Real Life Options for New Construction Evaluation

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Warren Energy Engineering, LLC
Task: Calibrated energy model approach for a NC (and sometimes retrofit) project

Problem: No \(^\text{working}\) Model
What you probably already know:

- Energy savings from building models
- Energy models and their problems
- Alternate verification strategies (A/B/C)
If you don’t know:

- How do we get verified savings?

\[ \text{Savings} = \text{Baseline Energy Use} - \text{Post Energy Use} \pm \text{Adjustments} \]

IPMVP and UMP
Building Simulation Guidance

- IPMVP option D uses a simulation to predict baseline or post-install usage
- UMP NC measure classified as:
  - Newly Constructed Buildings
  - Additions to Existing Buildings
  - Major Renovations to Existing Buildings
Why not another approach?

- In NC, there’s no baseline, no established load profile
- What typically happens?
  - Pass through savings?
  - Verification only?
  - Eliminate savings from individual measures if not fully verified?
So, why no model?

Where’s the model?

Why can’t we get it?
What do we do?

Verify Equipment?
Create a model?
Is it already calibrated?
Compare to bills?
Adjust outputs?
What’s the problem?

The evaluator receives the model…

- Incompatible software
- Model details not easily verifiable
- Numerous measures / systems
- Missing supplemental files
- Original model incorrect or incomplete
Developing an Approach

Is an executable model available?

No

Is there sufficient budget to construct a model?

Yes

UMP NC Protocol

No

Is there > 6 months utility data available?

Yes

No

Plot monthly kWh vs. weather

Plot daily average kWh vs. weather

Modeled vs. actual, similar load profiles?

Yes

No

Alternative approach needed

Project Verified!
NC Evaluation Method

- So, we need an alternative approach
  - A method to assess ex-ante model adequacy
  - A systematic approach to adjust ex-ante savings

or…
Guidelines

1. View post-installation model results by end-use
2. Compare model outputs to utility bills to identify likely errors
3. Inspect equipment and collect any available trend data
4. Make end-use-level or measure-level adjustments to model outputs
Example: Middle School

- New Construction (other building existed on site previously)
- Appendix G baseline
- No executable model available, only outputs
- No baseline utility data, >1 year post utility data
Example: Middle School

Other issues:

- Wrong baseline (NG available, they used electric heating baseline)
- Overestimated summer occupancy
- Equipment modeled and not installed
Example: Middle School

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<table>
<thead>
<tr>
<th></th>
<th>ELECTRICITY</th>
<th>KMH</th>
<th>LIGHTS</th>
<th>TASK LIGHTS</th>
<th>MISC EQUIP</th>
<th>SPACE HEATING</th>
<th>SPACE COOLING</th>
<th>HEAT REJECT</th>
<th>PUMPS &amp; AUX</th>
<th>VENT FANS</th>
<th>REFRIG DISPLAY</th>
<th>HT PUMP SUPP</th>
<th>DOMEST HOT WTR</th>
<th>EXT USAGE</th>
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Example: Middle School
Example: Middle School

- Verified electric savings were negative
- There was net gas savings, which could be claimed by the program
- Gas savings offset electrical penalty, realization rates were bad, but incentive level was reasonably accurate
Example: Manufacturing Facility

- Existing building with VFD installation
  - VFDs used to reduce flow of CV units
- Ex-ante savings inaccurate, model estimations were incorrect:
  - Post fan kW higher than anticipated
  - No model access, an alternate approach was needed
Example: Manufacturing Facility

Other issues:

- Limited post-installation data
- Interactive effects
- Sensitive production facility
Example: Manufacturing Facility

How did we achieve verified savings?

- Ex-post BL kW lower than ex-ante
- Ex-post actual flow was higher than anticipated

<table>
<thead>
<tr>
<th>Unit</th>
<th>Ex-Ante Baseline Design CFM</th>
<th>Ex-Ante Post Design CFM</th>
<th>Post Average CFM (60% of Design)</th>
<th>Ex-Ante Average CFM Saved</th>
<th>Actual Observed CFM</th>
<th>Ex-Ante Baseline Design CFM - Actual Observed CFM</th>
<th>Difference between Ex-Ante Post Design CFM and Actual Observed CFM</th>
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<tbody>
<tr>
<td>AHU-1 SF</td>
<td>14,000</td>
<td>6,386</td>
<td>3,832</td>
<td>10,168</td>
<td>11,160</td>
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<td>13,621</td>
<td>10,100</td>
<td>8,350</td>
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<td>8,030</td>
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<td>5,175</td>
<td>7,775</td>
<td>12,583</td>
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<td>4,626</td>
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<td>11,750</td>
<td>5,200</td>
<td>(4,040)</td>
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<td>4,626</td>
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<td>6,500</td>
<td>700</td>
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<td>AHU-11 SF</td>
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<td>3,360</td>
<td>3,840</td>
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<td>AHU-12 SF</td>
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<td>6,500</td>
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<td>AHU-16 SF</td>
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<td>5,142</td>
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<td>13,765</td>
<td>10,000</td>
<td>4,750</td>
<td>(5,250)</td>
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<tr>
<td>Sum</td>
<td>224,900</td>
<td>106,661</td>
<td>60,681</td>
<td>156,881</td>
<td>160,600</td>
<td>4,750</td>
<td>(50,222)</td>
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</table>
Example: Manufacturing Facility

Average kW vs. Average Daily Temp

Ex-Post Savings
Ex-Ante Savings
Example: Manufacturing Facility

- Verified Savings were 25% of ex-ante savings
- Using actual data, we were able to correct the model baseline
- Using the model, we were able to expand the actual post
Our Approach

- When modeled outputs inaccurately reflect actual operations, alternate approach may be needed
- Make educated adjustments to end-use level outputs
Our Approach

Our examples:

- Allow for adjustment with limited resources/time
- More accurate than “verification only”
Does It Work?

Our solution:
- Based on original model
- Feasible without an operable model
- Uses site specific observations/data
- Viable for new construction and retrofit projects
- Can improve on customer submitted models
- More rigorous than simple verification
Thank you!

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