From Industrial Energy Efficiency to the Local Electric Utility: A Perspective on the Integration of Power Engineering and Energy Efficiency

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Roadmap

• IAC Program
• Typical Recommendations
• Puget Sound Energy Distribution Planning
• Partnership Project Proposal
• Energy Efficiency at PSE
• Large-scale Demand Reduction
• PSE Examples
• National and International Programs
• Barriers to Project
• Progress
• Conclusion
IAC Program Summary

• Sponsored by the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Industrial Technologies Program

• IAC performs one-day energy, waste, & productivity audits for small- and medium-size manufacturers
IAC Program Summary

UW is one of 26 IACs at various universities & colleges in U.S.
IAC at the University of Washington

- University of Washington IAC started in September 2006

- Staff includes professors, graduate students and undergraduate students

- Service area includes WA, ID, MT, AK, HI

- Completed 22 Assessments with energy savings exceeding 8.5 million kWh and 300,000 therms which correspond to savings of over $1,000,000.
Assessment Training

• Each site visit provides IAC members the opportunity to:
  – Identify the Most Significant Energy Usage & Waste Streams
  – Take Measurements and Talk to Plant Personnel
  – Gather Documentation to Estimate Energy Usage of Specific Equipment/operations
Typical Measurements Taken:

- Temperatures
- Flow rates (air and water)
- Motor RPMs, temperatures, dimensions, operation
- Boiler operation
- Air compressor temperatures, dimensions, operation
- Dataloggers deployed for a week and mailed back to IAC
Assessment Recommendations

• IAC members have the opportunity to recommend upgrades for:
  – Motors (NEMA premium motors, Belts, VFDs, Maintenance Programs)
  – Compressors (VFD compressors, Leaks, Control Scheme)
  – Lighting (Fluorescents, CFL Ballasts, Daylighting, Controls)
  – Process Heating (Insulation, Heat Recovery, Burners)
  – Waste Reduction
  – Production Efficiency
Database Example: Assessment Summary

Assessment #UW0016

<table>
<thead>
<tr>
<th>Assessment Date</th>
<th>03/06/2008</th>
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<tbody>
<tr>
<td>SIC</td>
<td>2099</td>
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<tr>
<td>SIC Description</td>
<td>Food Preparations, Nec</td>
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<tr>
<td>NAICS</td>
<td>311999</td>
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<tr>
<td>NAICS Description</td>
<td>All Other Miscellaneous Food Manufacturing</td>
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<td>Principal Product</td>
<td>Tofu and Tofu Products</td>
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<td>Sales</td>
<td>$2,000,000</td>
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<tr>
<td># of Employees</td>
<td>22</td>
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<tr>
<td>Plant Area (Sq.Ft.)</td>
<td>10,000</td>
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<tr>
<td>Annual Production</td>
<td>540,000 Pounds</td>
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<td>Production Hrs. Annual</td>
<td>3,510</td>
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<td>Location (State)</td>
<td>HI</td>
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<tr>
<td>Fiscal Year (Budget Year)</td>
<td>2008</td>
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<tr>
<td>Yearly Energy Cost</td>
<td>$98,896</td>
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</table>

Current Energy Usage & Costs

<table>
<thead>
<tr>
<th>Energy Sources</th>
<th>Yearly Usage</th>
<th>Yearly Cost</th>
<th>Unit Price</th>
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</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>73,415 KWh</td>
<td>$14,635</td>
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<td>Demand Charge</td>
<td>300 KWh-Month/Year</td>
<td>$1,718</td>
<td>$5.73</td>
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<td>Electricity Fees</td>
<td>-</td>
<td>$0</td>
<td>-</td>
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<tr>
<td>Natural Gas</td>
<td>2,419 MMbtu</td>
<td>$82,543</td>
<td>$34.12</td>
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</table>

Recommended Reduction in Usage & Costs

<table>
<thead>
<tr>
<th>Energy Sources</th>
<th>Yearly Usage</th>
<th>Yearly Cost</th>
<th>% Saved</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>28,510 KWh</td>
<td>$5,416</td>
<td>37%</td>
<td>$0.199</td>
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<tr>
<td>Demand Charge</td>
<td>18 KWh-Month/Year</td>
<td>$101</td>
<td>6%</td>
<td>$0.199</td>
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<tr>
<td>Natural Gas</td>
<td>2,249 MMbtu</td>
<td>$52,128</td>
<td>63%</td>
<td>$34.12</td>
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</tbody>
</table>

http://iac.rutgers.edu/database/findassessment.php?ID=UW0016
A Transition…

• Summer internship with Electric Distribution Planning at Puget Sound Energy

• Summary of Work
  – Fuse Coordination for South King County, North King County
  – Load Balancing
  – Protection Device Recommendations for Circuits
  – N – 1 Contingency Analysis
  – Distribution Planning/Energy Efficiency Partnership Project…..
The Proposal

• Can Energy Efficiency Services (EES) be more integrated with Distribution Planning?
  – Many areas where distribution circuits and/or substations are nearing capacity
  – Traditional Plan: Brand new substation or double-bank of a substation
  – Alternative Plan: Targeted energy efficiency in these circuits
Alternative Plan

• EES attempts to provide distribution capacity project deferral through:
  – Targeted Energy Efficiency projects in overloaded circuits
  – An attempt to reduce 1MW of base load demand

• 1MW Demand Reduction $\approx 50A$ Reduction at Substation Circuit Breaker

• 50A Reduction can defer select substation upgrades out 1 year, saving approximately $500,000 in capital interest (an estimate determined by distribution planners at PSE)
PSE Approach to Energy Efficiency

• Driven by kWh, not kW
• Goal of 50MW/yr reduction
• 50MW is spread over entire PSE territory; can be in any location
• Focus: generation demand reduction
• Alternative Plan still allows goals to be met with additional possibility of substation investment deferral
How 1MW of Demand Reduction is achieved

• Large Commercial/Industrial Customers
  – Lighting, HVAC, Refrigeration, Equipment Controls, Motors, VFD’s, Retro-CX
  – Heating and Domestic HW Fuel Switching (Electric Equipment → Gas Equipment)

• Small Commercial
  – Lighting, HVAC

• Residential Customers
  – Multi-family weatherization programs
  – Compact Fluorescent Lamps

• EES offers rebates and grants that pay up to 70% implementation costs
Example – Lighting Retrofit Verification

390 kW Peak

110 kW Load Reduction Reflected in Peak

280 kW Peak

Delayed morning startup from motion sensors

AMR Shots Courtesy of PSE
What EES Provides

- Most costs of program
- Targeted mailing/brochures
- Energy Assessments for businesses in target area
- Efficiency Education
- Efforts to implement projects of a particular load shape in a circuit based on needs of distribution planning
  - Base Load Reductions
  - Peak Load Reductions
  - Fuel Switching
- Rebates and Cost Incentives for EE Capital Projects
What Electric Distribution Provides

- In order to target a particular circuit, EES asks for:
  - Detailed Circuit Diagram, in map form
  - Explanation of which load type is priority
  - Load Reduction target
  - Timeline for when the circuit becomes critically loaded
  - Communication and level of feedback from distribution planning to determine program effectiveness
PG&E Model Energy Communities Program

- **Purpose of Project:**
  - Determine if targeted energy efficiency programs focused on specific distribution planning area could effectively and economically reduce local peak load
  - Determine whether intensive marketing and implementation techniques could garner the desired and necessary high market penetration levels
  - Assess the program’s performance and customer acceptance of selected program delivery mechanisms

- **Results:**
  - Ran for two years (1991 – 1993) producing approximately 2.3 MW of demand reduction coincident with local area-specific peak, and reducing 4.3 million kWh annually, deferring substation capital investment for at least two years
Manweb Holyhead Transformer Capacity Shortfall

- Targeted effort in 1992 in Welsh Town of Holyhead
- Utility forecasted that two existing 33-kV transformers and related cabling needed to be upgraded at a cost of approximately $1.375 Million
- Power Save Plan developed by Manweb succeeded in deferring transformer upgrades 5 years and achieved goal of reducing peak load by 10 percent
### Holyhead ‘Power Save Project’ Details

<table>
<thead>
<tr>
<th>Sector</th>
<th>Measure</th>
<th>Savings (kVA)</th>
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<tbody>
<tr>
<td>Residential</td>
<td>Compact fluorescent lamps</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Insulation &amp; weather-stripping</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Hot water heater blanket</td>
<td>47</td>
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<tr>
<td>Small commercial</td>
<td>Compact fluorescent lamps</td>
<td>7</td>
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<td></td>
<td>Hot water heater blanket</td>
<td>5</td>
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<tr>
<td></td>
<td>Lighting upgrades</td>
<td>92</td>
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<tr>
<td>Large commercial/</td>
<td>Power factor correction</td>
<td>282</td>
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<tr>
<td>industrial</td>
<td>Lighting upgrades</td>
<td>125</td>
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<tr>
<td></td>
<td>Other industrial</td>
<td>55</td>
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<td><strong>Subtotal</strong></td>
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<td><strong>720</strong></td>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>808</strong></td>
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</table>

Example Location: Bainbridge Island

- New substation planned to be built in three years to support existing load on two existing substations
- 54 MW Winter Peak Load on both substations
- ~8,000 Customers on both substations
  - 6,800 residential
  - 1,150 commercial/industrial
- ~2% (1 MW) Load growth
- Target → EES Projects (Lighting, Weatherization) attempt to reduce total loading on substations by 1 MW each year, deferring the installation of substation planned, saving as much as $500,000/yr
Substation 1 & Substation 2 Winter Peak Day
22-Jan-08

Image Courtesy: PSE
Barriers to Project

• Lack of communication between Energy Efficiency Services and Electric Distribution Planning
• No project like this has been initiated at PSE before
• Planners Doubt that amount of demand reduction is possible
• Ability to accurately track results
• Time commitment for Planners
Steps Taken So Far

- Substation Load Research
  - Load Growth, Future Upgrades
- Customer Type Research
  - Residential, Commercial, Industrial
- Identification of possible substations/circuits
- Determination of Target Circuit and Demand Reduction Goal
  - Substation in Kent Valley
  - Additional Substation planned to be built in 5 yrs
  - Whole Substation Target of 2 MW Reduction
- Program tentatively planned to begin January 2009
Conclusion

• “Aging infrastructure” requires new and unique solutions
• Energy efficiency provides a temporary, albeit powerful solution
• Projects can substantially reduce substation loading without the need to build new equipment
• Partnership provides an opportunity for more effective company integration
• A new idea for PSE, but not a new idea elsewhere → Many successes have occurred around the world
Resources


Any questions?