TECHNICAL REVIEW OF THE ACT ON ENERGY BUSINESS PROGRAM TECHNICAL REFERENCE MANUAL NO. 2008-1

Final

Prepared for:

AMEREN ILLINOIS UTILITIES

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1. EXECUTIVE SUMMARY

1.1 Methodology

We conducted a technical review of each measure from Program Year 1 in the Ameren ActOnEnergy Technical Reference Manual (TRM)[1], to assess the reasonableness of underlying algorithms, technology assumptions, and calculated savings values. Our findings regarding individual assumptions and algorithms may be categorized as follows:

1. ACCEPTABLE AS IS: assumption or algorithm is reasonable and appropriate.
2. REVISE OVER TIME: the assumption or algorithm is acceptable for the near term but should be improved over time through the evaluation process or program experience.
3. ERROR OR DISAGREEMENT: We believe the assumption or algorithm contains an error or we disagree on the value or approach and refer the matter for follow-up discussion.
4. INSUFFICIENT DOCUMENTATION: A determination of the adequacy of the assumption or algorithm cannot be made because of insufficient documentation.

The preferred data sources for assumptions are recent local primary research; evaluation, measurement, and verification (EM&V); and program experience. Since those sources were generally not available in Illinois when Ameren assembled documentation and developed default savings values, we understand that some assumptions must be drawn from data sources that involve a compromise between age, rigor, or location. In some cases, Ameren has used simple averages to combine assumptions into default values – this is generally an acceptable approach in the near term, but one that can be improved upon over time. When assumptions are described as "needing revision", we may propose an existing alternative data source or suggest using the evaluation process, market research, or program experience to revise the assumption through a collaborative review process.

The types of issues we considered in our review include:

Measure definition – Provides a description of the efficient technology, the required technology performance specifications, and the applications where the technology is eligible. There must be consistency between the TRM and the participant application form (official program rules) to ensure the default savings occur. Reviewed issues include:

- Does the description define the measure without ambiguity to ensure that only those measures that will achieve the default savings will be accepted into the program?
- Are the performance specifications complete to ensure the default savings will be achieved?
- Are the performance specifications independently rated or certified?

[1] ActOnEnergy Business Program-Program Year 1, June 2008 through May 2009, Technical Reference Manual (TRM), No. 2008-1, dated February 3, 2009.

- Does the description define the eligible base case applications?

Measure Savings Engineering Analysis – Provides the algorithms used to calculate non-coincident demand reduction, coincident demand reduction, and annual energy savings for each measure. Reviewed issues include:

- Are the equations correct for the measure?
- Do the algorithms provide reasonable estimates for the range of applications and operating conditions of participants in the program?
- Are factors missing from the equation?

Measure Savings Assumptions – Documents the wattages, efficiency ratings, and operating assumptions for baseline and efficient equipment to calculate non-coincident demand reduction, coincident demand reduction, and annual energy savings. Reviewed issues include:

- Is the baseline equipment type and performance appropriate for the measure description?
- Does the assumed baseline reflect federal standards?
- Are the efficiency ratings and wattages appropriate for the range of full-load and part-load operating conditions expected of participants?
- Do the operating hour assumptions provide a reasonable representation for program participation?
- Are the load factors, HVAC interaction factors, and coincident factors reasonable?
- Are the assumptions documented?
- Are the data sources appropriate for program delivery territory?

Measure Savings Results – Presents the default values that are derived from the algorithms and assumptions. Potential issues include:

- Has the calculation been correctly performed to generate the default values (are there math errors)?
- Is the weighting or averaging of data to derive a single default value reasonable?
- Do individual default values cover too broad of a range?
- Are the units for the savings correct and clearly presented?

Other Observations (where noted, not identified for all measures)

- Priority areas for future research
- Pending federal standards and state/local regulations that may affect the measure
- Issues for evaluation or field verification

1.2 Key Findings

A number of cross-cutting issues were identified for each end use. This section provides a high-level summary of these issues. Detailed findings are presented in Section 2 below.

Lighting

- Ameren should identify savings units in the TRM (e.g., per lamp, per fixture, per watt reduced, etc.) when presenting tables of results. Ameren also needs to note whether kW savings is coincident or noncoincident.
- Ameren should remove redundant terms, such as DI and WHF, as well as EI and WHF_e from default lighting calculations.
- When offering a single default value to represent multiple baseline and measure options, Ameren should provide documentation of the base wattage and replacement wattage, as well as the weighting approach used to generate a single value.
- There are a number of potential issues related to the mapping of 2005 DEER market sectors to the Ameren TRM and Standard application including the use of simple averaging when combining multiple DEER market sectors into one facility type.
- The TRM does not sufficiently document noncoincident kW to confirm that Appendix D hours are used consistently in all measures.
- It is not clear how Ameren is using the information in Appendix D.
- It is not clear how Ameren is handling coincidence factors when reporting savings in the TRM. The TRM does not sufficiently document noncoincident kW to confirm which coincidence factors are used and whether they are used consistently in all measures.
- The TRM does not sufficiently document noncoincident kW to confirm that HVAC interactive factors are used consistently in all measures. We recommend a set of HVAC interaction factors that are specific to Illinois be developed.

HVAC Systems

- For each measure type, Ameren should only list algorithms actually used by the measure.
- If Ameren is claiming heating season savings, we would need to see documentation of base case efficiency, heat pump efficiency, and heating season full load operating hours.
- Ameren's three sets of algorithms are set up to provide absolute impacts, rather than per unit impacts. Cooling equipment performance values are usually set for a size range.
- Ameren should include both a coincidence and redundancy factor in HVAC algorithms.
- Ameren should use the 2006 IECC code as its baseline and can modify efficiency levels over time based on the evaluation process.

- Building operating hours should not be used for cooling full load hours.
- Ameren should be very diligent to label units in all default savings values presented, and distinguish between coincident and noncoincident kW demand savings.
- The application of DEER weather sensitive HVAC data to Illinois is problematic, but acceptable until other values can be determined.

Motors

- The review did not identify any cross-cutting issues for motors.

Refrigeration

- With the exception of Ice Makers, the Ameren default savings values for Refrigeration measures are acceptable for the near term but should be improved over time through the evaluation process, market research, or program experience.
- When using default values from secondary sources, Ameren should document the source and any adjustments or averaging of data to create the default savings values.
- The application of DEER weather sensitive data to Illinois is problematic, but acceptable until other values can be determined.
- The measure descriptions are not complete and need to include all relevant details on the efficiency measure, the baseline, and application notes that are associated with the savings values.
- Ameren has pasted an algorithm for anti-sweat heater controls into every refrigeration measure. This needs to be revised so that staff and evaluators referring to the TRM do not get confused.
- It is critical that Ameren identify the units for the savings in the TRM (e.g., per motor, per square foot, per machine, etc.) when presenting tables of results. Ameren should also note whether kW savings is coincident or noncoincident.

The following table summarizes the technical review findings for each reviewed measure from Program Year 1 included in the TRM. For each of the four types of issues reviewed (measure definition, engineering analysis, assumptions, results), we provide a rating as follows:

1 – ACCEPTABLE AS IS: assumption or algorithm is reasonable and appropriate.

2 – REVISE OVER TIME: the assumption or algorithm is acceptable for the near term but should be improved over time through the evaluation process or program experience.

3 – ERROR OR DISAGREEMENT: We believe the assumption or algorithm contains an error or we disagree on the value or approach and refer the matter for follow-up discussion.

4 – INSUFFICIENT DOCUMENTATION: A determination of the adequacy of the assumption or algorithm cannot be made because of insufficient documentation.

Given that multiple issues were assessed within each category for each measure, the rating represents the lowest ranking across all of the issues. Therefore, a measure may rank higher in some areas compared to what is presented here.

Table 1: Summary Table

Measure	Measure Definition	Engineering Analysis	Assumptions	Results
Lighting				
BPL60: High Performance T8 Relamp and Ballast	3	2	3	4
BPL61: Low-Wattage T8 Relamp and Reballast	3	2	3	3
BPL62, BPL64, BPL65, BPL70: New T5/T8 Fluorescent Fixtures (savings per watt reduced)	1	2	3	3
BPL63: Fluorescent Fixtures with Reflectors	2	2	3	2
BPL71: High Intensity Fluorescent	1	2	3	4
BPL72: Controls for H.I.F. Systems BPL73: Remote Mounted Occupancy Sensors BPL74: Occupancy Sensors BPL77 Controls for HID Systems	3	2	4	3
BPL75 250W/320W Pulse Start Metal Halides/Ceramic Metal Halides BPL76 750 Pulse Start Metal Halides BPL85 Ceramic Metal Halide Fixtures	2	2	2	3
BPL78: LED Exit Signs	1	2	2	1
BPL80: CFL Lamps (Screw-in up to 25 watts) BPL82: CFL Lamps (Screw-in over 25 watts) BPL83: CFL Lamps (Screw-in with integral reflector up to 30 watts)	1	2	3	3
BPL81: Cold Cathode Fluorescent Lamps (CCFLs) or LED Lamps	2	2	2	2
BPL84: LED Recessed Downlamps	1	2	2	2
BPL85 Ceramic Metal Halide (CMH) Fixtures	3	2	2	3
BPL86 Ceramic Metal Halide (CMH)	1	2	3	3

Measure	Measure Definition	Engineering Analysis	Assumptions	Results
Integral Ballast Lamps				
BPL87: Hard-wired CFL fixtures, ≤ 30 watts BPL88: Hard-wired CFL fixtures, > 30 watts	1	2	1	2
BPL90: Permanent Lamp Removal (not applicable for PY2 since will be a custom measure in PY2 and later)	3	2	3	3
BPL91: Alternate Highbay Fixture Replacement Option	3	2	2	3
BPL92: Reduced Wattage 4-foot and 8-foot LAMP ONLY	2	2	4	2
HVAC Systems				
BPC1,2,3,4,5,6,7 and 8: Unitary or split system air conditioning systems and air source heat pumps	3	3	3	3
BPC10,11 and 12: Water cooled chiller and air cooled chillers	2	3	3	-
BPC13 and 14: Room air conditioners (through wall units)	2	3	2	3
BPC15: Package terminal air conditioning/heat pumps	2	3	2	4
BPC20: Variable frequency drives on HVAC motors	3	3	3	-
Motors				
Premium Motors	2	3	3	3
Refrigeration				
BPR1: Strip curtains	2	3	2	3
BPR2 and 3: Anti-sweat heater controls	2	3	2	3
BPR4 and 5: Electronically commutated motors (ECM)	2	3	2	3
BPR6: Evaporator fan controls	2	3	2	3
BPR7: Automatic door closers for walk in freezers	2	3	2	3
BPR9: Beverage machine controls BPR10: Snack machine controls	2	3	2	3
BPR8: Energy Star vending machine	2	3	2	3
BPR20,21,22,23,24,25 and 26: High efficiency ice makers	2	3	2	3

2. C&I STANDARD MEASURES

2.1 Lighting

2.1.1 Cross-cutting Review

Several issues cut across most of the individual lighting measures and are addressed below.

Units and Labeling of Default Value Tables

It is critical that Ameren identify the units for the savings in the TRM (e.g., per lamp, per fixture, per watt reduced, etc.) when presenting tables of results. Ameren must also note whether kW savings is coincident or noncoincident.

Default Savings Algorithms

The Ameren TRM identifies two different algorithms for calculating per unit default savings values for lighting retrofit measures, including controls:

Ameren Equations for "gross customer connected load kW savings"

$$\Delta kW = DI \times CD \times ((Watts_{BASE} - Watts_{EE}) / 1000) \times ISR \times WHF_d$$

$$\Delta kW = ((Watts_{BASE} - Watts_{EE}) / 1000) \times ISR \times WHF_d$$

For Energy Savings

$$\Delta kWh = EI \times ((Watts_{BASE} - Watts_{EE}) / 1000) \times HOURS \times ISR \times WHF_e$$

$$\Delta kWh = ((Watts_{BASE} - Watts_{EE}) / 1000) \times HOURS \times ISR \times WHF_e$$

The term "DI" adjusts for the demand interactive effect for conditioned spaces, and "WHF_d" is described as an adjustment for a fractional increase in avoided demand savings from air conditioning. Ameren has set "WHF_d" equal to 1.0 for all lighting measures, while values for "DI," when used, were drawn from ComEd documentation. The terms DI and WHF_d are redundant, and we recommend that only "DI" be used in all lighting default calculations. Similarly, the terms EI (energy interactive effect adjustment factor, used by ComEd) and "WHF_e" (waste heat factor for energy, the fractional increase in avoided energy savings due to reduced operation of air conditioning equipment annually averaged, set equal to 1.0 by Ameren) are redundant, and we recommend using the values for EI that Ameren has drawn from ComEd's documentation. The term "CD" is the coincident diversity factor and should not be included in an estimate of connected load savings, but should be included in all lighting measures (except for controls, depending on the algorithm used) when coincident savings are estimated. These factors are discussed further below.

Ameren also includes the term ISR, or "in service rate" in all lighting equations but sets the value at 1.0. Prior to EM&V results, we suggest the in-service rate is only needed for screw-in compact fluorescent lamps. This is discussed further below.

We recommend the following equations be used in the tracking system for all lighting

measures, except screw-in CFLs and controls:

> $Watts_{BASE}$ and $Watts_{EE}$ are the connected or "nameplate" power consumption of the baseline and energy efficient technology, normalized to a convenient unit of measure.
>
> Noncoincident kW savings = ($Watts_{BASE}$ – $Watts_{EE}$) /1000
>
> Coincident kW savings = Noncoincident kW savings * Coincidence Factor * Demand interactive effect
>
> kWh savings = Noncoincident kW savings * Annual operating hours * Energy Interactive Effect

The equation components "$Watts_{BASE}$" and "$Watts_{EE}$" are addressed on a measure-by-measure basis. The crosscutting components of the equations (annual hours, coincident factors, etc.) are addressed below. Lighting occupancy sensor algorithms are addressed in the write-ups for those measures.

Additional factors to adjust these equations to net savings at the generation level are not addressed in this review. Ameren should be aware of any changes in the sequence of where coincidence factors are being applied when impacts are drawn from ComEd. ComEd has applied coincidence factors at the measure level, while Ameren includes a coincidence factor in a gross-to-net equation in Section 2.0 of the TRM.

Derivation of Noncoincident Demand Reduction

When offering a single default value to represent multiple baseline and measure options, Ameren should provide documentation of the base wattage and replacement wattage, and the weighting approach used to generate a single value. The base-measure scenarios chosen and how they are weighted have a significant impact, often 25% or more, on the single default value.

Installation Rate

One can add an adjustment factor to the noncoincident kW savings equation to account for situations where a portion of the incented units are placed into storage rather than installed ("in-service rate", "storage rate" or "installation rate"). In commercial lighting, the distinction is made between CFL and non-CFL lighting, and the level of program verification. For example, 2005 DEER[2] provides a 100% installation rate for non-CFL lighting, and a 92% installation rate in CFLs offered through standard incentives.

It is acceptable that Ameren not include this factor in its commercial non-CFL lighting algorithms, because we expect a high installation rate for those commercial lighting measures (at or close to 100% installed). We also believe a 100% installation rate on hardwired CFL fixtures is a reasonable initial default value. Installation rate may be an issue for commercial screw-in CFL lighting. Given that screw-in CFLs are not included in the 2009

[2] *2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report – Residential and Commercial Non-Weather Sensitive Measures*.

Standard program, it is not necessary to add an installation rate factor to the lighting algorithms used in that program at this time.

Fixture storage can be identified through the impact verification process, and an adjustment factor can be added in the future if it is significant for any measure or building type.

Facility Type Designations

The Ameren TRM presents default savings values and input values that vary by facility type for 1) annual operating hours, 2) coincidence factors (CD), 3) demand interactive effects (DI), and 4) energy interactive effects (EI). We believe it is necessary that each of these four factors vary by building/facility type when calculating default values. Ameren relies on secondary data for default values for these factors, some of which came from ComEd. ComEd has used 2005 DEER in deriving their lighting annual operating hours, coincidence factors, and the interactive effects. Ameren appears to have used ComEd's DEER values for coincidence factor, demand interactive effect, and energy interactive effect.

Data in DEER is disaggregated into more types than ComEd or Ameren has chosen to use in developing default savings, so ComEd mapped data from 21 DEER "market sector" types into 10 ComEd buildings types. ComEd then added two additional building types: a "Heavy Industry" and a "Miscellaneous" type that is a simple average of data from the other ComEd building types. The Ameren TRM provides tables of coincidence and interactive effects factors that exactly match ComEd. However, the supporting TRM spreadsheets do not reflect the same level of detail, and appear to only use the average (Miscellaneous/Other) values for the CD, DI, and EI factors when we could identify adjustments in the spreadsheets.

The DEER to ComEd to Ameren mapping is summarized below.

Table 2: Facility Type Mapping

2005 DEER Market Sector	Ameren and ComEd TRM Default Assumptions for CD, DI, and EI	Ameren Standard Application
Education - Primary School	K-12 School	School/College
Education - Secondary School		
Education - Community College	College/University	
Education – University		
Grocery	Grocery	Grocery
Health/Medical – Hospital	Medical	Medical
Health/Medical – Clinic		
Lodging – Hotel	Hotel/Motel	Hotel/Motel
Lodging – Guest Room		
Lodging – Motel		
Manufacturing - Light Industrial	Light Industry	Manufacturing/Industrial
	Heavy Industry	
Office – Large	Office	Office
Office – Small		
Restaurant - Sit-Down	Restaurant	Restaurant
Restaurant - Fast-Food		
Retail - 3-Story Large	Retail/Service	Retail/Service
Retail - Single-Story Large		
Retail – Small		
Storage – Conditioned	Warehouse	Warehouse/Distribution
Storage – Unconditioned		
Warehouse – Refrigerated		
Not Identified	Miscellaneous	Other

The mapping process determines how secondary data is translated into the range of default values that Ameren is using to calculate program savings for lighting, based on participant reported facility type selections. Mapping has a significant impact on default demand and energy savings, whether DEER or other sources are used.

The following issues regarding the mapping process and facility type selection process could affect default savings and verified gross impacts:

- Ameren's Standard program application form has combined two facility types from the default values calculation: School (K-12) and College/University into one check box designator on the application: School/College. Ameren should explain how this is implemented in the database tracking and reporting system.
- In general, ComEd and Ameren appear to have used simple averaging when combining multiple DEER market sectors into a single building/facility type. This may skew the averaged value inappropriately for some facility types. A weighted average approach based on program participation profile, annual energy usage, or peak demand would be a better method of combining data values. A simple average is acceptable for calculating initial default values, but should be revisited in future years.

- The Standard program relies on the customer to select facility type by checking "all that apply, where the work is to be done" from ten check box options on the application. There are concerns with this self report method:
  - Participants may check the box based on their business type (e.g., manufacturing/industrial) when the space affected by project could be a different type (e.g., an office), or they may check both.
  - Participants in mixed use commercial buildings may check the predominant facility type (e.g., office) when the space being retrofit is a different type (e.g., a ground floor restaurant or retail space).
  - The project may have multiple facility types checked, and it is not clear how Ameren will select the default values.

The evaluation effort will question participants on their building types, providing insight into whether assumptions tied to building type reported on the application form are accurately representing the participant profile, and potentially inform possible improvements if there are discrepancies.

Default Annual Operating Hours

The Ameren TRM references 2005 DEER (through ComEd) for annual operating hour assumptions which are not shown in the measure write-ups but are listed in Appendix D of the TRM. The TRM does not sufficiently document noncoincident kW to confirm that Appendix D hours are used consistently in all measures. However, it appears that Appendix D was used for all lighting measures except LED downlamps (BPL84). Supporting spreadsheets suggest that different factors may have been used in some cases.

Below are the concerns raised regarding ComEd's use of DEER to derive annual operating hours. Because Ameren uses the same values as ComEd, these issues are also relevant to Ameren.

> *ComEd has relied upon 2005 DEER for most of the annual operating hour assumptions for the initial default values. We are aware of other sources of operating hours developed and used in other states, but none that is clearly better than DEER as a starting point (DEER draws from evaluation and metering results). ComEd has made some adjustments to the DEER values (some documented and others not explained). The use of DEER as a starting data source for annual hours of use is reasonable, and we support case-by-case revisions for specific buildings types when a solid case can be made for an alternate source, or as Illinois metered data becomes available.*
>
> *DEER uses separate annual operating hour tables for CFL and non-CFL lighting measures that ComEd has also adopted. This results in annual operating hour differences for Offices, Retail/Service, Restaurant, Hotel/Motel, and Miscellaneous.*
>
> *We would like ComEd to explain the following issues or their revise default values*:

1. *ComEd's Prescriptive program application form has combined two building types from the default values calculation: School (K-12) and College/University into one check box designator on the application: School/College. The assumed hours of use are substantially different (1,873 hours for schools, 3,433 for colleges/universities). ComEd should explain how this is implemented in the database tracking and reporting system.*

2. *ComEd has increased the hours of use over DEER by a factor of 1.5 for the two industrial building types, citing data from Efficiency Vermont and PG&E. DEER industrial hours are 2,860 (for "manufacturing – light industrial"), ComEd raises that to 4,290 hours, while the Efficiency Vermont TRM uses 5,913 hours, and PG&E working papers use 6,650 hours for process industrial and 4,400 hours for assembly industrial. While DEER industrial hours are the lowest among these and other sources, ComEd has not provided an explanation why 4,290 hours is a better value for their industrial customer base.*

3. *The 2005 DEER source provides annual operating data for three storage and warehouse types: Storage Unconditioned (2,860 hours), Storage Conditioned (2,860 hours), and Warehouse Refrigerated (2,600 hours). ComEd has increased annual operating hours by 1.5 times the DEER values. The simple average from the DEER data is 2,733 hours, while ComEd's assumption for Warehouse uses 4,160 hours. Studies from other states show hours of use for warehouses that range from 2,388 to 5,632 hours per year. Further explanation or supporting documentation from ComEd is requested.*

4. *ComEd sometimes show warehouse hours as 3,597 hours, and Ameren has incorporated that discrepancy into the default values.*

5. *On two measures in the Medical building type, Reduced Wattage T8's and High Performance 4-foot T8, ComEd has used without explanation 8,736 annual operating hours instead of the simple average (6,474 hours) of DEER's Hospital (8,736 hours CFL and non-CFL) and Clinic (4,212 hours CFL and 8,736 hours non-CFL) that was used for annual hours in other non-CFL measures. ComEd should explain which value(s) they propose for non-CFL lighting and update the Medical building type annual operating hours if needed. We believe the 2005 DEER value of 8,736 hours for non-CFL lighting in Medical Clinic buildings would be high if this building type is selected by participants operating outpatient facilities.*

6. *Heavy industrial hours of use are identical to light industrial. The purpose and definition of this additional category is not clear.*

7. *Lodging (hotel/motel) hours of use for non-CFL measures takes a simple average (4,941 hours) of guest room (1,145 hours) and general common areas (8,736 hours). It is not clear if this was intended. ComEd should revisit this, although the 4,941 hours of use average for non-CFL lighting in ComEd's hotel and conference building type is closer to values used in nearby states (MN, MI, WI) than the DEER values. For CFL lighting, ComEd has averaged two common area values (one for hotel, one for motel) with one guest room value resulting in 6,206 hours, which*

does not seem appropriate. ComEd should revise the CFL hours to reflect an average between rooms and common areas for a single building.

Appendix D

Appendix D provides tables of annual hours of use, coincidence factors, HVAC interaction factors, peak kW savings, and annual energy savings, all by building type. The tables draw data from ComEd's technical reference documentation. In the measure write-ups, Appendix D is listed as a reference for operating hours, but it also appears to document savings values. In some cases, there are two or three tables in Appendix D where savings values are derived, but only one table shown in the main write up. In other cases, there are multiple tables in Appendix D showing measure savings, when only one table is required by the measure analysis.

It is not clear how Ameren is using the information in Appendix D.

Coincidence Factors

The first discussion of loadshapes and coincidence factors is provided in Section 6.0 of the TRM. The TRM includes a loadshape for commercial lighting ("Loadshape #1") with a summer coincidence factor of 70%, and all the lighting measure characterizations in Section 8.0 of the TRM reference this loadshape. Many of the measures also include a reference table and refer to Appendix D, drawn from ComEd, that lists coincident diversity factors by facility type for use in the algorithm.

It is not clear how Ameren is handling coincidence factors when reporting savings in the TRM. The TRM does not sufficiently document noncoincident kW to confirm which coincidence factors are used and whether they are used consistently in all measures. It appears that Appendix D was used for all lighting measures except LED downlamps (BPL84).

The coincidence factors the Ameren TRM references from ComEd came originally from 2005 DEER. We are aware of other sources of coincident factors developed and used in other states, but none that are clearly better than DEER as a starting point. Overall, but with a few minor exceptions, the coincidence factors from DEER are more conservative (lower) than factors provided in deemed databases from Michigan and Minnesota (who draws from Vermont, Arkansas, and Xcel). The Pennsylvania TRM uses coincidence factors that are slightly lower than DEER.

The use of DEER as a starting data source for coincidence factors is reasonable, and we support case-by-case revisions for specific buildings types when a solid case can be made for an alternate source, or as Illinois metered data becomes available.

HVAC Interaction Factors

The Ameren TRM references 2005 DEER (through ComEd) for demand interactive effect and energy interactive effect factor assumptions which are shown in measure write-ups and in Appendix D of the TRM. The TRM does not sufficiently document noncoincident kW to confirm that HVAC interactive factors are used consistently in all measures. However, it appears that Appendix D was used for all lighting measures except LED downlamps (BPL84). Supporting spreadsheets suggest that different factors may have been used in some cases.

The California Evaluation Framework discourages using the HVAC interactive factors outside of the location they were developed for:

> "There are many complicated interactions between internal gains, shell heat gains, thermal mass effects, HVAC system efficiency, and HVAC system control. Thus, HVAC interactions are best investigated with building energy simulation programs and for particular climate regions. Hourly simulation programs are best suited to calculating demand interaction factors. HVAC interactions are influenced by a number of factors, such as:
>
> - Climate
> - Relationship of building internal and solar loads to the overall envelope heat losses (balance point temperature)
> - Coupling of internal load to HVAC load
> - Building thermal mass
> - HVAC system type
> - HVAC system fuel
> - HVAC system efficiency
> - HVAC system controls
>
> Thus, it is not appropriate to use a single HVAC interaction factor for all buildings, measures, and climates. HVAC interactions should be investigated over the range of climates and building characteristics listed above."

We are aware of other sources developed and used in other states, but none that offer a more compelling case than DEER for immediate revisions. It is not clear whether the HVAC interaction factors from DEER account for unconditioned space and buildings in their derivation, or whether they should only be applied to conditioned spaces.

We recommend a set of HVAC interaction factors that are specific to Illinois be developed.

2.1.2 Measure-by-Measure Review

BPL60: High Performance T8 Relamp and Ballast

Measure Definition

The measure definition in the TRM should include CEE's specification parameters for high performance T8s because the CEE web site reference (www.cee1.org) leads to separate qualifying lists for reduced wattage T8s and high performance T8s, and CEE may change their specification criteria over time. The TRM definition says that 1 Unit = 1 to 4 lamps and 1 ballast, but the wattage reduction for those four scenarios are significantly different, both in absolute terms and per lamp, so it is not clear if the unit is "per lamp" or "per fixture." The TRM lists both 4 foot and 8 foot lamps as incented measures, but 8 foot lamps are not referenced in the definitions. The base technology only specifies T12 fixtures, without

specifying magnetic ballasts and four foot or eight foot lamps. It is not clear if conversions between 4 foot and 8 foot systems are included.

The 2009 application form for BPL60 allows either T12s or 32W T8s as a base technology, and allows high performance or low wattage T8s in 4 or 8 foot lamps as the incented technology. If the application form for a program year redefines a measure, then the TRM must be updated as well.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

The primary uncertainty for demand impact is the base fixture wattage, which appears to assume standard magnetic T12 ballasts and 34 watt lamps for four foot fixtures, although it is not specifically stated. If the baseline ballasts were entirely electronic with 34 watt T12 lamps, the default savings would be 2/3 lower.

Ameren provides a table of single default values that appears to be per lamp. However, the TRM does not clarify whether it applies to one, two, three, or four lamp retrofits or 4 or 8 foot systems. If a single value covers all four (or more) options, then Ameren should document the weighting scheme used to combine these cases.

Ameren includes the table of coincident and interactive effect factors in the TRM, but there is insufficient documentation of noncoincident kW savings to determine whether these values have been incorporated into the default values.

Measure Savings Results

There is insufficient documentation of noncoincident kW savings to determine what scenarios the default values apply to or whether they are reasonable.

BPL61: Low-Wattage T8 Relamp and Reballast

Measure Definition

The measure definition in the TRM does not adequately define the energy efficient option because the CEE web site reference is the main address (www.cee1.org), and CEE has multiple lighting lists. The definition does not specify number of lamps or length (4 or 8 foot). The TRM describes both 4 foot and 8 foot lamps as incented measures. The base technology only specifies T12 fixtures, without specifying magnetic ballasts and four foot or eight foot lamps.

The measure has two baselines: either existing T12 or higher wattage T8s. These baselines have significantly different savings associated with the incented technology.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

The primary uncertainty for demand impact is the base fixture wattage, which appears to assume standard magnetic T12 ballasts and 34 watt lamps for four foot fixtures, although it is not specifically stated. If the baseline ballasts were entirely electronic with 34 watt T12 lamps, the default savings would be 2/3 lower. A second eligible baseline is a higher wattage T8 (32W or 59W). The T8 baseline will have significantly lower impacts than a T12 baseline.

Ameren provides a table of single default values that appears to be per lamp. However, the TRM does not clarify whether it applies to one, two, three, or four lamp retrofits or 4 or 8 foot systems. The table also fails to specify whether it represents the T12 baseline, a T8 baseline, or a weighting between the two.

We recommend separate tables of default values for the T12 and T8 baselines. If a single value will cover multiple options within a baseline, then Ameren should document the weighting scheme used to combine these options.

Ameren includes the table of coincident and interactive effect factors in the TRM, but there is insufficient documentation of noncoincident kW savings to determine whether these values have been incorporated into the default values.

Measure Savings Results

There is insufficient documentation of noncoincident kW savings to determine what scenarios the default values apply to or whether they are reasonable.

Ameren should create separate default value tables for the T12 and T8 baselines.

BPL62, BPL64, BPL65, BPL70: New T5/T8 Fluorescent Fixtures (savings per watt reduced)

These four measures share energy analysis approach in the TRM and differ only in the fixture efficiency characteristics.

Measure Definition

There are no issues with the measure definitions. Pre-approval is required for these measures and we believe that requirement is needed to ensure the baseline wattage is correctly estimated, and that the participant has selected a qualifying fixture. Ameren requests specifications for the new fixtures with the final application – those specifications need to cover the ballast and lamp as well as fixture efficiency. The Ameren TRM has listed the high efficiency qualifying criteria under the "Baseline Efficiencies" heading, and this should be revised. The TRM and the application form should have identical language defining the baseline system and the incented measures.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

The assumptions for these measures are addressed in the cross cutting discussion. Ameren should clarify whether the rounded kWh values shown in the results tables are used in the tracking system, or whether the exact values are used (0.001 noncoincident kW times the annual hours of use times the energy interactive factor). If the rounded kWh values in the tables are used, then the impacts could be significantly different from the underlying assumptions. For example, each noncoincident watt saved in a retail/service project with stated defaults of 4,210 annual hours times the 1.11 energy interactive factor saves 4.673 kWh, but if rounded to 5 kWh the savings are 7% higher. This is significant for projects saving hundreds of kilowatts.

Similarly, Ameren needs to clarify whether the kW savings per watt reduced shown in the default tables are noncoincident or coincident savings, and whether the tracking system is using rounded values for coincident watts. If Ameren is rounding coincident watts to exactly 0.001 kW per each noncoincident watt saved, then this is equivalent to setting demand interactive factors and coincidence factors to 1.0 for all building types. This would result in a significant difference for some building types. For example, each noncoincident watt saved in a school saves only 0.5166 coincident watts, 48% lower than a rounded value of one watt.

Measure Savings Results

Ameren should confirm the values used in the tracking system and revise the TRM to present impacts that are not overly rounded.

At presented, we cannot confirm that the default values have correctly used the coincidence and interactive factors.

BPL63: Fluorescent Fixtures with Reflectors

Measure Definition

The measure definition does not specify a baseline, and allows twelve four foot options: 1, 2, 3 or 4 lamp high performance T8s, T5, or high output T5s and an unspecified number of 8 foot options. The Ameren TRM has listed the high efficiency qualifying criteria under the "Baseline Efficiencies" heading, and this should be revised. The TRM and the application form should have identical language defining the baseline system and the incented measures.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

The primary uncertainty for demand impact is the base fixture wattage, which appears to assume standard magnetic T12 ballasts and 34 watt lamps for four foot fixtures, although it is not specifically stated. If the baseline ballasts were entirely electronic with 34 watt T12 lamps, the default savings would be 2/3 lower. A second potential baseline could be a higher wattage T8 (32W or 59W). The T8 baseline will have significantly lower impacts than a T12 baseline. A third potential baseline would be a T12 or T8 fixture with a more lamps per fixture than the incented fixtures, so that savings could include lamp removal.

Ameren provides a table of default values that give a single value by building for four foot lamp systems, and a single value by building type for 8 foot systems. Savings in the TRM appears to be per lamp. However, the TRM does not clarify whether it applies to one, two, three, or four lamp retrofits. The table also fails to specify whether is represents the T12 baseline, a T8 baseline, or a weighting between the two.

We recommend separate tables of default values for the T12, T8, and delamping baselines. If a single value will cover multiple options within a baseline, then Ameren should document the weighting scheme used to combine these options.

Ameren includes the table of coincident and interactive effect factors in the TRM, but there is not sufficient documentation to determine whether these values have been incorporated into the default values.

Measure Savings Results

There is insufficient documentation of noncoincident kW savings to determine what scenarios the default values apply to or whether they are reasonable.

Ameren should clarify the baseline definition, and create separate default value tables for each baseline.

Ameren should clarify the units of the savings.

BPL71: High Intensity Fluorescent

Measure Definition

There are no issues with the measure definition.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Even though the program collects baseline watts, installed watts, and hours of operation from the participant, it is still necessary to use lighting default values for the coincident factor, and Ameren should include HVAC interactive effect factors if the fixtures are installed in conditioned space (for example, big box retail or groceries). The algorithms in the Ameren TRM do not include coincident factors and assume HVAC interaction factors are equal to 1.0.

Measure Savings Assumptions

The assumptions for this measure are addressed through the cross cutting discussion.

Measure Savings Results

As presented, we cannot confirm that the default values have correctly used the coincidence and interactive factors.

Appendix D is not consistent with the TRM write-up.

BPL72: Controls for H.I.F. Systems; BPL73: Remote Mounted Occupancy Sensors; BPL74: Occupancy Sensors; and BPL77: Controls for HID Systems

These four measures share the same energy analysis approach in the TRM and differ only in technology characteristics.

Measure Definition

The measure definitions need revision. They should state whether ultrasonic detectors are eligible and whether exterior lighting is eligible. The definition for BPL72 (for fluorescent systems) allows daylight dimming, but does not specify whether continuous or step dimming are eligible, the minimum numbers of steps, and the minimum power level. The definition for BPL77 (for HID systems) does define daylight dimming requirements. Some of the specifications appear to be model specific or proprietary ("Unique Smart Cycling") – if these are required criteria then the algorithm should reflect the associated savings.

Measure Savings Engineering Analysis

The algorithms in the Ameren TRM are not consistent with the referenced savings shown in Appendix D.

We suggest the following equation as an alternative for energy savings:

> kWh Reduction = Connected wattage/1000 * annual operating hours * time off fraction *energy interactive effect

Some sources use separate savings factors when calculating energy and demand savings from occupancy sensors, and use the following equation to calculate demand reduction:

> Coincident kW savings = Connected wattage/1000 * Sensor control demand savings fraction * demand interactive effect

where the "Sensor control demand savings fraction" is an average demand reduction over the peak period, which may be supported by analysis of light logger studies.

Measure Savings Assumptions

Using data from Southern California Edison and DEER, Ameren assigns one of two "occupancy off rates" to a building type based on whether it is a low occupancy type (50%

time off) or high occupancy type (20% time off). Ameren does not indicate in the TRM write up which category is assigned to each facility type, but it does appear in Appendix D.

Ameren uses the same occupancy off rate for energy savings and demand reduction. Other data sources, including the Lighting Research Center[3], define separate values for demand and energy savings fractions, and present them by application or space type (restroom, private office, classroom, etc.). The demand savings fractions are lower than the energy savings fractions.

For Ameren, the high occupancy type sensor off rate is 20%, and the low occupancy off rate is 50%. The 20% savings value is comparable or lower than other sources, while the 50% value is on the high end. These default values are reasonable, but are candidates for revision through the EM&V process.

There are no references or assumptions provided for fluorescent daylight dimming savings fractions, so we cannot determine how savings for that type of control are calculated.

The TRM states that operating hours are taken from DEER for non-CFL lighting, except for guest rooms. If the occupancy sensor is controlling fixtures that have received an incentive from Ameren, those fixtures have operating hours associated with them that may come from the participant, DEER, or other source. It is not clear which set of hour assumptions are being used when occupancy sensors are added to program supported fixtures.

Measure Savings Results

Ameren should revise the demand reduction and energy savings equations. HVAC interactive factors and coincident demand reduction need to be addressed in the equations.

Ameren needs to define a savings fraction for demand and energy for each facility type, for occupancy sensors and daylight dimming sensors.

Ameren needs to clarify the hours of use that will be used.

Ameren should revise future default kW savings using information that may be available from program participation, EM&V results, and market research to update the savings fractions for demand reduction and energy savings.

BPL75: 250W/320W Pulse Start Metal Halides/Ceramic Metal Halides; BPL76 750: Pulse Start Metal Halides; and BPL85: Ceramic Metal Halide Fixtures

These three measures share the same energy analysis approach in the TRM.

Measure Definition

The measure definition should clarify whether new fixtures are required, or whether retrofit kits are acceptable. Retrofit kits should consist of a permanently wired ballast and retrofit

[3] Von Neida, Bill, Dorene Maniccia and Allan Tweed. 2000. An analysis of the energy and cost savings potential of occupancy sensors for commercial lighting systems. Illuminating Engineering Society of North America 2000 Annual Conference: Proceedings. New York: IESNA.

lamp, and not include screw-in retrofit lamps. The definition should also clarify whether self-ballasted ceramic metal halide lamps are eligible.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

Ameren assumes that these metal halide lighting technologies will be placed in non-conditioned areas and that the energy and demand interactive effects are equal to 1.0. These measures could quite likely be placed into air-conditioned big box retail and grocery buildings where HIDs are common. Applications for ceramic metal halide lighting include accent lighting and down-lighting which may be found in retail and large offices. It would be reasonable to include demand and energy interactive effects for these measures using the factors developed by facility type.

Ameren assumes the coincidence factors for these lighting measures will be equal to 1.0. Due to the long warm-up and restrike times for HID lighting, that is a reasonable assumption for the initial default savings value, but should be reconsidered after impact evaluation.

Wattage removed and installed will be provided by the participant, and Ameren will provide the operating hours.

Measure Savings Results

Ameren should use HVAC interactive factors for conditioned space.

Ameren should revise future default kW savings using information that may be available from program participation, EM&V results, and market research to confirm whether the interactive effect and coincident factors should remain equal 1.0.

BPL78: LED Exit Signs

Measure Definition

There are no issues with the measure definition.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

Ameren obtained demand and energy savings from the ComEd TRM. The ComEd and Ameren single default savings values for this measure of 0.041 kW and 342 kWh are reasonable. We have the following comments on ComEd's analysis.

ComEd assumes that the base exit sign uses two 20 watt incandescent lamps and an LED replacement uses 5 watts, for a demand reduction of 35 watts. These assumptions are used in other states, even though the base population may include lower wattage incandescent signs and compact fluorescent signs, and there are variations between double and single faced signs. For example, 2005 DEER assumes a 36 watt reduction and Wisconsin assumes 34 watts reduction.

ComEd uses average values for demand and energy interactive effects of 1.18 and 1.11, respectively, even though these factors vary by building type for other types of lighting. There is no technical basis for that simplification, and at a measure level the average impacts could differ by up to 7% from the values that vary by building type. We expect the overall impact of this simplification on the program level lighting savings use will be minimal because exit signs are a small portion of building lighting load.

Measure Savings Results

The use of one default demand reduction value and one energy saving value for all sign types in all building types is a reasonable simplifying assumption. If Ameren creates a targeted retrofit effort to change out exit signs in large numbers in specific building types (e.g., large offices), Ameren should use building specific interactive effect adjustment values.

BPL80: CFL Lamps (Screw-in up to 25 watts); BPL82: CFL Lamps (Screw-in over 25 watts); and BPL83: CFL Lamps (Screw-in with integral reflector up to 30 watts)

These three measures share the same energy analysis approach in the TRM.

These measures are not eligible in the Standard program for program year 2009, but screw in CFLs are available to small businesses through a separate offering.

Measure Definition

No issues with the measure definition for BPL80 and BPL83. Ameren's measure definition for BPL82 allows CFLs up to 200 watts, which is acceptable, but Ameren's impacts for BPL82 used a ComEd analysis that only considered CFLs up to 40 watts.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

If this measure is offered through standard incentives in the future, for example with specialty CFLs, consider adding a factor to the demand savings algorithm to adjust for in-service rate if the 2008 evaluation finds that storage is an issue.

Measure Savings Assumptions

Ameren provides two tables of demand and energy saving impacts for BPL80 (15 watts or less, and 16 to 25 watts) taken directly from analysis by ComEd. For the CFL reflectors of BPL83, Ameren uses ComEd's impacts for the 16 to 25 watt CFLs even though CFL reflectors up to 30 watts are eligible – we do not view this as a significant difference because the range of incandescent lamps covered are the same (60 to 100 watts).

Ameren's impacts for high wattage CFLs (BPL82) were taken directly from an analysis by ComEd that only examined CFLs up to 40 watts. This is a significant difference and Ameren should revise the analysis to include the full range of eligible CFLs.

In a review of ComEd's analysis, the pairings of CFLs to incandescent lamps were reasonable (e.g., 60 watt incandescent paired with 13 to 18 watt CFLs) and were consistent with 2005 DEER. The impacts incorporate ComEd's assumptions for annual hours of use, coincidence factors, and HVAC interactive effects. Ameren references these assumptions.

Measure Savings Results

The use of ComEd's impact values for measures BPL80 and BPL83 results in savings that are reasonable for Ameren. ComEd's analysis is not appropriate for measure BPL82, and Ameren should revise the impacts for that measure.

The range of impacts covered by the single average default value in each of the two wattage categories for BPL80 and BPL83 is large, roughly ± 40%. If this measure were to be offered in the future in high volume, it might be necessary to include additional categories.

If these measures are offered through the standard program in the future, the default kW savings for each category should be calculated using program participation or market research rather than the simple average.

BPL81: Cold Cathode Fluorescent Lamps (CCFLs) or LED Lamps

Measure Definition

The measure definition allows replacement of incandescent lamps of 100 watts or less, while the CCFL and LED lamps are limited to 8 watts or less. Manufacturers suggest 8 watt CCFLs and LEDs as replacements for incandescent lamps of 40 watts or less. It is not clear why the measure is limited 8 watts, given that 13 watt and 18 watt CCFLs are available in the market (60 to 75 watt incandescent replacements), and higher wattage LEDs are also available. The LED lamp should have performance criteria established as part of the measure definition to ensure that the replacement provides adequate light levels – if not, persistence could become an issue. The ENERGY STAR web site (as of 6/1/2009) states that the ENERGY STAR LED lighting program currently does not qualify LED bulbs.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Although the eligible CCFLs and LEDs are a screw-in lamp technology, we would not expect a high storage rate due to the current high cost of the lamps. Storage rates can be checked through the EM&V process, and an adjustment factor added to the algorithms in the future if necessary.

Measure Savings Assumptions

Ameren provides a table of demand and energy saving impacts that was taken directly from analysis by ComEd for CCFLs (but not LEDs). ComEd's analysis limited the measure to replacement of 40 watt incandescent or less. The pairings of CCFLs to incandescent lamps are reasonable. We have not rigorously checked to determine whether the CCFL analysis is appropriate for LEDs, but they are roughly comparable.

The default kW savings is a single value based on a simple average of three pairings that range from 10 watt to 32 watt reduction. The weighting should be revised over time based on program experience and EM&V results. ComEd appears to have used the 2005 DEER CFL lighting hours of use for this measure.

Measure Savings Results

Ameren's use of ComEd's CCFL analysis for this measure results in reasonable default values. However, the measure definition should be limited to 40 watt incandescent or less.

Use program experience and the EM&V process to revise the default kW reduction calculation (wattage reduction pairs and weighting).

An adjustment factor can be considered in the future if storage is found to be significant through the EM&V process or market research.

BPL84: LED Recessed Downlamps

Measure Definition

There are no issues with the measure definition.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

Ameren characterizes the impacts for this measure by using one example of a 12 watt LED replacing a 75 watt incandescent down lamp fixture. This is a reasonable pairing. However, ENERGY STAR qualifying LED down lamps range from 11 to 15 watts, and 477 to 673 lumens. This measure should be analyzed after further program experience to cover the full range of participating retrofits.

Ameren provides a reference table in Appendix D of operating hours, coincident factors, and HVAC interactive effects factors, but it is from an ICF study, not the ComEd/DEER values used in other measures.

Measure Savings Results

Ameren appears to use a different set of assumptions to calculate the impacts for this measure.

Ameren should revise future default kW savings using information that may be available from program participation, EM&V results, and market research to update the weighting percentages and wattage reduction pairs.

BPL85: Ceramic Metal Halide (CMH) Fixtures

Measure Definition

The measure definition does not define a baseline for the incandescent fixtures. Under the baseline heading, Ameren has listed the required wattages of the CMH fixtures.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

Ameren assumes that these metal halide lighting fixtures will have energy and demand interactive effects equal to 1.0, implying a non-conditioned space. These measures are very likely to be placed into air-conditioned spaces, so we recommend that interactive effects be accounted for in the impact calculations.

Ameren assumes the coincidence factors for these lighting measures will be equal to 1.0. Due to the long warm-up and restrike times for HID lighting, that is a reasonable assumption for the initial default savings value, but should be reconsidered after impact evaluation.

The Ameren TRM does not indicate how wattage reduction will be determined, but the Ameren 2009 application form shows that the wattage removed and installed will be provided by the participant, and Ameren will provide the operating hours.

Measure Savings Results

Ameren should use HVAC interactive factors for conditioned space.

Ameren should revise future default kW savings using information that may be available from program participation, EM&V results, and market research to confirm whether the interactive effect and coincident factors should remain equal 1.0.

The TRM should clarify that the participant will provide the wattage removed and installed to calculate the demand reduction.

BPL86: Ceramic Metal Halide (CMH) Integral Ballast Lamps

Measure Definition

There are no issues with the measure definition.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

The Ameren TRM assumes that the CMH lamps will have energy and demand interactive effects equal to 1.0, implying a non-conditioned space. These measures are very likely to be placed into air-conditioned spaces, so we recommend that interactive effects be accounted for in the impact calculations.

Ameren assumes the coincidence factors for these lighting measures will be equal to 1.0. Due to the long warm-up and restrike times for HID lighting, that is a reasonable assumption for the initial default savings value, but should be reconsidered after impact evaluation.

The Ameren TRM does not indicate how the wattage reduction was determined. However, the 45 watt noncoincident demand reduction shown is reasonable for 25 watt self-ballasted CMH lamp replacing a 75 watt incandescent lamp. To calculate the energy savings, Ameren appears to have used ComEd's assumptions for annual hours of use by building type.

Measure Savings Results

Ameren should use HVAC interactive factors for conditioned space.

Ameren should revise future default kW savings using information that may be available from program participation, EM&V results, and market research to confirm whether the interactive effect and coincident factors should remain equal 1.0.

BPL87: Hard-wired CFL fixtures, ≤ 30 watts and BPL88: Hard-wired CFL fixtures, > 30 watts

Measure Definition

There are no issues with the measure definitions.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Although installation in-service rate is an issue for screw-in CFLs, we do not expect storage to be an issue with hardwired CFL fixtures and do not recommend adding an adjustment factor unless it is found to be an issue in the impact evaluation.

Measure Savings Assumptions

Ameren provides tables of demand and energy saving impacts for these measures taken directly from analysis by ComEd. In a review of ComEd's analysis, the pairings of CFLs to incandescent lamps were reasonable (e.g., 75 W incandescent paired with 18 W to 26 W

CFLs), cover the likely applications, and are consistent with 2005 DEER, although not necessarily exhaustive.

Measure Savings Results

The use of ComEd's impact values for measures BPL87 and BPL88 result in savings that are reasonable for Ameren.

The range of impacts covered by each category is roughly ± 50%, based on the simple average. The default kW savings for each category should be revised over time using program participation or market research rather than the simple average.

BPL90: Permanent Lamp Removal

Measure Definition

The measure definition in the TRM is not sufficient to define the baseline, the eligible energy efficient alternatives, or the default savings values. This is a complex measure that could cover four baseline scenarios for eight foot lamps (T12 or T8, normal, or high output) and 6 baseline scenarios for 4 foot lamps (T12 or T8, 4, 3, or 2 lamp fixtures). As a result, a measure definition must be very detailed to properly set default values. This is a custom measure in the 2009 program year.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

Ameren has taken their impacts for 4 foot lamp removal directly from analysis by ComEd, and also appears to have used ComEd's estimate for 8 foot lamps of 108 watts per lamp removed. In our review of ComEd's analysis, we found that ComEd calculated the default wattage reduction per lamp removed by dividing the base fixture wattage by the number of baseline lamps per fixture, but the calculation should be made by subtracting the measure fixture wattage from the baseline fixture wattage, and dividing that wattage difference by the number of lamps removed.

ComEd has attempted to address the allowable range of baseline and installed measure input wattages by using a weighted average of a subset of various eligible lamp and ballast combinations, but does not document the source of the weights. The combinations in ComEd's weighted average do not cover the full range of lamp and ballast types allowed by ComEd's measure definition, and we have a concern that ComEd's two single per lamp default savings values (one for 8 foot and one for 4 foot) are not effectively representing the measure impacts.

Measure Savings Results

If this is to be a standard measure, Ameren needs to create a detailed measure definition that matches the claimed savings.

Ameren should calculate the reduction per lamp by subtracting installed measure fixture wattage from the baseline fixture wattage, and dividing the difference by the number of lamps removed.

BPL91: Alternate Highbay Fixture Replacement Option

Measure Definition

The measure definition should define a baseline and performance specifications for the efficiency measure.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Even though the program collects baseline watts, installed watts, and hours of operation from the participant, it is still necessary to use lighting default values for the coincidence factor, and Ameren should include HVAC interactive effect factors if the fixtures are installed in conditioned space (e.g., big box retail or groceries). The algorithms in the Ameren TRM do not include coincidence factors and assume HVAC interaction factors are equal to 1.0.

Measure Savings Assumptions

The assumptions for this measure are addressed through the cross cutting discussion.

Measure Savings Results

The TRM does not confirm that the demand reductions and energy savings claimed by Ameren under this measure have used coincidence and HVAC interactive factors.

The default savings values in Appendix D are not consistent with the TRM write-up.

BPL92: Reduced Wattage 4-foot and 8-foot LAMP ONLY

Measure Definition

The measure name says “LAMP ONLY”, but the measure definition includes T12 lamps in the baseline. A conversion from T12 to T8 lamps would in nearly all cases involve replacement of the ballast.

Measure Savings Engineering Analysis

Ameren should use the default lighting demand and energy savings algorithms described in Section 2.1.1 above.

Measure Savings Assumptions

Ameren provides tables that give single default values for 4 foot and 8 foot lamps by building type per lamp. To develop the default values, Ameren would need to compare fixture wattages for standard and low wattage lamps, and then weight the values for 1, 2, 3,

and 4 lamp fixtures, and for 4 foot lamps, weighting 25 watt and 28 watt replacements. Neither the fixture wattages nor the weighting percentages are documented, and the participation profile could differ significantly from the default weighting, resulting different impacts. Hours of use are not documented.

Although the default values provided by Ameren are reasonable, default impacts could vary by 20% depending on how undocumented assumptions are combined.

Measure Savings Results

Ameren should revise future default kW savings using information that may be available from program participation, EM&V results, and market research to update the weighting percentages for baseline and measure lamps.

2.2 HVAC Systems

2.2.1 Cross-cutting Review

Several issues cut across most of the individual cooling measures, and are addressed below.

Algorithms

Under each cooling measure, Ameren shows three separate algorithm types, whether or not they are relevant to the measure. These three algorithms are energy and demand savings for:

1. Small unitary equipment under 5 tons, based on SEERs and HSPF
2. Unitary equipment over 5 tons, PTAC/PTHP, and room air conditioners based on EERs
3. Chillers, based on kW/ton

These equations are even listed under the VFD measure, where they are not relevant. To avoid confusion, Ameren should only list the algorithm used by the measure.

The algorithm set includes equations for estimating heating season savings for heat pumps. However, we have seen no additional documentation that heating season calculations were performed. If Ameren is claiming heating season savings, we would need to see documentation of base case efficiency, heat pump efficiency, and heating season full load operating hours.

Ameren's three sets of algorithms are set up to provide absolute impacts, rather than per unit impacts. Cooling equipment performance values are usually set for a size range, and size in tons is the most convenient unit for presenting cooling system default savings data.

Ameren does not include a coincidence factor in any of the cooling demand savings equations. Other deemed savings databases use coincidence factors in the range of 0.80 to 0.90 for cooling. ComEd is using 0.85 as a coincidence factor for unitary equipment 5 tons

or less, a factor of 0.90 for unitary equipment greater than 5 tons, a factor of 0.333 for chillers, and a factor of 0.90 for room air conditioners.

ComEd has included a "redundancy factor" in their noncoincident kW savings calculation for equipment greater than 5 tons, to take into account that as the size of units increase, the percentage of oversizing increases. ComEd redundancy factors vary from 1.0 for units under 5 tons, to 0.5 for units greater than 60 tons.

The equations we recommend for Ameren are as follows:

For unitary HVAC 5 tons or less, room air conditioners, and PTAC/PTHP:

Noncoincident kW savings per ton = (12/Baseline EER – 12/Replacement EER)

For unitary HVAC greater than 5 tons:

Noncoincident kW savings per ton = Redundancy Factor * (12/Baseline EER – 12/Replacement EER)

For chillers:

Noncoincident kW savings per ton = (peak kW per ton Baseline – peak kW per ton Replacement)

For all equipment

Coincident kW savings per ton = Noncoincident kW savings per ton * Coincidence Factor

Annual kWh Savings per ton = Noncoincident kW savings per ton * Full Load Cooling Hours

For chillers, annual energy savings may be based on the IPLV kW per ton savings.

For unitary HVAC 5 tons or less, most deemed databases find it acceptable to use SEER in place of EER when calculating demand savings, even though SEER is approximately 14% to 20% greater than EER.

Illinois HVAC Baseline

Commercial energy code in Illinois is based on the 2006 IECC code. We recommend that the efficiencies required by that code be used as the baseline. It is possible that standard practice may be more efficient than code: this can be examined over time through market research and the evaluation process.

Full Load Cooling Hours per Year

Throughout the cooling section, the Ameren energy savings algorithms include a factor for the cooling full load hours per year (FLHs), but do not provide a documented source of cooling full load hours. In some cases, Ameren provides a table of building operating hours, which are more like occupied hours when lighting is operating. It appears Ameren may have used the building operating hours for cooling full load hours on some measures. This would be an error to fix. The tables of operating hours Ameren provides are far higher than cooling full load hours.

We would recommend that Ameren seek out literature on estimated run time hours for cooling instead of basing it on operating or lighting hours. Manufacturer's representatives for chillers and unitary equipment could probably provide reasonable run-time assumptions.

As one alternative, the 2007 ASHRAE Handbook lists equivalent full load cooling hours for St Louis, based on a 2000 study by CDH Energy (Chapter 32). The values from ASHRAE, compared with assumptions from Ameren, are presented in the table below:

Table 3: Equivalent Full Load Cooling Hours for St. Louis

Source	Schools	Office	Retail	Hospital
ASHRAE 2007	460-550	680-1100	850-1500	1260-2330
Ameren Operating Hours	1270	3435	3068	4532

The Ameren operating hours are significantly higher.

Other Points

Ameren should be very diligent to label units in all default savings values presented, and distinguish between coincident and noncoincident kW demand savings. Careful labeling will guard against error and misinterpretation by tracking system developers and the evaluation team.

A minor point, but Ameren mentions on some measures that the cooling unit must be UL listed. This should be changed to NRTL (Nationally recognized testing lab) listed. There are other testing labs beside UL like CSA, TUV and ETL. We assume that Ameren does not want to exclude units if another lab has listed it.

Ameren supporting spreadsheets reference DEER HVAC data. The application of DEER weather sensitive data from even northern California to Illinois is problematic. Wet bulb temperature is much higher in southern Illinois than in Northern California most of the time. This in turn affects cooling kW load and cooling run time.

When Ameren draws from CEE for qualifying efficiencies, this should be noted in the TRM. CEE has specific terms and conditions for use of their materials.

2.2.2 Measure-by-Measure Review

BPC1, BPC2, BPC3, BPC4, BPC5, BPC6, BPC7 and BPC8: Unitary or Split System Air Conditioning Systems and Air Source Heat Pumps

Measure Definition

In addition to the cross cutting issues noted above, we identified two issues with the measure definition. Ameren's qualifying criteria match the CEE tier definitions currently designated as Tier 1 and Tier 2, and Ameren should note this in the TRM. When using the CEE definitions, CEE states that for electrical resistance heating section types, to increase

their required minimum EER by 0.2. This is not addressed in Ameren's measure description. In referencing CEE's materials, Ameren may be obligated by CEE's terms and conditions to add the electrical resistance footnote.

Measure Savings Engineering Analysis

Ameren's algorithms for noncoincident kW savings, coincident kW savings and annual energy savings are not acceptable for generating default savings values.

Measure Savings Assumptions

Ameren's assumptions for noncoincident kW savings, coincident kW savings and annual energy savings are not acceptable for generating default savings values.

Measure Savings Results

Ameren presents tables of kWh savings and kW savings by building type and equipment size for unitary equipment. We cannot accept any of the values shown, as they are much larger than we would estimate if they are per ton. If they are per whole equipment as the unit, then the impacts for small units are too large, and impacts for large units are too small. For example, comparing ComEd to Ameren:

Table 4: Impact Comparison across Ameren Illinois Utilities and ComEd

Office	Noncoincident kW per ton		Annual kWh savings per ton	
Example	Ameren	ComEd	Ameren	ComEd
5 ton, SEER=15	0.36545	0.123	908.14	121.0
15 ton, EER =12	0.36941	0.150	894.81	117.8

BPC10, BPC11 and BPC12: Water Cooled Chillers and Air Cooled Chillers

Measure Definition

The measure definition should provide more detail to establish qualifying efficiencies and rating requirements. The 2006 IECC code is appropriate for the Illinois baseline. The high efficiency qualifying tiers defined by Ameren match those offered by ComEd and are reasonable.

Measure Savings Engineering Analysis

The crosscutting comments above apply to chiller measures. Ameren presents tables of kWh savings and kW savings by building type and equipment size for water cooled chillers, and the values appear to be per ton. We cannot accept any of the values shown, as they do not match the supporting documentation. In particular, the Tier 2 units appear to save less than the Tier 1 units, indicating a possible calculation error. The Tier 2 equipment impacts

are roughly what we would expect for these units, but it is not clear how Ameren arrived at the values.

Measure Savings Assumptions

The default impact values for air cooled chillers cannot be derived from the assumptions provided, and are higher than what we would expect.

Measure Savings Results

No other comments for this measure here.

BPC13, BPC14: Room Air Conditioners (through wall units)

Measure Definition

The measure description does not define the eligible units, although the qualifying efficiency levels are reasonable.

Measure Savings Engineering Analysis

Please see the HVAC Systems Cross-cutting Review for a discussion of the algorithms used for this measure.

Measure Savings Assumptions

The baseline is said to be defined by Epact but no value is given (room air conditioners have been covered by NAECA legislation).

Measure Savings Results

There is no table providing demand impacts. We do not accept the default values for annual energy savings, due to a math error. We would expect annual energy savings in the range of 200 kWh per year, but the impacts given in the TRM are in the range of 0.0002 kWh per year.

BPC15: Package Terminal Air Conditioning/Heat Pumps

Measure Definition

The measure description does not fully define a qualifying unit.

Measure Savings Engineering Analysis

Please see the HVAC Systems Cross-cutting Review for a discussion of the algorithms used for this measure.

Measure Savings Assumptions

The baseline should be drawn from the 2006 IECC code, which is higher than the federal standard.

Measure Savings Results

This measure provides impacts for a retrofit measure and a new construction measure. There is insufficient documentation to determine whether the default values provided are reasonable.

BPC20: Variable Frequency Drives on HVAC Motors

Measure Description

The measure description lacks detail that we believe is necessary to achieve the savings. It appears to be the case that the measure description as written could pay for the installation of a VSD on a system that was constant CFM or GPM without any throttling valves or vanes or bypass dampers, which is the case for the majority of older HVAC systems. Adding a VSD alone without evaluating the project as a system may not save energy - the system should also have to be redesigned to take advantage of a VFD. For example, VAV boxes would be installed for terminal units on air systems.

Measure Savings Engineering Analysis

The TRM for this measure provides a kWh savings value without providing units or algorithms.

Measure Savings Assumptions

The TRM for this measure provides a kWh savings value without providing assumptions.

Measure Savings Results

No other comments for this measure here.

2.3 Motors

2.3.1 Cross-cutting Review

There are no cross-cutting issues for motors.

2.3.2 Measure-by-Measure Review

Premium Motors (No Measure Code in TRM)

Measure Definition

This measure is a well established technology. One factor missing is a coincidence factor on the demand equation, even though Ameren's kW impacts are presented as coincident peak savings. The motor load factor is reasonable. The assumed hours of use are lower than we have seen in other deemed savings databases, especially for larger motors.

Measure Savings Engineering Analysis

Ameren provides algorithms to calculate demand and energy savings, and they have described the correct baseline and efficiency levels. However, their tables of impacts do not match the algorithms and assumptions.

Measure Savings Assumptions

Ameren refers to a table of baseline efficiencies, but the table is not in the TRM. The supporting documentation suggests impacts were drawn from 2005 DEER, and we would not recommend that approach. It would be better to build up the impacts from assumptions documented in the TRM.

The kW values for TEFC motors have an obvious math error (the peak savings is given as 1.08 kW for a 1 HP motor (which draws only 0.75 kW), and other small motors have equally high kW impacts). The annual kWh savings for TEFC motors is not consistent with the assumed hours or the kW impacts shown. The impacts for ODP motors contain a different error. The kW impacts for small ODP appear reasonable, but the impacts for large motors are too large. For example, the TRM kW savings for a 100 HP ODP motor is 2.54 kW, yet the efficiency improvement is only 94.1% to 95.4%. By comparison, ComEd used the same assumption set as Ameren and calculated a coincident demand savings of 0.600 kW for a 100 HP 1800 RPM ODP motor.

Measure Savings Results

We do not accept the default motor values that appear in the Ameren TRM. We suggest Ameren revise the values by calculating the impacts for each motor using the equations and assumptions already documented in the TRM for efficiencies, load factor, operating hours, and add a coincidence factor. For example, ComEd has used a coincidence factor of 0.74 for all motors.

2.4 Refrigeration

2.4.1 Cross-cutting Review

Source of Default Values and Reasonableness

With one exception for Ice Makers, the Ameren default savings values for Refrigeration measures are acceptable for the near term but should be improved over time through the evaluation process, market research, or program experience. The source of the refrigeration default values were 2005 DEER, work papers from SCE and PG&E, and the ICF program plan for Ameren (for automatic door closers).

When Ameren derives default values from secondary sources, they should identify the source and any adjustments or averaging of data to create the default savings values. This documentation should appear in the TRM, not just supporting spreadsheets.

The application of DEER weather sensitive data to Illinois is problematic. Humidity and the latent cooling required to remove it from the air are more pronounced in the humid Illinois

climate than in the dryer California climate, even for Northern California. A more local source of data should be developed if it already has not been. Equipment manufacturers may have models they use to estimate savings in the Illinois area for example. Wisconsin Focus on Energy, Iowa utilities, and Minnesota may also be sources of assistance as they have many years of experience with refrigeration in their programs.

Measure Definitions

The measure descriptions are not complete and need to include all relevant details on the efficiency measure, the baseline, and application notes that are associated with the savings values.

Algorithms

Ameren has pasted an algorithm for anti-sweat heater controls into every refrigeration measure. This is incorrect and needs to be revised so that staff and evaluators referring to the TRM do not get confused. Even for anti-sweat heaters, the algorithm has not been used; Ameren used secondary data from an SCE work paper.

If the default value is not derived from a specific algorithm, an algorithm should not be shown.

Units for Savings

It is critical that Ameren identify the units for the savings in the TRM (e.g. per motor, per square foot, per machine, etc.) when presenting tables of results. Ameren must also note whether kW savings is coincident or noncoincident.

2.4.2 Measure-by-Measure Review

BPR1: Strip Curtains

Measure Description

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown the wrong algorithm. They also need to show the units for the savings (per square foot), document the source of default values, note whether kW savings are peak or noncoincident.

Measure Savings Assumptions

Please see the Cross-cutting Review for a discussion of this issue.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.

BPR2, BPR3: Anti-Sweat Heater Controls

Measure Definition

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown an algorithm for anti-sweat heater controls, but did not use the algorithm in deriving their default values. Ameren needs to show the units for the savings (per linear foot - width), document the source of default values, and note whether kW savings are peak or noncoincident.

Measure Savings Assumptions

Please see the Cross-cutting Review for a discussion of this issue.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.

BPR4, BPR5: Electronically Commutated Motors (ECM)

Measure Definition

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown the wrong algorithm. They need to show the units for the savings (per motor), document the source of default values, and note whether kW savings are peak or noncoincident.

Measure Savings Assumptions

Please see the Cross-cutting Review for a discussion of this issue.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.

BPR6: Evaporator Fan Controls

Measure Definition

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown the wrong algorithm. They need to show the units for the savings (per motor), document the source of default values, and note whether kW savings are peak or noncoincident.

Measure Savings Assumptions

Please see the Cross-cutting Review for a discussion of this issue.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.

BPR7: Automatic Door Closers for Walk-In Freezers

Measure Definition

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown the wrong algorithm. They need to show the units for the savings (per door closer), document the source of default values, and note whether kW savings are peak or noncoincident.

Measure Savings Assumptions

Please see the Cross-cutting Review for a discussion of this issue.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.

BPR9, BPR10: Beverage Machine Controls and Snack Machine Controls

Measure Definition

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown the wrong algorithm. They need to show the units for the savings (per machine), document the source of default values, and note whether kW savings are peak or noncoincident.

Measure Savings Assumptions

One factor that should be added into the program is the exemption of schools that are following federal regulations on shutting down soft drink dispensers during meal services.

Federal regulations required that if a school used federal funds for any breakfast or lunch programs that the soft drink dispensing machines had to be disabled for a period during before and after breakfast and lunch to encourage more healthy alternatives. Some schools may already have their machines on local timers which will affect savings.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.

BPR8: ENERGY STAR© Vending Machine

Measure Definition

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown the wrong algorithm. They need to show the units for the savings (per machine), document the source of default values, and note whether kW savings are peak or noncoincident.

Measure Savings Assumptions

Please see the Cross-cutting Review for a discussion of this issue.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.

BPR20, BPR21, BPR22, BPR23, BPR24, BPR25, BPR26: High Efficiency Ice Makers

Measure Definition

Ameren needs to expand the measure definition.

Measure Savings Engineering Analysis

Ameren has shown the wrong algorithm, they need to show the units for the savings (per machine), they need to document the source of default values, and they need to note whether kW savings are peak or noncoincident.

The Ameren default values were taken directly from SCE work papers. When comparing these values with ComEd's default values, drawn from PG&E work papers and analysis using an ice maker savings algorithm, the ComEd values show substantially lower savings on the small ice makers, but slightly higher savings on the larger ice makers. ComEd's default values for small ice makers are closer to the values used in Wisconsin.

Ameren should revisit the SCE work papers to determine whether the default values for ice makers are appropriate.

Measure Savings Assumptions

Please see the Cross-cutting Review for a discussion of this issue.

Measure Savings Results

Please see the Cross-cutting Review for a discussion of this issue.