A Risk-Based Approach to Industrial Energy Efficiency Technical Review

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ABSTRACT

The role of technical review is to mitigate risk to demand-side management (DSM) program administrators. If done effectively, technical review should aid the cost effectiveness of DSM programs by improving on targeted net-to-gross ratios and savings persistence.

Ex-post impact evaluations of programs have detailed guidelines and protocols for evaluators to follow, however those conducting the technical review of ex-ante projects have limited guidance material to follow.

This paper identifies and assesses current practices and results for ex-ante technical review of large, unique and, primarily, industrial capital incentive projects. The result is a risk-based, framework to align industrial technical review practices and advise an appropriate approach and rigor for maximizing the cost-effectiveness to DSM programs.

Part A: Jurisdictional Review of Industrial Energy Efficiency Program Ex-ante Technical Review

To identify and assess the benefits and costs of industrial energy efficiency program ex-ante technical review, a review of North American industrial energy efficiency programs was conducted. Research considered program design and objectives, delivery models in order to identify specific jurisdictions with established and substantial industrial energy efficiency programs that are, for the most part, administered and reported independently of commercial and other sector programs.

The following programs were deemed to represent the best combination of applicability and access to relevant information:

- BC Hydro's Power Smart Partners - Industrial (Transmission and Distribution)
- Wisconsin's Focus on Energy – Industrial
- California Public Utilities Commission's (CPUC) Southern California Industrial and Agricultural (SCIA) and Pacific Gas & Electric's (PG&E) Fabrication, Process and Manufacturing

Review of Impact Evaluation reports, and other information made available by the above organizations, was conducted in order to identify instances and establish benchmarks for commonly reported metrics that could be used as indicators and comparisons for program and technical review success, as shown in Table 1 below.

Table 1. Impact Evaluation Metrics and Indicators

Impact Evaluation Metric	Program Success Indicator
Net-to-Gross ratios	Cost effectiveness; quality of technical review
Verified savings vs. Gross savings	Quality of technical review
Incentives as a percentage of total expenditures	Cost-effectiveness; program administration efficiency
Total expenditures as a percentage of budget	Program participation
Target achievement	Program participation
Various utility cost and benefit to cost ratios (TRC)	Cost-effectiveness

While the practices employed by evaluation professionals are fairly standardized, there are some notable exceptions, such as the CPUC policy that "spillover" is not included in net reported savings results (Intron 2010 (PG&E); Intron 2010 (SCIA)). Thus, caution must be employed when comparing Impact Evaluation report results.

Significant findings:

- Both BC Hydro's Power Smart Partners – Industrial and Wisconsin's Focus on Energy – Industrial achieved very high realization rates, at 96.5% (average PSI Transmission and Distribution, CY 2005 - 2010[1]) and 97% (average FY02 – CY10) (Schauer et al. 2010), respectively.
    - Focus on Energy included confidence intervals for the accuracy of their ex-ante reported project savings, which is an observed best practice.
- BC Hydro's Power Smart Partners – Industrial (F2003-F2006) program achieved the highest net-to-gross ratio, of programs researched, by a significant margin, at 91% (Tiedemann and Sulyma 2008).
    - Approximately 30% and 65% higher than Focus on Energy and PG&E results (Intron 2010), respectively. Per note above, CPUC results do not include spillover.
- CPUC Impact Evaluation reports include several recommendations for program practice improvements, most significantly those specific to baseline establishment.
- Energy Trust of Oregon prepares "true-up" reports to evaluate project and program persistence beyond the initial evaluation period.
    - Similarly, Focus on Energy reports lifetime and lifecycle (run-rate) in addition to first-year savings.

Further investigation into BC Hydro's Power Smart – Industrial technical review process was conducted in order to gain context for the above results. Investigations were designed to gather information that is applicable to the time period of the evaluation results[2] (F2003 – F2006), review practice evolutions applicable to the later range of the gross verified (measurement and verification) vs. gross reported data provided (~CY2007 – 2010) for calculation of realization rates, as well as the most recent review practices.

[1] Based on data provided by BC Hydro staff. Previous reports of earlier program cycles yielded similar results, though the actual results are no longer available.

[2] Willis staff includes Steve Ireland, former manager of Power Smart Technical Services (1996 – 2006) and other Power Smart personnel, including the author (2005 – 2009). Thus, some of this research was internal, based on personal experience.

From these investigations, it is clear that Power Smart has pursued continuous improvement of the technical review process over several program cycles, with the objective of improving customer satisfaction and review efficiency, while maintaining technical review accuracy. From a date preceding the F2003 – F2006 program cycle, Power Smart Industrial technical review established and later refined a robust review scope, based on demand-side management (DSM) industry principles. This scope and a general approach have contributed to their success in achieving high realization rates.

During more recent program cycles (2007-08 to present), the primary shift in their approach is to make the review process more proactive by involving the technical review engineers at the earlier stages of project development. This shift is considered to be instrumental in achieving the Power Smart Engineering group's ultimate goal of reducing review efforts and processing application volumes at a rate that is approximately three times previous rates.

The implementation of these changes included the creation of an engineering department dedicated to field services that act as a liaison between program participants and their consultants, account managers and technical review engineers (Gudbjartsson 2012). While this is a new development for BC Hydro, the deployment of technical field services to program participants is conducted in other North American industrial energy efficiency programs. The difference, observed in the case of BC Hydro, is the integration with their technical review process and the collaboration with participant's engineering consultants.

Conclusions

BC Hydro's Power Smart Partners – Industrial and Wisconsin's Focus on Energy – Industrial programs provide examples of best practices for industrial technical review in terms of a scope and approach to achieve accurate results (realization rate). BC Hydro's program achieves high participation and customer satisfaction levels.

In all cases of industrial energy efficiency programs reviewed, the most significant opportunity to mitigate risk and improve program cost effectiveness through the technical review process is in a more proactive management of the net-to-gross ratio. As identified in CPUC Impact Evaluation reports, this can be achieved, for the most part, with improvements to base case establishment practices.

Empirical results and testimony suggest that pro-active technical review (i.e. involvement at the early stage of project/opportunity identification) is instrumental in achieving efficiency in the review process. Additionally, technical resources are best equipped to implement and manage the improved baseline establishment practices suggested by CPUC evaluation results; however, early (pro-active) involvement is necessary in order for net-to-gross, and subsequently cost-effectiveness improvements, to be realized.

Part B: Industrial Technical Review Approach and Framework

This part is divided into two sub-parts, based on the conclusions in Part A:

1. Presentation of technical review best practices for establishing a base case.
    - Assessing the timing and impact of the remaining life of existing system
    - Establishing the anticipated replacement in absence of "the project"

2. Presentation of a technical review standard to align ex-ante accuracy with the appropriate review rigor.

The following technical review approach and framework is intended for pro-active involvement of program technical resources, as per the conclusions in Part A.

Best Practices for Base Case Establishment

Efficiency project persistence is often conceptualized as the effective measure life (EML) or effective useful life (EUL) and administered by estimates and/or standards for the operable lifetime of the installed project; or the median project lifetime in a sample of a population of similar project types[3]. In this manner, the year-over-year project savings are calculated relative to a baseline that is based on pre-existing equipment, for the entire period of the EUL.

This does not properly account for the anticipated replacement in absence of the project, which should limit the project persistence or impact the incremental savings in any case where it is less than the EUL.

As stated in the CPUC PG&E Impact Evaluation, “This assumption would only be justifiable in situations where the program induced an early replacement of equipment that would otherwise have had a very high probability of continuing in operation for a period equal to the EUL of the new equipment.” (Intron 2010 (PG&E), 1-5)

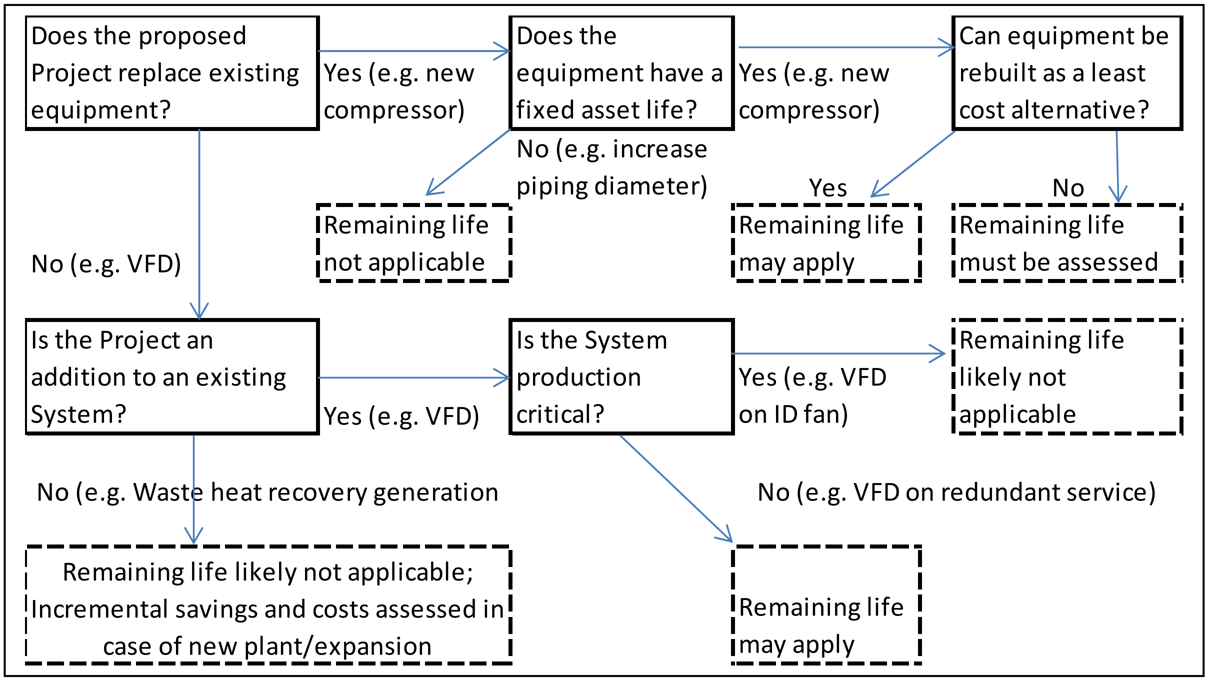
However, the CPUC Impact Evaluation’s position that efficiency programs’ ability to influence early replacement projects (i.e. anticipated replacement in absence of project > savings period) is a rare occurrence, does not appropriately recognize the industrial operating and economic environment. In the present day industrial sector, it is the norm for equipment to run well beyond the manufacturers specified technical asset life, especially in facilities with good maintenance practices, or in the case of equipment that can be rebuilt at a significantly lower cost than replacement. These factors need to be considered when assessing remaining life.

Additionally, from a technical perspective[4], the issue of remaining life does not apply to all projects. The following decision flow provides guidance as to the need to consider remaining life of existing equipment for different project scenarios.

[3] As explained in the Focus on Energy Evaluation Business Programs: Measure Life Study. KEMA: August 25, 2009

[4] Economic considerations are outside the scope of this paper; these should be addressed by program design e.g. incentive payback thresholds and tiered incentive rates.

Figure 1. Remaining Life Decision Flow Chart



In the case of equipment that can be rebuilt as the least cost option, a general gauge for the applicability of remaining life is if the rebuild is expected to cost more the half the cost of replacement, then replacement would likely be considered in absence of an incentive. However, participant and project specific context should be included in the assessment.

Determining the remaining life of existing, operable, equipment is not an exact science. It is often overlooked by program applicant and non-technical program staff (sales/account management), especially since willful ignorance is typically in their interest, as it impacts a potential incentive. This leads to difficult and conflictive situations for technical review personnel, whereby applying an appropriate method will often have a negative impact on participant satisfaction. Lowering an expected incentive may have detrimental impact in cases where conditional approval has already been sought and received based on the anticipated incentive. This is a primary example of the benefits of proactive involvement of technical review personnel, who are best equipped to effectively manage the issue of remaining life to maximize program cost-effectiveness.

For practicality reasons, the "project incentive persistence" should be de-coupled from the "program reported persistence", in order to provide the flexibility to maintain program satisfaction/participation while reporting based on best available information. Because determining the remaining life of equipment is not an exact science, technical review recommendations should be based on categorizing projects according to standard remaining life bins, based on pre-defined project characteristics. The intention being that the standard would provide accurate forecasts for the population of projects for a given program, without expecting that the values are accurate in every case.

With the involvement of technical resources at the project inception stage, professional judgments can be applied in order to categorize and bin potential opportunities, thus setting appropriate expectations for project incentives. In order to make informed discretionary decisions, program specific tools should be developed that enable the merits of individual projects to be assessed. For example, the Table 2 below, based on data from the Ontario Power Authority's (OPA) Process and Systems Upgrades Initiatives, depicts estimates of the program break-even periods (full and incremental program cost basis), based on full "project incentive persistence" (10 years). As shown in Table 2, it may be in the programs interest to provide a full incentive, even if the anticipated replacement timeline is less than the savings period. An alternative, also shown below, is to use demand-side management cost tests, such as total resource cost ratios.

Table 2. Project Payback vs. Program Break-even

Project Payback (years)									
Simple Payback (w/o incentive)	5.0	4.4	4.0	3.6	3.3	3.1	2.9	2.7	2.5
Project Payback (w/ incentive)	3.0	2.4	2.0	1.6	1.3	1.1	1.0	1.0	1.0
Program Break-even (years)									
Project basis (incentive only)	4.7	4.7	4.7	4.7	4.7	4.7	4.4	3.9	3.5
Program basis (all costs)	9.4	9.4	9.4	9.4	9.4	9.4	8.7	7.8	7.0
Project lifetime for TRC of 1.0	8.1	7.2	6.5	5.9	5.4	5.0	4.7	4.4	4.2
Project lifetime for TRC of 1.4	12.4	10.7	9.4	8.5	7.7	7.1	6.6	6.2	5.8

Technical Review Standard Framework

While the findings in Part A regarding the leaders in industrial energy efficiency program technical review best practices are highly specialized/specific, they are not unique. BC Hydro's industrial energy efficiency programs have previously been identified as industry leading in areas of program design and implementation by various bodies other jurisdictions. BC Hydro's industrial project incentive technical review scope has been adapted and applied to other North American industrial energy efficiency programs, such as the Ontario Power Authority's Industrial Accelerator Program and Process and Systems Upgrades Initiatives. A modified version of this scope is presented below:

1. Establish a **base case**, including:
    a. System and general operation description
        i. Including, changes to the operation of the system, known or anticipated, in absence of, or in addition to, the project.
    b. System boundary and documentation of all energy consuming equipment within
    c. Current condition of the system and establishment of **remaining life**
        i. Analysis of the anticipated economic and technical end-of-life of current equipment and anticipated replacement in the absence of the project, resulting in a determination of the number of years that the equipment replacement has been accelerated and the consequential impact on energy savings
    d. Detailed operation of the system
        i. Hours of operation and relationship with production, or other global variables
        ii. Operating parameters (local variables) and performance (efficiency)

    e. Development of the baseline energy consumption
        i. Accounting for the base case operation, operational changes, and condition, including anticipated replacement in absence of the project
        ii. Based on metered data and/or models/simulation, as applicable
            - Models and simulations for theoretical base cases (where anticipated replacement < savings period) based on assessment of standard technology efficiencies/energy performance standards

2. Measure analysis, including:
    a. Estimation of energy savings: at appropriate interval (e.g. hourly, daily, seasonal or annual) and duration (e.g. first-year, lifetime, etc.), including:
        i. Applicability and estimation of interactive effects, within and outside of the system boundary
        ii. Applicability and determination of incremental versus full savings (per base case, remaining life and associated baseline energy consumption)
            - Incremental relative to the energy performance standards of equipment that would be installed in the absence of the project and higher efficiency capital improvements directly influenced by the incentive.
    b. Determination of expected project life, based on measure life and remaining life (per base case) – i.e. the minimum value
3. Project cost analysis, including:
    a. Assessment of project cost estimate accuracy
    b. Assessment of cost eligibility, as per program rules and relevance to the project scope
    c. Applicability and determination of incremental versus full costs (per base case, remaining life)
        ii. Incremental relative to equipment that would be installed in the absence of the project and higher efficiency capital improvements directly influenced by the incentive.
4. Assessment of other benefits and costs, including:
    a. Changes in operating and maintenance costs, production/productivity, etc.
5. The benefit of the project to ratepayers in accordance with conservation and demand management industry standards (not in technical review scope)

Discussion with program personnel provides insight into BC Hydro's technical review process, design and a general overview of the expectations and approach. However, it does not provide a public standard that other program administrators can consistently implement in order to achieve comparable technical review realization rates and effectively mitigate risk. To that end, a framework for conducting the above scope has been developed based on Willis' experience in performing technical review services for the OPA's industrial programs. This framework attempts to incorporate parts of the BC Hydro process, design and approach, as well as elements of best practices from other industrial energy efficiency programs, previously identified, to effectively and appropriate mitigate risk.

For the purpose of technical review, risk is defined as the product of project materiality and savings uncertainty. The critical variables for technical review best practices for mitigating risk, while achieving accuracy (realization rate), customer satisfaction (timeliness and ease) and cost-effectiveness (NTGR and incentives as % of budget) are the appropriateness of information requirements and the rigor of review.

In order to develop a standard framework for applying the appropriate rigor (including information requirements) to the above-described technical review scope a stratified, a risk-based approach was developed. A continuum of information requirements and review approaches were developed for each technical review scope item and divided into appropriate tiers; between two and four. As shown in Table 3, below.

The quantitative scope items that impact the energy savings – specifically, the baseline electricity consumption and estimated future consumption/energy reduction – were further divided into their components (e.g. power, operating variability, operating hours, etc.) and uncertainty assumptions were generated for each component, as shown in Figure 2, below.

Table 3. Tiered Information Expectations and Approach by Review Scope Item

SoW Item	Tier 1: < 1,000 MWh	Tier 2: 1,000 – 1,750 MWh	Tier 3: 1,750 – 3,000 MWh	Tier 4: > 3,000 MWh
Base Case – System Description, Boundary and Equipment, Current Condition/ Remaining Life (1.a, 1.b & 1.c) *In case of anticipated replacement < savings period; Description of standard efficiency base case system in absence of the project consistent with adjacent*	**Expectations** - Provision of major equipment information (model, type, capacity, hp, etc.) - Description of system function/operation and current condition is sufficient, unless: - Condition description raises issues regarding equipment remaining life. - System information or TR experience suggests potential for Interactive Effects (in which case, a PFD or other details may be required) **Review Approach** - Discussion or information requests, as necessary to address application deficiencies and understand base case system operation (including future in absence of project) - Refer to previous section for review of remaining life and anticipated replacement	**Expectations** - Provision of all energy-consuming equipment information (model, type, capacity, hp, etc.) and specifications/performance curves for major equipment - Description of system function/operation, w/ PFDs, P&IDs and SIDs, as available, typically required. - Current equipment condition should be accompanied by equipment age, run-time, previous failures, and/or current operation and maintenance issues/costs. **Review Approach** - Site-visit, discussion and information requests, as necessary to address application deficiencies and understand base case system operation (including future in absence of project). - Refer to previous section for review of remaining life and anticipated replacement		

Table 3. Tiered Information Expectations and Approach by Review Scope Item

SoW Item	Tier 1: < 1,000 MWh	Tier 2: 1,000 – 1,750 MWh	Tier 3: 1,750 – 3,000 MWh	Tier 4: > 3,000 MWh
Base Case – Detailed Operation and Baseline Energy (1.d & 1.e) *In case of anticipated replacement < savings period; Where anticipated replacement is a like-for-life replacement, use existing base case. Otherwise, see below.*	**Minimum Requirements (for Remaining Life > 0)** Power Estimates: 100% T2 (±12.5%), or 75% T3 + 25% T1 (±10.6%) Power Variation: T1 Operating Hours: T1 **Review Approach** - Review includes independent calculation of the Baseline Energy for Application validation and M&V Plan purposes. - Review of operating variations and cross-reference of operating variables limited to check of application calculations, corrections only if necessary, and (verbal) confirmation of assumptions applied in Application.	**Minimum Requirements (for Remaining Life > 0)** Power Estimates: 50% T4 + 50% T3 (±4.5%), or 75% T4 + 25% T2 (±4.3%) Power Variation: T2 Operating Hours: T2 **Review Approach** Review includes independent calculation of the Baseline Energy for Application validation and M&V Plan purposes. Including, for variable systems, independent review of operating variations and cross-reference of operating variables (equipment performance/ efficiency[5]) to check Baseline Energy estimate.	**Minimum Requirements (for Remaining Life > 0)** Power Estimates: 50% T4 + 50% T3 (±4.5%), or 75% T4 + 25% T2 (±4.3%) Power Variation: T3 Operating Hours: T3 **Review Approach** Review includes independent calculation of the Baseline Energy for Application validation and M&V Plan purposes. Including, for variable systems, regression analysis of power and correlating variable(s) (or suitable alternative) + independent review of operating variables (equipment performance/ efficiency) for extrapolation to annual baseline	**Minimum Requirements (for Remaining Life > 0)** Power Estimates: 90% T4 + 10% T1 (±2.1%) Power Variation: T4 Operating Hours: T4 **Review Approach** Review includes independent calculation of the Baseline Energy for Application validation and M&V Plan purposes. Including, regression analysis of power and correlating variable(s) + independent review of operating variables (equipment performance/ efficiency), if appropriate (summation of 8,760 data may be sufficient).
Base Case – Modeled Baseline Energy	**Expectations** - Estimated load based on comparable benchmark **Review Approach** - As above, to extent possible	**Expectations** - Calculated load based on equipment specifications and assumed loading **Review Approach** - As above, to extent possible	**Expectations** - Calculated load based on equipment specifications and comparable benchmark for loading factors **Review Approach** - As above, to extent possible	**Expectations** - Calculated load based on equipment specifications and comparable benchmark for loading factors **Review Approach** - As above, to extent possible

[5] Establishing base case equipment performance/efficiency is often for the purpose of projecting post-project energy consumption

Table 3. Tiered Information Expectations and Approach by Review Scope Item

SoW Item	Tier 1: < 1,000 MWh	Tier 2: 1,000 – 1,750 MWh	Tier 3: 1,750 – 3,000 MWh	Tier 4: > 3,000 MWh
Measure Analysis – Energy Savings (2.a)	**Expectation** T1 **Review Approach** - Information requests, as necessary to understand calculations. - Complete and correctness review of application estimate, if it meets above expectation (average operating point analysis acceptable; multi-points for variable operation/different modes, incl. seasonality) - Benchmark comparison to published results and internal experience, if possible. - Alternative estimate developed (per Energy Savings T1 standard) if expectation not met, or application estimate outside benchmark range. - Consideration of savings deterioration (relative to deteriorating base case) for project lifetime. If < 10% of savings, document qualitative expectation. If > 10%, see T3	**Expectation** T2 **Review Approach** - Information requests, as necessary to understand calculations (incl. samples). - Detailed review and check of application estimate, if it meets above expectation (average operating point analysis acceptable, if ~even distribution expected; multi-points for variable operation/ different modes, incl. seasonality) - Benchmark comparison to published results and internal experience, if possible. - Alternative estimate developed (per Energy Savings T2 standard) if expectation not met, or application estimate outside benchmark range. - Assessment of savings deterioration (relative to deteriorating base case) for project lifetime. If < 10% of savings, document assessment. If > 10%, see T3	**Expectation** T3/T4 **Review Approach** - Information requests, as necessary to understand calculations (incl. samples). - Alternative estimate developed (per Energy Savings T3 standard) for comparison to application estimate (continuous operating point analysis expected, unless even distribution documented; in which case, multi-points for different modes, incl. seasonality). - Benchmarking to comparable (verified) installations/case studies is a last resort for cases involving proprietary solutions (preferably 3rd party results), or measures that are otherwise impractical to independently estimate projected consumption. - Assessment/investigation of savings deterioration (relative to deteriorating base case) for project lifetime. If, notable deterioration expected, apply quantification of deterioration to lifetime energy savings.	
Measure Analysis – Interactive Effects (2.a.ii)	**Expectation:** per Base Case System Description and Boundary **Review Approach** Potential existence/impact considered based on information provided and reviewers knowledge of similar systems. If expected to exist, but less than 10%, no quantitative analysis (just acknowledged). Otherwise, apply adjacent approach.		**Expectation:** per Base Case System Description and Boundary **Review Approach** Potential existence/impact considered based on information provided, reviewers knowledge of similar systems and/or independent research, if likely to exist. Quantitative estimate developed/integrated within Baseline Energy and Energy Savings	
Measure Analysis – Incremental Savings (2.a.iii)	**Review Approach** - If Remaining Life/ anticipated replacement > savings period, incremental savings are not applicable. - If Remaining Life/anticipated replacement < savings period, Incremental Savings integrated within Energy Savings analysis based on separate Baseline Energy values for respective periods (pre & post-anticipated replacement date)			

Table 3. Tiered Information Expectations and Approach by Review Scope Item

SoW Item	Tier 1: < 1,000 MWh	Tier 2: 1,000 – 1,750 MWh	Tier 3: 1,750 – 3,000 MWh	Tier 4: > 3,000 MWh
Measure Analysis – Expected Project Life (2.b)	**Review Approach** Expected Life = minimum of remaining life (anticipated replacement) and measure life Measure life review based on Wisconsin Measure Life Study		**Review Approach** Expected Life = minimum of remaining life (anticipated replacement) and measure life Measure life review based on Wisconsin Measure Life Study, permanence of implemented measure and assessment of technical useful life of critical equipment to be installed	
Project Costs Green = down Tier (lower risk) Red = up Tier (higher risk)	Other Tier Inclusions: >50% sensitivity margin[6] for Projects < 1,750 MWh T1 Exclusions: < 10% margin	Other Tier Inclusions: >25% margin <3,000 MWh (>1,750), or <10% margin <1,000 MWh T2 Exclusions: >25% margin, or <10% margin	Other Tier Inclusions: >25% margin > 3,000 MWh, or <10% margin < 1,750 MWh (>1,000) T3 Exclusions: >25% margin, or <10% margin	Other Tier Inclusions: < 10% margin < 3,000 MWh (>1,750) T4 Exclusions: >25% margin
Estimate Accuracy (3.a)	**Requirements** - Breakdown of Project costs by major cost categories (separation of equipment costs from total sufficient for turnkey vendor solutions) - Budgetary quote for major equipment, if available **Review Approach** - Information requests, as necessary to meet requirements - Completeness and correctness review of application estimate - Benchmark comparison to similar projects/equipment	**Requirements** - Breakdown of Project costs by major cost categories and (significant) line items, as appropriate - Budgetary quotes for all significant equipment **Review Approach** - Information requests, as necessary to meet requirements - Completeness/correctness review - Benchmark assessment of project costs, or (if similar comparisons not available) - Assessment via independently obtained comparative equipment quotes	**Requirements** - Breakdown of Project costs by major cost categories and (significant) line items, as appropriate - Budgetary quotes for all significant equipment and construction, if applicable **Review Approach** - Information requests, as necessary to meet requirements - Completeness/correctness review - Assessment via comparative equipment and construction quotes, if feasible - Benchmark comparison of other (soft) costs	**Requirements** - Breakdown of Project costs by major cost categories and (significant) line items, as appropriate - Budgetary quotes for all significant equipment and construction, if applicable **Review Approach** - Information requests, as necessary to meet requirements - Completeness/correctness review - Assessment via comparative quotes, or estimation methods, if necessary (quotes not available/account for less than 75% of project costs) - Benchmark comparison of other (soft) costs

[6] Sensitivity margin is a calculation of the % change in project costs before the incentive is impacted, per program rules. The above example is based on the OPA's Process and Systems Upgrades Initiatives, limitations of a one-year post-incentive payback and 70% of project costs.

Table 3. Tiered Information Expectations and Approach by Review Scope Item

SoW Item	Tier 1: < 1,000 MWh	Tier 2: 1,000 – 1,750 MWh	Tier 3: 1,750 – 3,000 MWh	Tier 4: > 3,000 MWh
Project Cost – Eligibility (3.b)	**Requirements** as per Estimate Accuracy (3.a) above **Review Approach** - Determination of cost item eligibility and applicability to project scope - Additional information requests for cost item details, as necessary, to assess eligibility in case of questionable cost items			
Project Cost – Incremental Costs (3.c)	**Requirements** as per (modeled) Base Case System Description (1.a) and Estimate Accuracy (3.a) above **Review Approach** - If Remaining Life/ anticipated replacement > savings period, incremental costs are not applicable. - If Remaining Life/anticipated replacement < savings period, Incremental Costs calculated as the difference between the equipment that would be installed in the absence of the project, per (modeled) Base Case, and higher efficiency capital improvements directly influenced by the incentive. Apply applicable Project Cost – Estimate Accuracy (3.a) Tier approach above.			
Other Benefits/Costs (OB/C) Green = down Tier (lower risk) Red = up Tier (higher risk)	Apply incentive calculation sensitivity margin approach above + Other Tier Inclusions: If OB/C <5% of project benefits (PB), for all projects T1 Exclusions: If OB/C > 25% PB	Apply incentive calculation sensitivity margin approach above + Other Tier Inclusions: If OB/C <10% of PB, for project all projects or > 25% OB/C of PB <1,000 MWh T2 Exclusions: If OB/C >25% PB or <5%	Apply incentive calculation sensitivity margin approach above + Other Tier Inclusions: If OB/C >25% of PB, for projects >1,000 MWh T3 Exclusions: If OB/C <10% of PB	
	Expectation Explanation of the source of benefits or costs **Review Approach** - Information requests, as necessary to meet requirements - Application value accepted unless it significantly deviates from reviewer's experience. In case of upward deviation, expectations and review adjusted to T2. - If no OB/C's identified, reviewer does not investigate	**Expectation** - Explanation and calculation of other benefits or costs must be provided. - Values based on comparables, industry standards, benchmarks, etc. typically acceptable, unless actual data is readily available **Review Approach** - Information requests, as necessary to meet requirements - Completeness and correctness review of the calculation - Validation of benefit/cost source - Independent calculation only if necessary/practical	**Expectation** - Explanation and calculation of other benefits or costs must be provided - Values should be based on actual data, whenever possible/feasible - Provision of asset maintenance agreements and/or extended warranties, if applicable/purchased **Review Approach** - Information requests, as necessary to meet requirements - Independent calculation for verification of application value or determination of alternative value	

Figure 2. Technical Review Uncertainty Estimations

Accuracy Assumptions - Uncertainty Estimations							
T1		**T2**		**T3**		**T4**	
<u>Base Case:</u> Baseline Energy Consumption							
Power Estimates kW from nameplate data, (with context e.g. loading estimate/ description from operator): 10 - 30%	20%	kW from Amps, with estimated Volts and power factor: 10 - 15%	12.5%	kW from Amps, with power factor measurement and estimated Volts, or vice versa, with motor spec pf info: 5 - 10%	7.5%	kW measurements, or calculation based on measured Amps, Volts and power factor: 0.5 - 2.5%	1.5%
Power/Production Variations (estimations include assumption that base case production is representative of future production)							
Constant Operation Mean power from spot measurement, with **constant** loading justification (for calc: Baseline Energy = mean power x operating hours): 10 - 20% ***Variable Operation*** Annual extrapolation of operation (load or other operating parameter) based on < 2 weeks continuous data, with production/mode variation cross-reference, but without a correlating parameter for extended period: 10 - 20%	15%	Mean power from multiple spot measurements (within short period) that demonstrate **constant** loading + justification (for calc: Baseline Energy = mean power x operating hours): 5 - 15% Annual extrapolation of operation based on > 2 weeks (incl. multiple production cycles) of continuous data, with production/mode variation cross-reference, but without correlating parameter for extended period: 5 - 15%	10%	Mean power from multiple spot measurements, distributed over course of year/time of day, that demonstrate **constant** loading + justification (for calc: Baseline Energy = mean power x operating hours): 2.5 - 7.5% Annual extrapolation of operation based on > 2 weeks (incl. multiple production cycles) of continuous **load** data, with correlating parameter for full year: 2.5 - 7.5%	5%	12+ month power/load data: 0 - 5%	2.5%
Operating Hours (estimations include assumption that base case production is representative of future production)							
Constant Operation (typically single motor system, or multiple motors that always run together, or are totally independent)							
Annual operating hours estimated from operating/production schedule and operator experience: 10 - 20%	15%	Annual hours from < 2 weeks continuous operating data/log extrapolation + supporting info from schedule/operator experience: 5 - 15%	10%	Annual hours from > 2 weeks continuous operating data/log extrapolation + supporting info from schedule/operator experience: 2.5 - 7.5%	5%	12+ month operating log (or 8,760 system, less maintenance and shutdown): 1 - 4%	2.5%
Variable Operation (including multiple motor systems, with sequencing based on demand)							
Annual opeating hours (per motor) from extrapolation of operation data/log based on < 2 weeks continuous data, with production/mode variation cross-reference: 10 - 20%	15%	Annual opeating hours from extrapolation of operation data/log based on > 2 weeks (incl. multiple production cycles) of continuous data, with production/mode variation cross-reference: 5 - 15%	10%	Annual operating hours from extrapolation based on > 2 weeks (incl. multiple production cycles) of operation log/run-time data, with correlating parameter for full year: 2.5 - 7.5%	5%	12+ month operating log (alternatively, all motors operate 8,760 hours, less maintenance and annual shutdown, with supporting information): 1 - 4%	2.5%
<u>Energy Savings:</u> Post-Project Projected Consumption or Energy Reduction %							
Efficiency measure correlated to a current operating parameter, including production/operating hours (in case of specific efficiency improvement)							
Uncertainty of **average savings %** (single-point) based on engineered/experienced estimate/ benchmark & new equipment specs (if applicable)	20%	Uncertainty of projected consumption based on spot measured operating conditions and/or detailed engineering calculation & new equipment specs, **for each distinct mode**	10%	Uncertainty of projected consumption based on continuous measured operating conditions & new equipment specs	5%		
Efficiency measure relates to changing operating parameters; no pre and post-project correlation							
Uncertainty of projected consumption based on engineering calculation (incl. new equipment specs, if applicable) + projected operation (e.g. reduced flow, pressures, etc.) based on benchmarking/ industry experience	20%	Uncertainty of projected consumption based on engineering calculation (incl. new equipment specs, if applicable) + calculation/simulation of projected operation (e.g. reduced flow, pressures, etc.) based on spot measurement of current conditions	10%	Uncertainty of projected consumption based on engineering calculation (incl. new equipment specs, if applicable) + calculation/simulation of projected operation (e.g. reduced flow, pressures, etc.) based on continuous measurement of current conditions	5%		

The uncertainty assumptions are based on Willis' project and measurement and verification (M&V) data analysis experience[7]. The uncertainty assumptions were combined via uncertainty calculation methods to arrive at total energy savings uncertainty values. Table 4 presents the project materiality ranges (in MWh/year) and associated expected uncertainty, based on the assumptions in Figure 2 and description of review and requirements in Table 3.

Table 4. Technical Review Savings Uncertainty and Risk by Tier

	Tier			
	1	**2**	**3**	**4**
Electricity Savings Range (MWh/yr)	**< 1,000**	**1,000 < x < 1,750**	**1,750 < x < 3,000**	**> 3,000**
Assumed Mean Project Size by Tier (MWh/yr)	550	1,375	2,375	4,000
PR Tier Threshold based on Levelized Risk (MWh/yr)	1,000	1,750	3,000	5,000
Uncertainty Estimates				
Base Case	43%	25%	14.5%	7.1%
Power	28%	14.5%	9.5%	4.6%
Measurement Accuracy - Option A	13%	4.5%	4.5%	2.1%
Measurement Accuracy - Option B	11%	4.3%	4.3%	n/a
Variation	15%	10%	5.0%	2.5%
Operating Hour Variability	15%	10%	5.0%	2.5%
Electricity Savings	**54%**	**32%**	**19%**	**12%**
Projected Consumption/% Reduction	20%	10%	5%	5%
Incentive Risk				
Incentive Risk based on Assumed Mean Project Size	$59,400	$88,140	$89,180	$93,960
Levelized Incentive Risk for Max Savings per Tier	$108,000	$112,175	$112,650	$117,450

These values represent the expected maximum savings result uncertainty, within the bounds of appropriate project assumptions. Meaning, greater deviations are possible, if due to contradiction of a given assumption or in the event of an unforeseen circumstance (the majority of unforeseen circumstances should be mitigated by appropriate technical review). Also meaning, the average savings results are expected to deviate from estimated values by a lesser percentage (especially in the lower tiers), but confidence intervals cannot be developed at this time.

The initial technical review risk associated with each tier was calculated based on the median project materiality and the uncertainty. The materiality bandwidths and subsequent risk calculations were iterated until an approximately levelized technical review risk was achieved for all tiers, as depicted in Table 4, above. The combination of the above tables make-up a technical review standard framework that can be applied to any industrial energy efficiency, energy acquisition, capital incentive program.

[7] Work is under way to track an update assumptions based on future verified data

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