HVAC Energy Efficiency projects - Verification of energy savings – Cost effective sub-metering

Alex Koncar – GreenKon – Sydney, Australia
Traditional metering

- Tracking of energy use at facility level
- Minimised costs of metering
- One utility meter per facility
- Locally read
- No information on energy consumption of individual building services
Sub-metering – metering of individual energy consumptions

› High energy cost
› Tightened budgets
› Sustainable energy and energy reduction goals
› Identification of issues and energy saving potential
› Verification of utility bills
› Determination of energy efficiency of equipment and systems
› Verification of energy savings
Sub-metering – metering of individual energy consumptions

Metering on its own does not save energy. Complementary procedures include several actions:

• Collect the data
• Keep records
• Analyse the data
• Take Action
Sub-metering and M & V plan – energy savings

a) Informal M & V Plan – generic

b) Formal M & V Plan in line with EVO’s IPMVP:

• Accurate
• Consistent
• Relevant
• Transparent
• Cost effective
• Suitable to the readers level of understanding
• Creation and certification by CMVP
Sub-metering and M & V plan – quantification of energy savings in line with IPMVP

- Option A (Retrofit Isolation: Key Parameter Measurement)
- Option B (Retrofit Isolation: All Parameter Measurement)
- Option C (Whole Facility)
- Option D (Calibrated Simulation)

Energy Savings = Baseline energy consumption – Post-implementation energy consumption (Reporting Period) + Adjustments (to compensate for different conditions between Baseline and Reporting period)
### Sub-metering and M & V plan – quantification of energy savings in line with IPMVP

<table>
<thead>
<tr>
<th>ECM Project Characteristic</th>
<th>Suggested Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need to assess ECMs individually</td>
<td>X X X</td>
</tr>
<tr>
<td>Need to assess only total facility performance</td>
<td>X X</td>
</tr>
<tr>
<td>Expected savings less than 10% of utility meter</td>
<td>X X X</td>
</tr>
<tr>
<td>Significance of some energy driving variables is unclear</td>
<td>X X X X</td>
</tr>
<tr>
<td>Interactive effects of ECM are significant or unmeasurable</td>
<td>X X</td>
</tr>
<tr>
<td>Many future changes expected within measurement boundary</td>
<td>X X</td>
</tr>
<tr>
<td>Long term performance assessment needed</td>
<td>X X X</td>
</tr>
<tr>
<td>Baseline data not available</td>
<td>X</td>
</tr>
<tr>
<td>Non-technical persons must understand reports</td>
<td>X X X</td>
</tr>
<tr>
<td>Metering skill available</td>
<td>X X X</td>
</tr>
<tr>
<td>Computer simulation skill available</td>
<td>X</td>
</tr>
<tr>
<td>Experience reading utility bills and performing regression analysis available</td>
<td>X</td>
</tr>
</tbody>
</table>

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M & V plan – Cost Effective sub-metering

• Thorough knowledge of employed HVAC System (Design and operations of equipment and controls) and other energy systems.
• Thorough knowledge of electrical reticulation/switchrooms and position/loads of HVAC System components in it (represented in Electrical Single Line Diagram)
• Load measurements (to ascertain size of current transformers considering the difference between a maximum load and name plate reading)
• Thorough knowledge about trend of energy use/power demand (using utility bills and smart metering interval data) and its correlation to variable weather conditions (regression analysis using CDD and HDD – Cooling and Heating Degree Days, ands actual energy consumption data.
• Awareness of available budget
• Knowledge on cost effective meters and processing softwares
• Use of existing sub-meters (properly validated) and the likes (VSD controllers for pumps and fans with HLI- High Level Interface, temporary loggers, etc.)
• Creation of virtual meters
• Minimal ongoing fees for analysis and reporting
M & V plan – Cost Effective sub-metering – Case study
M & V plan – Cost Effective sub-metering – Case study

› **Sydney Museum - Complex Close Control HVAC System** (Central CHW and HW systems with sea water cooling, multiple AHUs, VSD controllers on pumps and fans, humidifiers, space pressurisation, Demand Ventilation, Economy Cycle, Carbon filtration, etc).

› Business as usual to sub-metering design approach from two tenderers

› M & V Plan offered by CMVP

› Comparisons

› Client’s decision

› Winning M & V Plan
### M & V Plan - Cost Effective sub-metering – Case Study

<table>
<thead>
<tr>
<th>Supply No.1</th>
<th>Supply No.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summation Utility Meter No.1</td>
<td>Summation Utility Meter No.2</td>
</tr>
<tr>
<td>Schneider's existing sub-meter</td>
<td>Schneider's existing sub-meter</td>
</tr>
</tbody>
</table>

#### MSB 1
- MCCI Plantroom & Chillers
- PCHW pump 1
- PCHW pump 2
- PCHW pump 3
- CW pump 1
- CW pump 2
- CW pump 3
- SCHW Pump 1
- SCHW Pump 2
- SCHW Pump 3
- SCHW Pump 4
- HW pump 1
- HW pump 2
- SWP 1
- SWP 2
- SWP 3
- SWP 4
- AHU 1
- AHU 2
- AHU 3
- AHU 4
- AHU 9
- PFC
- Light and Power
- 3x 3x 14.4kW HW

#### MSB 2

<table>
<thead>
<tr>
<th>LEGEND</th>
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<tbody>
<tr>
<td>Yellow</td>
</tr>
<tr>
<td>Light Green</td>
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<tr>
<td>Light Blue</td>
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<tr>
<td>Blue</td>
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<tr>
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<tr>
<td>Green</td>
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<tr>
<td>Red</td>
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