Investor Confidence Project

Prodexpo Workshop
18th October 2017

Presenter – ICP Europe Technical Team:
Dave Worthington, Managing Director, Verco
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 649836.

The sole responsibility for the content of this presentation lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.
What is generating investment risk?

- Poor or non-existent baseline data
- Variety of project types and outcomes
- Unexpected changes to demand
- Variable level of expertise
- Project host engagement
- Inconsistent documentation
Contents

• ICP Europe tools and process
• US project examples
• Europe project examples
• ICP detailed requirements
• Q&A
ICP Europe tool development overview

1. Review core requirements of existing USA protocols
2. Research equivalent European/international standards and resources, with feedback from Tech Forum
3. Add additional European/international standards and resources not already covered
4. Adapt existing USA protocols, and add relevant standards and resources
5. Publish draft protocols
6. Update protocols accordingly incorporating feedback from technical experts
7. Develop Annex A Index of National Resources with input from specialists across Europe
8. Adapt existing USA Project Development Specification and publish
Annex A: Index of National Resources

ENERGY PERFORMANCE PROTOCOL

ANNEX A: INDEX OF NATIONAL RESOURCES

VERSION EU 0.2 – APRIL 2016

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What project types is IREE™ designed for?

Buildings

Industry

District energy systems

Street lighting upgrades
Building Types

- **Large**
  - Whole building retrofit, dynamic modeling

- **Standard**
  - Whole building retrofit, no dynamic modeling

- **Targeted**
  - Single or limited number of EE measures

Tertiary

Apartment
Protocol Selection and Documentation

Many different ECMs?

ECMs affect only one or a few end-uses?

No interactive effects, or lighting projects only?

Complex interactive effects? e.g. whole building retrofit

No

Using dynamic simulation?

No

No

No

No

Yes

Yes

Use Large Tertiary or Apartment Blocks Protocol

Use Standard Tertiary or Apartment Blocks Protocol

Use Targeted Tertiary or Apartment Blocks Protocol

Yes

Yes

Using dynamic simulation?

Yes

Project Development Specification

Annex A Index of National Resources

Quality Assurance Specification

Technical Forum (blog, recordings)
Website Resources

• Supporting documents
  – All six protocols
  – PD Specification
  – QA Specification

• Technical Forum
  – QA Checklists
  – Call recordings
  – Technical forum blog notes
Professional training and credentialing

Project Development

- Chartered, or relevant degree + suitable professional qualification e.g. CMVP
- 5 years’ PD experience (case studies)
- References
- PI insurance
- Attend PD training

Third-Party Verification

- Meet PD requirements, plus:
- 3 years’ technical review experience
- References
- Attend PD and QAP training with test
ICP Quality Assurance Checklist v1.0

Client: [Insert Client Name]
Project: [Insert Project Name]
Project Developer: [Insert Project Developer Name]

Energy Performance Protocol
Standard Tertiary v1.0

Baselining Core Requirements
- 12-36 months utility data
- Utility baseline period
- Energy end-use estimates
- Weather data - related baseline
- 12 mos occupancy - related baseline
- Building asset data
- Baseline operational/performance data
- Normalised / regression-based baseline
- Utility rate structure
  (if Demand Charges or Time of Use apply)
  - Annual load profile
  - Average daily load profiles
  - Peak usage
  - TOU summary by month (if applicable)

Savings Calculations
- Energy Analyst credentials
- Weather file
- Energy Efficiency Report
  - Energy Conservation Measures (ECMs)
  - ECM calculations
  - ECM variables and assumptions
  - ECM results
  - Cost estimates
  - Investment criteria
  - Quality assurance statement

Design, Construction, and Verification
- Operational Performance Verification plan
- OPV authority credentials

Operations, Maintenance, and Monitoring
- Ongoing management regime
  - Project Developer Credential

QA Firm: Verco Advisory Services
Reviewer*: Bethan Phillips
Date: 13 July 2016
Signature:

*Reviewer must be qualifying individual per ICP QA Application

By signing this ICP QA checklist, the ICP Quality Assurance Provider attests to having reviewed the project development documentation and certifies that the project substantially follows the ICP Energy Performance Protocols and the ICP Project Development Specification. This Quality Assurance review and signature does not constitute a guarantee of energy savings performance, nor does it signify that the reviewer is taking professional responsibility for the required documents and engineering produced by the Credentialled Project Developer.
US project examples
Arverne View, New York City - Bright Power

- Leading energy services company
- Energy efficiency upgrade of apartment blocks e.g. upgraded boilers, lighting, appliances
- Projected savings: 38% gas, 30% electricity, or 34% overall – actual savings were 31%

<table>
<thead>
<tr>
<th>Investment</th>
<th>$6,605,651</th>
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<tbody>
<tr>
<td>Cost Savings</td>
<td>$811,593</td>
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<tr>
<td>Incentives</td>
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<td>Percent Savings</td>
<td>34.2%</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>6.4 years</td>
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</table>
2520 College Avenue, Berkeley, CA - Association of Energy Affordability

• Five storey apartment block

• AEA carried out comprehensive audit and identified EE measures – e.g. LED lighting areas in common areas, boiler replacement

• Also obtained government rebates

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<table>
<thead>
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<tr>
<td>Investment</td>
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<td>Cost Savings</td>
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<tr>
<td>Incentives</td>
<td>$36,750</td>
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<tr>
<td>Percent Savings</td>
<td>29% (electric) 19% (fuel)</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>4.1 years</td>
</tr>
</tbody>
</table>
First Presbyterian Church, Connecticut - Sustainable Real Estate Solutions

- Sanctuary, office, classrooms and auditorium

- Johnson Controls carried out audit, and used ICP-compliant methodology

- Measures include BMS expansion, AHU conversion, boiler replacement, motor upgrades

<table>
<thead>
<tr>
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<tr>
<td>Incentives</td>
<td>$24,016</td>
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<td>Percent Savings</td>
<td>13.50%</td>
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<td>Simple Payback</td>
<td>15 years</td>
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</table>
Maiden Lane, New York City - SClenergy

- 17 storey office building
- Time Equities (real estate company) is sponsor
- Dynamic modelling to evaluate savings
- Measures include BMS upgrade, VSDs, motor replacements, heating plant upgrades, new backup chiller

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<td>Incentives</td>
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<tr>
<td>Percent Savings</td>
<td>41%</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>5.1 years</td>
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</table>
Europe project examples
Projects

- Project overview
- Lessons learnt: successes and difficulties
- Time taken now and in future
- Benefits brought by ICP
Project 1

Consortium of 3 NHS Trusts, Liverpool, UK
Project overview

• Carbon and Energy Fund is PD (fund, facilitate and project manage)

• Verco is QAP

• Investor is Macquarie Bank

• Energy Performance Contract awarded to Engie (formerly Cofely) of 15 years

• Construction began Jan 2016

• IREE certification awarded!
Project overview

• New gas-fired CHP energy centres
• EE measures include new variable speed drives for motors, plant optimisation, lighting retrofit programme

• Annual savings:
  – Guaranteed 14,500MWh
  – £1.85m
  – Average energy savings 50%
  – Average carbon savings 33%
Process

- Standard Tertiary protocol applied retrospectively
- Feasibility study carried out by separate energy consultancy
- CEF’s existing standard spreadsheet tools used for baseline/savings calcs
- QAP review extrapolated for all future CEF projects
Estimated time taken

Current:

• QA: ~3 days, spread over a few weeks
• PD (CEF): ~1 day (excluding training and credentialing)

Future:

• QA: 0.5 days?
• PD: 0 days?
Successes and difficulties

• Well managed, tried and tested approach to setting up EE projects – makes review easier

• Open to tweaking processes to meet ICP requirements within reason

• Will be applied to future CEF projects, including new programme in Ireland

• Complex documentation to review; some relevant ICP documentation contained in these (not always in separate documents)

• Had to be careful not to ask for too much!
Project 2

Commercial Office, London, UK
Project overview

- Project owner is professional services firm
- Large hi-spec office building in central London
- Investment from European/national/local sources (LEEF)
- PD is ESCO ICP credentialed organisation (CES Energy)
- Verco is QAP and Technical Advisor to Amber LEEF
- 10 year EPC
- IREE certification achieved
Project overview

• Measures comprise:
  – Natural gas fired CHP (2,026kWe)
  – Absorption chiller (1MW)
  – Auxiliary equipment
  – Electrical upgrades

• Total project cost ~€4.3m

• Standard Tertiary protocol

• IPMVP Option B
Estimated time taken

Current:
- QA: ~5 days
- PD: ~2-3 days?

Future:
- QA: 2 days?
- PD: 1-2 days?
Successes and difficulties

- Verco’s dual role enabled efficiency savings for client, although ultimate aim should be to combine two roles
- Site close to Verco offices so easy to visit
- Minimal additional effort for PD
- Difficult to navigate way through information, numerous spreadsheets
- Careful to ask for information in a coordinated manner and to minimise number of requests
Project 3

Student accommodation, Mannheim, Germany
Project overview

• State-owned student hall of residence complex of 8 buildings (mainly residential – 776 students)

• Originally barracks, built 1930s and ’60s with more recent refurbishment

• ESCO appointed under an EPC

• KEA BW acting as PD; Verco is QAP

• Using Freemind’s Energis software

• QA process not yet complete
Project overview

• Standard Apartment Blocks protocol

• Measures comprise:
  – 5 wood pellet boilers (130-220kW)
  – Natural gas fired CHP (22We)
  – PV
  – Insulation
  – Web-based BMS
  – LED lighting
  – New metering (heat and elec) to optimise system performance
  – Mechanical ventilation system upgrades
Project overview

• Investment €2.9m

• Annual savings:
  – Target energy reduction 67%
  – €198k guaranteed including water
  – €40k avoided maintenance costs
Successes and difficulties

• Process benefitted from KEA’s review of protocols
• Software useful (though some tweaks required)
• Good potential for future projects
• Proof will be in KEA’s view on additional work
• Intermediary PD – more legwork
• Accessing and reviewing savings calculations
• Site and team not local, different working practices
Estimated time taken

Current:

• QA: not complete – so far, 3 days
• PD (KEA BW): 5 or more days?

Future:

• QA: 2 days?
• PD (KEA BW): 3 days?
Benefits brought by ICP

CEF:

- Helps sell CEF to public sector/NHS trusts – differentiates against other public sector frameworks
- Demonstrates to their investors engaged in best practice initiatives
- Helped sell into Ireland

CES Energy/Amber:

- CES Energy gain credibility when selling to investors
- Amber – marketing value
General lessons learnt

- Wide variation in savings calculations
- Early engagement is important
- Additional effort can be minimal
- Committed contract price is typically final piece of jigsaw
- Consistent document management is key
- Greater scope for use of dynamic simulation
ICP Stages – Detailed requirements
1.Baseline Development

2. Savings Calculations

3. Design, Construction & Verification

4. Operations Maintenance & Monitoring

5. Measurement & Verification
## Baseline Development

<table>
<thead>
<tr>
<th>Element</th>
<th>Large</th>
<th>Standard</th>
<th>Targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalised baseline (energy consumption equation)</td>
<td>✓</td>
<td></td>
<td>Maybe</td>
</tr>
<tr>
<td>Energy end-use consumption</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Weather data</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Occupancy data</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Building asset, operational, performance data</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Retrofit isolation baseline</td>
<td>-</td>
<td>Maybe</td>
<td>Maybe</td>
</tr>
<tr>
<td>Load shapes (when interval data available)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Interactive effects</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Where relevant to the ECMs
Baseline Development

Normalised Baseline

• Collect historical energy use and cost data
  – Electricity, on-site fuel for heating and cooling, district steam, and hot water or chilled water
  – Three year period (minimum 12 months)
  – Calendarise if necessary
  – Do not use data from periods including “major renovations”
    • Note renovations affecting > 10% gross floor area
    • Note other changes affecting > 10% energy use

PDS section 4.2.1

EN16247-2 Energy Audits – Part 2
  PDS section 4.2.5
Baseline Development
Building Asset, Operational, Performance Data

• Collect building asset, operational, and performance data
  – Model development (Large protocols)
  – Building performance tracking
  – Analysis of ECMs
  – ECM implementation
  – ECM performance tracking
Baseline Development

Load Profiles – if demand charges/time of use pricing are in effect

• Determine impact on monetary savings

• Annual load profile - showing monthly consumption and peak demand

• Average daily load profiles - use 15-minute interval data (if available), to develop profiles for weekday/weekend day types, all four seasons

• Time of Use summaries by month (if applicable)
## Baseline Development Documentation – Underwriting Period

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large and Standard; Targeted if relevant</td>
<td>Weather data</td>
</tr>
<tr>
<td>All</td>
<td>Baseline period (start and end dates)</td>
</tr>
<tr>
<td>All</td>
<td>Energy data</td>
</tr>
<tr>
<td>All</td>
<td>Access to all building asset, operational and performance data</td>
</tr>
<tr>
<td>All</td>
<td>Utility rate structure</td>
</tr>
<tr>
<td>If applicable:</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>Interval data; sub-metered data; load profiles; monthly peak demand</td>
</tr>
<tr>
<td>All</td>
<td>On-site weather data</td>
</tr>
</tbody>
</table>
QUESTIONS
Q1: What is the minimum amount of baseline data needed for projects? 

a. 12 months  
b. 24 months  
c. 36 months
Q1: What is the minimum amount of baseline data needed for projects?

a. 12 months
b. 24 months
c. 36 months
Q2: Daily load profiles are required for every ICP project?
   a. Yes, this is an essential part of baselining.
   b. No, it depends on whether utility costs vary according to time of use.
Q2: Daily load profiles are required for every ICP project?
  a. Yes, this is an essential part of baselining.
  b. No, it depends on whether utility costs vary according to time of use.
1. Baseline Development

2. Savings Calculations

3. Design, Construction & Verification

4. Operations Maintenance & Monitoring

5. Measurement & Verification
# Savings Calculations

<table>
<thead>
<tr>
<th>Element</th>
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<th>Targeted</th>
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</thead>
<tbody>
<tr>
<td>ECM Descriptions</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Dynamic energy modelling</td>
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<td>-</td>
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</tr>
<tr>
<td>ECM savings calcs – modelling</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ECM savings calcs – non-energy modelling</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Interactive effects</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cost estimates</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Investment criteria</td>
<td>✓</td>
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<tr>
<td>Reporting</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</table>

*Lighting projects only*
Savings Calculations

ECM Descriptions; Cost Estimates

• ECM descriptions
  – Present condition, proposed measure

• Cost estimates
  – At the feasibility stage, direct quotes (minimum of three) or past experience can be used
  – **Final investment package must be based on contracted price**
  – Must include:
    • Construction feasibility review
    • Labour and materials
    • Line items for professional fees, engineering, commissioning, construction management, permitting, M&V, overhead and profit, contingency

• Lifecycle Cost Analysis is optional
Savings Calculations

Energy Modelling – Large

• Energy modelling savings calculation approach
  – Large protocols
  – Software meets current nationally or internationally recognised specifications (8,760 hour simulation)
  – Minimise assumptions - if required, they should be conservative

• Energy model calibration
  – Ideally, use real weather data corresponding to baseline period - if too time-consuming and expensive, provide justification and use adjusted average weather file
  – Normalised Mean Bias Error (NMBE) of 5%
  – CV(RMSE) of 15% relative to monthly calibration data

• Results incorporated into report, detailing
  – Modelling process - inputs and outputs, assumptions
  – Calibration efforts
Savings Calculations

Non-Energy Modelling ECM Calculations – Standard and Targeted

• Non-energy modelling methods
  – Spreadsheet-based
  – Regressions analysis
  – Proprietary tools

• Interactive effects
  – Standard projects – must be accounted for unless it can be shown that estimated adjustment for each measure <5% of predicted saving

• Inform savings calculations
  – Document sources of inputs and assumptions – never embedded

US Uniform Methods Project
US DOE FEMP
## Savings Calculations

*Documentation – Underwriting Period*

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>Energy modeller qualifications</td>
</tr>
<tr>
<td>Standard and Targeted</td>
<td>Energy consultant qualifications</td>
</tr>
<tr>
<td>Large</td>
<td>Model input files; output files; weather file</td>
</tr>
<tr>
<td>Large</td>
<td>Calibrated model inputs and calibration results</td>
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<tr>
<td>Standard and Targeted</td>
<td>Workbooks, calculation tools; weather file</td>
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<tr>
<td>All</td>
<td>Basis for cost estimates</td>
</tr>
<tr>
<td>All</td>
<td>Summary of savings (% energy end-use consumption for Large and Standard)</td>
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</tbody>
</table>
QUESTIONS
Q: Targeted projects don’t need to consider interactive effects – true or false?

a. True
b. False
Q: Targeted projects don’t need to consider interactive effects – true or false?

a. True
b. False
Q: All ICP projects must use dynamic simulation – true or false?

a. True
b. False
Q: All ICP projects must use dynamic simulation – true or false?

a. True

b. False
Q: What costing information should the final investment package be based on?
   a. Minimum of three direct quotes from contractors.
   b. The contracted price.
   c. Past experience.
Q: What costing information should the final investment package be based on?
   a. Minimum of three direct quotes from contractors.
   b. The contracted price.
   c. Past experience.
1. Baseline Development
2. Savings Calculations
3. Design, Construction & Verification
4. Operations Maintenance & Monitoring
5. Measurement & Verification
## Design, Construction & Verification

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<td>Operational performance verification (OPV) report</td>
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<td>Systems manual</td>
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<td>-</td>
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Design, Construction & Verification

Operational Performance Verification

• OPV plan
  – Developed preconstruction
  – Verification activities: design review, etc…
  – Systems involved; roles and responsibilities
  – Key performance indicators

• OPV approaches
  – *Visual inspection* - verify the physical installation of the ECM
  – *Spot measurements* - measure key energy-use parameters for ECMs or a sample of ECMs
  – *Pre-functional checklist / functional performance testing* - test functionality and proper control
  – *Trending and data logging* - setup trends or install data logging equipment and analyse data, and/or review control logic
Design, Construction & Verification

Operational Performance Verification

• OPV effort
  – Consultation with energy auditors
  – Monitoring of designs, submittals and project changes
  – Inspections of implemented changes
  – Means of reporting deviations from design
    • Help the client / PD team to *fully install the measure properly* and then re-verify its performance; or
    • Work with the PD team to *revise the ECM savings estimates* using the actual post-installation data and associated inputs.
• Systems manual
  – Building design and construction (owner’s project requirements, current facility requirements, basis of design, construction/project record documents)
  – Facility, systems and assemblies information
  – Operational requirements
  – Maintenance requirements and procedures
  – Training
  – Commissioning process report: OPV plan, testing reports, issue and resolution logs
# Design, Construction & Verification Documentation

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Documentation</th>
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<tbody>
<tr>
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<td>Qualifications of the OPV provider</td>
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<td>Large and Standard</td>
<td>OPV Plan</td>
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<tr>
<td>All</td>
<td>OPV concise report</td>
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<tr>
<td>Large and Standard</td>
<td>Systems manual</td>
</tr>
<tr>
<td>All</td>
<td>Statement that project conforms to intent of scope</td>
</tr>
<tr>
<td>All</td>
<td>Training materials and record of training</td>
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</table>
1. Baseline Development
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# Operations, Maintenance & Monitoring

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<tr>
<td>Training on OM&amp;M procedures</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Operators manual</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tenant outreach</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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Operations, Maintenance & Monitoring
OM&M Plan – Large and Standard

• OM&M procedures
  – Process of continuous improvement and monitoring
  – Tracking, analysing, diagnosing issues
  – Resolving issues
  – Maintain indoor conditions

• Methods include:
  • Periodic inspections
  • Monitoring-based commissioning
  • Automated fault detection and diagnostic tools
  • Ongoing commissioning
  • Recommissioning
  • Periodic data analysis
• OM&M Plan: framework for ongoing management regime
  – Process and intent
    • Manual or automated tools or processes to use
  – Resources and established roles / responsibilities
  – Quantifiable performance goals (based on performance indicators)
  – Operation and assignment of responsibilities
• Operator’s Manual
  – Often combined with Systems Manual
  – Photographs
  – Reduced-size as-built drawings and schematics
  – List of major equipment
  – Invoices for major equipment purchases and repairs
  – Balance reports
  – Equipment locations
  – Control system logic
  – O&M instructions
  – Training materials
Operations, Maintenance & Monitoring
Training on OM&M Procedures

• OM&M Training
  – Often combined with OPV training
  – Management structure: roles and responsibilities
  – Performance metrics
  – ECM maintenance
  – Predictive maintenance
  – Automated management / maintenance
  – Issue resolution

“First line of defence”
Operations, Maintenance & Monitoring

Tenant Outreach

• Can be critical to success of the ECM project
  – Notify tenants of improvements made in the building, and any behaviour modifications required
  – Communications to tenants can include:
    • Poster campaigns
    • Flyer distribution
    • Training sessions
## Operations, Maintenance & Monitoring

*Documentation*

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large and Standard</td>
<td>OM&amp;M Plan (ongoing management regime)</td>
</tr>
<tr>
<td>Large and Standard</td>
<td>Organisational chart</td>
</tr>
<tr>
<td>Large and Standard</td>
<td>Maintenance plans and service response log</td>
</tr>
<tr>
<td>All</td>
<td>Training curriculum</td>
</tr>
<tr>
<td>All</td>
<td>Operator’s manual</td>
</tr>
</tbody>
</table>
QUESTIONS
1. Baseline Development
2. Savings Calculations
3. Design, Construction & Verification
4. Operations Maintenance & Monitoring
5. Measurement & Verification
## Measurement & Verification

<table>
<thead>
<tr>
<th>Element</th>
<th>Large</th>
<th>Standard</th>
<th>Targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td>M&amp;V Plan</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Whole building (Option C)</td>
<td>✓</td>
<td>Maybe</td>
<td>-</td>
</tr>
<tr>
<td>Retrofit isolation – all parameters (Option B)</td>
<td>-</td>
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<tr>
<td>Retrofit isolation – key parameters (Option A)</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Collection of energy data</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Verified calculations and Report</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Measurement & Verification

Process

• Follow IPMVP

• M&V Process
  1. Document baseline
  2. Plan and coordinate M&V activities
  3. Verify operations
  4. Gather data
  5. Verify savings
  6. Report results

Pre-construction

Post-construction
• M&V Plan
  – Compliant with IPMVP
    • Plan requirements described in IPMVP Core Concepts, Section 7
  – Select appropriate Option(s)
  – Define routine and non-routine adjustments
  – Define measurement boundary
  – Collect baseline and post-construction data
  – Option A: estimated parameters
Measurement & Verification
Performance Period Efforts

• Operational performance verification

• Data collection
  – Metering equipment; data logging equipment; BAS trending
  – Erroneous or missing data

• Verified savings

• M&V reporting
  – IPMVP Core-2016, Section 7.4
# Measurement & Verification Documentation

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>All</td>
<td>M&amp;V Plan</td>
</tr>
<tr>
<td>All</td>
<td>Routine adjustments</td>
</tr>
<tr>
<td>All</td>
<td>Pre-retrofit collected data (baseline period)</td>
</tr>
<tr>
<td>All</td>
<td>Post-retrofit collected data (reporting period)</td>
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<tr>
<td>All</td>
<td>Non-routine adjustments</td>
</tr>
<tr>
<td>Large</td>
<td>Description of regression model and verified savings</td>
</tr>
<tr>
<td>Standard and Targeted</td>
<td>Revised savings calculations</td>
</tr>
<tr>
<td>All</td>
<td>M&amp;V Report</td>
</tr>
</tbody>
</table>
Worked examples
Example 1: Residential building retrofit

- ECMs include
  - Boiler upgrade
  - Reduction in apartment setpoints
  - Lighting retrofit, internally and externally
  - New ventilation system with heat recovery
  - New domestic hot water pumps with demand-controlled variable speed drives

- Complex interactions between measures

- Difficult to assess savings using spreadsheet-based calculation approach: dynamic simulation

- Large Apartment Block protocol
Example 2: Boiler replacement in 20 offices

• Discrete measure
  - Simple to estimate savings

• Energy savings are expected to be 15%

• Measurement boundary to be drawn around boiler

• IPMVP Option A or B likely to be most appropriate

• **Targeted Tertiary protocol**

• A sampling approach can be adopted to energy audit, provided representative sample is selected

• Only the baseline associated with the boilers needs to be developed
Example 3: Retail building upgrade

• ECMs consist of lighting retrofit, upgrades to BMS, air handling unit improvements, installation of variable speed drives

• Savings can be estimated using spreadsheet-based calculation approach

• IPMVP Option C likely to be most suitable

• Standard Tertiary protocol
Q: The IREE™ logo is a guarantee of project performance – true or false?

a. True
b. False
Q: The IREE™ logo is a guarantee of project performance – true or false?

a. True

b. False
Summary - Important FACTS to remember

• Any EE project that follows state of the market origination processes already does “everything ICP requires” – ICP is an overarching standardizing layer to the process

• ICP supports best practices standards, tools or engineering methodologies already in the market place

• ICP is flexible and adaptable to different project complexity and investment levels

• There is nothing like ICP in the global market – relevance of the Performance Period for persistence of savings
Questions and discussion
The ICPEU and I3CP projects have received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 649836 and 754056. The sole responsibility for the content of this document lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.