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Built Environment Today

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CC: William Murphy, Research Liaison Section 7.0, [William.murphy@uky.edu](mailto:William.murphy@uky.edu)  
FROM: Michael Vaughn, MORTS, [mvaughn@ashrae.org](mailto:mvaughn@ashrae.org)  
DATE: January 23, 2019  
SUBJECT: Research Topic Acceptance Request (1872-RTAR), "Updating Site Energy Targets for ASHRAE Standard 100-2018 - Energy Efficiency in Existing Buildings"

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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](mailto:William.murphy@uky.edu), or [RL7@ashrae.net](mailto:RL7@ashrae.net), in the work statement draft.

1. Clarify the expected approach.
2. The expected approach should be more detailed and clearly indicate whether the experimental validation is required.
3. If more testing is needed, the funding may not be sufficient..

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 **December 15, 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.

<b>Project ID</b>	<b>1874</b>	
<b>Project Title</b>	Climatic Design Conditions for Roof Top HVAC Equipment	
<b>Sponsoring TC</b>	TC 4.2, (Climatic Information)	
<b>Cost / Duration</b>	\$75,000 - 12M	
<b>Submission History</b>	1st Submission	
<b>Classification: Research or Technology Transfer</b>	Basic/Applied Research	
<b>RAC 2018 Winter Meeting Review</b>		
<b>Essential Criteria</b>	<b>Voted NO</b>	<b>Comments &amp; Suggestions</b>
<b>Background:</b> 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 - Good background, references cited, and some indication of the magnitude of the air heating effect is given, as it might affect HVAC rooftop equipment.
<b>Research Need:</b> Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.		9 - The need is clear...namely, for better design data for the 'microclimate' region on roofs for evaluating potential effects on HVAC plant. 3 - Many relevant studies were already done. 12- Having justification to promote CO2 or any other refrigerant is not necessary. The relevance is in getting an accurate air inlet temperature and enhance system efficiency through design? Looking online at 3 different manufacturers, it seems that RTU are sold on cooling load and not selected based on climatic data or geographic location. Looking at EU rating standard, RTUs are rated at 35C cooling and 7C heating there doesn't seem to be what-ifs (roof color, texture, etc.) in the rating scale.
<b>Relevance and Benefits to ASHRAE:</b> 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.		9 - Clearly relevant. 4 - Connection to ASHRAE's Strategic Plan would be useful.
<b>IF ABOVE THREE CRITERIA ARE NOT ALL SATISFIED - MARK "REJECT" BELOW &amp; CONTINUE REVIEW BELOW</b>		
<b>Other Criteria</b>	<b>Voted NO</b>	<b>Comments &amp; Suggestions</b>
<b>Project Objectives:</b> 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 - These are clear, but the challenge of developing what are termed 'simple' relationships (between the broader local climate and the rooftop microclimate) should not be underestimated. It may be necessary to restrict the evaluation to particular representative typical geometries, and to consider the local wind profile as influenced by local terrain factors and height. 3- There are many relevant studies, and the project objectives seems to be almost similar and are not distinct. 6 - this may require further definition to reduce ambiguity on 2,3,4.
<b>Expected Approach and Budget:</b> 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:		2 - If more testing is needed, the funding may not be sufficient. 9 - This is broadly ok, but note the comments above under 'objectives'. Allowance of time and resource might have to be made for sufficient monitoring and measurements in practical situations. For that reason, I think the current funding range is low, and the duration is short. Be prepared to adjust these. 7 - The expected approach should be more detailed and clearly indicate whether the experimental validation is required. 6 - concerns about enough budget
<b>References:</b> Are the references provided?		
	<b>Initial Decision?</b>	
<b>Decision Options</b>		<b>Final Approval Conditions</b>
ACCEPT AS-IS		2 - Need is well established, objectives and approach are clear. If more testing is needed, the funding may not be sufficient. 9 - Clearly-explained RTAR, proposing useful research. Work with RL to develop the WS with sufficient detail, and taking into account comments above, namely: i) the challenge of developing what are termed 'simple' relationships (between the broader local climate and the rooftop microclimate) should not be underestimated. It may be necessary to restrict the evaluation to particular representative typical geometries, and to consider the local wind profile as influenced by local terrain factors and height; ii) Allowance of time and resource might have to be made for sufficient monitoring and measurements in practical situations. For that reason, I think the current funding range is low, and the duration is short. Be prepared to adjust these. 4 - Connection to ASHRAE Strategic Plan. 7 - Clarify the expected approach. 3 - There are many relevant studies, and the project objectives seems to be almost similar and are not distinct. 6 - I like the concept; see comments above for refinements. 12 - I think it would be nice to have data for industrial design purposes, but link to refrigerant needs to be broken all systems (controller logic) could benefit. I worry that to the manufacturers of RTUs, this knowledge is well known and is already built in to existing controller logic designs allowing for product differentiation.
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: **11/29/18**

(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:  
**Updating Site Energy Targets for ASHRAE Standard 100-2018 - Energy Efficiency in Existing Buildings**

**RTAR # 1872**  
 (To be assigned by MORTS)

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

**ASHRAE Standard 100-2018 - Energy Efficiency in Existing Buildings**

Research Classification:  
 Basic/Applied Research   
 Advanced Concepts   
 Technology Transfer

Responsible Committee: **TC 7.6 – Building Energy Performance**

Date of Vote: **11/27/18**

For		<b>11</b>
Against	*	<b>0</b>
Abstaining	*	<b>1</b>
Absent or not returning Ballot	*	<b>4</b>
Total Voting Members		<b>16</b>

RTAR Authors  
 Lead: **Joseph Firrantello**  
 Others: **Dennis Landsberg**  
**J. Patrick Carpenter**

Co-sponsoring TC/TG/MTG/SSPCs (give vote and date)  
**SSPC 100 – Energy Efficiency in Existing Buildings**  
 Vote: **9-0-1-5 CNV (Yes-No-Abstain-Ballot Not Returned) - 10/5/18**

Expected Work Statement Authors  
 Lead: **Joseph Firrantello**  
 Others: **Dennis Landsberg**  
**J. Patrick Carpenter**

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

Has an electronic copy been furnished to the MORTS?  
 Has the Research Liaison reviewed the RTAR?

Yes	No
<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>

\* Reasons for negative vote(s) and abstentions

**Title:**

Updating Site Energy Targets for ASHRAE *Standard 100-2018 - Energy Efficiency in Existing Buildings*

**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)***

Standard 100 sets EUI (energy use intensity) targets for existing buildings derived from mid-2000s survey data. This research updates the targets using the latest US building stock surveys. The updates will set lower targets, reflective of the current building stock, and enable Standard 100 to keep pace with its peers.

**Background**

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

The Standard 100-2018 compliance path includes O&M, energy management, energy auditing, and building upgrades. If a building meets its energy target, it complies, and is not required to pursue further upgrades and M&V. Note this research concerns site energy targets, not source energy targets.

Standard 100 EUI targets are based on building use, climate zone, and hours occupied. Background on the targets is divided into **data** and **methods**.

The **data** used to establish Standard 100 EUI targets are from CBECS 2003 [1] and RECS 2005 [2]. The most recent survey data are CBECS 2012 [3] and RECS 2015 [4]. CBECS and RECS microdata are offered for free download by the US DOE.

The **methods** used to develop the current EUI targets [5], [6] are applied to each building use type.

1. **Use survey data to calculate EUI for desired percentile(s) of the building stock.** (choice of appropriate percentiles is outside the research scope)
2. **Calculate climate zone adjustment factors using modeled data from US DOE Reference Buildings [7].** Modeled results are available without further modeling effort.
3. **Calculate occupied hour adjustment factors using survey data**

The EUI target tables are derived from Items 1 and 2. Factors for hours occupied are from Item 3. Currently, the methods used for development are not fully transparent or replicable.

Methods for ranking building energy use are legion and will not be reviewed in full. The DOE's Energy Star program [8] is an obvious comparison: it calculates a percentile-based score using CBECS data. Energy Star scores based on CBECS 2012 began rollout in August 2018, with initial estimates of score changes up to 16 percentile points [9]. Energy Star is well established with available methodology. However, it is not appropriate for a consensus standard due to the inability to modify or to directly replicate.

## Research Need

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

Research is needed to 1) Develop a transparent, replicable method for calculating Standard 100 energy targets 2) Update current targets using survey data collected approximately 10 years after the current data sources.

The Standard 100 EUI target methodology is most similar, conceptually, to Energy Star. Standard 100 draws from the same data as Energy Star. Energy Star has extensive history, technical rigor, and successful branding. However, Energy Star does not use a fully transparent, consensus-based process. While Energy Star is a powerful existing tool, the use of an external, non-consensus resource in a key step of the compliance path is discouraged.

The EUI targets in Standard 100-2018 need to be refreshed to better reflect the existing building stock, provide owners with increased accuracy about the place of their building among its peers, and motivate further reduction in existing facility energy use.

An update using the most recent survey data (CBECS 2012 and RECS 2015) coupled with a transparent and replicable methodology will provide a defensible CMP (continuous maintenance proposal) to change Standard 100 site energy target tables.

## 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)***

The objectives of the project are:

- Establish methods to calculate site energy targets for buildings from existing CBECS 2012 and RECS 2015 data sets.
- Develop energy targets using CBECS 2012 and RECS 2015 data for the building/climate combinations currently included in Standard 100. This shall include factors for end-users to adjust energy targets for significant parameters (e.g., occupied hours).

The objectives ultimately produce material that will be included in a continuous maintenance proposal (CMP) for updating the EUI targets in Standard 100.

The development of source energy targets is specifically excluded from the project scope. The current source energy targets were derived by applying weighted source energy factors to previously established site energy targets. Establishing those source factors is a complex issue and separate from analysis of site energy survey data.

## 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 [X], Surveys [  ], Field tests [...], Analyses and modeling [X], Validation efforts [X], Other (specify) [  ]

The expected approach is straightforward and shall consist of components typical to data analysis work.

1. Review literature, benchmarking programs, data sets, and other resources
2. Summarize existing methods
3. Establish candidate methods
4. Establish evaluation criteria, e.g., various statistical measures, validation, usability
5. Evaluate candidate methods using established criteria
6. Produce final recommendation on methods and energy targets for inclusion in CMP for ASHRAE Standard 100-2018 – Energy Efficiency in Existing Buildings

The survey data is collected and freely available for use; no allowance shall be made for further collection of survey data. Any validation efforts shall be against either established methods or other established, freely available data sets. No allowance shall be made for further acquisition of validation data through purchase or collection.

Cost components shall be:

1. Personnel costs to perform the work
2. Travel as directed by ASHRAE Research Project requirements

The duration shall be relatively short due to the nature of the work: use of existing data sets and improvements built upon existing methods in a rich subject area.

## 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)***

The research directly supports areas that ASHRAE has been heavily involved in for years, including existing building energy use and developing/maintaining a formidable authorship and involvement in relevant consensus standards. Standard 100 was recently re-released after a thorough re-engineering and is taking its initial steps towards market penetration. Timely responses to new data will enable Standard 100 to maintain relevancy in the ecology of programs involving energy benchmarking, equipment/operation improvements, and results verification.

The potential impact on energy consumption is significant, with rough top-end estimates of a 30% decrease in building energy use in the US. Additionally, the nature of Standard 100 aligns well with ASHRAE's general interest in quantification of the impact of its standards. The research is intended to be a firm step forward that supports real outcomes.

The research aligns with the following goals in the ASHRAE Research Strategic Plan:

- *Goal 1 - Maximize the actual operational energy performance of buildings and facilities*
- *Goal 3 - To reduce significantly the energy consumption for HVAC & R, water heating and lighting in existing homes*
- *Goal 5 - Support the development of ASHRAE energy standards and reduce effort required to demonstrate compliance*

The research aligns with the following items in the ASHRAE Strategic Plan Starting 2014:

- *Goals and Objectives*
  - *ADAPT: Work collaboratively within the global community to increase the value, usefulness and accessibility of building sciences and technology.*
    - *Work to translate science and technology into practical tools and resources that drive effective building design, operations, and management.*
- *Outcomes and Measures*
  - *Outcome – Improved building performance*
  - *Measure – Measurable improvement in energy use intensity (EUI)...*

There are numerous stakeholders in this area, including building owners/operators (public and private), consulting engineers & auditors, researchers, utilities (e.g., gas, electric), district energy suppliers (e.g., steam, chilled water), and the government employees involved with the CBECS and RECS programs. Many have been, and continue to be, involved in the continuous maintenance of Standard 100.

The US DOE funded the original development of energy targets, but investigations into further funding have not met with success.

### Anticipated Funding Level and Duration

Funding Amount Range: \$ 50,000 - \$80,000

Duration in Months: 3-6 months

### References

List the key references cited in this RTAR

- [1] US EIA, "Commercial Building Energy Consumption Survey (CBECS)," 2003. [Online]. Available: [www.eia.gov/consumption/commercial/data/2003/](http://www.eia.gov/consumption/commercial/data/2003/). [Accessed: 18-Jun-2018].
- [2] US EIA, "Residential Energy Consumption Survey (RECS)," 2005. [Online]. Available: [www.eia.gov/consumption/residential/data/2005/](http://www.eia.gov/consumption/residential/data/2005/). [Accessed: 18-Jun-2018].
- [3] US EIA, "Commercial Building Energy Consumption Survey (CBECS)," 2012. [Online]. Available: [www.eia.gov/consumption/commercial/data/2012/](http://www.eia.gov/consumption/commercial/data/2012/). [Accessed: 18-Jun-2018].
- [4] US EIA, "Residential Energy Consumption Survey (RECS)," 2015. [Online]. Available: [www.eia.gov/consumption/residential/data/2015/](http://www.eia.gov/consumption/residential/data/2015/). [Accessed: 18-Jun-2018].
- [5] T. R. Sharp, "Derivation of Building Energy Use Intensity Targets for ASHRAE Standard 100 (ORNL/TM-2014/215)," US Department of Energy, Washington, DC, 2014.
- [6] ASHRAE, "Informative Annex J: Derivation of Energy Intensity Targets for Standard 100," in *ANSI/ASHRAE/IES Standard 100-2018 - Energy Efficiency in Existing Buildings*, Atlanta, GA: ASHRAE, 2018, pp. 79–92.
- [7] US DOE, "Commercial Reference Buildings," 2011. [Online]. Available: <https://www.energy.gov/eere/buildings/commercial-reference-buildings>.
- [8] US EPA, "Energy Star." [Online]. Available: [www.energystar.gov](http://www.energystar.gov). [Accessed: 28-Jun-2018].
- [9] US EPA, "Updates to ENERGY STAR® metrics with new market data," 2018. [Online]. Available: [www.energystar.gov/buildings/facility-owners-managers/existing-buildings/use-portfolio-manager/update-energy-star-scores-cbecs](http://www.energystar.gov/buildings/facility-owners-managers/existing-buildings/use-portfolio-manager/update-energy-star-scores-cbecs). [Accessed: 28-Jun-2018].

### 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.