Investor Confidence Project

Project Developer and Quality Assurance Assessor Training
May 9th 2018

Presenters:
Luís Castanheira, ICP Europe Technical Director
Bethan Phillips, ICP Europe Technical Team
WELCOME
Your Presenters

- 20 years in Sustainable Energy
- Energaia – Energy Management Agency
- Porto Polytechnic Engineering School
- EU Commission Expert
- CMVP and IPMVP Technical Committee Member
- Energy auditor, BREEAM, EPBD building energy assessor

Luís Castanheira
ICP Europe Technical Director
Your Presenters

- 15+ years in low energy building design and sustainable energy solutions
- Principal consultant at Verco
- Building services engineering, mechanical engineer
- CMVP accredited, ISO 50001 lead auditor
- Energy audits, feasibility studies (CHP, district heating, etc), sustainability assessments
European Commission Disclaimer

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Agenda

• Housekeeping
• Strategic approach
• What is the Investor Confidence Project?
• Roles and responsibilities
• Process and tools available
• ICP Stages – requirements
• Worked examples
• Application process

This webinar will be recorded
Housekeeping

• You are all muted by default to minimize background noise, but we want your participation!

• You can ask questions either using the chat box or raising your hand on gotowebinar control panel anytime

• We will stop at the end of each section for QA

• We will use a poll facility to assess comprehension and guide interaction

• At the end we will have an open QA session

• We will get back to you if there is any question we cannot answer in the course of this training session

• Training should take a maximum of 2 hours + QA
Strategic approach

• All participants are knowledgeable and experienced professionals

• This training is only the beginning of a longer journey

• ICP Project Developers and Quality Assurance Assessors are crucial agents for the success of our scheme and the transformation of the Energy Efficiency market
What is the Investor Confidence Project?
Lack of Standardisation = Greater Risk
Investor Ready Energy Efficiency Project

Consistent Documentation

Third-Party Quality Assurance

Certified Professional

Best Practices and Standards
Ensures transparency, consistency and trust-worthiness through **best practice** and independent verification.
An international framework for reducing owner and investor risk, lowering due diligence costs, increasing certainty of savings achievement and enabling aggregation.
Baselining

Savings Projections

Design, Construction, Verification

Operations, Maintenance, Monitoring

Measurement & Verification (M&V)

Procedures

- Best Practice Workflow
- Standard Industry Practices

Documentation

- Standard Documentation Package
- Itemized Outputs Required
The IREE™ Certification is delivered prior to investment decision.
What project types is IREE™ designed for?

- Buildings
- Industry
- District energy systems
- Street lighting upgrades
Street Lighting

One Protocol

Single protocol for all types of street lighting energy efficiency projects
Street Lighting: European context

• 60-90m street lights across Europe
• 75% more than 25 years old
• Approx annual energy cost €3bn
• Energy saving potential from LED of 50-75% or €1.9bn
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
Roles and responsibilities
ICP Project Developer

• Attend training

• Meet network requirements:
  – Qualifications
  – Experience
  – Professional insurance
Third Party

• Someone who may be indirectly involved with, but is not a principal party to, an arrangement, contract, deal, or transaction

• ICP requires third-parties for:
  – Measurement and Verification
  – Quality Assurance
ICP Quality Assurance

• Energy efficiency investors lack expertise

• Multiple investors separately evaluating a project = time and money wasted

• QA assessor
  – Independent
  – Represent the investor’s interests
  – Ensures project conforms to ICP protocols
  – Can also be an ICP Project Developer
Quality Assurance ‘Specialists’

• Spreadsheet calculations
• Implementation costs / investment criteria
• Commissioning (OPV)
• Measurement and verification
Project Developer Responsibilities

• Represents project owner’s interests
• Components clearly identified and organised
• Available to QA Assessor and others as appropriate

• Develop and assemble documentation (investment) package:
  – Submit all documentation required by protocol
  – Ensure calculations are fully transparent, and all assumptions documented and explained
QA Assessor Responsibilities

- Ensure project was developed in accordance with the most appropriate approach taken from the ICP Protocol
- Validate that all necessary documentation is provided and complete
- Check methodologies, assumptions, and results (technical review)
- Complete the ICP Checklist
ICP QA Checklist Qualifier

“By signing the ICP QA checklist, the ICP Quality Assurance Assessor attests to having reviewed the project development documentation and finds that the project is consistent with the ICP Protocol as deemed applicable to the project based upon the data that are available. *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 credentialed Project Developer.*”
Project Team Communication

• Involve QAA early on in project development
• Maintain professional perspective and independence
• Collaborative approach
• Ask for clarifications
Process and tools available
# Project Development Tasks

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Select a baselining approach</td>
<td>Develop initial savings estimates</td>
<td>Appoint an Operational Performance Verification Resource</td>
<td>Select and document ongoing management regime e.g. periodic inspection/aM&amp;T</td>
<td>Develop an IPMVP based M&amp;V plan</td>
<td></td>
</tr>
<tr>
<td>Collect asset information, plans, drawings and utility asset registers</td>
<td>Establish preliminary cost estimates</td>
<td>Develop OPV plan</td>
<td>Develop OM&amp;M plan</td>
<td>Appoint an M&amp;V professional</td>
<td></td>
</tr>
<tr>
<td>Work with the M&amp;V specialist to define the measurement boundary</td>
<td>Ascertain preferred financial analysis metrics</td>
<td>Where appropriate, make provisions for the development and implementation of training</td>
<td>Where appropriate, make provisions for the development and implementation of operator training</td>
<td>Provide the M&amp;V Plan, input data sets, assumptions and calculation to all parties</td>
<td></td>
</tr>
<tr>
<td>Establish the baseline period</td>
<td>Develop a set of recommended ECMs</td>
<td>Make provisions for updating systems manual (if one already exists)</td>
<td>Make provisions for updating operator’s manual (if one already exists)</td>
<td>Option A/B: Collect post-retrofit energy / performance data</td>
<td></td>
</tr>
<tr>
<td>Collect hourly electricity consumption data, independent data, utility rate schedule, historical energy use data and independent variable data</td>
<td>Develop a project inventory for the proposed ECMs</td>
<td>If no systems manual exists, at minimum provide full inventory of installed equipment</td>
<td>Make provisions for the development and execution of instructions to notify affected stakeholders</td>
<td>Option A/B: Performance data analysis</td>
<td></td>
</tr>
<tr>
<td>Define the project boundary</td>
<td>Estimate the total annual operational hours</td>
<td>Where appropriate, make provisions for a simple OPV report</td>
<td></td>
<td>Option A/B: Verified savings calculations</td>
<td></td>
</tr>
<tr>
<td>Develop a project inventory</td>
<td>Calculate and document the estimated annual performance period energy consumption</td>
<td></td>
<td></td>
<td>Option C: Post-utility data</td>
<td></td>
</tr>
<tr>
<td>Calculate estimated operational hours, power consumption and hence baseline energy consumption</td>
<td>Develop detailed energy savings calculations</td>
<td></td>
<td></td>
<td>Option C: Identify / quantify non-routine adjustments</td>
<td></td>
</tr>
<tr>
<td>Cross-check the baseline energy consumption using spot measurements</td>
<td>Develop final investment package for ECMs</td>
<td></td>
<td></td>
<td>Option C: Regression based analysis</td>
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</tr>
<tr>
<td>Calendarise independent variable data</td>
<td>Prepare final report summarising ECMs</td>
<td></td>
<td></td>
<td>Develop a deemed savings plan</td>
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<tr>
<td>Develop the baseline energy consumption model and test accuracy</td>
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<tr>
<td>Establish peak demand and pricing (where it is in effect)</td>
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<tr>
<td>Chart average daily demand (where demand charges or time-of-using pricing is in effect)</td>
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</tbody>
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### Key

- **All approaches**
- **Measurement based approach**
- **Deemed savings approach**
# Quality Assurance Tasks

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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Review and approve selected baseline period</td>
<td>Review and approve credentials of individual responsible for energy model/savings calculations</td>
<td>Review and approve credentials of individual responsible for OPV</td>
<td>Review and approve OM&amp;M plan, setting out procedures</td>
<td>If using a measurement based approach: Review and approve M&amp;V plan</td>
</tr>
<tr>
<td></td>
<td>Review and approve electricity data and rates, significant variable data and energy baseline</td>
<td>Review and approve credentials of individual responsible for designing the lighting system</td>
<td>Review and approve OPV plan</td>
<td>Review and approve selected ongoing management regime</td>
<td>Review and approve credentials of individual responsible for M&amp;V</td>
</tr>
<tr>
<td></td>
<td>Review and approve energy consumption model</td>
<td>Review and approve energy savings calculations, including supporting data</td>
<td>Review and approve systems manual/full inventory</td>
<td>Review and approve operator's manual (if one exists)</td>
<td>Review and approve the deemed savings plan</td>
</tr>
<tr>
<td></td>
<td>Review and approve regression model when used</td>
<td>Review and approve annual operational hours and total annual post-retrofit energy consumption calculations</td>
<td>Review and approve training (interview system operators)</td>
<td>Review and approve training (interview system operators)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review and approve project inventory</td>
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<tr>
<td></td>
<td>Review and approve investment package</td>
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<tr>
<td></td>
<td>Review and approve ECM report including final energy cost savings and pricing for each measure</td>
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</table>

**Key**

- All approaches
- Measurement based approach
- Deemed savings approach
Project Acceptance

• Descriptions of deficiencies and issues
  – Documentation requirements
  – Methodologies, assumptions, and results

• Reasonableness
  – Document how items were resolved, or why they were left open

• Complete and sign the QA Checklist

• Project certified as IREE™
Quality Assurance Tools

- ICP QA Checklist
- ICP PD Specification
- Project Registry
ICP Quality Assurance Checklists

• Specific to the protocol (one checklist)
• Focuses on underwriting phase
• Required components and documentation
  – Baselining
  – Savings Calculations
  – OPV
  – OM&M
  – M&V
ICP Project Development Specification

• Supplements protocol
• More detailed guidance on requirements in protocol
• Additional resources
• Linked to protocol sections
Questions and polls
ICP Stages - Requirements
1. Baseline Development
2. Savings Calculations
3. Design, Construction & Verification
4. Operations Maintenance & Monitoring
5. Measurement & Verification
Protocol Approach and Documentation

**Street Lighting Protocol**

- **Measurement-Based Approach**
  - Direct monitoring of energy consumption
  - IPMVP compliant
  - Preferred approach: more robust

- **Deemed Savings Approach**
  - Estimations of consumption based on reliable asset information
  - No requirement for when to use it, but generally when:
    - Billing based on deemed savings approach, and/or
    - No energy monitoring system installed

**Street Lighting Project Development Specification**
## Baseline Development

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Measurement-based</th>
<th>Deemed Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalised baseline (energy consumption equation)</td>
<td>Maybe</td>
<td>-</td>
</tr>
<tr>
<td>Electricity consumption data</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>System asset, operational, performance data</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Retrofit isolation baseline</td>
<td>Maybe</td>
<td>-</td>
</tr>
<tr>
<td>Load shapes (when interval data available)</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Project Inventory</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Estimated annual baseline energy consumption</td>
<td>-</td>
<td>✓</td>
</tr>
</tbody>
</table>

Where relevant to the ECMs
Baseline Development
All approaches: System Asset, Operational, Performance Data

• Collect system asset, operational, and performance data
  – Drawings, equipment inventories, surveys, monitoring or measurements etc.
  – System performance tracking
  – Analysis of ECMs
  – ECM implementation
  – ECM performance tracking

• Provide a summary of activities and processes
Baseline Development

Deemed savings approach: Estimated baseline calculation

• Define project boundary

• Develop project inventory for fixtures and fittings undergoing replacement
  – Include fixtures which are not operational
  – Power consumption from manufacturer’s data, national reference documents or on-site measurement (preferred option).

• Calculate estimated total annual operational hours
  – Account for effects such s local sunrise/sunset times and weather effects
  – Nationally recognised approach, or use on-site measurement (preferred option).

• Calculate estimated power consumption by fitting type and operating hours
Baseline Development
*Deemed savings approach: Estimated baseline calculation*

- Estimated annual baseline energy consumption = $\sum$ power consumption x operating hours *(for each equipment category)*

- Cross-check with spot measurements (sampling) and/or comparing with national databases (e.g. inventory and charge code)

- Deviation >10%: written justification required

- Document all assumption, calculations, measurements
Baseline Development

Measurement-based approach: Data collection

• Collect historical energy use and cost data
  – Define measurement boundary/project boundary
  – At least one full energy-use cycle (for most street lighting systems this will be one year)
  – Electricity, renewable energy and any other resources consumed
  – Calendarise if necessary
  – Energy end-use breakdowns to create boundaries and reality checks associated with energy savings estimates

PDS section 4.2.1
Street Lighting PDS section 1.2

EN16247-1 Energy Audits – General requirements
ISO 5002 Energy Audits – Requirements with guidance for use
Baseline Development
Measurement-based approach: Regression-based model

• Develop an energy-use equation
  – Achieve an appropriate goodness of fit of energy data variability to independent variables
  – Perform regression analysis
    • Initial check on R-squared – in some cases it may be hard to achieve a high R-squared value
  – Model should be evaluated on the basis of predicted savings: must be greater than twice the standard error of the baseline value
  – Uncertainty analysis not required, but recommended
  – Proprietary tools may be available

IPMVP: Statistics and Uncertainty for IPMVP 2014 (section 1)
Baseline Development
Measurement-based approach: Energy end-use consumption / Weather

• Estimate or measure end-use energy use
  – Calibrate baseline energy model
  – Calibrate energy savings estimates

• Where relevant to ECMs, collect independent variables data corresponding to the baseline period (e.g. traffic)
  – At least one full energy-use cycle (for most street lighting systems this will be one year)

• Other independent variables
  – e.g. number of burn outs,
  – changes to illuminance levels etc.

EIA Based Electric Usage Allocation (kWh)

- Space Heating: 7,001
- Cooling: 1,347
- Ventilation: 2,693
- Water Heating: 7,405
- Lighting: 8,213
- Cooking: 2,424
- Refrigeration: 9,156
- Office Eq.: 22,216
- Computers: 404
- Other: 942
Baseline Development
Measurement-based approach: Retrofit isolation baseline

• ECM specific baseline
  – IPMVP Option A or B M&V approach
  – Same approach as whole-system baseline development
  – Define measurement boundary
    • Specific piece of equipment
    • End-use
  – Define
    • Constant / variable load
    • Constant / variable schedule

IPMVP Core Concepts 2016
Section 5.1
Baseline Development
All approaches: 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 all four seasons

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

<table>
<thead>
<tr>
<th>Baseline approach</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both</td>
<td>Statement of basis for the baselining approach selected</td>
</tr>
<tr>
<td>Measurement-based</td>
<td>Baseline period (start and end dates)</td>
</tr>
<tr>
<td>Measurement-based</td>
<td>Energy data</td>
</tr>
<tr>
<td>Deemed Savings</td>
<td>Project inventory</td>
</tr>
<tr>
<td>Deemed Savings</td>
<td>Details of power consumptions of relevant equipment</td>
</tr>
<tr>
<td>Deemed Savings</td>
<td>Calculations relating to baseline energy consumption</td>
</tr>
<tr>
<td>Both</td>
<td>Access to all asset, operational and performance data</td>
</tr>
<tr>
<td>Both</td>
<td>Utility rate structure</td>
</tr>
<tr>
<td>If applicable:</td>
<td></td>
</tr>
<tr>
<td>Measurement-based</td>
<td>Operational hours, weather and traffic data (if relevant to project)</td>
</tr>
<tr>
<td>Both</td>
<td>Interval data; sub-metered data; load profiles; monthly peak demand</td>
</tr>
</tbody>
</table>
Baseline Development
Questions and polls

QUESTIONS
1. Baseline Development

2. Savings Calculations

3. Design, Construction & Verification

4. Operations Maintenance & Monitoring

5. Measurement & Verification
## Savings Calculations

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Measurement-based</th>
<th>Deemed Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM descriptions</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ECM savings calcs – models/spreadsheets</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Investment criteria</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fixed prices for each ECM</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Investment package</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Reporting</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Savings Calculations

*Deemed savings approach*

• Repeat baselining process for proposed ECMs:
  – Project inventory including number of items and estimated power consumption
  – Estimate total annual operational hours for each piece of equipment
  – Calculate and document annual performance period energy consumption
Savings Calculations

ECM Descriptions; Cost Estimates

• ECM descriptions
  – Present condition, proposed measure

• Cost estimates
  – At the feasibility stage, direct quotes 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

• Long term financial analysis is optional
Savings Calculations

Investment Criteria

- Programmes and projects have individual criteria
  - ICP does not specify investment criteria to be used
  - Job of PD is to ascertain and inform preferred financial metrics
    - Implementation costs
    - Estimated savings
    - Available incentives
    - Effective useful life
    - Escalation rates
    - Interest rates
    - Discount rates
    - Cost of capital
    - Lease terms
    - Other appropriate financial inputs
Savings Calculations

**Spreadsheets and tools**

- Analysis methods
  - Spreadsheet-based
  - Regressions analysis
  - Proprietary tools

- Assumptions and inputs
  - Documented
  - Never embedded
  - Reasonable
Savings Calculations

Report

• Summary report: industry-accepted format
  – Results
  – Methods used
  – Data
  – Pricing for each ECM and package of ECMs
  – Predicted energy savings: energy consumption, % volume, cost savings

EN 16247-1 Energy audits – Part 1
Section 5.6
### Savings Calculations

**Documentation**

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both</td>
<td>Energy modeller/consultant qualifications</td>
</tr>
<tr>
<td>Both</td>
<td>System designer qualifications</td>
</tr>
<tr>
<td>Both</td>
<td>Where proprietary or third-party software has been used: input files; output files; calculation descriptions</td>
</tr>
<tr>
<td>Both</td>
<td>Where open-book calculations have been used: calculation process description, workbooks, calculation tools</td>
</tr>
<tr>
<td>Both</td>
<td>Basis for ECM costs</td>
</tr>
<tr>
<td>Both</td>
<td>Summary report – including annual predicted energy savings by fuel type</td>
</tr>
<tr>
<td>Deemed Savings</td>
<td>Project inventory: all equipment within the project boundary</td>
</tr>
<tr>
<td>Deemed Savings</td>
<td>Calculations relating to: annual operational hours; total annual baseline energy consumption</td>
</tr>
</tbody>
</table>
1. Baseline Development

2. Savings Calculations

3. Design, Construction & Verification

4. Operations Maintenance & Monitoring

5. Measurement & Verification
## Design, Construction & Verification

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Protocol</th>
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<tbody>
<tr>
<td>Appoint an Operational Performance Verification (OPV) resource</td>
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<tr>
<td>Operational Performance Verification (OPV) plan</td>
<td>✓</td>
</tr>
<tr>
<td>Operational Performance Verification (OPV) report</td>
<td>Maybe</td>
</tr>
<tr>
<td>Training</td>
<td>Maybe</td>
</tr>
<tr>
<td>Update Systems manual/full Inventory of the installed equipment</td>
<td>✓</td>
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</tbody>
</table>

Where appropriate to the nature of the ECMs/scale of the project
Design, Construction & Verification

Operational Performance Verification

• 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
  – **Targeted 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

Deemed savings approaches
Well-known ECMs, predictable or low savings

ECMs with greater savings/uncertainty
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 *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.
Design, Construction & Verification
Operational Performance Verification

- OPV plan
  - Developed preconstruction
  - Verification activities: design review, etc…
  - Systems involved; roles and responsibilities
  - Target energy budget
  - Description of OPV report (where appropriate to nature/scale of project)
  - Provisions to:
    - Develop training plan for operators (ECM descriptions, target performance, etc.) (where appropriate to nature/scale of project)
    - Update Systems Manual, or
    - If no Systems Manual exists, provide a full inventory of the installed equipment, as a minimum
• Systems manual
  – System design and construction (owner’s project requirements, current system requirements, basis of design, construction/project record documents)
  – Operational requirements
  – Maintenance requirements and procedures
  – Commissioning process report: OPV plan, testing reports, issue and resolution logs
  – Training
<table>
<thead>
<tr>
<th>Approach</th>
<th>Documentation</th>
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<tbody>
<tr>
<td>Both</td>
<td>Qualifications of the OPV provider</td>
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<tr>
<td>Both</td>
<td>OPV Plan</td>
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</table>
Design, Construction & Verification

Questions and polls
1. Baseline Development
2. Savings Calculations
3. Design, Construction & Verification
4. Operations Maintenance & Monitoring
5. Measurement & Verification
## Operations, Maintenance & Monitoring

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Protocol</th>
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<tbody>
<tr>
<td>OM&amp;M plan (ongoing management regime)</td>
<td>✓</td>
</tr>
<tr>
<td>Training on OM&amp;M procedures</td>
<td>Maybe</td>
</tr>
<tr>
<td>Update Operators manual (if one exists)</td>
<td>Maybe</td>
</tr>
</tbody>
</table>

Where appropriate to the nature of the ECMs
Operations, Maintenance & Monitoring

**OM&M Plan**

- **OM&M procedures**
  - Continuous improvement and monitoring
  - Tracking, analyzing, diagnosing issues
  - Resolving issues
  - Maintain system performance

- **Methods include:**
  - Periodic inspections
  - Remote management and monitoring systems
Operations, Maintenance & Monitoring
OM&M Plan

• OM&M Plan: framework for ongoing management regime
  – Process and intent
    • Manual or automated tools or processes to use
  – Resources and established roles / responsibilities
    • Organisational chart
    • Technical qualifications for O&M
  – Provisions to:
    • Use approved installers (where national certification schemes exist)
    • Develop training plan for operators (ECM descriptions, target performance, issue resolution, etc.) (where appropriate to nature/scale of project)
    • Update Operator’s Manual
    • Develop instructions to notify stakeholders of implemented ECMs
• **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
  - Equipment locations
  - Control system logic
  - O&M instructions
  - Training materials
## Operations, Maintenance & Monitoring

**Documentation**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Documentation</th>
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</thead>
<tbody>
<tr>
<td>Both</td>
<td>OM&amp;M Plan (ongoing management regime)</td>
</tr>
<tr>
<td>Both</td>
<td>Organisational chart</td>
</tr>
</tbody>
</table>
Operations, Maintenance & Monitoring
Questions and polls

Any Questions
1. Baseline Development
2. Savings Calculations
3. Design, Construction & Verification
4. Operations Maintenance & Monitoring
5. Measurement & Verification
# Measurement & Verification

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Measurement-based</th>
<th>Deemed Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appoint an M&amp;V resource</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>M&amp;V Plan</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Whole facility (Option C)</td>
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<td></td>
</tr>
<tr>
<td>Retrofit isolation – all parameters (Option B)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Retrofit isolation – key parameters (Option A)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Deemed Savings Plan</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Collection of energy data</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Verified calculations and report</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Measurement & Verification
Deemed savings approach: Pre-construction

• Post-retrofit verification
  – Check asset information for each piece of installed equipment consistent with pre-retrofit assumptions
    • Power consumption
    • Operating hours
  – Not compliant with IPMVP
  – Does not need to be carried out by a qualified M&V professional
Deemed Savings Plan

- Develop pre-retrofit
- Verify asset information
- Define project boundary
- Documentation of the planned process for establishing the deemed energy savings:
  - Collect estimated annual baseline energy consumption
  - Collect estimated post-upgrade energy consumption
Measurement & Verification

Deemed savings approach: Performance period efforts

1. Develop Deemed Savings plan
2. Collect data
3. Install measures
4. Deemed Savings report
5. Verify savings
6. Data collection
Measurement & Verification

Measurement-based approach: Option C

• Whole Facility
  – Option C: Utility bill analysis
  – Savings estimates > 10% system energy use
  – Energy use equation/regression analysis
  – Routine and non-routine adjustments
  – Statistical evaluation
    • $R^2 > 0.75$
    • $CV[RMSE] < 15\%$
    • MBE +/- 7\%
    • $T$-stat > 2.0
Measurement & Verification
Measurement-based approach: *Options A and B*

- Retrofit Isolation
  - Option A: Key parameter measurement
  - Option B: All parameter measurement

  - Specific to each ECM
  - Develop measurement boundaries
  - Estimated parameters
Measurement & Verification

Measurement-based approach: 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-retrofit

Post-retrofit
Measurement & Verification

Measurement-based approach: M&V application – pre-construction

• M&V Plan
  – Compliant with IPMVP
  – Select appropriate Option(s)
  – Define:
    • Routine and non-routine adjustments
    • Measurement boundary
    • Measurement period
  – Meter locations, accuracy
  – Collect baseline and post-construction data
  – Option A: estimated parameters
Measurement & Verification

Measurement-based approach: Performance period efforts

- Develop M&V plan
- Collect data
- Install measures

M&V report
- Verify savings
- Data collection
## Measurement & Verification Documentation

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<tr>
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<td>M&amp;V Plan</td>
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<tr>
<td>Measurement-based</td>
<td>Routine and non-routine adjustments</td>
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<tr>
<td>Deemed Savings</td>
<td>Deemed Savings Plan</td>
</tr>
<tr>
<td>Both</td>
<td>Pre-retrofit collected data (baseline period)</td>
</tr>
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</table>
Measurement & Verification

Questions and polls
Worked examples
Example 1: Retrofit of LED luminaires

- Discrete measure
  - Simple to estimate savings

- Measurement/project boundary to be drawn around number of luminaires in system

- IPMVP Option A or B/Deemed Savings approach likely to be most appropriate

- A sampling approach can be adopted, provided a representative sample is selected

- Only the baseline associated with the luminaires needs to be developed (if other energy uses)
Example 2: Major street lighting upgrade

- ECMs consist of luminaire retrofit, installation of a new Central Management System and replacement of most ‘at-risk’ street lighting columns.

- Billing based on metered data

- Measurement boundary should include all energy using components – i.e. include the entire system.

- IPMVP Option C approach likely to be most suitable
Application Process
Application timeline

• A link to the PD and QAA applications will be sent to attendees of today’s training

• A link to test for QAA applications will also be sent

• Applications must be submitted by 23rd May

• We will contact you if we require additional information or clarifications on your submission

• Once our review is complete, we will notify you to confirm your official status as a member of the ICP PD/QAA network
Project developer requirements

• List of individuals who will oversee ICP projects and their credentials - option 1 (professional engineer) or option 2 (engineering/science degree plus additional certification) – describe relevance of qualification

• Sign Declaration of Honour confirming PD experience across 5 ICP stages:
  • Baselining
  • Savings calculations
  • Design, Construction and OPV
  • Operations, Maintenance and Monitoring
  • Measurement and Verification

• Proof of Professional Indemnity insurance

• Acknowledge ICP T&Cs and to information being correct

• Company logo and brief details
QA assessor requirements

- List of individuals who will oversee ICP projects and their credentials - option 1 (professional engineer) or option 2 (engineering/science degree plus additional certification) – describe relevance of qualification

- Sign Declaration of Honour confirming QA experience across 5 ICP stages:
  - Baselining
  - Savings calculations
  - Design, Construction and OPV
  - Operations, Maintenance and Monitoring
  - Measurement and Verification

- Proof of Professional Indemnity insurance

- Acknowledge ICP T&Cs and to information being correct

- Company logo and brief details

- Take QAA test – online, 40 questions, 30 mins
Investor Confidence Project
europe.EEperformance.org

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