

# **Leveraging Standard Data Models to Streamline Whole Building Retrofits**

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## **ABSTRACT**

To meet decarbonization goals, reduction of greenhouse emitting fuels in existing buildings needs to accelerate quickly. By one estimate, we need to be performing between 10 to 50 times the current number of deep retrofits to meet these goals. Residential whole building retrofit energy efficiency programs are a critical piece of meeting these goals. Current options for these programs to calculate savings for energy efficiency are either simple engineering calculations or custom whole building energy simulations. Both of these approaches have their limitations that become more pronounced as the programs scale to higher volumes. This paper describes a third approach: standardized simulations that provide a more scalable solution than either of these existing approaches. Specifically, standardized simulations improve on custom whole building energy simulations by reducing the data collection, data processing, and time needed for building energy modeling. Standardized simulations improve on the simple engineering calculations by providing home specific accuracy needed for time and location demand impacts as well as guidance on heat pump load sizing.

These benefits will be detailed based on the authors' experiences from implementation of the New York State Energy Research and Development Authority (NYSERDA) Comfort Home Pilot whole building load reduction pilot program serving over 1000 homes over the last two years.

## **Introduction**

This paper introduces the term, Standardized Simulation, as a new approach to calculating energy savings. The goal of this approach is to harness the power of energy simulations with a much simpler user experience through simplified inputs and pre-defined packages of energy conservation measures (ECMs). The New York State Energy Research and Development Authority (NYSERDA) Comfort Home Pilot program design leverages the standardized simulation approved for use in New York and showcases the scaling potential of this approach. The details of this approach are described below.

## **Background**

Data standards help the entire energy efficiency industry reduce costs of processing information (US DOE 2013). For example, data standards encourage investments in workflow automation by both collectors of data (e.g., contractors and energy raters) and consumers of data (e.g., incentive programs and energy rating systems). If contractors and the companies that provide tools for contractors know that their investments in workflow automation will be usable for more than one utility program, the benefit of that investment increases with little or no increase in cost. Utility programs that consume data are more likely to invest in automation if they know that multiple contractor tools are leveraging those standards. Data standards also

support market growth, by enabling energy efficiency contractors and raters to more easily enter new markets and grow their companies across regional boundaries.

US Department of Energy (DOE) and the National Renewable Energy Lab (NREL) have invested in building interfaces based on data standards to their flagship modeling tool, EnergyPlus. This investment was critical to the work described in this paper and makes the implementation of a standardized simulation practical.

There are two commonly supported methodologies for calculating savings for residential deep retrofits, but each have their limitations when trying to scale. The simple engineering calculations common to Technical Resource Manuals (TRMs) only provide accurate savings in aggregate and are not designed to provide accurate savings per home. TRM based engineering equations also struggle to support emerging technologies like cold climate heat pumps and synergistic packages of measures. The other common savings methodology, custom whole building modeling, is expensive to implement per building for high volume programs, such as residential retrofits. NYSERDA has found that participating contractors in their Home Performance with Energy Star (HPwES) program spend nearly four times as much as Heating, Ventilation, and Cooling (HVAC) contractors on bid preparation (Moriarta 2020). A broader explanation of the various approaches to standardizing calculations for regulated energy efficiency program is contained in the US DOE publication, "Guidance on Establishing and Maintaining Technical Reference Manuals for Energy Efficiency Measures" (Schiller et al. 2017).

This paper presents an alternative approach called Standardized Simulations. The standardization here refers to using transparent methods for converting the simplified user inputs into the details required by the energy model. Reducing and standardizing the data collection has a greater impact when using whole building modeling. According to the DOE, "Inconsistency among modelers, modeling errors, and the cost of modeling are exacerbated by poor integration of energy modeling tools within existing architecture and engineering workflows. Lack of automation and interoperability increases the likelihood of human transcription errors, leads to differences in interpretation between modelers, and soaks up time and money that would be better spent analyzing results and exploring conservation opportunities." (US DOE 2016). Standardized simulations built using data standards provide the benefits of custom whole building modeling such as measure interactivity and supporting time and location dependent demand calculations. Simplifying the input to the simulations makes these calculations available to the contractor at a reduced labor cost per job completed.

The data enrichment process of the Standardized Simulation approach leverages the power of data standards to streamline the development of the simulation and reduce the costs of adapting the simulation process to new technologies or geographies. The standardized simulation savings approach described in this paper is being used by Comfort Home to determine savings for residential retrofit measure packages to reduce heating and cooling loads to prepare homes for electrification. This method has been developed by Performance Systems Development (PSD) with support and funding from New York State Energy Research and Development Authority, US Department of Energy and E4TheFuture. The method has been approved by the New York State Public Service Commission and published in the New York State (NYS) TRM Version 9 in November 2021<sup>1</sup>.

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<sup>1</sup> Published in August 2021:

[https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/\\$FILE/NYS%20TRM%20V9.pdf](https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf)

## Review Current Tools and Data Standards

This section provides a short review of the software tools and data standards used to support a standardized simulation-based program.

### Software Tools

#### Audit tools

Used by contractors to collect data. Most include the ability to calculate savings, but the savings methodology may or may not align with the DSM program requirements. The audit tool needs to be able to send data to a program management system. This can be through proprietary means for fully integrated systems or through a data standard. Audit tool examples from New York include the spreadsheet based EmpCalc program used by NYSERDA's low-income programs, PSD's Targeted Residential Energy Analysis Tool (TREAT) and other HPXML standardized data producing audit tools using physics-based energy simulations.

#### Program management tools

Used by program administrators to track and report on activity in a program. These software applications can provide means for contractors to import data from audit tools or enter data directly. The savings can either be imported from the audit tool or calculated directly by the program management application through a separate savings calculation tool. Standardized simulations use the latter mechanism.

#### Savings calculation modeling tools

An example of a standalone energy modeling tool is the OpenStudio/EnergyPlus application supported by DOE. See Figure 1 for an example of how these tools connect to each other. The standardized simulation described in this paper uses an OpenStudio/ EnergyPlus framework<sup>2</sup> and can support calculations for a wide range of energy conservation measures and standardized packages for the residential sector. The OpenStudio software runs on top of the EnergyPlus engine and supplies a more flexible framework for getting data in and out of the engine. The most important of these is the ability to send a Home Performance XML (HPXML) file into OpenStudio and leverage work by DOE to transform that into the data format needed by the EnergyPlus model<sup>3</sup>.

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<sup>2</sup> The OpenStudio/EnergyPlus framework and the validation testing conducted by US Department of Energy and others is described in supplemental documentation for the *Custom Measure Category 5: Residential Retrofit Standard Simulations for Measure Packages, Chapter A: Third Party Validation for the Open Source Tools (EnergyPlus and OpenStudio)*.

<sup>3</sup> Although the method currently approved for the NYS TRM v9 focuses solely on weatherization measures, PSD is expanding this scope to include complex measures such as heat pumps, controls, energy storage, and other improvements. DOE has provided funding for these additional measures and measure packages under a Small Business Innovation Research grant to PSD. DOE has also funded an expansion of this approach into multifamily buildings.

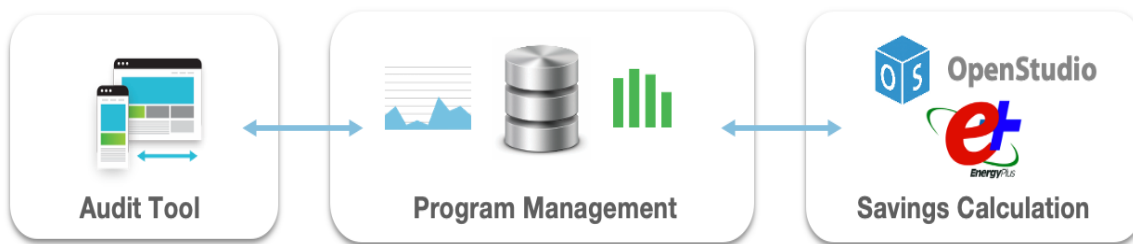


Figure 1. Example software architecture connecting the audit tools to a credentialed EnergyPlus based calculation

## Existing Data Standards

### Home Energy Score Data Model

#### *Background and general information*

The development of the Home Energy Score (HES) was driven by DOE's desire to supply an asset-based analysis of residential home energy performance. An asset rating tries to remove occupant specific variations to allow comparison to other homes based on differences in fixed characteristics. The primary goal is to provide standardized energy assessment information for homeowners, buyers, and sellers of detached single-family and townhomes in the United States (Bourassa et al. 2012). In this paper, the data standard refers to the Home Energy Score data model, separate from generating an actual Home Energy Score.

#### *Reasons for using this standard*

The use of this model in the standardized simulation is driven by the recognition that it represents the fixed asset data points that are the most influential in the energy usage of a home. The DOE has already done a lot of work to reduce the inputs to the simulation for simplified asset rating including the engineering, definition of the terms for the data model, and publishing the data (Bourassa et al. 2012). The HES model provides an optimized set of the critical fields needed to characterize the energy usage state of a building<sup>4</sup>.

#### *Enhancements needed*

Since HES is an asset score, it does not collect any data that would affect the operation of the building, such as number of occupants, thermostat set points, or appliance fuels. The other significant limitation with the use of the HES data model for energy efficiency (EE) programs is that HES supports ECMs at a generic whole building level that is not suitable for calculations tied to energy efficiency program reporting and incentives for site specific improvements, i.e. 300 square feet of insulation installed as retrofit. The data model for the standardized simulation used by Comfort Home includes additional fields for operational inputs and improvement details beyond the HES data model.

#### *Summary*

With those limitations in mind, the HES data model is still a good starting point for capturing information about the state of the existing building and identify where improvements may be needed. In Portland, OR where there is a city mandate for generating a HES at time of

<sup>4</sup> The HES Data model can be found here <https://betterbuildingssolutioncenter.energy.gov/sites/default/files/A3%20-%20Tool%20Data%20Collection%20Form%20%28v.2019%29.pdf>

sale, program administrators were able to identify clusters of homes that would benefit from multiple upgrades spanning from lighting to HVAC to envelope measures (Antonopoulos 2020). For the work in this paper, HES provides a reference for what information to collect from the user. The Comfort Home Pilot program uses a “less than HES” data model where certain fields were eliminated as not needed for this specific program design. This reduction outweighed the enhancements needed.

## **Home Performance XML**

### ***Background and general information***

The Home Performance XML (HPXML) data standard, or the BPI-2100-S-2013 Standard for Home Performance-Related Data Transfer<sup>5</sup>, was originally designed by PSD on behalf of the Building Performance Institute (BPI) to allow EE programs to support multiple modeling tools. HPXML addresses two data-related challenges in the home performance industry: data collection efficiency and interoperability (Andrulis, Thomas, and LeBaron 2012). From its start over 10 years ago, HPXML has become a de-facto standard in the industry. Many of the standalone energy audit tools generate HPXML and several programs (including NYSERDA and Arizona Public Services) have attempted to leverage HPXML to support contractor choice of tools via a market approach. The cost to contractors to enter all the data required for a HPXML based energy model is significant. Review of this data entry is an additional cost to the program and the contractor (resubmission) (Schryer et al. 2020).

### ***Reasons for using this standard***

HPXML’s greatest strength is its ability to define a building in detail. Much of the work in the last ten years has been driven by using HPXML to support modeling using OpenStudio and other tools. NREL’s investment in building interfaces to EnergyPlus based on HPXML makes the standardized simulation practical. HPXML, as currently designed, allows for the description of the building at specific points in time.

### ***Enhancements needed***

One of the drawbacks of HPXML for use in standardized simulations is its limited support for packages of improvements. The development of a separate data model, Heat Pump Ready XML, described next, precluded the need to enhance HPXML to address this weakness.

### ***Summary***

The level of detail supported by HPXML makes it ideal for supporting energy models. For the work described in this paper, user collected data is transformed into HPXML which is then fed into the energy simulations as described below in the Standardized Simulations.

## **Data Models Created Through This Research**

### **Heat Pump Ready XML**

ECMs are presented to the customer as pre-defined packages rather than allowing the homeowner to choose specific ECMs. This is designed to reduce contractor bid costs and streamline customer choice resulting in a higher sales closing rate. This bundling approach makes electrification a viable option for many homes where it would otherwise remain a stranded option (Saxena et al. 2020). This bundling of measures is partly supported by HPXML, but not easily. To better support this, a new data transfer mechanism for communicating between

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<sup>5</sup> See definition of HPXML: <https://www.bpi.org/sites/default/files/BPI-2100-S-2013%20Standard%20for%20Home%20Performance-Related%20Data%20Transfer%20v2.2.0.pdf>

the program management tool and the savings calculation tool was developed. The data standard and data transfer method, named HPRXML for Heat Pump Ready eXtensible Markup Language, was leveraged by the NYSERDA Comfort Home Pilot Program and documented in the NYS TRM<sup>6</sup> to represent a specific sets of measure packages. This HPRXML was then translated into a collection of HPXML files used to drive EnergyPlus, following a process documented in the TRM and summarized below. Support for this type of streamlined scenario management is currently limited in the previously mentioned standards.

## **Standardized Simulations**

The goal of standardized simulations is to provide a mechanism of calculating accurate savings at scale. The starting point of this approach is to take a whole building energy simulation and reduce the number of user inputs to the minimum needed for calculating acceptably accurate savings. Previous work has shown that simulations with simplified inputs and automated error checking can provide accurate savings predictions. Realization rate studies have shown that calibrated energy models can improve savings prediction accuracy (Lenihan 2015). Field studies of simplified asset ratings, using similar standardized simulation methods and standard occupancy related inputs, also have shown strong correlations between predicted and actual usage (Roberts et al. 2016). The main difference that a standardized simulation has over previous reduced input models is the transparent methods used to transform the data. This transparent transformation relies heavily on data standards. This transparency is necessary for the standardized simulation to be reference as a credentialed method in a TRM.

## **Savings Calculation Workflow**

The transformation of the HPRXML data model into HPXML uses an approach called “Improvement Driven Modeling” shown in Figure 2. This approach leverages the fact that the energy savings is primarily driven by the change in the model. Detailed data collection efforts are focused on defining the specifications of the changes to the building. The HPXML files generated by the method are fed into the open source OpenStudio-HPXML Measure<sup>7</sup> developed by NREL. The OpenStudio-HPXML Measure is called to run the EnergyPlus simulations using the building descriptions in corresponding HPXML files.<sup>8</sup>

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<sup>6</sup> See link for NYS TRM:

[https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/\\$FILE/NYS%20TRM%20V9.pdf](https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf)

<sup>7</sup> Reference: <https://github.com/NREL/OpenStudio-HPXML>

<sup>8</sup> More information about this Measure can be found here: <https://openstudio-hpxml.readthedocs.io/en/latest/>

## AUTOMATED ENERGYPLUS IMPROVEMENT DRIVEN MODELING (BETTER-MORE ACCURATE, CHEAPER, FASTER)

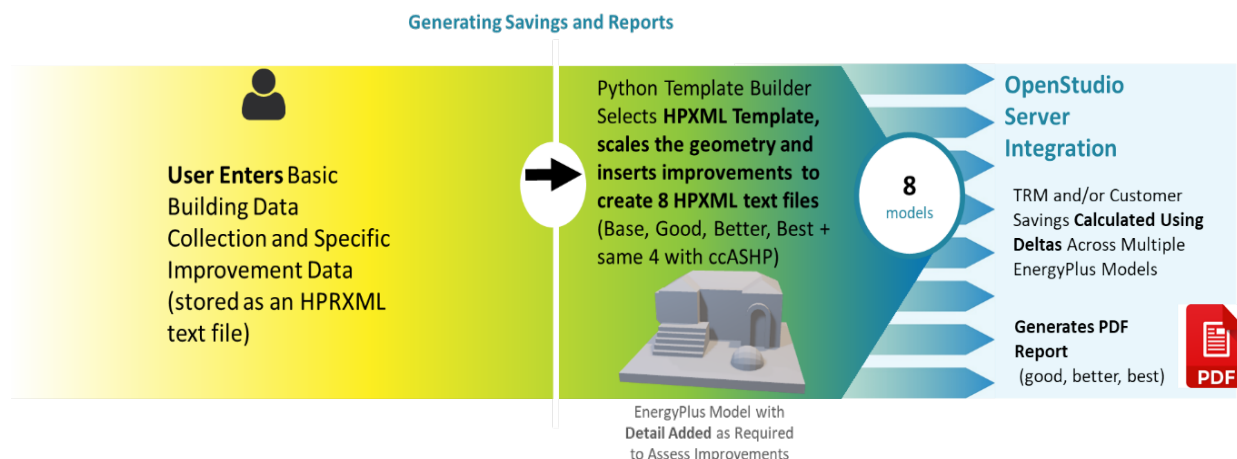


Figure 2. Transforming data from user to server

Total electricity end use, total natural gas or other fuel end use, peak electric and gas demand, zone sensible heating load, and zone sensible cooling load are pulled from the results for each simulation. To calculate savings, the values for performance metrics across improvement packages are subtracted from those for the base building results. The formulas, assumptions, and tables supporting the transformation from HPRXML into HPXML are provided in supplemental documentation for the NYS TRM, v9, *Custom Measure 5: Residential Retrofit Standard Simulations for Measure Packages, Chapter B: Detailed Description for Transforming Standardized Program Data (HPRXML) into HPXML*.

The standardized simulation is executed by transparently transforming the program data provided in HPRXML format into the HPXML data standard before processing by the OpenStudio/ EnergyPlus simulation framework. Encapsulating this logic in a separate server is critical to support the calculations of the standardized simulation to be replicated on a local computer as shown in Figure 3.<sup>9</sup> This is important to allow transparent Evaluation, Measurement & Verification (EM&V) of the savings results. A program evaluator can obtain an HPXML file for one or more jobs and view how the inputs are transformed into a building simulation model.

<sup>9</sup> Support for replicating the generation of an EnergyPlus simulation using the OpenStudio “measure” is provided in supplemental documentation for the *Custom Measure Category 5: Residential Retrofit Standard Simulations for Measure Packages, Chapter G: Methods for Third Party Review of the Residential Retrofit Standard Simulations for Measure Packages Savings Method*.

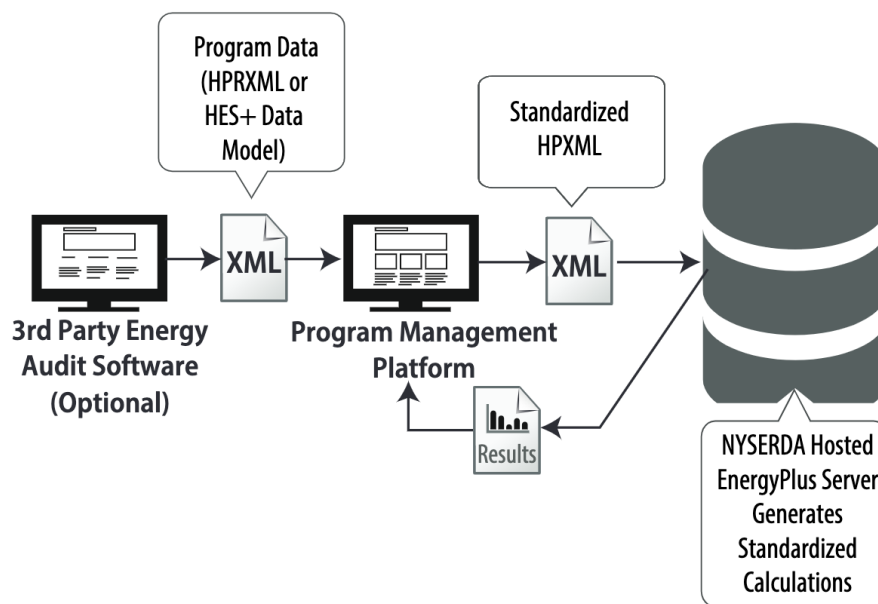


Figure 3. Architecture for supporting NY TRM Standardized Simulations

## Standardized Simulation Benefits Compared to TRM Engineering Equations

Standardized Simulations provide improved prediction of detailed physics-based models with time and effort more in-line with basic asset and deemed savings approaches. Some of the advantages that standardized simulations have over simpler savings calculations include:

- **Packages:** Multiple measures interact with each other within the physics of the simulation. For example, envelope measures change the heating or cooling load in the building, which can affect the savings from HVAC equipment or controls.
- **Floors:** Floors above unconditioned spaces are not exposed to the outdoor temperature. Calculating the seasonal temperature performance of this unconditioned space can be addressed in a simulation.
- **Windows:** Improvements to window U-Value also reduces the transmission of solar gain into the building. This solar gain varies with the direction of the window. Hourly simulations are required to effectively evaluate these impacts.
- **Complex Technologies:** Technologies where performance varies with temperature (e.g., heat pumps) or with changes in schedule, can be represented accurately.
- **Fuel conversions:** Load reductions resulting from implementation of residential retrofit measure packages may include fuel conversion retrofits that are readily accounted for by standardized simulation methods.
- **Equipment Specific Cold-Climate Heat Pumps:** Equipment specific low temperature performance metrics are pulled from Northeast Energy Efficiency Partnership curated list of cold-climate Heat Pumps (ccHPs) and passed into the OpenStudio calculations. This provides greater accuracy of peak and back-up heat at low temperatures. Oversizing effects are also captured and can be used for quality assurance.

The standardized simulation allows for a wider range of inputs relative to published tables of variables in a TRM, thereby increasing accuracy. For example:

- Expansion in the number of weather files available, from 7 to 49, offering improvements in accuracy of up to 10% for building locations outside of the seven urban areas currently in the TRM.
- Operation hours for heating and cooling equipment are not fixed, annual values. Equipment run times are flexible and determined by the load in the simulation.
- Thermostat settings can be adjusted to better reflect occupant operation of equipment. This can help reduce overestimation of savings.

### Standardized Simulation Benefits Compared to Custom Whole Building Simulations

In addition to reducing the number of inputs, standardized simulations provide a number of features over other savings calculation tools and HVAC sizing tools that comply with Manual J. Table 1 lists features supported by the Comfort Home Pilot compared with other savings and load sizing tools such as TREAT, NYSERDA's EmpCalc spreadsheet tool, and Manual J8.

Table 1. Comparison of features for different tools and approximate number of inputs

| Feature                                       | Comfort Home     | TREAT and other HPXML Producing Simulations | EmpCalc | Manual J8 | Manual J8, Insulation, and Heat Pump |
|-----------------------------------------------|------------------|---------------------------------------------|---------|-----------|--------------------------------------|
| Insulation/Air Sealing                        | Yes              | Yes                                         | Yes     |           | Yes                                  |
| Windows                                       | Yes              | Yes                                         |         |           |                                      |
| Load Sizing                                   | Yes              |                                             |         |           | Yes                                  |
| Accurate Low Temperature Performance of ccHPs | Yes              |                                             |         |           |                                      |
| Home Energy Score                             | Yes              |                                             |         |           |                                      |
| Gas Peak                                      | Yes              |                                             |         |           |                                      |
| Interacted Savings                            | Yes              | Yes                                         |         |           |                                      |
| Time and Location Dependent Impacts           | Yes              |                                             |         |           |                                      |
| Rough number of Inputs                        | 75 <sup>10</sup> | 100+                                        | 50      | 85        | 135                                  |

The development of the standardized simulation included simplification and optimization of inputs. Only the inputs with the strongest relationships to predicted savings are exposed to the user, others are defaulted or abstracted. These input simplifications, along with conservative assumptions on preconditions in the buildings, are key to managing the variability in results. Utilities often avoid custom measure modeling-based approaches to minimize savings variability and avoid low realization rates. The other benefit standardized simulations have over custom models is their ability to easily support interactive calculations for packages of energy

<sup>10</sup> Assumes load sizing. If not needed, system can provide home specific defaults to reduce user input requirements.

conservation measures. A package approach streamlines the sale of the home improvement work by reducing the effort of customer education needed. Packages combined with the sensitivity analysis,<sup>11</sup> drive the definition of the standardized program data model HPRXML.

### **Additional Outputs from the Residential Retrofit Measure Packages**

As noted above, the OpenStudio/EnergyPlus based method provides additional metrics beyond annual savings and demand impacts that may be of high value to decarbonization programs.

- **A Block Load Calculation of “Equivalent” Heating and Cooling Loads** When modeled HVAC equipment is indicated as ‘auto-sized’, these capacities are calculated by the EnergyPlus / OpenStudio workflow to set the auto-sized capacity values. These values are available as outputs from the simulation. These whole building peak heating and cooling loads are calculated using an approach tested to be equivalent to industry standard load calculations (Thomas et al. 2021). Testing involved running an approved Manual J 8 tool with detailed input against the simplified inputs of the OpenStudio measure for a set of houses in different NY weather zones. This equivalent block load calculation method estimates the peak heating and cooling load contributions of windows, doors, walls, roofs, floors and infiltration/ ventilation components and occupant related internal gains that are described within an HPXML file.
- **Time and Location Dependent Peak Demand** The EnergyPlus / OpenStudio workflow generates several data outputs that support the estimation of location specific values of Peak Demand. A machine learning algorithm (also used by the DOE Asset Score Tool) has been used to map one of 49 different TMY3 Weather files to each of the 1,753 New York Zip Codes for hyper-local weather. For each HPXML file and associated simulation run, a maximum value of the whole building electricity meter is reported, along with the paired 10-minute time stamp of occurrence. In addition, the simulation provides the peak value (and time of peak) of all electricity end-uses, such as electric heating or electric cooling. Finally, the workflow also produces time series outputs for whole building electricity, which can be post processed to estimate values associated with a coincident system peak.
- **Gas Peak Heating Load** The EnergyPlus / OpenStudio workflow can use the same techniques available for estimating Peak Electrical Demand impacts that are described above, for Natural Gas. For each HPXML file and associated simulation, both the time of peak and magnitude of peak Natural Gas, for both whole building usage and the heating end-use, can be generated.
- **Customer Facing Interacted Fuel Conversion Calculations** The standardized simulation supports the calculation of interacted savings, such as the conversion from existing equipment to heat pumps, without any envelope improvements, and in combination with each of the measure packages. Savings calculations that use code baseline values of performance (equipment and windows for example) can be run in parallel with actual baseline performance values, providing customers with site and project specific savings for their project without requiring additional contractor effort.

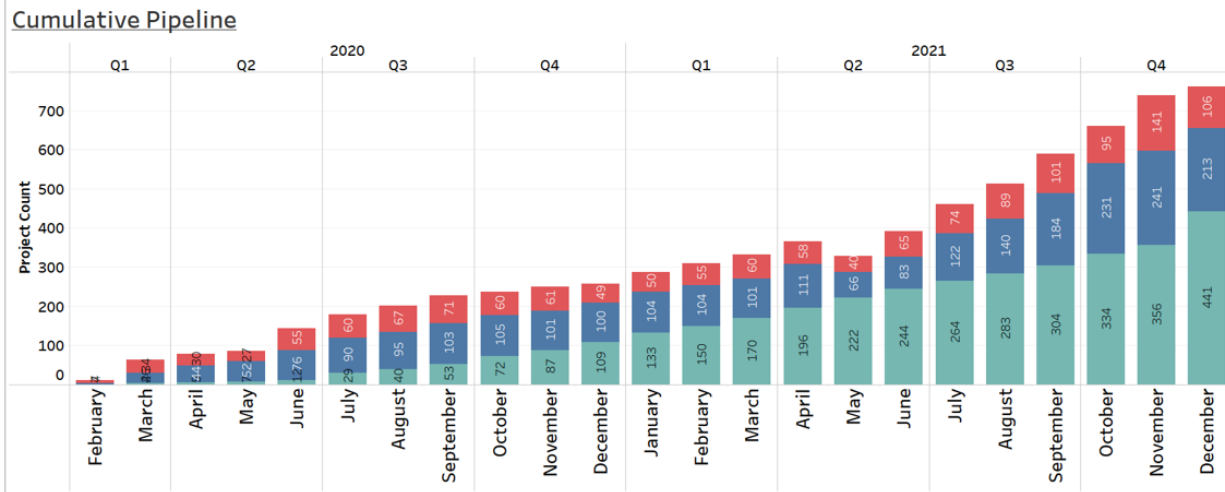
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<sup>11</sup> The sensitivity analysis is described in supplemental documentation for *the Custom Measure Category 5: Residential Retrofit Standard Simulations for Measure Packages, Chapter C: Validation of Savings Results*.

## Comfort Home Pilot Case Study

To reach the New Efficiency: New York (NE:NY) Order and New York State's Climate Leadership and Community Protection Act (CLCPA) decarbonization objectives, NYSERDA and the New York utilities must decarbonize over four million residential dwellings over the next 30 years. The Comfort Home pilot program is a market rate whole building, residential energy efficiency program run by NYSERDA to help meet the decarbonization goals of the CLCPA and NE: NY (Schryer et al. 2020). Primary pilot goals were to streamline program delivery and test the impact on sales to install cycle time reduction and increased conversion rate by the following actions: 1) eliminate need to custom model estimated savings for every home and instead use standardized simulation for specific measure packages to demonstrate savings to the homeowner and report program savings, 2) test a market segmentation tool to target customers based on certain home characteristics and psycho-demographic criteria (primary fuel type, home age, homeowner income, education, etc.) when used with documented sales pitch to sell a specific measure package. Highlights include the use of pre-defined packages of load reduction measures, emphasizing the synergy of the load reduction with the installation of a right-sized heat pump for cold climate use. Implementation of the new NY TRM standardized simulation method reduces the number of inputs required to achieve an acceptable savings estimate consistent with estimated savings and gross realization rates from prior evaluation studies while also leveraging inputs for use in load calculations in preparation for heat pump installation.

Project goals for this pilot were somewhat constrained due to COVID and a related pause in conducting home assessments during 2020 just as the pilot launched. As the industry began recovering, contractors were able to leverage the new savings tool and sales strategies to offer customers appropriate measure packages for the home and completing a cumulative number of 757 projects in the pipeline with 441 installed projects by 2021 year-end. The goal is to triple production to 1,500 completed projects in 2022 and double completed projects to achieve cumulative metric of 4,500 projects by 2023 year-end. The pilot fully anticipates meeting these goals given the recent 12 – 15% growth rate in cumulative number of projects in the pipeline per month, see Figure 4. As customers enroll in the program, they progress from Customer Enrolled status (red) to Assessment Completed (blue). If the homeowner agrees to proceed with the work, the project status progresses to Install Approved (teal). Both Assessment Completed and Install Approved represent end states and thus are expected to grow over time.



## Project Status

■ Customer Enrolled      ■ Assessment Completed      ■ Install Approved

Figure 4. Cumulative pipeline of home participation

Using the standardized simulation method to demonstrate estimated savings to the homeowner eliminated the need for auditors to custom model every home and allowed them to focus on selling the right package for a “ready” homeowner. Sales cycle time was cut from 156 days in 2020 to 64 days in 2022 to achieve an average savings of 27 MMBtu/project. Average savings by package type is presented in Figure 5 below. Based on internal program reporting, the conversion rate from assessment to completed install was 51%, thereby exceeding previous reported conversion rate of ~35% for HPwES as reported in previous evaluation studies. Pilot work is still underway to test use of the market segmentation tool to target customers based on certain home characteristics and psycho-demographic criteria to further improve the conversion rate, drive cycle time reduction and reduce the cost of customer acquisition.

## Savings Results

The New York Residential Retrofit Standardized Simulation consists of three envelope packages that are presented by order of priority based on the estimated load reduction and savings impact realized from the package installation in the climate zone as identified by building zip code and mapped to the appropriate NREL TMY3 weather file. By standardizing the package offered to the consumer, the contractor may reduce customer acquisition costs while driving consumer choice to the greatest impact. The package improvements are designed in a tiered approach to achieve the highest reduction in the home’s heating and cooling loads thereby making the home ready for clean heating solutions aligned with electrification goals in New York. The simulation methods are both flexible and extensible enabling custom packages to satisfy policy goals specific to given regions. The three standard packages are

- **Package 1:** attic air sealing and insulation, basement rim joist seal and insulate
- **Package 2:** wall insulation, floor insulation, and all measures included in Package 1
- **Package 3:** ENERGYSTAR windows or equivalent and all measures included in Package 2

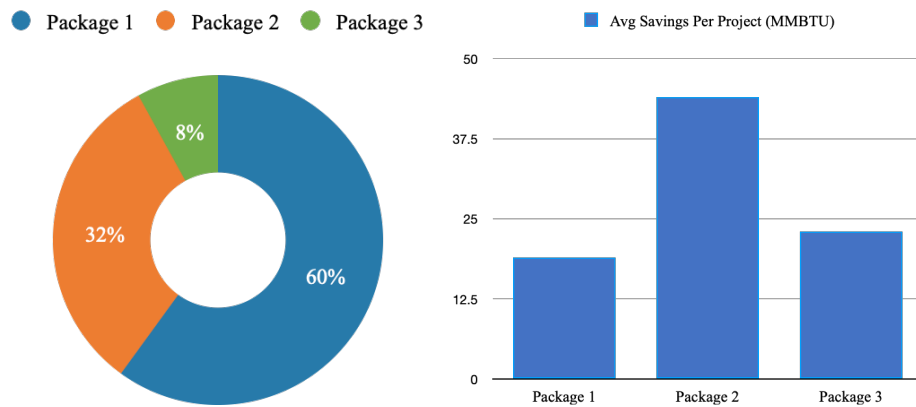


Figure 5. Breakdown of number of projects and average savings per package type

Figure 5 shows savings results from the Comfort Home pilot. Package 1 and Package 2 weatherization improvements achieved an average savings of 19 MMBtu/project, and 42 MMBtu/project, respectively. Approximately 8% of the projects completed to date opted to include high performance window retrofits under Package 3 to achieve an additional 23 MMBtu savings for sites that already met the program criteria for Package 1 and 2. Average load reduction for comprehensive installs in 2021 was approximately 1.5 tons. While these packages are meant to be cumulative, the reality is that there is a significant break between customers willing to do whole house insulation and air sealing (Packages 1 and 2) and those adding windows (Package 3). The drop in savings from Package 2 to 3 reflects that many of the homes that had windows installed had already met the program criteria for insulation and air sealing in Packages 1 and 2 and thus the savings often reflect just the savings from windows alone and not the previously completed insulation work.

Future work will further leverage the sale of pre-defined load reduction packages, emphasizing the synergy of the load reduction with the installation of a right-sized heat pump for cold climate use. Adding load calculation inputs to help right size heat pumps after weatherization improvements will further assist contractors by reducing the time needed to achieve an acceptable savings estimate consistent with estimated savings and gross realization rates from prior evaluation studies.

## Conclusion

The use of data standards to support streamlining delivery of whole building deep retrofits can be a critical strategy to meeting the decarbonization goals necessitated by the climate change crisis. These methods can be used to expand the pool of trade allies who can meaningfully contribute to deep retrofits, reduce the costs of participating in utility DSM programs, streamline the reporting needs for energy efficiency programs, as well as making it easier to properly size heat pumps as part of a deep envelope retrofit. Prioritization of weatherization improvements, targeting segmented customers, and use of standardized data at time of home assessment helps to direct homeowner decision-making and demonstrates the ability to more than “save a ton” of heat pump capacity with the added benefit of an estimated average heat pump peak demand savings of 3.8 kW in the northeast. The investments that DOE has made in the definition and use of such standards in their tools allows for programs to take advantage of those tools to provide innovation and drive energy efficiency programs to the next level.

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