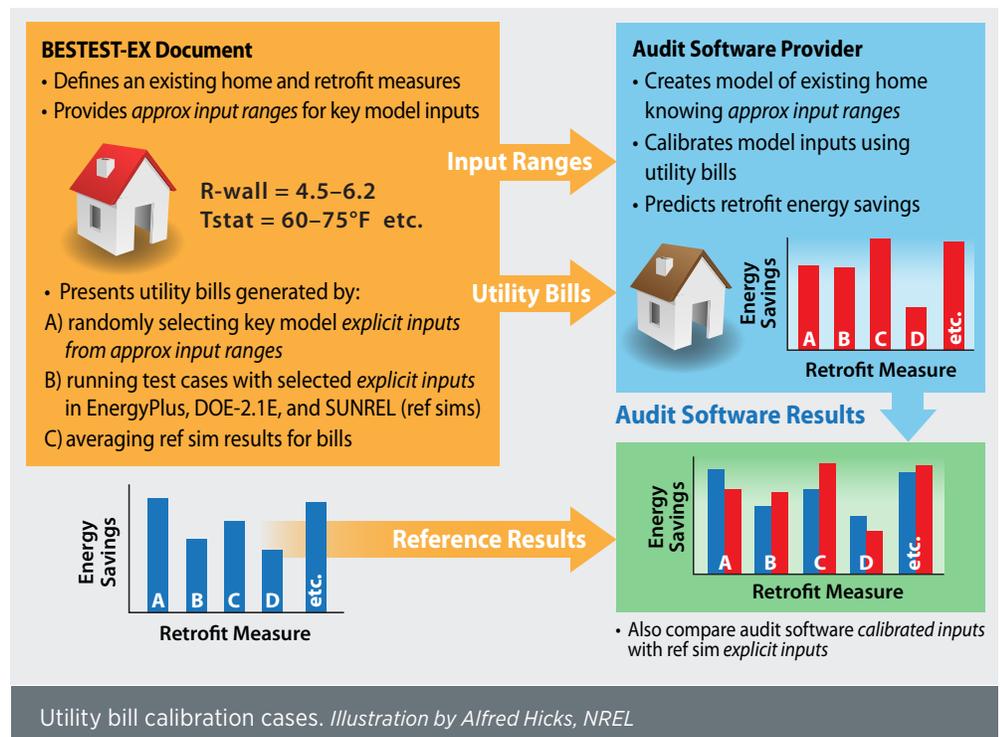
BESTEST-EX is helping software developers identify and correct bugs in their software, as well as develop and test utility bill calibration procedures.

#### Benefit

Improvements to audit tools will reduce risks associated with purchasing, selling, and financing home energy upgrades based on predicted energy savings.

#### Funding Support

This research was sponsored by the U.S. Department of Energy's Building Technologies Program.



Field trial results from five software providers were also analyzed to estimate the benefit of calibrating models to utility bill data. Calibration tended to improve predictions for:

- Scenarios where there was a large difference between utility bills and predicted pre-retrofit energy consumption
- Individual retrofit measures with robust energy savings (e.g., insulation in a heating climate, windows in a cooling climate)
- Combinations of retrofit measures.

Calibration had little benefit for cases where the initial pre-calibration prediction of energy consumption was close to the utility bills. In other words, calibration did not consistently find other more correct input sets with improvements to pre- and post-retrofit data under those conditions.

For the scenarios considering combinations of retrofit measures, the estimated average absolute improvement in accuracy of the predicted annual utility bill savings was \$133 (heating climate) and \$47 (cooling climate).

NREL is developing a second generation of BESTEST-EX test cases by exploring methods for directly comparing software predictions to measured utility billing data. NREL's goal is to provide developers with the tools they need to assess and improve the accuracy of their software over a range of building types, locations, and occupants.

Contact the NREL research team at [BESTEST-EX@nrel.gov](mailto:BESTEST-EX@nrel.gov) if you would like more information about BESTEST-EX or would like to join the BESTEST-EX Working Group.

## For more information

Judkoff, R.; Polly, B.; Bianchi, M.; Neymark, J. (2011). "The Building Energy Simulation Test for Existing Homes (BESTEST-EX) Methodology." Presented at the Building Simulation 2011 Conference, Sydney, Australia, November 14-16, 2011. NREL Report No. CP-5500-51655.

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NREL BESTEST-EX Website.

[www.nrel.gov/buildings/bestest\\_ex.html](http://www.nrel.gov/buildings/bestest_ex.html).

