Shaping Tomorrow's Built Environment Today

1791 Tullie Circle NE ▪ Atlanta, Georgia 30329-2305 ▪ Tel 678.539.1211 ▪ Fax 678.539.2211 ▪ http://www.ashrae.org

Michael R. Vaughn, P.E.
Manager Research & Technical Services
mvaughn@ashrae.org

TO: Dennis Landsberg, Chair TC 7.6, drlrm@aol.com
Eric Yang, Research Subcommittee Chair TC 7.6, ericyangcem@gmail.com
CC: William Murphy, Research Liaison Section 7.0, William.murphy@uky.edu

FROM: Michael Vaughn, MORTS, mvaughn@ashrae.org

DATE: January 23, 2019

SUBJECT: Research Topic Acceptance Request (1822-RTAR), "Supplemental Normalization Parameters for Alternate/Enhanced Expression of Energy Performance"

During their winter meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted to accept it with comments for further development into a work statement (WS) provided that the key comment(s) and question(s) below are addressed to the satisfaction of your Research Liaison, William Murphy, William.murphy@uky.edu, or RL7@ashrae.net, in the work statement draft.

1. Previous RAC comments should be addressed individually and summarized to assure comments are taken into account.
2. Perform an adequate literature search and revise the objective of the project accordingly.

The work statement draft must be approved by the Research Liaison prior to submitting it to RAC.

An RTAR evaluation sheet is attached as additional information and it provides a breakdown of comments and questions from individual RAC members based on specific review criteria. This should give you an idea of how your RTAR is being interpreted and understood by others. Some of these comments may indicate areas of the RTAR and subsequent WS where readers require additional information or rewording for clarification.

The first draft of the work statement should be submitted to RAC no later than **December15, 2020** or it will be dropped from display on the Society's Research Implementation Plan. The next likely submission deadline for a new work statement on this topic is **March 15, 2019** for consideration at RAC's 2019 spring meeting. The submission deadline after that for work statements is **May 15, 2019** for consideration at the RAC's 2019 annual meeting.

Project ID	**1822**	
Project Title	**Supplemental Normalization Parameters for Alternate/Enhanced Expression of Energy Performance**	
Sponsoring TC	TC 7.6, (Building Energy Performance) co-sponsor SSPC 100,	
Cost / Duration	$150,00 -$160,000 - 24M	
Submission History	**2nd Submission, RTAR Rejected A17**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2019 Winter Meeting Review		
Essential Criteria	**Voted NO**	**Comments & Suggestions**
Background: The RTAR should describe current state of the art with some level of literature review that documents the importance/magnitude of a problem. References should be provided. If not, then note it in your comments.		**9** - The background identifies poor correlation of energy use with floor area, but gives little background detail that qualifies the issue. One reference is cited (airline terminals and 'stacked' approach) but its utility for this problem is not expanded upon. **4** - Too little info on how the proposed approach improve evaluation of energy performance of buildings. Additionally, energy performance of buildings depends to a large extent on the occupant behavior. Will this be included? Insufficient evidence for the need and benefits of the proposed approach. **7** - Peer-reviewed journal papers completely missing in the references section. See also previous comments from RAC.
Research Need: Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.		**9** - The need seems evident, but this is not adequately supported by the case that has been presented. For example, is USDOE already doing this? If so, then how will the work proposed in the RTAR align with that? **4** - No clear information on the past attempts to improve EUIs. **7** - The energy use of buildings is directly comparable only if they are of the same kind. To justify the research project some more background is needed.
Relevance and Benefits to ASHRAE: Evaluate whether relevance and benefits are clearly explained in terms of: a. Leading to innovations in the field of HVAC & Refrigeration b. Valuable addition to the missing information which will lead to new design guidelines and valuable modifications to handbooks and standards. Is this research topic appropriate for ASHRAE funding? If not, Reject.		**7** - Not clear what missing information the project would bring.
IF ABOVE THREE CRITERION ARE NOT ALL SATISFIED - MARK "REJECT" BELOW & CONTINUE REVIEW BELOW		
Other Criteria	**Voted NO**	**Comments & Suggestions**
Project Objectives: Based on the background and need, evaluate whether the project objectives are: 1. Aligned with the need 2. Specific 3. Clear without ambiguity 4. Achievable If not, then appropriate feedback should be provided.		**9**- More detail is needed. For example, will energy performance data come from a model-based predictive approach, or from measurements, or both? If so, what methodology will be adopted? **7** - In the Objectives section are included tasks that should be more properly included in the Expected approach section. The results of the projects are not clearly indicated. **3** - The RTAR should show some examples of "Supplemental Normalization Parameters for Alternate/Enhanced Expression of Energy Performance" The RTAR lacks in concreteness. Why only three buildings? Is it enough for the purpose of the project?
Expected Approach and Budget: Is there an adequate description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision. Anticipated funding level and duration:		**9** - More detail needed to evaluate. This should be aligned to the objectives and steps planned. **4 -** It is doubtful whether application of the proposed methodology in 3x3=9 buildings is sufficient for its validation. The cost of USD 160k seems too high. **7** - Very limited number of buildings for each building type. See also previous RAC comments. **3** - The analysis of the data base is required. There would be lots of available building energy use database. This type of the study should be done with the common or the latest deep learning analysis for the existing data. **6** - Would like further details on approach
References: Are the references provided?		**4** - There are references but not complete. Haberl et al. Is missing as well as ASHRAE Standard 100 is not on the reference list. **7 -** Only three general references.
Decision Options	**Initial Decision?**	**Final Approval Conditions**
ACCEPT AS-IS		**2** - The scope has been paired down to three samples of three building types. Even if the candidate normalization parameters do not correlate well with modeling and field data, we will have a good overview of candidate normalization parameters to consider for other building types. The scope is simple and achievable. **9** - The general aim and intention of this project is good, and may well be of significant importance to ASHRAE. The main problem is with the lack of detail in the current RTAR, which is too sketchy. More details and specification are needed. The work needs to be identified and put into context against any existing on-going work or initiatives. Surely there must be other work going on about energy performance of buildings, in the US and other countries. How does the proposed work fit in with that? Perhaps the RL could work with the TC to help develop the RTAR further? **7** - Perform an adequate literature search and revise the objective of the project accordingly. See also previous RAC approval conditions. **3** - Why doesn't the study use the existing data? This type of study would be done by the statistical analysis and the RTAR should describes how the study would lead the successful results with the approach described in the RTAR. **6** - Would like further evidence of value. **12** - accept as is with the caveat that the WS be better written. I had no idea what this was about on the first read. I had to come back to it for a deeper read and understanding. A WS moving to RFP should be easy to follow for any engineer, not just those skilled in Std 100. **Additional Comments**: *need to be better written to make easier to understand. Previous RAC comments should be addressed individually and summarized to assure comments are taken into account.*
ACCEPT W/COMMENTS		
REJECT		

ACCEPT Vote - Topic is ready for development into a work statement (WS).
ACCEPT W/COMMENTS Vote - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s)
REJECT Vote - Topic is not acceptable for the ASHRAE Research Program

Research Topic Acceptance Request Cover Sheet

Date: 8/6/18

(Please Check to Insure the Following Information is in the RTAR)

A. Title	✔
B Executive Summary	✔
C. Background	✔
D. Research Need	✔
E. Project Objectives	✔
F. Expected Approach	✔
G. Relevance and Benefits to ASHRAE	✔
H. Anticipated Funding Level and Duration	✔
I. References	✔

Title:

"Supplemental Normalization Parameters for Alternate/Enhanced Expression of Energy Performance"

RTAR # 1822

(To be assigned by MORTS)

Results of this Project will affect the following Handbook Chapters, Special Publications, etc.:

Research Classification:

Basic/Applied Research	
Advanced Concepts	
Technology Transfer	✔

Responsible Committee: TC 7.6

Date of Vote: 8/6/18

For		10
Against	*	0
Abstaining	*	0
Absent or not returning Ballot	*	4
Total Voting Members		14

RTAR Authors

Lead:
Dennis Landsberg
Others:

Co-sponsoring TC/TG/MTG/SSPCs (give vote and date)

SSPC 100
8-6-18 9-0-0-7 16

Expected Work Statement Authors

Lead:
Dennis Landsberg
Others:
Joe Firrantello
Bruce Hunn
J. Patrick Carpenter

Potential Co-funders (organization, contact person information):

	Yes	No
Has an electronic copy been furnished to the MORTS?		✔
Has the Research Liaison reviewed the RTAR?	✔	

* Reasons for negative vote(s) and abstentions

RTAR # 1822-5/9/17

Title:

Insert proposed project title

"Supplemental Normalization Parameters for Alternate/Enhanced Expression of Energy Performance"

Executive Summary

Describe in summary form the proposed research topic, including what is proposed, why this research is important, how it will be conducted, and why ASHRAE should fund it (50 words maximum)

EUIs are currently based only on building area, This research will develop additional normalization parameters reflecting energy use categories not adequately represented by building area. Usable and enforceable EUIs that address additional parameters are needed by Standard 100 and for use in benchmarking, energy efficiency programs and code application.

Background

Provide the state of the art with key references (at the end of this document) substantiating it (300 words maximum)

A large variety of stakeholders rely on the Energy Utilization Index (EUI), measured in Btu/sq ft-yr, to characterize, benchmark and compare building energy performance. Building owners and decision makers are interested in EUI characterization, because of its ease of use, to help understand building performance. Government entities are mandating benchmarking for tracking building improvements and progress toward program targets. Comparisons of EUIs are used in code compliance, energy efficiency programs and by owners of portfolios of similar buildings.

Enhancements to EUI are needed because the energy performance of some building types is not strongly correlated with floor area. Restaurant energy performance is more related to the number of customers, and hospital energy use to the number of patients. A data center can have a significant impact on the EUI of an office building. A fast food chain with cooking off site will have a lower EUI than a restaurant with on-site cooking. Thus for many buildings, the EUI calculation can be enhanced by adding additional normalization variables.

For example, the energy performance of airline terminals and shopping malls has been demonstrated to be better represented by a "stacked" EUI approach. Haberl et al. applied a stacked approach to airline terminals, starting with an area based EUI and added factors to address items such as moving walkways, elevators, baggage handling, etc..

Research Need

Use the state of the art described above as a basis to specify the need for the proposed effort (250 words maximum)

The EUI as currently applied, which is based only on floor area normalization, may correlate poorly with measured energy use. This research will provide the means to develop methodologies that correlate better for specific building types and operating conditions.

Parameters are needed that provide enhanced correlation with the energy efficiency of building systems. The parameters will need to vary by building type. A methodology must be developed that is easy to apply by engineers and adopted by the Authority Having Jurisdiction (AHJ). The approach must improve correlation with the energy performance of building systems.

The building energy performance issue is being addressed by USDOE in the Superior Energy Performance Program for Industrial Buildings. The methodology uses a top down approach to reduce energy use over time. Normalization variables are tested for correlation with energy use over time and then energy use is normalized against those variables. This is a plant specific approach where the primary driver is often BTU/widget produced. Work is beginning on applying the method to commercial buildings. DOE has software that can be used to correlate the energy use of buildings against a variety of variables https://ecenter.ee.doe.gov/EM/tools/Pages/EnPI.aspx. Building floor area may or may not be important depending upon the building type.

Project Objectives

Based on the identified research need(s), specify the objectives of the solicited effort that will address all or part of these needs (150 words maximum)

1. Identify current and candidate normalization parameters and methodology for use in expressing building energy performance.
2. Select candidate parameters relevant to the performance of three building types; Hospital, Mixed Use Shopping Mall, Residential/Retail.
3. Evaluate the ability of the candidate parameters to produce repeatable results through application to the three building types.
4. Document the methodology for application to other building types.
5. Recommend next steps on how these parameters and methodologies can be used to refine relevant ASHRAE Standards.
6. Recommend additional building types for further investigation.

Expected Approach

Describe in a manner that may be used for assessment of project viability, cost, and duration, the approach that is expected to achieve the proposed objectives (200 words maximum).

Check all that apply: Lab testing ☐, Computations ☑, Surveys ☐, Field tests ☑, Analyses and modeling ☑, Validation efforts ☑ Other (specify) ( )

1. The project will develop and examine a range of normalizing parameters and methodologies for application to three commercial building types. The candidate building types are retail/residential, hospital and mixed use shopping mall. The building types selected for examination will reflect prevalent building types that are likely to benefit from this approach.
2. The methodology will be applied to 3 buildings for each building type and compared to the results in the Standard 100 floor area normalization methodology.
3. Site visits will be performed to ensure that the input data for the parameters being examined are accurate.
4. Use data collected on site visits to examine the impact of the parameters on the EUI. Provide results of the examination to ASHRAE.

Relevance and Benefits to ASHRAE

Describe why this effort is of specific interest to ASHRAE, its impact, and how it will benefit ASHRAE and the society. How does it align with ASHRAE Strategic Plans and Initiatives? How does it advance the state of the art in this area in general? Are there other stakeholders that should be approached to obtain relevant information or co-funding? (350 words maximum)

ASHRAE focuses on national building standards. Energy efficiency standards are of primary importance in reducing building energy use, which is a major federal mandate. This research will improve the value of ASHRAE energy efficiency standards thereby furthering ASHRAE Goals 1, 5, 7 and 10.

2010-2015 Research Plan extended to 2018: Better characterization of building energy efficiency will improve targeting energy efficiency efforts and enhance the ability of building owners and building operators to improve and maintain the energy efficiency of buildings. This project will contribute to the following ASHRAE Research Plan goals: Goal 1- Maximize building energy performance through more effective measurement. Goal 5 – Support the development of ASHRAE energy standards and reduce compliance effort through the expressions of EUI that reflect building performance. Goal 7 – Support the development of tools, procedures and methods suitable for designing low energy buildings by improving our understanding of how building characteristics impact building energy efficiency. Goal 10 – Significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education by improving understanding if the factors that drive energy efficiency by building type.

Anticipated Funding Level and Duration

Funding Amount Range: $150-160,000

Duration in Months: 24

References

List the key references cited in this RTAR

1. The Business Case for Superior Energy Performance.
http://www.energy.gov/eere/amo/business-case-sep
2. Therkelsen,Peter, Prakash Rao, and Aimee McKane Development of an Enhanced Payback Function for the Superior Energy Performance Program,LBNL-190883, 2013.
http://www.energy.gov/sites/prod/files/2015/10/f27/LBNL-190883.pdf
3. Methodology to Develop the Airport Terminal Building Energy Use Intensity (ATB-EUI) Benchmarking Tool, Transportation Research Board Final Report for ACRP 09-10, 2015.

Feedback to RAC and Suggested Improvements to RTAR Process

Now that you have completed the RTAR process, RAC is interested in getting your feedback and suggestions here on how we can improve the process.

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Michael R. Vaughn, P.E.
Manager Research & Technical Services

mvaughn@ashrae.org

TO: Bruce Hunn,, Chair TC 7.6, hunnbuildingenergy@gmail.com
David Eldridge, Research Subcommittee Chair TC 7.6, dse@grummanbutkus.com

CC: Christopher Wilkins, Research Liaison 7.0, chris.wilkins@crbusa.com

FROM: Michael Vaughn, MORTS, mvaughn@ashrae.org

DATE: July 18,, 2017

SUBJECT: Research Topic Acceptance Request (1822-RTAR), "Alternate Expressions of Building EUI as Energy Performance Metrics"

During their recent Annual meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted 5-0-0 to reject it. The following are the consensuses reasons for rejecting this RTAR:

1. This RTAR needs a significant rewrite with citations that justify the research need, a project approach that flows from the research need, and a rational for the budget and duration.
2. A concern on this topic is how this approach will be different from past approaches (such as for example by the ASHRAE Working Group) that were not successful. The RTAR needs to demonstrate how this approach will be different and why it will have a higher likelihood of success.
3. Part of the research need is stated as Metrics must be easy to apply such that they can be adopted by the Authority Having Jurisdiction (AHJ). There is nothing in the RTAR that supports that the new metrics would be easier to use or that they would advance the adoption of Standard 100.

An RTAR evaluation sheet is attached as additional information and it provides a breakdown of comments and questions from individual RAC members based on specific review criteria. This should give you an idea of how your RTAR is being interpreted and understood by others and may suggest the need for additional revisions to the RTAR.

By rejecting this RTAR, RAC is strongly suggesting to the TC that this particular topic be dropped from the TC research plan based on the information that has been provided.

If the TC wishes to pursue this topic further, we recommend that you first review RAC's comments and then discuss with your RL (Christopher Wilkins, chris.wilkins@crbusa.com or RL7@ashrae.net) the scope and topic of the project before submitting a new RTAR.

The next submission deadline for RTARs and WSs is **August 15, 2017** for consideration at the RAC 2017 fall meeting. The submission deadline after that is December 15, 2017.

Project ID	**1822**	
Project Title	**Alternate Expressions of Building EUI as Energy Performance Metrics**	
Sponsoring TC	TC 7.6, (Building Energy Performance)	
Cost / Duration	$150,000 - $160,000 / 24 Months	
Submission History	**1st Submission**	
Classification: Research or Technology Transfer	Basic/Applied Research	
RAC 2017 Annual Meeting Review		
Essential Criteria	**Voted NO**	**Comments & Suggestions**
Background: The RTAR should describe current state of the art with some level of literature review that documents the importance/magnitude of a problem. References should be provided. If not, then note it in your comments.		**#14** - It is not clear how the cited references are linked to the Background. **#3**- The energy efficiency of building systems can be well estimated with primary energy base i.e. barrel of oil equivalent (BOE). There is no description of energy unit. How the electricity use and gas combustion is compared? #6 **-** Good topic. However a lot of similar work has been conducted outside of ASHRAE. Authors may want to expand their literature search to include work conducted by IEA-EBC projects, in China, European countries.#5- Interesting that a EUI Bt/ft2-year is an accepted, but is (and I would agree) an unacceptable metric with huge variation/variables which impact it based on building type and occupancy/use.
Research Need: Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.		**#14** - It is not clear how the cited references are linked to the Research needs. #8 - I'm not terribly familiar with standard 100, but it appears from the comments that this standard is not being used anywhere which is a concern. **#6** - If the research is mainly to discuss the EUI and its influencing factors, yes. If the purpose is to find a method how to adjust the EUI, no
Relevance and Benefits to ASHRAE: Evaluate whether relevance and benefits are clearly explained in terms of: a. Leading to innovations in the field of HVAC & Refrigeration b. Valuable addition to the missing information which will lead to new design guidelines and valuable modifications to handbooks and standards. Is this research topic appropriate for ASHRAE funding? If not, Reject.		
IF ABOVE THREE CRITERION ARE NOT ALL SATISFIED - MARK "REJECT" BELOW & CONTINUE REVIEW BELOW		
Other Criteria	**Voted NO**	**Comments & Suggestions**
Project Objectives: Based on the background and need, evaluate whether the project objectives are: 1. Aligned with the need 2. Specific 3. Clear without ambiguity 4. Achievable If not, then appropriate feedback should be provided.		**#4** - The proposed work intends to develop metrics; There is a risk that the metrics developed will not work; it will be difficult to compare bids if this is an open question problem; how to judge that some proposed metrics have higher chance of success than the others; the scope of the metric must be better defined as it is unclear which metrics will be used. The proposed work intends to develop metrics; There is a risk that the metrics developed will not work; it will be difficult to compare bids if this is an open question problem; how to judge that some proposed metrics have higher chance of success than the others; the scope of the metric must be better defined as it is unclear which metrics will be used. **#6** Arguably yes, but still need to be clearer.
Expected Approach and Budget: Is there an adequate description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision. Anticipated funding level and duration:		**#10** - The approach isn't very details. Are three types of buildings adequate? The author mentions a future project of up to 53 buildings. **#14** - Little discussion is provided to justify the funding level and duration. **#3** - Is it possible to get good results with only observation of 3 buildings for each building type. Even though this project is a pilot study, the number of observing buildings is too small. **#5** - Is it possible to get good results with only observation of 3 buildings for each building type. Even though this project is a pilot study, the number of observing buildings is too small. **#6**- Expected approach not clear. Will this be done by computer simulations, by field measurements and comparisons, or by what? How representative will the selected 3 buildings will be in terms of many influencing factors? How would this project be linked to the forthcoming effort? Because the above were not clear, it is hard to evaluate whether or not the budget is appropriate.
References: Are the references provided?		**CE** - Some general references are provided, but there is no linkage to the Background or Research Needs.
Decision Options	**Initial Decision?**	**Final Approval Conditions**
ACCEPT AS-IS		**#14**- This RTAR needs a significant rewrite with citations that justify the research need, a project approach that flows from the research need, and a rational for the budget and duration. **#3 -** It seems that the number of observation is too small and we cannot expect the meaningful outcome. **#4** - there must be clearer definition of the scope of the metrics. **#5** -Not sure the research will result in a new metric. Also the discussion that the standard has not been adopted is the result of the metric being poor or just the measuring energy use to a metric is not the best way to look at building and a compare them. For example, there discussion on heating and cooling degree days being tied by to the TVA.
ACCEPT W/COMMENTS		
REJECT		

ACCEPT Vote - Topic is ready for development into a work statement (WS).
ACCEPT W/COMMENTS Vote - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s)
REJECT Vote - Topic is not acceptable for the ASHRAE Research Program

Comments in Support:

Joseph Firrantello:

All,

I agree with Gordon that adoption is an issue, but I think Dennis is in a good position to push forward on this particular avenue. Other effort could still be expended by the committee, or ASHRAE in general, on feedback from/interaction with potential users/adopters.

Steve makes a number of good points, and I agree with Adrienne that his comments should be taken into consideration for the final RTAR (if possible at this point, as Dennis may have submitted already?) and further effort (whether revising of the RTAR if it gets sent back, or development of the Work Statement). Regarding the bit about Item 2 in Expected Approach being cut off mid-sentence, that looks to be a symptom of the PDF form. It can be expanded to show the rest of the the information, though I'm not sure if all PDF readers "play nicely" with the ASHRAE RTAR form.

I'm guessing that some of the complexities brought up may be further fleshed out in the work statement, or may end up being the responsibility of those who submit proposals. For example, "the perfect being the enemy of the good" has been a consistent point of consideration, and I would hope that both the work statement and any proposals would explicitly address the aim of simplicity.

In short, though I would not be surprised if further revisions end up being required, I stand with my original vote.

Joseph Firrantello, PhD, PE

Adrienne Thomle:

Mark and Wayne,
I do agree with Gordon in that no jurisdiction has adopted the standard and I personally would like to see ASHRAE put forth more effort to make it available to the potential users or to determine why it has not been adopted.
ASHRAE is an organization that moves at a slow pace and the research may not be completed and new EUI determination methods published and accepted by the industry for 3 to 4 years which allows more time for adoption.
Steve makes a few good points and I would like the research committee to consjder his input for the final RTAR. I stand with my original vote.
Adrienne

Jim Kelsey:

I do agree with Gordon in that no jurisdiction has adopted the standard and I personally would like to see ASHRAE put forth more effort to make it available to the potential users or to determine why it has not been adopted.

ASHRAE is an organization that moves at a slow pace and the research may not be completed and new EUI determination methods published and accepted by the industry for 3 to 4 years which allows more time for adoption.

Steve makes a few good points and I would like the research committee to consider his input for the final RTAR. I stand with my original vote.

Jim

Comments Opposed:

- **Gordon Holness –** While, in many ways, I hate to vote against this RTAR, I feel compelled to do so. Yes the current standard is essentially based on an "all things being equal approach" and yes the CBECS data base could be more "robust". But we started out on the rewriting of Standard 100 with a goal of providing AHJs with a simple to use, practical standard that could be applied to a wide range of existing buildings and offer the opportunity to achieve up to 30% energy use, on an aggregate basis.

  Is this an accurate approach – probably not. And yes we are faced with "confounding variables". But we could add a whole range of normalizing variables and methodologies that, while accurate in themselves, make it impossible to really compare buildings and impractical for AHJs to utilize. As the expression goes – "perfect if the enemy of good".

  I see, in the RTAR that the USDOE is trying to address these issues in Industrial Buildings (good luck with that one because there you really do have infinite variables). But if this was a key issue for USDOE then why aren't they similarly studying commercial buildings and why can't we have them spearhead this effort..

  We have probably spent two years on an effort to find alternatives to EUIs through our Working Groups – to no end. In addition, as I indicated in my email of 2-4-17, our intent here is to make the Standard even better. But the question becomes - Why? To date we have had very limited response from the industry and, to my knowledge, no jurisdictions anywhere have adopted the standard. Clearly we have not adequately promoted or marketed this great tool, nor met the goal in the Strategic Plan of "increase awareness, adoption and application of ASHRAE's offerings". Surely that should be the priority, not simply trying to further improve an unused standard.

  I would rather see this research effort conducted outside of the auspices of SSPC 100.

- **Steve Rosenstock –** There are good intentions in the RTAR, but some of the language needs to be improved to avoid research problems.

  For example, in the executive summary, it says "The EUI metric needs to evolve into a methodology that is fair, equitable and easy to apply". "Fair" and "equitable" to whom? To what type or types of buildings? What other ASHRAE technical research has ever tried to be "fair" or "equitable"? These

are subjective non-technical terms, and the research may try to "prove" that current EUI metrics and normalizations are "unfair" and/or "inequitable" to certain parties or buildings, which would be a waste of ASHRAE research funds.

There is other problematic language in the Background. It states "The current approach is not equitable to all buildings". However, the paragraph discusses normalization factors that can make current EUI values more technically accurate or appropriate. It does not show how current methods are "not equitable" (nor does it define the term in the context of EUI values).

It also discusses floor area metrics, but does not show where the 80% correlation statistic comes from, or how much "worse" other buildings are (what research paper or web site did these statistics come from?).

Another paragraph talks about weather normalization, and then the last sentence provides an unsupported concluding statement about square footage, not weather adjustments.

In addition, under the "Research Need" area, the paragraph on the US DOE Industrial Superior Energy Performance Program appears to presume the research answer, without discussing the problems that have been identified with the DOE approach that uses overstated and inaccurate "source energy" estimates that do not have anything to do with how buildings use delivered energy efficiently. This section (and the associated references) should be removed from the RTAR.

Also, it states "Metrics must correlate with the energy efficiency of building systems, as contrasted to energy performance as described above." This sentence is confusing, as it is not clear what the difference between "energy efficiency" and "energy performance" is. Also, it conflicts with Project Objective #1, which states "Develop metrics, to characterize the **performance** of three types of buildings." (*emphasis added*). Also, the word "performance" is vague and undefined for this RTAR.

In addition, saying that the research could be applicable to 90.1 and 189.1 is problematic, as 189.1 is a green commercial building standard that looks at many other aspects of buildings outside of energy efficiency (such as site sustainability, water use, construction, materials, etc.) and uses CO2e emissions as a metric in its performance path, while 90.1 is a design standard used for new and totally renovated commercial buildings, where the energy usage data for buildings that average 30-40 years in age is unlikely to be appropriate.

In the Expected Approach section, Item 2 has been cut off in mid-sentence, so it is incomplete. Under Item 1, the third sentence starting with "The selection could be based upon

prevalence of building types….” conflicts with the second sentence that states “It is recommended that…” which details the types of buildings that should or will be used. Such a conflict further weakens the document.

RTAR # 1822-5/9/17

Title:

Insert proposed project title

"Supplemental Normalization Parameters for Alternate/Enhanced Expression of Energy Performance"

Executive Summary

Describe in summary form the proposed research topic, including what is proposed, why this research is important, how it will be conducted, and why ASHRAE should fund it (50 words maximum)

EUIs are currently based only on building area, This research will develop additional normalization parameters reflecting energy use categories not adequately represented by building area. Usable and enforceable EUIs that address additional parameters are needed by Standard 100 and for use in benchmarking, energy efficiency programs and code application.

Background

Provide the state of the art with key references (at the end of this document) substantiating it (300 words maximum)

A large variety of stakeholders rely on the Energy Utilization Index (EUI), measured in Btu/sq ft-yr, to characterize, benchmark and compare building energy performance. Building owners and decision makers are interested in EUI characterization, because of its ease of use, to help understand building performance. Government entities are mandating benchmarking for tracking building improvements and progress toward program targets. Comparisons of EUIs are used in code compliance, energy efficiency programs and by owners of portfolios of similar buildings.

Enhancements to EUI are needed because the energy performance of some building types is not strongly correlated with floor area. Restaurant energy performance is more related to the number of customers, and hospital energy use to the number of patients. A data center can have a significant impact on the EUI of an office building. A fast food chain with cooking off site will have a lower EUI than a restaurant with on-site cooking. Thus for many buildings, the EUI calculation can be enhanced by adding additional normalization variables.

For example, the energy performance of airline terminals and shopping malls has been demonstrated to be better represented by a "stacked" EUI approach. Haberl et al. applied a stacked approach to airline terminals, starting with an area based EUI and added factors to address items such as moving walkways, elevators, baggage handling, etc..

Research Need

Use the state of the art described above as a basis to specify the need for the proposed effort (250 words maximum)

The EUI as currently applied, which is based only on floor area normalization, may correlate poorly with measured energy use. This research will provide the means to develop methodologies that correlate better for specific building types and operating conditions.

Parameters are needed that provide enhanced correlation with the energy efficiency of building systems. The parameters will need to vary by building type. A methodology must be developed that is easy to apply by engineers and adopted by the Authority Having Jurisdiction (AHJ). The approach must improve correlation with the energy performance of building systems.

The building energy performance issue is being addressed by USDOE in the Superior Energy Performance Program for Industrial Buildings. The methodology uses a top down approach to reduce energy use over time. Normalization variables are tested for correlation with energy use over time and then energy use is normalized against those variables. This is a plant specific approach where the primary driver is often BTU/widget produced. Work is beginning on applying the method to commercial buildings. DOE has software that can be used to correlate the energy use of buildings against a variety of variables https://ecenter.ee.doe.gov/EM/tools/Pages/EnPI.aspx. Building floor area may or may not be important depending upon the building type.

Project Objectives

Based on the identified research need(s), specify the objectives of the solicited effort that will address all or part of these needs (150 words maximum)

1. Identify current and candidate normalization parameters and methodology for use in expressing building energy performance.
2. Select candidate parameters relevant to the performance of three building types; Hospital, Mixed Use Shopping Mall, Residential/Retail.
3. Evaluate the ability of the candidate parameters to produce repeatable results through application to the three building types.
4. Document the methodology for application to other building types.
5. Recommend next steps on how these parameters and methodologies can be used to refine relevant ASHRAE Standards.
6. Recommend additional building types for further investigation.

Expected Approach

Describe in a manner that may be used for assessment of project viability, cost, and duration, the approach that is expected to achieve the proposed objectives (200 words maximum).

Check all that apply: Lab testing ☐, Computations ☑, Surveys ☐, Field tests ☑, Analyses and modeling ☑, Validation efforts ☑ Other (specify) ( )

1. The project will develop and examine a range of normalizing parameters and methodologies for application to three commercial building types. The candidate building types are retail/residential, hospital and mixed use shopping mall. The building types selected for examination will reflect prevalent building types that are likely to benefit from this approach.
2. The methodology will be applied to 3 buildings for each building type and compared to the results in the Standard 100 floor area normalization methodology.
3. Site visits will be performed to ensure that the input data for the parameters being examined are accurate.
4. Use data collected on site visits to examine the impact of the parameters on the EUI. Provide results of the examination to ASHRAE.

Relevance and Benefits to ASHRAE

Describe why this effort is of specific interest to ASHRAE, its impact, and how it will benefit ASHRAE and the society. How does it align with ASHRAE Strategic Plans and Initiatives? How does it advance the state of the art in this area in general? Are there other stakeholders that should be approached to obtain relevant information or co-funding? (350 words maximum)

ASHRAE focuses on national building standards. Energy efficiency standards are of primary importance in reducing building energy use, which is a major federal mandate. This research will improve the value of ASHRAE energy efficiency standards thereby furthering ASHRAE Goals 1, 5, 7 and 10.

2010-2015 Research Plan extended to 2018: Better characterization of building energy efficiency will improve targeting energy efficiency efforts and enhance the ability of building owners and building operators to improve and maintain the energy efficiency of buildings. This project will contribute to the following ASHRAE Research Plan goals: Goal 1- Maximize building energy performance through more effective measurement. Goal 5 – Support the development of ASHRAE energy standards and reduce compliance effort through the expressions of EUI that reflect building performance. Goal 7 – Support the development of tools, procedures and methods suitable for designing low energy buildings by improving our understanding of how building characteristics impact building energy efficiency. Goal 10 – Significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education by improving understanding if the factors that drive energy efficiency by building type.

Anticipated Funding Level and Duration

Funding Amount Range: $150-160,000

Duration in Months: 24

References

List the key references cited in this RTAR

1. The Business Case for Superior Energy Performance.
http://www.energy.gov/eere/amo/business-case-sep
2. Therkelsen,Peter, Prakash Rao, and Aimee McKane Development of an Enhanced Payback Function for the Superior Energy Performance Program,LBNL-190883, 2013.
http://www.energy.gov/sites/prod/files/2015/10/f27/LBNL-190883.pdf
3. Methodology to Develop the Airport Terminal Building Energy Use Intensity (ATB-EUI) Benchmarking Tool, Transportation Research Board Final Report for ACRP 09-10, 2015.

Feedback to RAC and Suggested Improvements to RTAR Process

Now that you have completed the RTAR process, RAC is interested in getting your feedback and suggestions here on how we can improve the process.