



FirstView[®]

nbi new buildings institute

A Diagnostic Review of Building Energy Performance

What is FirstView[®]?

FirstView is a software tool and suite of services from NBI that enables a simple yet insightful diagnostic review of energy performance in commercial buildings. FirstView's calculation engine uses multivariable regression analysis to generate a weather-normalized simulation model of a building. The building's energy usage is disaggregated into heating, cooling, thermal baseload, and electric baseload. This allows building owners, operators and designers to better understand their building's energy use. FirstView can also provide diagnostics to help identify potential improvement opportunities.

Two FirstView Versions

NBI maintains two separate versions of FirstView. There is a subscription-based webtool that allows users to input their own buildings and obtain fully automatic analysis results online. NBI sponsors have access to the tool and others may buy access at newbuildings.org/firstview. NBI also provides custom analysis services and portfolio evaluations using a more complex and customized back-end version. If you are interested in custom FirstView analysis services please contact firstview@newbuildings.org.

What is an Energy Signature?

An Energy Signature is a display of normalized monthly energy use compared to monthly average outside temperature. Energy use is plotted on the vertical axis and

outside temperature is plotted on the horizontal axis. High energy use is expected during summer and winter months, while the milder "shoulder" seasons typically show lower energy use.

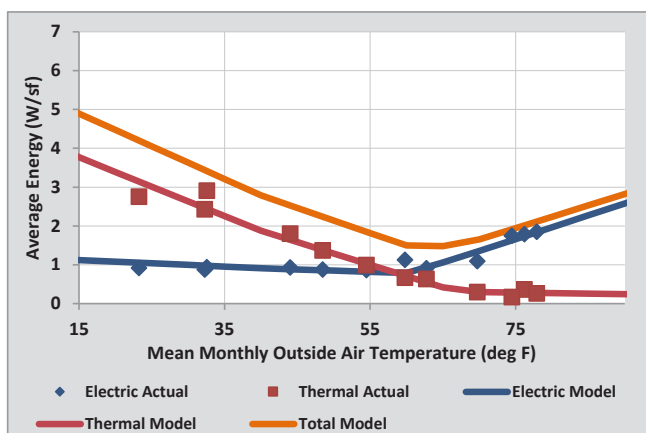
An Energy Signature reveals key performance indicators at a glance. For instance, a steeply sloping line in cold temperatures indicates a building whose heating energy use is highly sensitive to outside air temperature.

What is the difference between the FirstView software and the ASHRAE inverse modeling approach?

Although both the FirstView tool and the ASHRAE Inverse Modeling Toolkit (IMT) use energy signatures to visualize a building's energy use, the fundamental approaches differ. The IMT is essentially a statistical method of analyzing energy, using a regression algorithm to determine the relationship between temperature and energy use. In contrast, the FirstView tool uses a physics based building energy model to estimate energy use as a function of temperature. This model relies on physical parameters like building envelope heat transfer rate, internal loads wattages, and temperature setpoints. This method accounts for all energy sources (typically electricity and gas) and the interactions between different fuels. Once the energy model is properly weather-normalized and calibrated to match utility bills (a process that the FirstView tool completes automatically) it provides a powerful mechanism for exploring the energy use of your building.

How has the FirstView tool been tested?

The FirstView tool's calculation engine has been used on thousands of buildings. These analyses range from individual buildings to municipal benchmarking to large data sets on behalf of the USGBC's Building Performance Partnership (BPP) program and the Oregon Cool Schools Initiative.



Multiple independent validations of the FirstView methodology have been conducted. In late 2016 the National Renewable Energy Laboratory (NREL) published two reports comparing FirstView evaluations to both simulated and actual building utility usage. A high degree of correlation was found between actual building performance issues and FirstView results. These studies are titled “Methodology to Assess No Touch Audit Software Using Simulated Building Utility Data” and “Methodology to Assess No Touch Audit Software Using Actual Building Utility Data” and can be found at: nrel.gov/docs/fy17osti/66001.pdf and nrel.gov/docs/fy17osti/67236.pdf.

The California Energy Commission Public Interest Energy Research program has also funded the FirstView tool’s development. With PIER funding, NBI conducted a ‘deep dive’ into a group of 22 LEED buildings in California. For those with available monthly energy bills, NBI compared the results of the FirstView tool with inspections conducted during a walk through audit of the buildings.

A high degree of correlation was found in the results at a fraction of the cost and effort as the walk-through efforts.

What type of comparisons do FirstView software and services enable?

FirstView disaggregates energy usage into four broad categories: heating, cooling, thermal baseload, and electric baseload. The Energy Signature plot illustrates graphically what the software is analyzing algebraically on the back end. Algebraic analysis of the physics-based building simulation model enables comparisons including automated diagnostics, a peer building comparison, a design model comparison trending analysis.

1. Automated Diagnostics. FirstView automatically compares mathematic parameters revealed in the Energy Signature to thresholds in six key performance areas: electric baseload, heating (and winter ventilation) efficiency, cooling (and winter ventilation) efficiency, controls, HVAC reheat, and thermal baseload. Staff at New Buildings Institute set these diagnostic thresholds for particular building types based on comparisons to hundreds of typical and high-performance buildings analyzed with

FirstView. This enables the tool to quickly and automatically identify poor, average or high performance and directs attention to particular areas that warrant more attention.

2. Peer Building Comparison (Spectrum). In addition to a diagnostic comparison, FirstView software and services allow for an advanced benchmarking comparison that graphically illustrates how a reference building compares to its peers. For this, NBI staff defines a comparison spectrum of performance based on results from hundreds or thousands of previous FirstView runs. Currently, NBI has both high-performance and average-performance comparison spectra for offices, schools, multifamily buildings, fire stations, libraries, and community centers. NBI can also generate custom spectra for specific groups of buildings, such as a city or a building portfolio owned or managed by one group.

3. Design Model Comparison. FirstView can co-plot energy model predictions along with measured results. The energy signature enables a temperature normalized comparison between predicted modeled data (using TMY data) and utility bills using actual weather observations). While the idealized assumptions of an energy model often predict energy use that is lower than measured values, it serves as a useful target.

4. Trending. Using multiple years of utility bills, FirstView’s calculation engine can plot energy signatures for consecutive years to compare performance. This can be analyzed against specific information known about the building, such as changing vacancy rates or building system upgrades, to reveal underlying performance from year to year on the same plot.

How are the FirstView tool’s diagnostics generated?

Parameters for specific diagnostic categories are generated using past FirstView tool results and New Buildings Institute staff’s experience in building science research. After reviewing more than a thousand FirstView tool runs, along with decades of work in high performance buildings, NBI sets thresholds for each diagnostic category. The FirstView tool mathematically compares the results for a particular building to the thresholds to recommend targeted areas for energy savings.

Technically, how does the FirstView software work?

For a comprehensive analysis of how the FirstView software works, please refer to the RESOURCES section of the website. http://newbuildings.org/sites/default/files/FirstViewTool_NBI_aceee2010.pdf

What is an aggregated building data set, and how can it be used as a benchmarking tool?

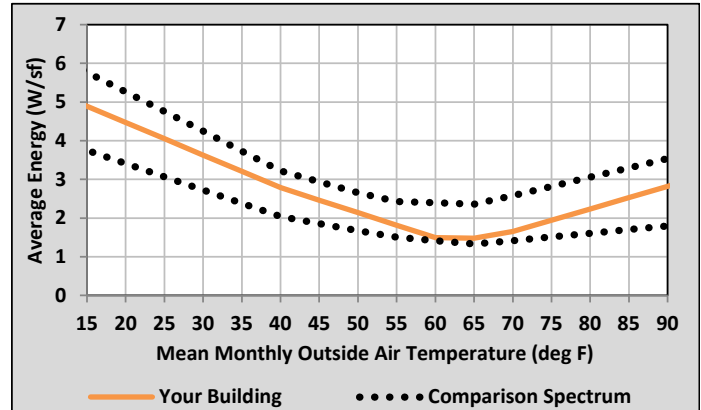
An aggregated building data set, commonly referred to as a ‘spectrum’ by NBI, is a sample set of buildings that serve as a benchmark for comparison. Spectra are aggregated energy signatures provided by NBI that include at least 10 buildings and do not reveal identifying details such as building name, specific location or exact size. As NBI analyzes more buildings with FirstView, we are able to expand comparison groups for users. For example, a user might be able to select a spectrum that represents 50 San Francisco area office buildings between 25,000 and 50,000 square feet.

As a service, NBI can help groups create their own spectrum or users may use any of the several spectra that NBI currently has available.

What is a ‘spectrum’?

One benefit of using FirstView to evaluate building performance is the ability to compare your building’s energy signature to the signatures of peer buildings. NBI has aggregated many peer building energy signatures and produced collective benchmarks to show the range of performance across many buildings. These comparison benchmarks are illustrated as ranges of energy signatures and each comparison dataset is referred to as a “spectrum.”

Energy Signature Comparison



Each spectrum is customized for a particular building type. NBI offers comparison spectra for several building types, including offices (both median and high-performance), multifamily buildings (both affordable and market-rate), libraries, fire stations, community centers, and K-12 schools. As a special service, NBI can also create a custom comparison spectrum for your building portfolio or geographical area.

What data do I need to run FirstView?

FirstView relies on the same dataset as Energy Star Portfolio Manager: basic building characteristics including building location, size (sq. ft.), and type; as well as at least one year of energy consumption including all fuels (electricity and gas, for instance). If significant process loads such as data centers, swimming pools, pumping stations, etc. are present this building must be analyzed using NBI’s back-end custom software as the webtool cannot disaggregate process loads in such cases.

How are renewables handled?

The primary goal of the FirstView tool is to account for the energy used within a building, regardless of generation method. Therefore, on site renewable energy should be treated just like energy purchased from the utility. For example, let’s consider a set of bills:

	December 2011	June 2011
Meter 1 (grid purchased electric)	10,000 kWh	-5,000 kWh
Meter 2 (Solar PV array)	5,000 kWh	15,000 kWh
Total usage input to the FirstView tool	15,000 kWh	10,000 kWh

How can data be input into the FirstView webtool?

There are three different ways to import data into the FirstView webtool. Users may upload batches of data using the Energy Star Portfolio Manager export format.

1. If you have buildings in Portfolio Manager you can click “Export All” and download the export spreadsheet. Then, by uploading this file to Firstview you can batch upload all your buildings in one action. Alternatively, you may download the template for this file here: newbuildings.org/product/firstview/.
2. You can enter electricity and gas data for a single building at a time by copying and pasting that data from a spreadsheet into the webtool.
3. You can enter building characteristics and usage data one field at a time in the using a standard web interface.

Is data input into the FirstView webtool confidential?

New Buildings Institute will never reveal any identifying information about your building without your permission. Data entered into FirstView may be aggregated and used for research purposes, but NBI will never reveal information about individual buildings. This aggregated data is used to generate comparison spectrums, which do not reveal any identifying details about individual buildings such as building name, location, size, or even individual building energy signature. If you have further data privacy questions or concerns please contact firstview@newbuildings.org.

Do I need submeters and interval data?

No. The only energy use data required for a FirstView tool analysis is your monthly utility bills. FirstView tool reports are not intended to replace the more complex, detailed and costly outputs from building automation, submeters or energy information systems. Instead, the FirstView tool provides a quick level of insight that can be applied to most buildings, even those that often do not have such systems and cannot afford to dedicate resources to detailed data analysis. After the FirstView tool has identified areas for further investigation, additional analysis tools or on-site auditing can be better directed and deployed with greater

efficiency. This includes a more detailed review of sub-metering data, if available.

What if my building has multiple electric meters, or uses more than two fuels?

Buildings with multiple meters will need to combine those usage amounts into one combined sum for each fuel type (electric, gas/steam, district chilled water). This may be the case if you have multiple electric meters feeding the building or may be due to having both grid-supplied electricity and on-site renewable generation. In either case, combine the kWh usage in the building into one monthly total. Similarly, if your building has multiple gas meters, these will need to be combined into one monthly total. Chilled water usage can be analyzed by NBI’s back-end custom FirstView tool.

How do I account for oil or propane deliveries?

The FirstView tool relies on actual energy used, not delivered. Therefore oil and propane deliveries will need to be adjusted into monthly usage. Feel free to contact NBI for additional guidance on how these fuels can be accommodated. You can reach us at firstview@newbuildings.org.

Does the FirstView tool work in all climate zones?

Yes, the FirstView tool works in all climate zones. Furthermore, the FirstView tool’s energy signature is an expression of the building’s characteristics and not the climate zone. In other words, since the FirstView tool normalizes for building size and temperature, even buildings in totally different climate zones can be easily compared.

How are thermal fuels like natural gas or district hot water compared to electricity?

Thermal energy usage, whether from natural gas or district energy, is converted and expressed in the same units as electricity to facilitate whole-building energy balance analysis. All fuels are combined in the FirstView analysis report plots.

What does Average Energy on the Y axis mean?

The vertical axis for energy use can be expressed in normalized W/SF or normalized kBtu/yr/SF. In this sense, normalized means the energy use is normalized both to building size and to the number of days in a month. Normalizing in this way makes the data inter-comparable between cases of different billing periods and building sizes and expands opportunities for comparisons. We have chosen to express the energy use in W/SF, but equivalent units of kWh/(Day*SF) or Therms/(Day*SF) could also be used.

Let's consider an example for a 10,000 SF building: In April the electric bill indicates 25,000 kWh of usage. Since April has 30 days, this is $25,000/30 = 833.3$ kWh/day. We can then convert days to hours with $833.3/24 = 34.7$ kWh/h or 34.7 kW. The final step is to normalize by building size and convert kW to W, which gives $34.7*1000/10,000$ SF = 3.47W/SF and/or kBtu/SF. If for some reason this bill was for a period of only 15 days, the Average Energy would be doubled, or 6.9W/SF.

Does the FirstView tool work for non-office building types?

The FirstView software works for many, but not all, building types. Building types with built-in comparison spectra include offices, schools, affordable and market-rate multifamily buildings, fire stations, libraries, and community centers. The FirstView tool may not be appropriate for laboratories, hospitals, data centers, grocery stores or other buildings with large and unpredictable process loads. Also, the FirstView method relies on whole-building energy usage data and cannot be used if the whole building's energy usage cannot be established. One potential example of this case is a multifamily building in which each tenant's energy usage cannot be conveniently gathered.

What if my building has large process loads?

Although the underlying energy model used by the FirstView tool can be used to analyze buildings with consistent large process loads, the current web tool does not offer this functionality. If your building has modest process loads the FirstView tool's analysis should not be

affected. However, buildings with large process loads may cause the FirstView tool to not allocate the process load energy accurately. For example, the model may assume that the large electric baseload from a datacenter provides sufficient heat to displace the need for a gas furnace. However, the datacenter may be designed such that the waste heat is vented outside your building and does not contribute to the heating/cooling load. Additionally, if your process load fluctuates, the driving factor behind that fluctuation, such as a production schedule in a machine shop, will not be captured in the FirstView tool's model. The NBI custom back-end FirstView software can analyze buildings with large process loads when the magnitude of those loads can be estimated.

What types of automated responses does the FirstView tool make?

The FirstView tool provides automated responses for the following key performance indicators:

- Electric Baseload
- Heating and ventilation efficiency
- Cooling and ventilation efficiency
- Controls
- HVAC Reheat
- Thermal baseload

For more information about the automated responses generated by the FirstView tool, see the Understanding FirstView Results factsheet: newbuildings.org/product/firstview/

How does the FirstView tool compare to other modeling packages, such as eQuest or EnergyPlus?

Other modeling tools are primarily intended for use during building design. These models are extremely detailed and provide a comprehensive framework for modeling hourly energy use, with the primary purpose of sizing HVAC equipment and predicting comparative energy use.

The intention of the FirstView software and services is quite different. In this case the building is already constructed and operating. Often the as-built condition has changed from the original model and operating conditions may

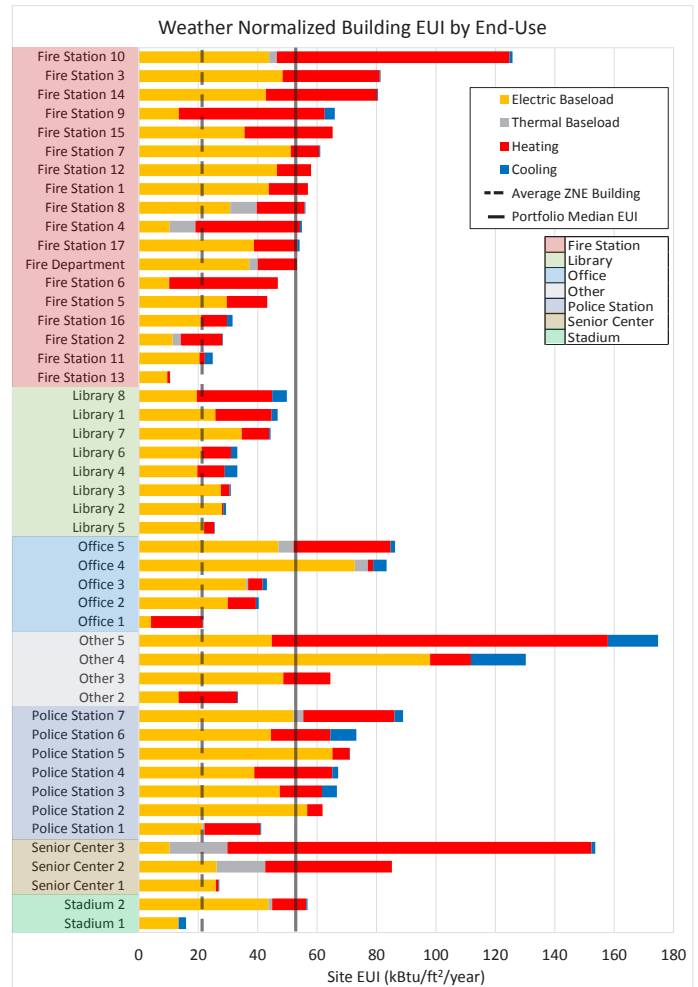
differ from the assumptions used during design. In many existing building cases a design model was not generated or cannot be found. Even if a model is available, a thorough audit and experienced modeling engineer would be required to properly calibrate the model to as-operated conditions. Each team may use a different approach and arrive at different conclusions. FirstView automates this process, providing a consistently calibrated energy model that can be compared from one building to the next. FirstView's approach aims to provide a lot of useful information at a low cost.

How can I evaluate more than one building at a time?

As a custom service, NBI can evaluate a portfolio of buildings with FirstView and produce a detailed custom report that considers individual building upgrades within the context of their peers. The prioritized upgrade recommendations contained in a FirstView Portfolio Analysis report allows building owners and managers to strategically plan energy-saving improvements across their portfolio. For example, this chart shows building EUI by end-use across the entire portfolio. In this example, Fire Station 10, Other 5, and Senior Center 3 clearly have much higher heating usage than their peers, indicating that these are good places to look for heating and ventilation improvements. A sample FirstView Portfolio Analysis Report is available at newbuildings.org/product/firstview/.

Where do I go for a second view?

FirstView software and services provides an initial diagnostic look at how buildings use energy. With that information, owners, operators and designers can make more informed decisions on how to prioritize their next steps. This might include conducting a more targeted audit, changing operating practices or working to minimize particular areas of a building's energy use. NBI has many resources to assist through our Advanced Building® suite of tools. newbuildings.org/hubs/advanced-buildings/



Founded in 1997, New Buildings Institute (NBI) is a nonprofit organization working to improve the energy performance of commercial buildings. We work collaboratively with commercial building market players—governments, utilities, energy efficiency advocates and building professionals—to remove barriers to energy efficiency, including promoting advanced design practices, improved technologies, public policies and programs that improve energy efficiency. We also develop and offer guidance to individuals and organizations on designing and constructing energy-efficient buildings through our Advanced Buildings® suite of tools and resources.

To learn more, visit: newbuildings.org.

