Standard Approach to Non-Standard Projects

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Outline

The Problem
The Measures
The Options
EUI Issues
Demand-side / Supply-side Efficiency
Benefits
The Goal

Determination of energy savings in large custom industrial verification projects

• Consistent – reduce cost, easier QA/QC
• Transparent
• Repeatable
• M&V Based
Challenges to Standardization

Custom resists standardization

- Unpredictable data availability
- Production dependent
  - Low granularity
  - Proprietary and confidential
  - Unclear Dependencies
To What Does it Apply?

- EE projects often affect support systems
  - Compressed Air
  - Process Cooling
- Projects typically involve an increase in a process’ efficiency
- Some projects reduce a system’s load
M&V Approach Options

- Verification Only
- Option D
  - Building model not usually feasible for industrial facilities
- Option C
  - Savings too small for a large industrial project
- IPMVP Option A/B
  - Retrofit Isolation
Retrofit Isolation – A&B

- Leverage short term pre-installation and post-installation data
- Normalize and annualize to production

Methods
- Energy Use Intensity
- Demand-side / Supply-side Efficiency Approach
Measurement Boundaries

SSE

kW

Process Cooling Plant

Tons

DSE

Production Systems

Production

EUI
Example Project

- Compressed Air
  - Demand Side Measures (air knives, solenoid valves)
  - Supply Side Measures (VFD Compressor)
- Customer Monitors
  - Production (daily)
  - CFM (hourly)
- Several weeks pre-install kW and post-install kW
Energy Use Intensity Approach

- Divide energy use by production
  - Can be useful
  - Our fallback approach
  - Required data is readily available
  - Is easily misused or over-simplified
  - Doesn’t tell you much about why RR isn’t 100%
**EUI Example Analysis**

- Is this sufficient data?

<table>
<thead>
<tr>
<th>Period</th>
<th>Production</th>
<th>Energy Use (average kW)</th>
<th>EUI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-installation</td>
<td>1,500</td>
<td>750</td>
<td>0.5</td>
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<tr>
<td>Post-installation</td>
<td>2,000</td>
<td>900</td>
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EUI Example Analysis

- Is this the savings?
- $0.5 \times 2000 = 1000 \text{ kW Baseline}$
- Savings $= 1000 - 900 = 100 \text{ kW}$

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Beware “Production Corrected”

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Assumes linear AND intercept = 0

[Graph showing linear relationship between production and energy use]
More typical EUI Dependence

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- Linear, but nonzero intercept
- At higher production, baseline would have been more efficient
Implications - typical EUI

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• Baseline 800 kW at 2000 Production
• Negative savings
The DSE/SSE Approach

Demand Side Efficiency and Supply Side Efficiency

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<th>Efficiency Type</th>
<th>Typical Efficiency Units</th>
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<tbody>
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<td>Compressed Air Measures</td>
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<td>Process Cooling Measures</td>
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<td>Supply Side (SSE)</td>
<td>kW/CFM</td>
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<tr>
<td>Demand Side (DSE)</td>
<td>CFM/Production</td>
</tr>
<tr>
<td></td>
<td>Tons of Cooling/Production</td>
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The Algorithm

Annual kWhsave = kWhbase - kWhpost

Where:
\[
\text{kWhbase} = \sum_i (\text{SSE}_{\text{pre},i} \times \text{DSE}_{\text{pre},i}) \times \text{production,}i \times \text{hours,}i
\]
\[
\text{kWhpost} = \sum_i (\text{SSE}_{\text{post},i} \times \text{DSE}_{\text{post},i}) \times \text{production,}i \times \text{hours,}i
\]

DSE, SSE are curves or table, not constants
Required Data

Short term (1-3 weeks) kW data pre
Short term output (CFM, tons)* data pre
Short term (1-3 weeks) kW data post
Short term output (CFM, tons)* data post
Short and long term production data

*Or ability to calculate
Supply Side Efficiency

**SSE - Low Flow**

- $y = -0.0011x + 1.0785$
- $R^2 = 0.9868$
- $y = -0.00018x + 0.53689$
- $R^2 = 0.45369$

**SSE - High Flow**

- $y = -0.00013x + 0.50415$
- $R^2 = 0.84274$
- $y = -0.00011x + 0.39237$
- $R^2 = 0.79872$
Demand Side Efficiency

- Aggregate energy data to the interval of the production data
- Modes may be needed rather than regression
- Often not “pretty” but better than assuming a constant value
Improved Savings Isolation

- Holding one term “unchanged”

\[
\text{kWh}_{\text{base}} = \sum_i (\text{SSE}_{\text{pre},i} \times \text{DSE}_{\text{avg},i}) \times \text{production},i \times \text{hours},i
\]

\[
\text{kWh}_{\text{post}} = \sum_i (\text{SSE}_{\text{post},i} \times \text{DSE}_{\text{avg},i}) \times \text{production},i \times \text{hours},i
\]

- A main benefit of the approach

- Not holding a term constant, but “unchanged”
Improved Savings Isolation

- If expect there to be improvement but feel negative savings are unrealistic

\[
kWh_{\text{base}} = \sum_i (SSE_{\text{pre},i} \times DSE_{\text{pre},i}) \times \text{production,}i \times \text{hours,}i
\]

\[
kWh_{\text{post}} = \sum_i (SSE_{\text{post},i} \times DSE_{\text{min},i}) \times \text{production,}i \times \text{hours,}i
\]
Improved Insight into the Project

- Did the CFM increase?
- Did the SSE improve?
- How would the plant have behaved at the new production levels in the absence of the project?
Remember

- When evaluating large non-standard custom industrial projects:
  - Think in terms of DSE and SSE
  - Hold one term unchanged, but not constant, when appropriate
  - Use caution with EUI methods
  - Real-time evaluation to ensure you get the data
Thank you!

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