What's the Value of Life? Review and Suggestions on Use of Lifetime Savings

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ABSTRACT

Expected useful life (EUL) or lifetime savings of energy efficiency (EE) measures are used in planning, evaluation and program savings reporting, but are used inconsistently across the European Union (EU) in valuing EE savings. The authors will assess the value and use of lifetime savings across the EU and the United States (US) examining requirements for verified lifetime savings, use of lifetime savings for cost-effectiveness and establishing why lifetime savings applied across multiple years is important. Many countries use lifetime savings for avoided cost analysis - the longer the life, the more likely the measure will be cost-effective, which is important for portfolio planning or for accounting greenhouse gas emission (GHG) reductions. But few countries require applying EULs consistently for annual savings reporting or tracking lifetime savings over consecutive years. EULs are typically an afterthought when reporting program savings with minimal oversight or verification. With the lack of verification of the EUL and how and if persistence is considered in the value, the confidence of the lifetime savings claim becomes highly uncertain. In the US, the State of Illinois recently adopted lifetime savings requirements and there is a new urgency in assigning verified EULs to measures. The authors also assess the value and use of lifetime savings across the EU.

Importance of EULs

Interest in lifetime valuation is dependent on the intent of the quantification of benefits. Each instance in using EULs is dependent on accuracy or lack of uncertainty. Depending on the nation, province, state, or energy consumer, EUL valuation can be critical in the following ways:

Cost-effectiveness testing: In the US, a main use of EULs is cost-effectiveness testing of EE programs and portfolios. Their primary test is the total resource cost test (TRC). Generally, US state regulatory bodies rely on cost-effectiveness metrics established by the California Standard Practice Manual (CPUC Standard Practice Manual) which is now being supplanted by the National Standard Practice Manual (National Practice Manual).

Lifetime emissions reduction: In the EU, a key use of EULs is in measuring GHG emissions reductions. GHG reduction goals are based on lifetime abatement strategies. These lifetime savings values are important in ensuring that GHG abatement goals are being achieved via quantification of the strategies implemented.

Valuation for financing: Energy parties are interested in quantifying potential lifetime benefits for investment in equipment and systems. The analysis is necessary for financing considerations when seeking funds.

Planning: A common use of EULs in the US is to estimate EULs and apply them to map out EE program planning and, in turn, EE portfolio planning. This is done where lifetime savings are used to assess savings over multiple years.

Life cycle analysis (LCA) for sustainability metrics: As the promotion of using LCA for design and refurbishment of buildings is growing, the relative importance of the embodied energy of the materials in the total energy demand of a building is now responsible over its whole life cycle, especially for low-energy or zero-energy buildings. As the EE improves, then the lifecycle of production, build, and operation emissions matter more.

Comparison to Other Resources (Supply-Side and Distributed Energy Resources)

In North America, utilities and regulators calculate the value of the demand side resource by the net present value of the lifetime energy savings times the avoided costs (this is generally based on the costs for building additional capacity and supplying energy). This approach, as well as calculating the levelized cost of energy savings which is based on the lifetime savings allows for comparing EE as a resource on the same metrics as supply side and other distributed energy resources.

It became clear during our EUL research that there is great disparity in how the US applies EULs (mostly for EE planning and cost-effectiveness testing) compared to the EU's use of EULs (for GHG abatement tracking). This is understandable given the differing EE focus in the US compared to the EU. But it's interesting that there is a clear dichotomy in EUL application. Except for California[1] and RGGI (Regional Greenhouse Gas Initiative)[2], there is virtually no focus on using EULs for emissions in the US. Similarly, EULs for EE cost-effectiveness testing is an afterthought in the EU. Beyond these uses, EULs should be considered for counting energy savings across multiple years and requiring multiple year savings.

Defining EULs

EUL is defined differently depending on the use of the term. A clear consistent application is all definitions focus on the equipment. The most common differences fall into two categories: persistence of the equipment and persistence of savings. The EUL definition is a combination of equipment technical life and the persistence of the equipment and the savings (Violette 2013, RTF 2015). The following figure illustrates the components of the EUL.

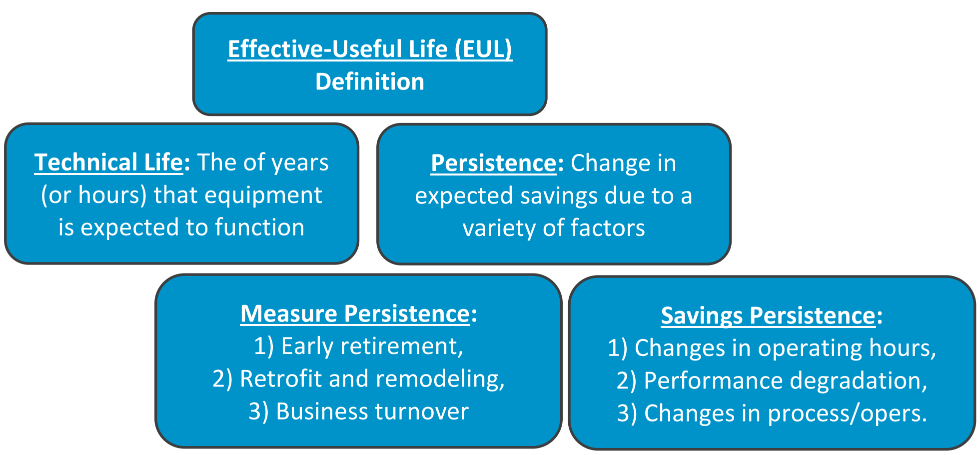

Figure 1. Components of the effective useful life

[1] California's annual statewide greenhouse gas (GHG) emission inventory is an important tool for establishing historical emission trends and tracking California's progress in reducing GHGs. The inventory provides estimates of anthropogenic GHG emissions within California, as well as emissions associated with imported electricity; natural sources are not included in the inventory.

[2] RGGI states include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont. RGGI detail can be found here: www.rggi.org

Technical lifetimes are generally meant as the theoretical lifetime of a technical installed solution (measure). Energy savings lifetime can differ from technical lifetime due to unexpected deterioration, anticipated substitution, changes in usage patterns of technologies, or other factors. Lifetime of savings in their turn might be difficult to assess because they may be more dependent on behavior or economic decisions, such as technology turnover (e.g. within homes, companies, and industries) then on the technical lifetime of solutions. Defining the components, we looked at the various definitions offered and have concluded that these offer the most comprehensive and quantifiable approach to the values:

Technical Life: This is the engineering life of the equipment. If an equipment is installed according to the specification and operates according to best practices and standard operating hours, the technical life will be measured. Typically, this aligns with manufacturer warranties, lumen depreciation test for LEDs, etc. It is important to note that the life defined may be conservative to help minimize manufacturer warranty claims. Additionally, any previous studies that measured life may not have been in the field long enough to capture the equipment's end of useful life. Further, many life studies are not based on primary field data, but rely on engineering judgments or references of values used in various jurisdictions. Some examples include industrial boilers and compressors that operate for more than 20 years. The most comprehensive field reported life is in the online platform ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) which has established for self-reporting. ASHRAE includes the life of existing equipment, as well as the life of the equipment replaced with new technology.

Measure Persistence: The measure persistence is the valuation of the time the measure is installed and operating as planned. Measure persistence can change when there is a remodel, business turnover, new home tenant/owner, early retirement, etc.

Savings Persistence: The savings persistence is the valuation of the degradation of equipment operation. This can be a result of overuse above the average, poor equipment maintenance, or just the nature of the technology.

The EU defines these values in the following terminology (Thomas and Vreuls, 2007):

- Technical life = design lifetime
- Measure persistence = correction factor for non-retention
- Savings persistence = correction factor for maintenance
- Savings lifetime = Minimum of one of the following three: economic lifetime[3], social lifetime[4], or design lifetime times the non-retention and maintenance correction factors.

EUL Examples from the US and the EU

US standards for EULs

In the US, there is no national body that sets guidelines for energy savings or lifetime savings. There is the Uniform Methods which provides guidance on different evaluation efforts including persistence. As such, this paper refers to the Uniform methods, however, each state typically established their own guidelines for EUL, if applicable. In the US, these values are a part of regulatory proceeding requiring EE programs to

[3] Economic lifetime is the period which a measure is economic to keep in service.

[4] Social lifetime is the period when after the equipment is replaced for reasons due to non-economic or technical reasons such as a larger screen television.

be cost- effective. Measure lists with a lifetime value to date has leveraged very little primary data collection and mostly rely on circuitous references with minimal original source documentation and derivation.

EULs Used in Illinois

In the State of Illinois, the General Assembly (legislature) passed the Future Energy Jobs Act, (“FEJA” December 2016). This law took effect as of January 1, 2018, and requires reporting savings with Cumulative Persisting Annual Savings (CPAS) calculations. This requires counting measure savings over the life of the measure - it requires an accurate assessment of measure savings for each year of a measure’s life. Qualification of lifetime savings and accuracy in values has become critical since required energy savings are increasing in Illinois. The Illinois law changes the prior requirement of annual (first year) savings goals and cost-effectiveness metrics which discount future savings (and showing lower value for future savings). This uncovered the need to have a deeper review of the underlying assumptions and certainty in the EULs – focus on longer lives and reporting on multiple years for each EE program and the aggregate portfolio savings. The first step of this work was to question the existing lifetime values used in the state. Many come from standard utility references with historic precedence of being considered strong sources.

Achieving greater savings through documenting cumulative savings over the life of a measure is done through implementing measures with longer savings lives. Overall savings must achieve enough savings each year to offset savings from measures that “die off” or don’t continue in the following year – this becomes an EE portfolio management issue. To illustrate the importance of EULs for tracking cumulative savings over the life of a measure, the following table is useful – the percentages (savings as a percent of electric sales) are example of a utility’s annual savings goal and how lifetime savings can be tracked on a cumulative basis:

Table 1. Example of Tracking Savings Over a Series of Years – Savings as a Percent of Annual Utility Sales

	2018	2019	2020	2021
Overall Utility Target	**8.3%**	**9.1%**	**10.2%**	**10.9%**
Prior savings persisting from 2012-2017	5.9%	5.4%	4.5%	3.9%
Savings persisting from 2018	2.4%	1.6%	1.3%	1.2%
Savings persisting from 2019		2.1%	1.8%	1.4%
Savings persisting from 2020			2.6%	2.2%
Savings persisting from 2021				2.1%
Total savings that count toward target	**8.3%**	**9.1%**	**10.2%**	**10.9%**

Source: Navigant Consulting and Illinois FEJA CPAS savings example

To help Illinois utilities comply with FEJA, the state undertook an effort to update Illinois EULs, and potentially update the Illinois Technical Resource Manual (Version 6 - current TRM in 2018). The review team prioritized measure EUL review for those measures with the highest savings within the utility portfolio. This assessment then identified if the EUL reference was from a quality source and age of source. As a result, most sources had limited justification since they have poor documentation or circuitous references that created the appearance of invalidity. Establishing a list of quality sources for high-impact measure review is important. This approach for TRM EUL values is comparable to the guidelines for the harmonization effort in the EU. To create a list of default values, it is important to document the following: information sources, methods for engineering estimates, identification of influencing factors, level of reliability, comparison to other Member States and last updated.

EU Standards for EULs

The 2013 EU standards (Article 7) focus on 2020 goals and require, at minimum, reporting year measures were implemented (year-of-action) and lifetime of savings (2013 EU Standards). Many of the EU goals are focused on measuring GHG reduction. This can be done with a country-specific value by counting savings for each individual action from implementation date through 2020 (straightforward method). An alternative method cannot exceed this calculated savings. Alternative methods that are provided to fit the interim timelines include index values to compensate for long life measures. In a 2016 report update from the European Commission Energy there is little change to the 2013 document (EU Energy Savings Calculations). That update emphasizes persistence of equipment that may have changes in production processes or reorganizations.

There are varying approaches and harmonizing Member States lifetimes or methodologies for lifetimes estimation would be useful. Harmonizing approaches could establish European default values or methodologies. With buildings, the EU standard EN 15495 provides guidelines for the assessment of lifetimes of actions that can be implemented in this sector. The current values are those typically with longer lives. In 2006, the Member States decided on a collaborative approach for the evaluation method for harmonizing. The actual work on the method is executed in the project "Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services" - this project provided harmonized measure lives (Thomas 2007, Vreuls 2007). These harmonized values replaced default, conservative values. An alternative, country-specific approach can follow a prescribed and transparent process that incorporates lifetime influence factors.

Measures for which there is no agreement or that are not discussed must rely on default conservative values to prevent optimistic bottoms-up analysis (calculated individually by guidelines established by country). The default values are deliberately conservative. Tables are available for these values.

Use of Measure Lives in the EU (for GHG) and US (for Cost-Effectiveness)

In comparison, the US has not created a national framework to measure GHG. As noted, California and RGGI have created GHG savings frameworks. California continues to expand GHG savings goals. It's anticipated that the RGGI states will add states as interest and demand to require and track GHG savings matures from a legislative and regulatory standpoint in the US. One could easily imagine California serving as an anchor of western states to agree to regional GHG goals too. But, to be clear, there are no federal-level GHG requirements for utility companies or for most corporations – federal law from Congress doesn't require GHG goals. There are environmental regulations, but those don't require GHG reductions – US environmental rules focus on reduction in pollution from chemical waste, bans on dumping manufacturing by products into open lands or waterways and other air and water-focused cleansing rules. Measuring GHG isn't a strong focus in Washington, D.C. or with many US states.

The EU has been very good at defining application of EULs for GHG, but there is little in the way of applying EULs for cost-effectiveness testing of EE measures and portfolios. US states control the EE regulatory framework in which measures and portfolios are managed and assessed. A key point is that US states with EE legislative and regulatory frameworks typically have a cost-effectiveness requirement where EULs are applied to programs and portfolios savings claims to determine cost-effectiveness over the life of the measure. If an EE portfolio is not cost-effective, cost recovery for those EE programs or portfolio may not be allowed. EULs are central to this analysis. The EU could consider including EULs in cost analysis on a broader so that EE measures are fully assessed on a cost-benefit basis and conversely, the US can use EULS for documenting GHG reduction potential.

Example Nation-Level EUL Approaches

Estimation approaches by each country uses differing approaches. Some examples include:

Denmark: The Danish EEO scheme moved in January 2011 from first-year energy savings only being considered to one that operates on lifetime bands. No savings are claimed when the measure lifespan is less than one year. If the savings are greater than one year, use factors apply to the actual measure lifetime. These have been set by the scheme administrator in a pragmatic fashion based on experience with average industrial energy saving measures. Only building envelope measures have lifetimes more than 15 years. This approach has the effect of favoring shorter lifetime measures over longer lifetimes. For example, a measure with a lifetime of 20 years generates 10 times the total energy saving as an equivalent measure with a lifetime of just two years, yet only receives three times the credit under the Danish scheme (1.5 uplift factor instead of 0.5).

France: The French scheme applies a discount rate of four percent to energy savings, which reduces the savings for longer life measures. The metric is termed "kWh Cumac."

United Kingdom: The British scheme targeted metrics are in lifetime carbon savings - these are not discounted. The UK uses the simplest savings form since the calculation is the energy savings achieved multiplied by the carbon dioxide content of the energy source saved and there is no discounting.

Guidance on Sources of Measures

EUL guidance on sources and the strength of measures is needed in leveraging EULs more fully in EE programs and portfolios. Below are approaches to EULs based on types of measure life sources and the strength of those sources. The source quality is important to establish since many of the sources are circuitous and not well documented. Defining the source quality provides a hierarchy and method for identifying an appropriate EUL or technical life.[5]

Table 2. EUL Source and Measure Strength

Source Name	Description
TYPE 1: Sources identified as highest strength: Primary research conducted or vetted by third-party entities such as trade organizations, national labs, or government organizations	

[5] Technical life is easier to "measure" and define, whereas the savings and measure persistence is not well documented.

	Source Name	Description
1.1	U.S. Department of Energy Federal Energy Conservation Standards	The U.S. Department of Energy (DOE) produces Technical Support Documents (TSD) detailing the analysis behind the federal conservation standards established for each product it regulates. Each TSD contains a chapter, often titled "Life Cycle Cost and Payback Period Analysis", that offers DOE's EUL estimate for the product and explains how this value was derived. The TSDs are linked from DOE's rulemaking page for each product, https://energy.gov/eere/buildings/standards-and-test-procedures. The TSD measure life values are based on shipment data, secondary literature research and primary research which include discussions with industry experts. Navigant considers as high quality because of the stakeholder review process and due diligence required to create these documents.
1.2	LED lighting reports prepared by Navigant	Navigant has performed extensive market research on the state of LED lighting for the US. DOE Solid State Lighting Program most recently published in 2016. It includes typical lifetime operating hours for each lamp type by sector. https://energy.gov/sites/prod/files/2016/09/f33/energysavingsforecast16_2.pdf
1.3	Appliance Magazine	Appliance Magazine publishes an annual report on the market value, life expectancy, and expected unit replacements for a range of consumer appliances. The appliances listed in this report change from year to year, so older versions of the report may be referenced for products no longer listed. Portrait of the U.S. Appliance Industry (2001-2009). U.S. Appliance Industry: Market Share, Life Expectancy and & Replacement Market, and Saturation Levels (2010). U.S. Appliance Industry: Market Value, Life Expectancy and Replacement Picture (2011-2014).
1.4	C&I Measure Life and Persistence Project	In 2011, Northeast Energy Efficiency Partnership sponsored this study of EUL of commercial and industrial lighting. The primary objective of this study was to conduct primary and secondary research and analysis for estimates of measure lifetimes that included on-site verification of CFL bulbs and fixtures, LED exit signs, HID fixtures, and T8 fixtures. Installations occurred from 1999-2009.[6] http://www.neep.org/sites/default/files/resources/NEEP_CI_Persistence_Report-FINAL.pdf
TYPE 2: Sources identified as medium-high strength: Meta-analyses conducted by third-party organizations, that show some level of evaluating the studies that comprise the dataset		
2.1	California DEER	The most recent and comprehensive DEER documentation of EUL sources was from 2008 and 2014. The 2008 version identifies all the sources reviewed and justification for selected measure life. The 2014 measure list identifies the source used for the measure life. Many of the original references are from 2005, http://deeresources.com/files/deer2005/downloads/DEER2005UpdateFinalReport_ItronVersion.pdf, p. 11-1.[7]

[6] This study may be considered outdated, but the methodology and documentation are of high quality.

[7] It is important to note that some values in DEER are from a 2000 California evaluation protocols. Therefore, it can be argued that the DEER is just a state TRM (item 3.1 – Type 3 source).

	Source Name	Description
2.2	Regional Technical Forum (RTF)	A reference workbook with ongoing revisions as measures undergo review. Like the 2008 DEER, the RTF identifies all the sources reviewed and justification for selected measure life.
2.3	GDS Reports	GDS Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures – 2007. This study used various data sources such as DEER, state TRMs, and evaluation studies with a working group to review and decide on each value.
2.4	European Environment Agency	The European Environment Agency provides sound, independent information on the environment for those involved in developing, adopting, implementing and evaluating environmental policy, and the public. This includes focus on measure life. www.eea.europa.ue
2.5	ASHRAE	Original source is from Akalin, M.T. 1978. Equipment life and maintenance cost survey (RP-186). ASHRAE Transactions 84(2):94-106; Recent work is ASHRAE system life database (research project 1237-TRP) - which is a crowd-sourced approach to collecting actual system data. https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=7
TYPE 3: Sources identified as medium strength: Compilations conducted by third-party organizations. Original sources should be cited, and locatable where applicable		
3.1	State TRMs	Many state TRMs reference each other and other sources of varying strength – inaccurate estimates can be adopted into other TRMs and continued for years. Due diligence on reference documentation is not always present for the measure life. Many TRMs are reviewed via a stakeholder process.
3.2	ENERGY STAR calculators prepared by U.S. EPA and DOE	EPA's Energy Star offers calculators to help estimate the energy and cost savings by choosing to buy Energy Star certified products. Within these calculators, Energy Star offers a typical EUL and cites the source, generally a single high-quality source (e.g., DOE, Appliance Magazine), but offers no analysis or discussion of the selected value. Energy Star's calculators can be accessed at www.energystar.gov. For example, their appliance calculator is available at www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx.
3.3	European Commission - European Climate Action	All EU countries monitor their emissions under the EU's greenhouse gas monitoring mechanism, which sets the EU's own internal reporting rules based on internationally agreed obligations: • emissions of 7 greenhouse gases from all sectors including energy • projections, policies & measures to cut greenhouse emissions • national measures to adapt to climate change. • low-carbon strategies • financial & technical support for developing countries www.ec.europa.eu/clima

	Source Name	Description
TYPE 4: Sources identified as medium-low strength: Primary research conducted by interested parties such as manufacturers, distributors, retailers or installers		
4.1	Interview with interested parties (with no statistical rigor or analysis)	Manufacturer, distributor, installer, etc. have a vested interest and may overstate the benefit.
TYPE 5: Sources identified as low strength: Source where the basis of measure life is anecdotal, based on design specs, warranty period, etc.		
5.1	Industry blogs, Implementer or Navigant experience	Typically based on professional judgment and not rooted in any data.

Prioritization of sources based on the above "types" is needed and can be applied to other nations' development of EULs - outlining strength of sources as a starting point is the first step. It is important to initially conduct aa secondary research of sources and, then, determine if primary research is necessary or feasible. Another layer of research is needed to identify which measures need review for persistence, economic or social lifetime considerations.

Suggestions to Conduct In-Depth EUL Values Review

Phased EUL Assessment Approach

The costs of doing a full EUL study is high. In accordance to the uniform methods project, the methodology of collecting the information can span multiple years. (Uniform Methods Project) Before embarking on such a study, Navigant proposes to further filter the priority measures for EUL quantification by conducting a phased approach – which is described as follows:

Phase One: Use industry regional experts with EUL knowledge and skills to assess high-impact measures and medium impact measures to determine where research is needed (i.e., which lifetime measures appear to be most uncertain and sensitive to "other factors" to address the measure and savings persistence questions). Sensitivity to other factors are based on the Northwest Regional Technical Forum guidelines that indicated if a factor impacting the measure is impactful if it changes the measure life by 20% or more (Regional Technical Forum, 2015). This current knowledge base is presented to stakeholders and determinations (harmonization) are made regarding where additional research will be most valuable to decision makers. If there is convergence or near unanimous assessment of the value, then there is not a reason to proceed to phase two. Progress for phase one with preliminary findings should be ready for presentation at the conference.

Phase Two: Based on knowledge established in Phase One, pursue field data collection on measures determined to be the most uncertain and where the studies are likely to yield the most useful updates and information for assessing measures and programs. At first, the proposal is to conduct a preliminary small sample survey across a larger set of measures to determine how likely additional information will result in changes to the lifetimes for measures. The small sample (e.g., a sample of 8 to 12) survey of installed measures will show if the current estimate is likely to be updated (i.e., changed based on a difference between the means/medians approach) when using a full study with as sufficiently appropriate sample. Persistence studies can be expensive particularly for long-lived measures and should only perform these studies where they will provide the most useful information.

Case Study – Building Automation Systems

The following is an example of Navigant's literature review for the building automation system (BAS) measure which is becoming an important business measure in commercial programs. New research for BAS is challenging and complex, the quality of sources is also difficult - it requires new research, stakeholder reviews and key decision making (harmonization). The BAS EUL in the Illinois TRM is based on DEER 2014 (California), which is aligned with primary literature review and meta-analysis. However, the DEER study sources are greater than 10 years old. Navigant found that the 2004 PG&E ninth year retention study included high-quality primary data sources. However, given the changes in technology since the BAS components were installed in ca. 1994, its EUL estimates are outdated. Technology has changed rapidly over the past 10 years and communication protocols and programming language can quickly become obsolete – older manufacturer support is lost for older BAS. Additionally, the 2009 Focus on Energy measure life study indicates that the measure life is dependent on system operator behavior.

Navigant considers the ASHRAE database, which compiles information on service life voluntarily submitted by ASHRAE members as part of its ASHRAE Owning and Operating Cost Database[8], as one of the strongest sources found because it provides lifetime data on various types of BAS components directly collected from its members. This database provided a significantly higher EUL estimate for BAS components with mean and median of the data ranging between 11-25 years. However, based on the disclaimer provided with the description of the database, ASHRAE claims that it does not investigate or verify the data that is submitted, which makes it difficult to assign high confidence to its estimates. In consideration of technology changes and behavior influences, Navigant recommends performing primary research.[9]

Conclusion

Interest in EUL is used in different ways in the EU and the US: cost-effectiveness testing, GHG emissions, EE portfolio planning, valuation for financing, lifecycle analysis for sustainability metrics, lifetime emissions reduction and comparison to other resources. The US is primarily focused on applying EULs for EE planning and cost-effectiveness testing, while the EU primarily uses EULs to ensure GHG emissions are reduced over time. The US and the EU would both benefit by pursuing EULS for broader application than is used today. Also, each of these uses would be improved by pursuing stronger precision and use of EULs – US state EE frameworks would be enhanced with a stronger focus on GHG emissions, EU frameworks would be improved by ensuring regulatory efforts were cost-effective. EE measure and portfolio-level savings would be improved greatly by increased analysis and application of accurate measure lives. Both the US and the EU should consider expanding application of EULs beyond their current limited use to grow savings beyond first year savings, leverage measures across their useful lives and apply savings in states and across savings to properly track and account for EE measure savings beyond annual savings goals.

There are various approaches to measuring and documenting EULs. The EU approach is well designed as is the US approach to using EULs for cost-effectiveness and designing portfolios. This requires

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[8] ASHRAE Owning and Operating Cost Database. Equipment Life/ Maintenance Cost Survey. ASHRAE Research Project 1237-TRP. *https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=7*

[9] As part of this study, Navigant recommends the consideration of measuring persistency of savings for the EMS technology.

thoughtful and well-designed analysis to discover EULs with the greatest impact, establish a framework to accurately assess measure lives and create a government-level system that properly credits utilities for measure and portfolio-level savings over multiple years.

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