INVESTOR CONFIDENCE PROJECT

COMPLEX INDUSTRY PROTOCOL

VERSION 1.1 – APRIL 2018

GBCI®

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 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.

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THE INVESTOR CONFIDENCE PROJECT

The Investor Confidence Project (ICP) is a global initiative that focuses on increasing energy efficiency deal flow by ensuring that projects are engineered robustly, financial returns are predictable, and project underwriting can be streamlined. The ICP system is comprised of the ICP Protocols and the Investor Ready Energy Efficiency™ Certification which offer a standardised roadmap for project developers, a market tested methodology for programme administrators, and a certification system for investors and facility owners to accurately and efficiently manage project risk.

ICP is administered by Green Business Certification Inc. (GBCI) and was conceived, incubated and developed by the Environmental Defense Fund (www.edf.org).

For more information, please visit:
ICP North America (www.eeperformance.org) or ICP Europe (europe.eeperformance.org)

Investor Ready Energy Efficiency™

Investor Ready Energy Efficiency™ (IREE) is a certification awarded to retrofit projects that conform to the requirements of the ICP Protocols, were originated under the direction of ICP developers, and certified through independent review by an ICP Quality Assurance Assessor. IREE projects provide investors, facility owners, and other stakeholders with a new level of confidence in project quality.

Investor Ready Energy Efficiency™ Certification occurs after completion of project design and engineering, but prior to construction.

Development of an ICP compliant project includes the following two periods:

- **Certification Period** (pre-IREE Certification). The Certification Period includes all procedures and documentation associated with project development that occur prior to construction. This includes the development of plans (such as the OPV, OM&M, and M&V plans) that describe the tasks and documentation that will be performed during the Performance Period.
- **Performance Period** (post-IREE Certification). The Performance Period refers to the construction and post-construction (post-retrofit) period after IREE Certification is achieved. The ICP Protocols require certain procedures and documentation that occur during the Performance Period which are specified in various plans that are developed during the Certification Period. These plans, and the requirements identified in them, should be explicitly required by the investor or facility owner to be included in the project developer's scope of work and contract. If necessary, the services of the Quality Assurance Assessor or other third parties may be retained during the Performance Period to oversee implementation.

ICP Complex Industry Protocol

To conform to the ICP Protocols, projects must meet the specified procedural and documentation requirements detailed in this document. In order to ensure the protocol requirements optimally fit the project, it is crucial that the project developer selects the correct ICP Protocol. This protocol is intended for complex industry energy efficiency projects that include:

- **Installation of new technology types or capacities, including new utility generation technologies** - for example, major changes to plant configuration requiring controls modifications
- **Installation of ECMs with variable and/or unpredictable loads** - for example, refrigeration plant

Where projects include bespoke, process-specific ECMs, the project developer must either have experience themselves in a similar process and technology, or they must work with an experienced specialist. This experience should be documented in the form of a CV and submitted to the Quality Assurance Assessor during the certification period. Where Energy Service Companies (ESCOs) are involved in developing projects, they must also meet any national requirements for ESCOs (see *Qualifications and Certifications List)*.

Additional resources to this protocol include:

- **Project Development Specification** is the reference guide for all ICP Protocols and includes detailed explanations of the requirements as well as supporting references and tools.
- **ICP Protocol Glossary** defines industry terminology found in the ICP Protocols.
- **ICP Acronym Dictionary** defines the various industry acronyms.
- This document also makes use of tool-tips to provide context and information associated with various terms and requirements.

Global Standards And References

Throughout this document, reference is made to European and international standards, guidance and resources when relevant to protocol requirements. Resource references are shown in *italics*. Where a relevant national standard, guidance or resource is available, this may be used as an optional alternative resource to the European or international standard, provided it can be demonstrated that it meets ICP requirements.

ICP Project Framework

The ICP Protocols are structured based on five project lifecycle phases that represent the entire lifecycle of a well-conceived and well-executed energy efficiency project. For each phase, the protocol establishes minimum requirements for:

- **Procedures** - specific tasks to be performed during the certification period.
- **Documentation** - required documentation supporting procedures, calculations, as well as plans that specify procedures to be executed in the performance period.

1.0 BASELINING

The baselining efforts involve the development of a baseline and collection of all the information needed to perform the tasks associated with the savings calculations, economic analysis, and development of plans for the performance period. Under a best practice approach, the starting point for any energy efficiency project is an energy audit, conducted by a qualified professional and following the requirements set out in *EN 16247-3 Energy audits - Processes and ISO 50002 Energy audits - Requirements with guidance for use*.

The baseline must establish how much energy a facility or system can be expected to use over a representative time period. This should cover all energy consumed at the facility which is within the measurement boundary. This may include any energy sources which are produced as waste streams or stored and consumed on-site, and any renewable energy sources that are generated and used on-site. Modelling methods for establishing the baseline in an industrial facility may include developing an energy-mass balance, and pinch analysis for the assessment and optimisation of thermal energy streams.

The baseline model should be normalised by factoring in the impact of independent variables such as production quantities and rate, ambient weather conditions and raw material composition. Where demand charges or time-of-use pricing are in effect, load profiles must be provided to show the pattern of daily demand and incorporated annual adjustments.

IPMVP Options B and C are appropriate M&V approaches under this protocol. In selecting an appropriate measurement boundary, the practicalities of collecting explanatory variable data to give a sufficiently accurate baseline model should be considered.

Guidance on developing baselines can be found both in *EVO 10000 – 1:2016, IPMVP Core Concepts* and *ISO 50006:2014 Energy Management Systems – Measuring Energy Performance Using Energy Baselines and Energy Performance Indicators.*

1.1 Procedures

1. **Work with the M&V specialist to define the measurement boundary** which will vary depending on the size and complexity of the ECM(s), and can be set at site level (Option C), or at the system or equipment level (Option B). The boundary should be set to be wide enough to capture the full extent of the energy changes caused by the ECM, yet also narrow enough to limit the effect from other ECMs. In practice, meeting the statistical validity requirement described in step 8 is likely to require the collection of data on independent variables that explain variations in energy use. Selecting a measurement boundary that is too broad - within which too many independent variables have a significant effect on variation in energy use - may make it impractical to achieve the statistical validity requirement.
2. **Establish the baseline period** such that at least one full energy-use cycle is represented. Where IPMVP Option C is used, 12 months of data is usually required. However, in industrial facilities, energy-use cycles may not be seasonal, and may instead relate to shift patterns or production cycles. In such cases, a shorter baseline period is acceptable provided it can be demonstrated that a period representative of a full energy-use cycle has been selected. Where assets that exhibit degradation in energy performance over time are being upgraded, a longer baseline period should be selected to give a realistic view of the asset's pre-upgrade

energy consumption. The baseline period should occurs immediately prior to the deployment of the ECM(s).

3. **Collect energy source data, independent data, and utility rate schedules** for all energy sources and fuels entering or leaving the defined measurement boundary to inform baseline and savings calculations. Data to gather should include:
   a. **Historical Energy Use**: Collect energy use data for all energy inputs to the measurement boundary with a goal of accounting for 100% of energy inputs.
      i. These data should be used as the basis for an analysis that is adherent with the requirements of IPMVP.
      ii. For non-metered fuel types either install sub-metering, utilise billing or other final use data to estimate energy use.
      iii. Metered data associated with energy that can be shown to have no interaction with the energy associated with the ECMs may be excluded.
      iv. Frequency of data collected should be sufficient to meet the regression modelling criteria set out below.
      v. Either exclude or adjust the baseline accordingly to account for any data which is not representative of typical operating conditions (for example, periods of unusually high or low production). Where a facility has different modes of operation, separate models may need to be created to meet the regression modelling criteria. Refer to PDS (section 1.4) for further guidance on adjusting for different operating modes. Cost data for electricity and each energy source should also be collected including unit and total annual costs.
      vi. Within the measurement boundary, include energy sources and fuels which are stored on site or produced as waste streams. For such sources, ensure the net consumption is calculated separately for each input energy source. Refer to PDS (section 1.4) for guidance on net energy consumption accounting.
   b. **Production Data:** For the defined baseline period, acquire production data at appropriate intervals, where this is relevant to explaining variation in energy use within the measurement boundary. This may be expressed as input materials, or broken down by SKU (Stock Keeping Unit) or volume of finished product.
   c. **Weather Data**: For the defined baseline period and where relevant to explaining variation in energy use within the measurement boundary, acquire weather data (such as degree-days for heating and cooling) from the closest weather station or on-site measurement for the baseline period.
   d. **Other Independent Variable Data:** Acquire other independent variables that significantly affect the energy use, such as raw material input characteristics (e.g. temperature and heat/moisture content), humidity, occupancy, etc., for the defined baseline period chosen or as otherwise needed for an accurate regression model.
   e. **Baseline Operational/Performance Data:** Acquire system performance data used to inform the energy savings calculations (e.g. equipment efficiencies and capacities). These data need to include a comprehensive data set for all facility systems and can be collected through interviews, reviews of facility documentation (as-built plans, controls sequences, etc.), observations, spot measurements, short-term monitoring, and functional performance tests.
   f. **Facility Asset Information**: Acquire data and material specifications/inventories for the physical parts of the facility that contain the systems within the measurement boundary,

following the requirements set out in *EN 16247-3 Energy audits - Processes* and *ISO 50002 Energy audits - Requirements with guidance for use*. This information will be referenced in any future adjustments to the facility and/or assets that may be made.

4. **Develop energy balances** for the systems associated with the proposed ECMs to understand the flow of energy in all streams entering and exiting the measurement boundary. Care should be taken to account for the energy content in **all** streams including, for example, heat contained within a wastewater stream. Use metered data or, where such data does not exist, use engineering calculations to model estimated consumption as set out in *EN 16212:2012 Energy Efficiency and Savings Calculation, Top-down and Bottom-up Methods (section 6)*.
5. **Calendarise the independent variable data** to the same time interval that aligns with the defined baseline period. Refer to PDS (section 1.4) for guidance on partial month billing data calendarisation.
6. **Establish the energy-use characteristics of the equipment or system which are within the measurement boundary**, broken down into load and hours-of-use components. Sources of information should include equipment inventories and operating performance, and should be consistent with calculated energy end-use consumption.
7. **Develop the baseline energy consumption model.** Where regression modelling is required, use the methodology described in *ISO 50006:2014 Energy Management Systems – Measuring Energy Performance Using Energy Baselines and Energy Performance Indicators (Annex D)*.
8. **For regression models, perform model sufficiency test** to an accuracy of achieving an appropriate goodness of fit of energy data variability to independent variables according to *IPMVP's Statistics and Uncertainty for IPMVP 2014*. Achieving a high R^2 value in industrial applications may be challenging and, in some cases, regression modelling may not be appropriate. In any case, assessment of R^2 values should only be used an initial check. Any candidate model should be evaluated on the basis of the predicted savings, which must be greater than twice the standard error of the baseline value, as set out in IPMVP - see *IPMVP: Statistics and Uncertainty for IPMVP, 2014 (section 1).* In the event that this criteria is not met, consider alternative approaches including more precise measurement equipment, more independent variables in the mathematical mode, larger sample sizes, or an IPMVP Option that is less affected by unknown variables.
9. **Establish peak demand and pricing** (where peak demand pricing is in effect), based upon hourly data as a minimum. Where hourly data are not available, explain why, and describe any potential impacts this may have on the baseline and savings calculations as well as how these issues will be addressed.
10. **Chart average daily demand** (where demand charges or time-of-use pricing is in effect) in 15-minute intervals (maximum available frequency if 15-minute is not available) with time on the x axis and kW on the y axis for typical weekday and weekend days in the spring, autumn, winter, and summer.

1.2 Documentation

- Full energy data as a computer-readable file, including:
    - Raw meter readings should include from-date and to-date, energy-unit value, energy use charges, demand quantities and demand charges. The duration of the energy data should match the defined baseline period, and be consolidated to a set of consistent periods (e.g.

monthly / weekly) common for all energy sources. Data may also include bulk-delivered fuel information, including units delivered and associated costs. Local currency should be used.
  - The dataset must cover all forms of purchased energy and energy produced on-site that are part of the baseline. Where applicable, this will include aggregated data for any third-party operated portions of the facility, or an approximation of energy use by the third-party, descriptions of the metering and sub-metering of energy in the facility, and an explanation of how energy costs are recharged.
  - Provide a brief description of how periods are consolidated to the integer years/months periods applied. Dates of meter reading periods will vary from one energy source to another.
- The start and end dates of the baseline period and why that period was chosen. Provide a brief description on how the baseline period has been selected, and how the independent variable(s) relate to the energy-use cycle.
- A summary of the facility's activities and energy uses, including a description of the processes undertaken within the facility. Refer to guidance in the Project Development Specification.
- All data used in the regression analysis, such as production data and weather data, corresponding to the baseline period.
- All analysis carried out on the baseline data including:
  - Energy balances for the facility and the systems within the measurement boundary
  - Regression analysis, including outcomes of the model sufficiency and statistical validity tests
- As appropriate for recommended upgrades, include facility drawings, equipment inventories, system and material specifications, field survey results and/or CAD take-offs, observations, short-term monitored data, spot measurements, and functional performance test results.
- Utility rate structure as published by the utility and the commodity provider (if the two are separate) including a breakdown of distribution costs, commodity costs, demand charges, taxes, and time-of-day variability for each of these elements.
- Copies of at least one bill, or equivalent data, preferably in a machine-readable format for all energy sources consumed, including the description of the tariff structure and any fixed charges.
- List of project-specific routine adjustment factors to be included in the M&V Plan.

2.0 SAVINGS CALCULATIONS

Calculations of estimated savings for projects using this protocol must be based on transparent calculation methods or tools. Energy efficiency projects in industrial facilities may take many forms, with different approaches taken to calculate energy savings. However, all savings calculations must be based on sound engineering methods, and be consistent with the following core IPMVP principles: best practice, accuracy, completeness, conservativeness and transparency.

The results of the savings calculation process should also be calibrated to estimated or known energy end-use consumption. Energy savings calculations must be developed using open source tools. However, supporting calculations may require the use of proprietary tools. Where these are used, the documentation must include history of previous use, detailed description of the calculation methodologies and assumptions used by the tool, as well as papers, studies or documentation demonstrating the technical rigour of the tool and methodologies employed.

In addition to the development of ECM savings calculations, other elements necessary to prepare an investment package must be documented here. This will necessitate detailed design work and coordination, and would usually include the design development of plant, pipework and ancillaries and civil and other supportive works to allow fixed prices to be generated.

Once the savings calculation process is complete, if there has been a substantial change to the magnitude of the expected energy saving compared to initial estimates, it may be necessary to revisit the baseline during the certification period (section 1.0). For example, if the expected saving is smaller than originally anticipated, the proposed baseline may not longer adhere to the statistical validity principle explained in section 1.1 (and EVO 10100 – 1:2014, *Statistics and Uncertainty for IPMVP*, section 1.2). This may necessitate the selection of a different measurement boundary, collection of more data on independent variables, or selection of an alternative IPMVP Option.

2.1 Procedures

1. **Develop initial savings estimates** by comparing the current facility or system to industry best practice, or by using benchmarking data, input from system operators or empirical observations from existing projects.
2. **Establish preliminary cost estimates** for each ECM under consideration. Initial quotes may be obtained from the contractor(s). Alternatively, cost estimates may be based on the engineer's experience with previous projects, detailed conceptual estimates, nationally recognised sources of cost estimating data, general contractor quotes or other sources.
3. **Ascertain the preferred financial analysis metrics** and criteria of the investor (or owner) in order to evaluate ECMs. Metrics may include simple payback period (SPB), return on investment (ROI), internal rate of return (IRR), net present value (NPV), cash-flow analysis, and/or savings-to-investment ratio (SIR). While energy savings (avoided utility costs) may be the primary source of financial returns from the project, ensure that other non-energy sources of cost savings or losses are integrated into the investment package, where these can be feasibly and unequivocally translated into monthly cash flows, and documented accordingly. Examples may include demand management or grid services, avoided equipment downtime, increased export of energy generated on site, improved workforce productivity or improved product

quality. Where required by the investor, carry out sensitivity analysis to assess the impact of variations in critical variables (e.g. production) on the predicted savings.

4. **Develop a set of recommended ECMs** and select ECMs that are likely to achieve the investment criteria. Under a best practice approach, this will be based on the results of the energy audit, as well as on the experience of the engineers involved, facility owner preferences, observed condition and operation of existing systems, preliminary calculations, and contractor recommendations. Where an energy audit is being carried out, and if national requirements exist for individuals or organisations conducting energy audits, then these requirements must be met (see *Qualifications and Certifications List)*.
5. **Develop detailed energy savings calculations**:
   a. **Choose an individual to perform energy savings calculations with one of the following:**
      i. Nationally/Internationally recognised energy savings calculation certification (see *Qualifications and Certifications List)*, **or**
      ii. At least three years' experience in an industrial environment, documented in the form of a CV outlining relevant project experience.

   b. **Where projects include bespoke, process-specific ECMs**, the project developer must either have experience themselves in a similar process and/or technology, or they must work with an experienced specialist. This experience should be documented in the form of a CV outlining relevant project experience.

   c. **Use open-book methods** such as spreadsheets, or commercially available or in-house methods.

   d. **Prepare input values** using on-site observations, measured data, and input from equipment suppliers, on-site engineering teams and any other relevant specialists.

- Prepare calculations in a readily readable and usable form based on facility documentation including plans, equipment schedules, field confirmations, observations and tests.
- Hourly energy consumption data should be used as the basis for calculations, unless it can be demonstrated that this is not required. Where hourly data is not available, the maximum frequency of data that is available should be used, in conjunction with a suitable calculation approach which compensates for this lower resolution of data.
- Document calculation processes, formulas, as well as assumptions used and their sources.
- Where inputs must assign efficiencies, rates, and other values that are not readily measurable, the basis of such assignments must be clearly stated.
- Identify equipment part-load profiles, operating conditions and associated efficiencies.
- Confirm operating schedules for shift patterns, seasonal variations, zone variations, overtime use, cleaning and maintenance schedules and practices.
- Disclose and describe inputs/outputs (identify and document defaults versus assumptions) including those from any companion tools (e.g. load calculators, field testing) used to create inputs for the savings calculations.
- Refer to IPMVP guidance and *EN 16212:2012 Energy Efficiency and Savings Calculation, Top-down and Bottom-up Methods (section 6)* for detailed guidelines for calculation methods and best practices.

- Where third-party proprietary calculation tools are used for supporting calculations, sufficient documentation must be included to validate unbiased assessment of energy savings estimates. The documentation should allow a Quality Assurance Assessor of reasonable skill and relevant experience to trace the projected saving back to the physics of the underlying system.
- Screening tools are an acceptable method for preliminary consideration of measure applicability, but must not be used as a substitute for detailed calculation methods.

e. **For each ECM, calculate the individual energy savings performance and cost effectiveness.** Clearly document the calculation methodology, formulas, inputs, assumptions and their sources**.**

f. **Account for interactive effects** associated with the ECMs, as well as interactions between measures, where required. If their magnitude is significant compared to the ECM energy savings, interactive effects should be estimated and the associated energy savings adjusted accordingly, and consideration should be given to expanding the measurement boundary to include them.

6. **Provide a statement of the energy prices** used to establish the monetary value of the savings. This conversion from energy savings to cost savings must be based on the appropriate local utility rate schedule in effect at the time or, if the facility is purchasing from an independent vendor, the commodity price and the utility distribution schedule of charges.
7. **Evaluate economics of each ECM** and package of ECMs included in the bid package.
8. **Obtain a fixed price for implementing each ECM which is based on the necessary detailed design work**. The final documentation package must have pricing based on bids that represent the price for which a contractor has committed to make the improvements. Design work may include an assessment of the impact of the proposed project on the operation of the facility and the environment, and a consideration of any likely interaction between proposed ECMs.
9. **Develop final investment package for ECMs** selected to be included in the project scope including operation and maintenance costs. Finalise model-based analysis and recommendations based upon pricing from bids received. The investment package should factor in operation and maintenance costs. Any long-term financial analysis metrics should incorporate available data or reasonable assumptions about the through-life performance of the proposed ECMs, taking account of any potential degradation in performance over time.
10. **Prepare a final report summarising ECMs** and compiling all required supporting data. The report must include a summary table with final energy cost savings and pricing for each measure and package of measures.

2.2 Documentation

- Qualifications of the person(s) performing the savings calculations.
- Where required, CV documenting relevant process experience for Project Developer or specialist.
- ECM savings results, including:
  - The submission of workbooks, spreadsheets and other open-source calculation tools used to develop savings estimates is preferred. However, if this is not feasible, then full details of all outputs should be provided, in addition to the items below.

    - Disclosure and description of inputs (identify and document defaults versus assumptions), including those from any supporting tools (e.g. load calculators, field testing) used to create inputs for the spreadsheet calculations.
    - Calculation process description that, with the necessary input information, would allow a reviewer to reconstruct the calculation including documentation of the formulas used, and assumptions used and their sources.
    - Demonstration that the energy savings results have been calibrated to energy balance consumption estimations or measurements.
    - Description of each interactive effect and documented estimates of impacts on energy savings where relevant.
    - Where relevant, submit evidence that national requirements for individuals or organisations conducting energy audits have been met.

- Where proprietary or third-party software modelling packages are used to support savings calculations:
    - Description of inputs/outputs (identify and document defaults versus assumptions).
    - Proprietary / third party model calculation description that with the necessary input files would allow a reviewer to reconstruct the calculations.
    - Proprietary / third party model input and output files together with information about the software that has been used (including version number).
- Report: Use of an industry-accepted format for reporting of results and for compilation of methods and underlying data is recommended. Refer to *EN 16247-3 Energy audits – Part 3: Processes (section 5.6)*
    - Annual predicted energy savings by fuel type shall be documented in terms of energy units, a percentage of the total volume of each energy source and as cost savings using the correct marginal rate for that energy type.
- Detailed cost breakdown with line-items for each of the major project elements including all plant, pipework and other ancillaries, civil and other preparatory works, operation and maintenance costs.

3.0 DESIGN, CONSTRUCTION AND VERIFICATION

It is important that the teams involved in implementing energy efficiency projects commit to realising the intent of the recommended ECMs accepted by the project owner, as detailed in the investment package. The ICP verification methodology utilises an Operational Performance Verification (OPV) approach to ensure that the individual implemented ECMs were installed correctly and are capable of achieving the predicted energy savings. OPV is a targeted process that focuses specifically on the ECMs involved in the project and differs from traditional Commissioning (Cx) which typically refers to whole facility optimisation.

The OPV process involves various methods based on measure type, complexity, and other factors. OPV processes may include visual inspection, targeted functional performance testing, spot measurements or short term monitoring of the installed systems and control sequences.

The OPV effort may be performed by an independent party or by the project developer as long as a Quality Assurance assessor is providing oversight to these efforts. Procedures performed during the performance period should be specified in the OPV Plan and addressed in the proposal and contract.

3.1 Procedures

1. **Appoint an Operational Performance Verification Resource**: A specified OPV resource shall be named in the OPV Plan who has one of the following qualifications:
    a. Nationally/Internationally recognised commissioning certification (see *Qualifications and Certifications List)*, **or**
    b. Three years or more of commissioning experience in an industrial environment, documented in the form of a CV outlining relevant project experience.
2. **Develop an Operational Performance Verification Plan** (pre-construction) that includes:
    a. Procedures to consult with the project developer; monitor designs, submissions and project changes; and perform a visual inspection of the implemented changes.
    b. Procedures to verify that the ECMs have been implemented as designed and can be expected to perform as conceived and projected by the energy audit. This will include descriptions of operational performance verification activities to be performed on the installed measures and details regarding documentation of operational performance verification results as part of the facility's permanent documentation following market-standard commissioning guidelines and standards.
    c. Provisions for the appointment of approved installers of the proposed equipment, where relevant national certification schemes exist (see *Qualifications and Certifications List)*.
    d. Provisions for the development and implementation of a training plan for operators to be conducted at the conclusion of the OPV effort that will train them in the correct operation of all new systems and equipment including how to meet energy performance targets.
    e. Provisions for the development and implementation of a Systems Manual (or update existing Systems Manual) at the conclusion of the OPV effort to document the modified systems and equipment and the process and responsibilities for addressing any future operational issues, to be prepared following guidance set out in *EN 13460:2009 Maintenance – Documents for maintenance.*

f. Description of the process to develop target energy budgets and/or other key performance indicators for the modified facility both as a whole, where appropriate, and also down to the level of individual systems and major equipment where required.

g. Description of the OPV report to be developed at the conclusion of the OPV effort that will detail activities completed as part of the OPV process and include significant findings from those activities.

3.2 Documentation

- Qualifications of the Operational Performance Verification Resource.
- Operational Performance Verification Plan.

4.0 OPERATIONS, MAINTENANCE, AND MONITORING

Operations, Maintenance, and Monitoring (OM&M) is the practice of systematic monitoring of energy system performance and implementing corrective actions to ensure "in specification" energy performance of ECMs over time. Good OM&M processes involve a proactive strategy for maintaining production continuity while optimising energy performance. Procedures to be performed during the performance period should be specified in the OM&M Plan and addressed in the proposal and contract.

4.1 Procedures

1. **Select and document ongoing management regime** including either periodic inspection, Supervisory Control and Data Acquisition (SCADA) and/or automatic Monitoring and Targeting (aM&T) reporting, software-based monitoring and fault detection, periodic recommissioning, or a combination of these approaches. Note that the use of a specific energy ratio (SER) for ongoing monitoring is not in itself sufficient, as this simple ratio provides no information on the underlying reasons for any observed change in performance. As such, an SER may be used as a high-level indicator only, when accompanied by one or more of the above methods.
2. **Develop an Operations, Maintenance and Monitoring Plan** (pre-construction) that includes:
    a. A description of the OM&M management regime to be selected. If a monitoring-based approach to OM&M is to be utilised, identify and document the number of points, interval and duration to be monitored by the selected monitoring system.
    b. Performance indicators at the component and/or system level that specify the acceptable performance bands outside of which corrective communication/response will be taken. These must be measurable and should be consistent with achieving close to desired facility/system level energy performance as defined in the Operator's Manual.
    c. Defined roles and responsibilities of the OM&M staff and plans for issue resolution and preventative (or predictive) maintenance.
        - Develop an organisational chart establishing contact information for all personnel involved in ongoing commissioning process and clear internal responsibility for the monitoring and response activities.
        - The technical qualifications needed to operate and maintain the upgraded equipment should be made clear in the OM&M documentation.
    d. Provisions for the development and implementation of a training plan that will be conducted for facility staff and service providers on new/modified equipment, management and monitoring software, and reporting regime. This training is to be conducted at the conclusion of the OPV effort and can be combined with the training described in the OPV section. Refer to *EN 15331:2011 Criteria for design, management and control of maintenance services for buildings* for guidance.
    e. Description of the process to develop performance verification criteria based on the OM&M regime(s) selected. This process should (when applicable):
        - Identify points, interval and duration to be monitored by the selected monitoring approach.
        - Chart the data points to be monitored and their relationship to the performance of the

new installations and modified equipment/systems.
- Install and test fault detection functions for system malfunctions or substantial deviations.
- Compare actual performance with savings projections for the same period given adjustment factors on a periodic basis.
- Specify the process to create and collate periodic performance reports covering all specified points. Reports are to include all observed deviations from projected operation, an analysis of their cause, and any recommended/executed corrective actions.

f. Commitment to the development of an Operator's Manual (or updating of existing Operator's Manual) targeting the new systems and their operation, including assignment of responsibilities for communication of performance issues and implementation of corrective action.

g. Provisions for the development and execution of instructions to notify facility staff of the project's implemented energy reduction improvements and descriptions of any associated best practices or recommended behaviour modifications.

4.2 Documentation

- Operations, Maintenance and Monitoring Plan.

5.0 MEASUREMENT AND VERIFICATION

Measurement and Verification (M&V) activities verify actual versus predicted performance and are crucial to understanding the efficacy of energy efficiency measures and projects. Prior to investment decision-making (e.g. as part of contract development and investment due diligence), an IPMVP-adherent M&V Plan for an energy efficiency improvement project must be developed and specified to ensure that reliable accounting methods for energy savings are in place.

The M&V procedures for this protocol are consistent with the methods outlined in *IPMVP Core Concepts-2016* Option B (Retrofit Isolation: All Parameter Measurement) and/or Option C (Whole Facility). Alternatively, projects may also follow an M&V approach which is compliant with *ISO 17741: 2016 General technical rules for measurement, calculation and verification of energy savings of projects.*

The pre-retrofit baseline of the energy using system(s) within the measurement boundary defined in the Baselining section of this protocol is used as the starting point for M&V calculations. The approach requires the following adjustments to baseline energy use:

1. **Routine adjustments**: Account for expected changes in energy use.
2. **Non-routine adjustments**: Account for unexpected changes in energy use due to factors other than the installed ECMs.

This adjusted baseline represents what the baseline energy use would have been if the project ECMs had never been installed, under the same set of post-retrofit conditions. Realised savings are then determined by comparing this adjusted pre-retrofit baseline energy use model with the actual post-installation energy use of the system(s) within the measurement boundary. The energy savings are verified through comparison of the pre- and post-retrofit energy performance of the system(s).

Selection of an IPMVP Option should take place as part of the Baselining stage and further details can be found in section 1.0 of this protocol. Option selection will depend on the magnitude of the expected energy savings relative to the variability of the baseline energy data, and the practicalities associated with collecting data on independent variables that explain variation in energy use within the measurement boundary. Refer to IPMVP documentation for guidance on selecting the most appropriate Option for an ECM.

The M&V effort may be performed by an independent party or by the project developer as long as a Quality Assurance assessor is providing oversight to these efforts.

5.1 Procedures

The M&V efforts must fully comply with applicable sections of *IPMVP Core Concepts-2016* Option B or C.

1. **Appoint an M&V Professional** during the certification period who meets one of the following sets of requirements:
   - Association of Energy Engineers (AEE) Certified Measurement & Verification Professional (CMVP) certification, **or**
   - At least three years of demonstrated M&V experience documented in the form of a CV

outlining relevant project experience

2. **Develop an IPMVP based M&V Plan** as early in the project development process as possible that adheres to the *IPMVP Core Concepts-2016, Section 7.1*.
3. **Provide the M&V Plan, input data sets, assumptions and calculations** to all parties in an efficiency project and any commissioned or independent reviewers.

5.2 Documentation

- M&V Plan adhering to the *IPMVP Core Concepts-2016*, Section 7.1. This M&V Plan should:
    - Contain all elements required by section 7.1 of the IPMVP;
    - Provide all adjustment parameters and formulae for routine and known or expected non-routine adjustments;
    - Define the principles upon which any unknown non-routine adjustments will be based;
    - Contain a full description of the calculation basis of any baseline models used, including whether the resulting model adheres to the IPMVP statistical validity requirement (EVO 10100 – 1:2014, *Statistics and Uncertainty for IPMVP*, section 1.2);
    - Provide a full evaluation of any baseline regression model based on the guidance in EVO 10100 – 1:2014, *Statistics and Uncertainty for IPMVP*, section 2.2;
    - Contextualise the expected savings in terms of statistical confidence and precision, as described in EVO 10100 – 1:2014, *Statistics and Uncertainty for IPMVP*, section 1.1.