



BPI-2400 Calibration Made Simple:

Practical Insights for Better Audits

Presented by:





AGENDA

1. Opening Discussion
 - Attendee experiences with calibration
2. What is a Calibrated Model?
 - Defining calibration and its role in energy modeling
3. Why Calibration Matters
 - Accuracy, customer trust, and improved realization rates
4. How to Calibrate a Model
 - Step-by-step: utility data → building inputs → model adjustments
5. Smart Data Collection
 - Prioritizing impactful inputs and managing uncertainty
6. Climate & Building Context
 - Regional variations, thermostat usage, HVAC, and insulation assumptions
7. Troubleshooting Calibration Issues
 - Common modeling pitfalls and how to avoid them
8. Q&A + Case Insights
 - Lessons learned from real-world programs using OptiMiser

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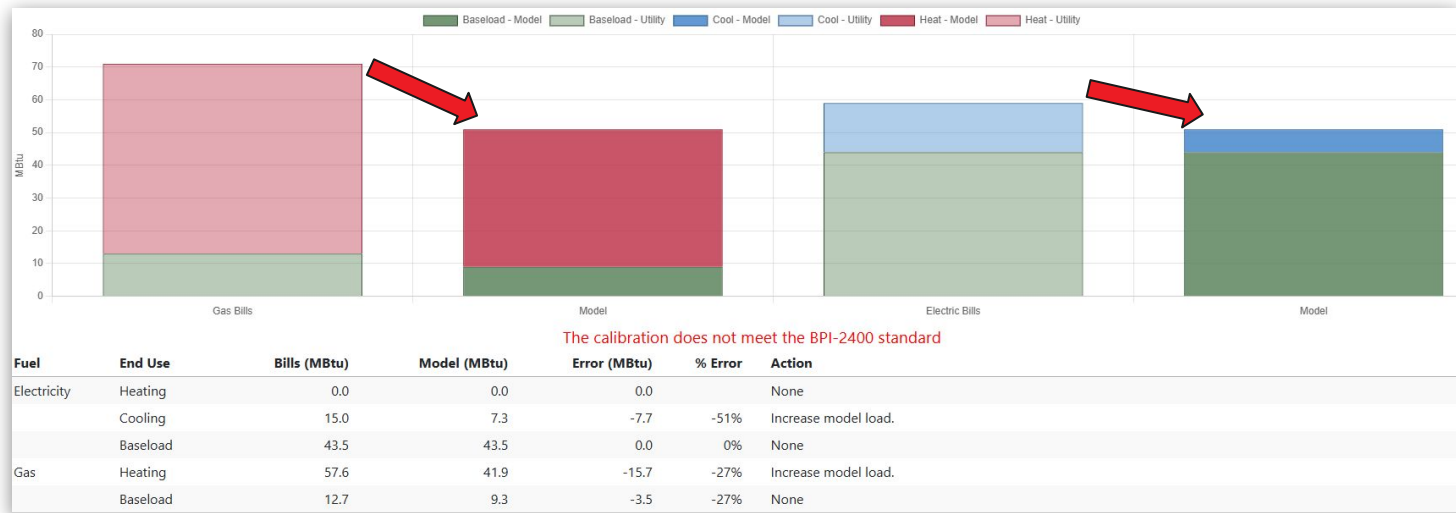
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What is not a Calibrated Energy Model?



Modeled building does NOT MATCH the energy consumption of the real building.

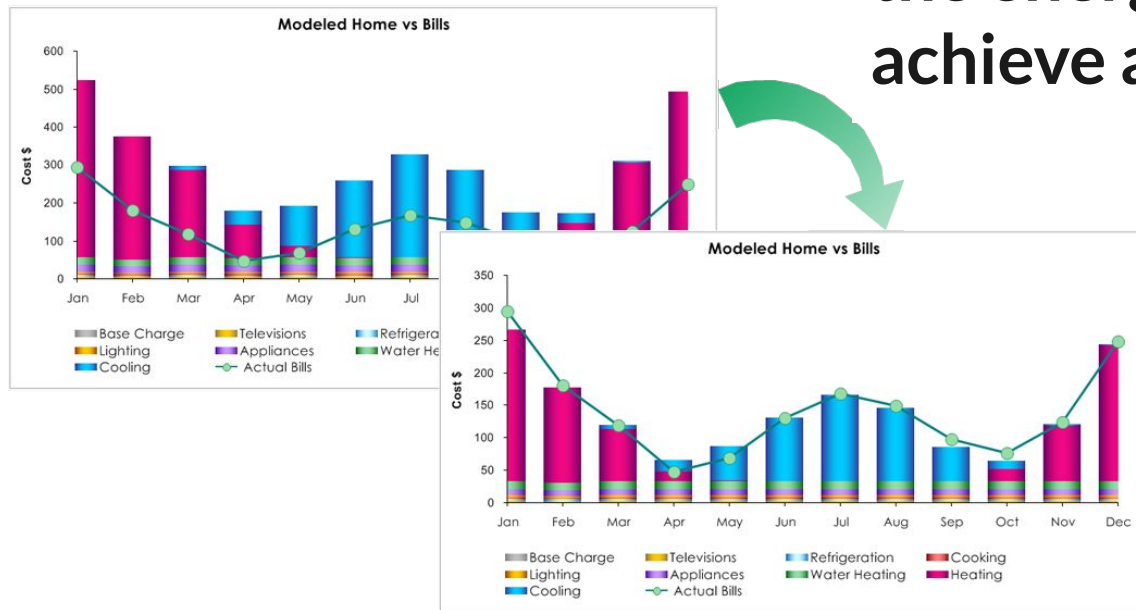
What is a Calibrated Energy Model?



Modeled building MATCHES the energy consumption of the real building and occupants.



Calibration is the process of adjusting the energy model to achieve alignment.



Models are really useful: they help us understand buildings, allow us to experiment with and optimize solutions, and can lead to unexpected discoveries.

Calibration is a great way to make sure your model has a solid foundation.

Why is calibration needed?

- Calibration to historical energy usage significantly improves the accuracy of savings predictions.
- Uncalibrated energy models can differ from actual usage by as much as 100% or more.
- Errors in the baseline model increase the odds that predicted ECM saving will have errors.
- This most commonly leads to overprediction of savings.

Improvements	Selected Energy Improvements	% Energy Saved	Cost	Save Year 1	SIR
Insulate attic	Increase attic insulation and coverage to save energy and increase comfort.	9.5%	\$2,106	\$141	4.9
Air seal / vent	Reduce air leaks and weatherstrip doors to save energy and increase comfort.	7.4%	\$1,465	\$97	1.6
• Air seal	Reduce air leaks and weatherstrip doors to save energy and increase comfort.	7.4%	\$1,465	\$97	1.6
Windows	Add storm windows or install new windows to save energy and increase comfort.	0.1%	\$2,190	\$5	.1
Insulate crawl	Warm your crawl space to save energy and increase comfort.	3.6%	\$683	\$41	2.0
Thermostat	Install a timed thermostat or increase your temperature setback to save energy.	8.3%	\$185	\$122	16.3
Heating + Cooling	Improve the efficiency of your heating and cooling system to save energy.	-	-	-	.0
Water heaters-all	Improve the efficiency of your water heating system to save energy.	7.3%	\$2,300	\$83	.8
• Water heater 1	Improve water heater 1	7.3%	\$2,300	\$83	.8
Package Total	Total for all Energy Improvements	36%	\$8,929	\$490	1.9

What can calibration do for me?





Calibration Saves Time While Maximising Information

Auditors using an auto-calibrating software can avoid time consuming measurements that aren't relevant to their proposed measures (e.g. window areas).

Green Homeowners United is using OptiMiser to calibrate models for Wisconsin's IRA program. Chief economist Kevin Kain says:

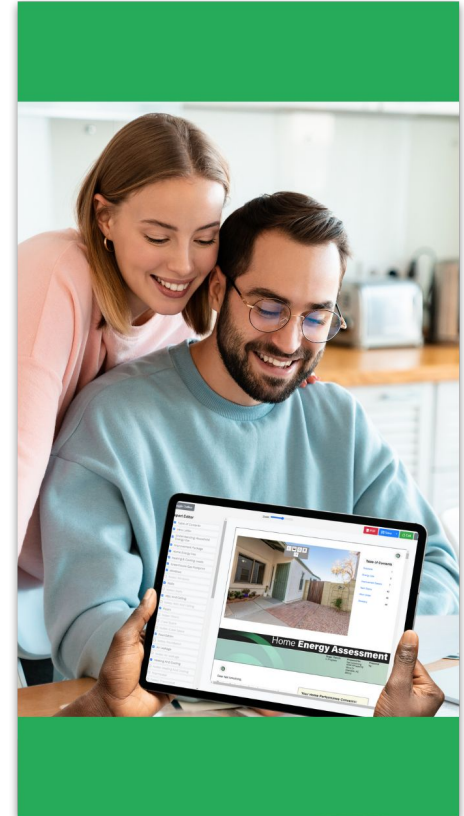
“70% of models calibrate with one click.

The ones that don't calibrate force me to check assumptions and investigate. I usually find a mistake in my inputs or discover some unusual occupant behavior or building feature that was overlooked.”

Improved customer confidence

Present the homeowner:

- A report that mirrors their experience with their home's energy use show them that you know what you are talking about.

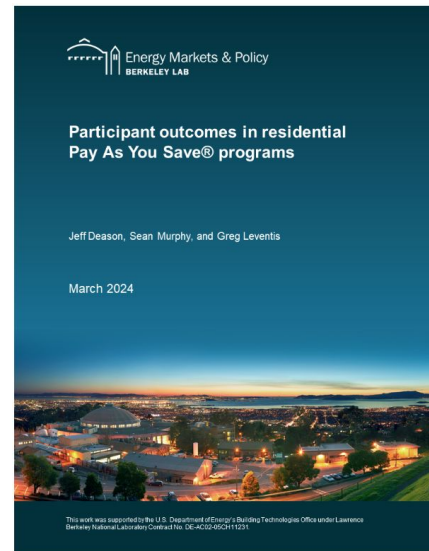




Calibration improves realization rates

A study conducted by Lawrence Berkeley National Laboratory (LBNL) found that programs using **OptiMiser's BPI-2400 auto-calibrated energy model** **achieved 83% realized savings**, the highest rate compared to other Pay As You Save (PAYS) residential programs evaluated in the study.

The actual energy efficiency benefits in these programs were also significant, with participants in one PAYS program **reducing their electricity and gas consumption by an average of 15% and 26%, respectively**.





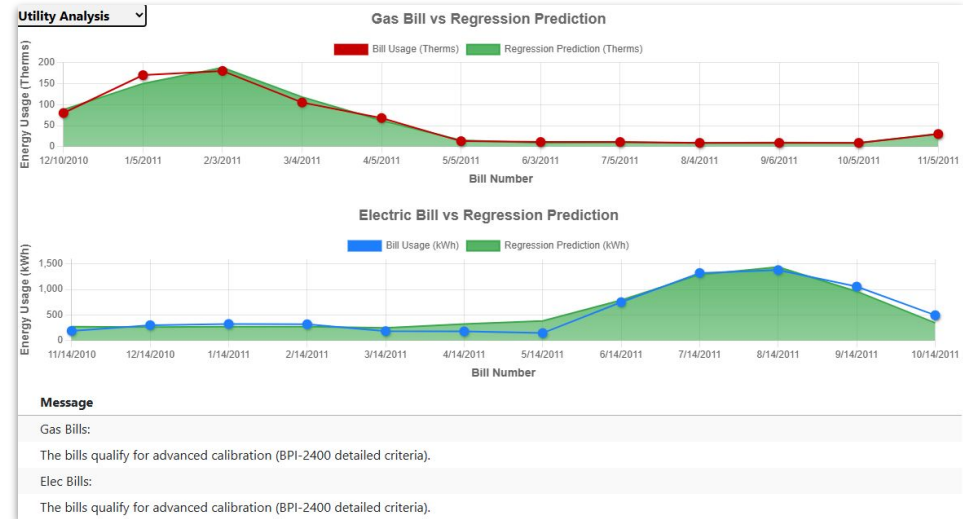
What is BPI-2400?

ANSI/BPI-2400-S-2015 is a standard for qualification of whole-house energy savings prediction through calibration to historical usage. The standard provides criteria for the following:

- Energy simulation software accuracy and output capabilities
- Energy simulation input constraints
- Qualification of utility data to be used in calibration
- Calibration targets and acceptance thresholds

How is calibration accomplished?

1. Prepare your utility data
2. Describe the building
3. Let the software adjust inputs to match real results.





1. Preparing utility data

Weather normalization

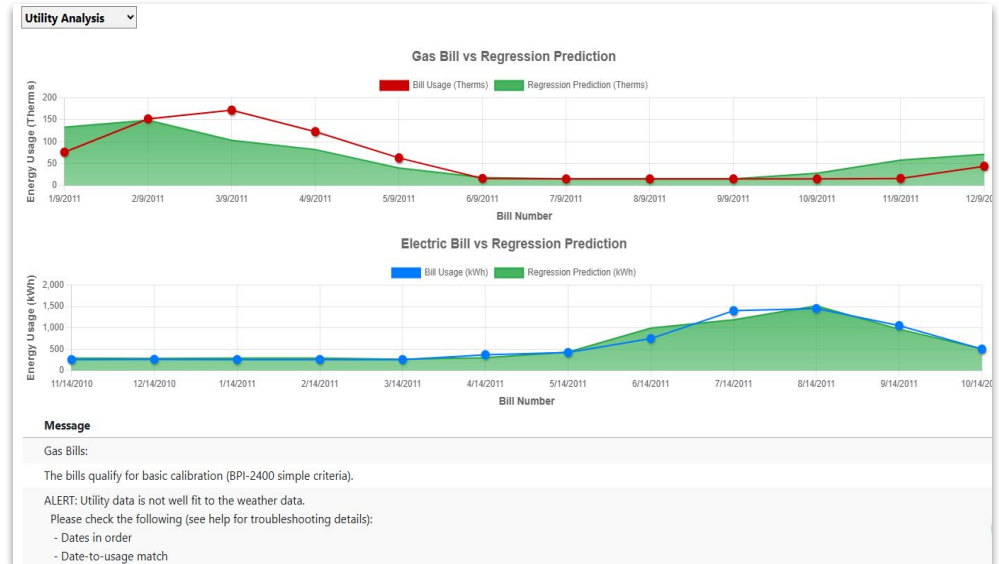
- Most models run on typical year weather and therefore use weather normalized bills as the calibration target
- Statistical model correlates usage to temperature or degree days
- Projects usage for typical year weather

Data quality matters!

- Exact amounts and meter read dates
- Avoid making guesses
- Quality bills yield more information leading to more accurate calibration

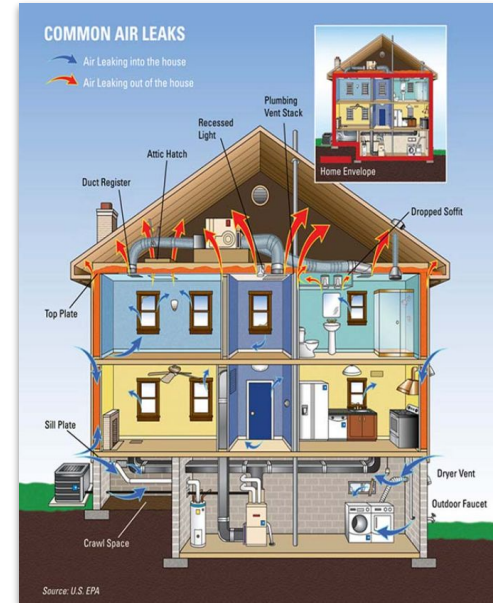
Utility Regression Analysis

- Regression analysis is sensitive.
- Review results to identify errors in bill data
- In this example the the auditor used the bill date instead of the meter read date leading to an offset



2. Describe the building

- Focus on the data that is most consequential to evaluating the measures that you want to consider, while other details can be left to the calibration.
- Where inputs are difficult to observe or time consuming to measure, identify a reasonable range of possibilities and use the model inputs to describe this uncertainty.





3. Let the Software cook!

Calibration should be performed with systematic and incremental adjustments to the model. This is an ideal job for software.

- A typical OptiMiser calibration will make around 100 adjustments to the model inputs
- Executing thousands of lines of code
- Carefully adjusting the model to fit the load shape of the bills

**Questions on the basic
framework?**

Practical advice for data gathering and inputs



Understand where careful measurements are most important



Don't make explicit assumptions where measurements aren't made

(when in doubt leave it blank)



Give the calibration room to operate by quantifying uncertainty

Improvements Matter

What you are improving matters

- Deltas drive savings
- Focus on the components that you want to improve
 - Minimal room for calibration.
- Less detail on other components
 - More room for calibration
 - (e.g. don't measure every window)

Improvements	Selected Energy Improvements	% Energy Saved	Cost	Save Year 1	SIR
Insulate attic	Increase attic insulation and coverage to save energy and increase comfort.	1.3%	\$1,056	\$52	1.0
Insulate crawl	Warm your crawl space to save energy and increase comfort.	1.8%	\$629	\$56	1.8
Duct/Pipe Eff	Seal or insulate your ducts or boiler pipes to save energy.	1.9%	\$995	\$166	2.5
Heating + Cooling	Install high efficiency heat pump	48.9%	\$13,164	\$1,614	1.8
• Heat+Cool 1	Improve heating and cooling system 1	55.9%	\$12,364	\$1,038	1.3
• Heat+Cool 2	Improve heating and cooling system 2	-7.0%	\$800	\$576	10.8
Package Total	Total for all Energy Improvements	54%	\$15,844	\$1,888	1.8

Thermostat set points matter

- Internal temperature is a major driver of heating and cooling loads
- Always investigate how the occupant uses their thermostat
- Always assume variability both in use and how the home is actually conditioned
- Well reasoned ranges are key for calibration



Heating Set Points	
High Temp: Min (°F) 	High Temp: Max (°F) 
66	70
Low Temp: Min (°F) 	Low Temp: Max (°F) 
64	68

Cooling Set Points	
Low Temp: Min (°F) 	Low Temp: Max (°F) 
76	80
High Temp: Min (°F) 	High Temp: Max (°F) 
78	82

Climate Matters

- Cooling dominated climates
 - Window distribution
 - Window shading
 - Cool roofs and radiant barriers
 - Duct location/condition
 - HVAC efficiency
 - Pools
 - Infiltration in humid climates
- Heating dominated climates
 - Infiltration
 - Shell insulation
 - Duct location/condition
 - HVAC efficiency
 - Crawlspace and Basements
- Temperate climates
 - HVAC efficiency
 - DHW
 - Pools
 - Hot tubs

Known unknowns - quantifying uncertainty

Establish ranges for inputs that either can't be measured or don't have consistent values.

- Unevenly applied attic insulation
- Degraded wall cavity insulation
- Unable to conduct leakage tests
- HVAC efficiency of older units

Use observations, published vintage tables, past experience, etc.

Wall Type 1

Ext. Wall Construction ?

Frame 2x4

Wall Insulation ?

Choose One

Choose One

Well Insulated

Insulated

Poorly Insulated

None

Specify

Cavity Insul ?

Choose One

Calibrate Depth ?

☒

Min Depth (in) ?

3.25

Max Depth (in) ?

4.5

Troubleshooting models that don't calibrate

Check for input errors

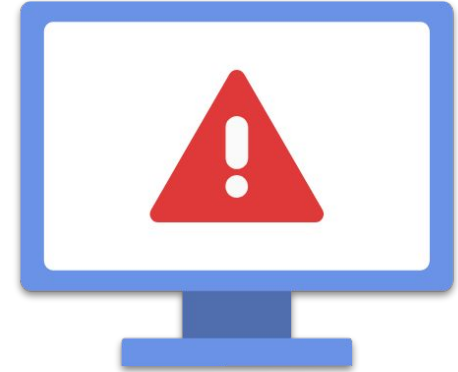
Interrogate the model's assumptions • Interrogate your own assumptions





Interrogate the model's assumptions

- Do regional quirks in housing or behavior make model defaults unreliable?
 - e.g. light colored exteriors and tile roofs in the SW
- Is the model double-counting insulation grade adjustments?
- Does the model include components not in the actual home?
 - e.g. no dryer present
- Has the model chosen the best weather station match for the location?
- If you haven't conducted a blower door, does the default infiltration seem appropriate?





Interrogate your own assumptions

- Are you assuming levels of performance that aren't experimentally justified?
 - e.g. all old wall insulation is garbage
- Are you used to using the BPI published effective R-values for degraded insulation?
 - We have found these to be too low to achieve calibration?
- Are you using age based degradation factors for HVAC efficiency?
 - We have found these to be too aggressive as well
- Have you asked the homeowner how they use their thermostat?
- Are their rooms that are not fully conditioned due to bad air flow or closed vents?

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