INVITATION TO SUBMIT A RESEARCH PROPOSAL ON AN ASHRAE RESEARCH PROJECT

2026-SP, Whole Life Carbon Calculation Guide for Building Systems

Attached is a Request-for-Proposal (RFP) for a project dealing with a subject in which you, or your institution have expressed interest. Should you decide not to submit a proposal, please circulate it to any colleague who might have interest in this subject.

Sponsoring Committee: Center of Excellence for Building Decarbonization (CEBD)

Budget Range: $250,000 may be more or less as determined by value of proposal and competing proposals.

Scheduled Project Start Date: **April 1, 2026, or** later.

All proposals must be received at ASHRAE Headquarters by 8:00 AM, EDT, December 15th, 2025. NO EXCEPTIONS, NO EXTENSIONS. Electronic copies must be sent to rpbids@ashrae.org. Electronic signatures must be scanned and added to the file before submitting. The submission title line should read: "2026-SP, Refrigerant Leakage Rate Emissions Tracking" and *"Bidding Institutions Name"* (electronic pdf format, ASHRAE's server will accept up to 10MB)

If you have questions concerning the Project, we suggest you contact one of the individuals listed below:

For Technical Matters
Technical Contact
Corey Metzger
E-Mail: corey.metzger@resourcece.com

For Administrative or Procedural Matters:
Manager of Special Projects
Derrick Nesfield
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Contractors who plan to submit a proposal must notify the Manager of Research and Technical Services (MORTS) via email by December 1st. This will ensure that they receive any late or additional information regarding the RFP before the bid due date. Monday, December 1st, 2025 is the deadline for submitting technical inquiries.

All proposals must be submitted electronically. Electronic submissions require a PDF file containing the complete proposal preceded by signed copies of the two forms listed below in the order listed below. **ALL electronic proposals are to be sent to rpbids@ashrae.org.**

All other correspondence must be sent to dnesfield@ashrae.org. Hardcopy submissions are not permitted. **In all cases, the proposal must be submitted to ASHRAE by 8:00 AM, EDT, December 15th, 2025. NO EXCEPTIONS, NO EXTENSIONS.**

The following forms (Application for Grant of Funds and the Additional Information form have been combined) must accompany the proposal:

(1) ASHRAE Application for Grant of Funds (electronic signature required) and
(2) Additional Information for Contractors (electronic signature required) ASHRAE Application for Grant of Funds (signed) and

ASHRAE reserves the right to reject any or all bids.

State of the Art (Background)

ASHRAE defines the following: whole-life carbon (WLC) emissions as the total greenhouse gas emissions, including operational carbon emissions and embodied carbon emissions over the life cycle of an asset (e.g., HVAC systems, electrical, plumbing and other systems, building physical components and construction materials). Greenhouse gases (GHG) are gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Besides CO_2, N_2O and CH_4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). Decarbonization is the process of removing or reducing GHG.

According to ASHRAE's "Position Document on Building Decarbonization"[1]: "...By 2030, the global built environment must at least halved its 2015 GHG emissions, whereby

- all new buildings are net zero GHG emissions in operation,
- widespread energy-efficiency retrofits of existing assets are well underway, and
- embodied carbon of new construction is reduced by at least 40%".

In order to achieve 40% reduction in embodied carbon and net zero operational carbon by 2030, a robust guide to standardizing WLC calculation is needed. Buildings are major contributors to global GHG emissions, with the construction and operation of buildings responsible for approximately 40% of annual global CO_2 emissions via building operations (27%) and embodied carbon (13%).[2] Within this, Building Systems significantly impact the carbon footprint. They account for a significant portion of a building's total WLC, stemming from various sources including material extraction, manufacturing processes, transportation, and end-of-life disposal.

Embodied carbon from Building Systems is particularly notable due to their complex supply chains and material diversity. Despite growing awareness, standardized methodologies for calculating and mitigating these emissions remain limited, including North America, underscoring the need for a cohesive framework to address their substantial environmental impacts.

Currently, the environmental impacts of Building Systems are usually overlooked since data availability is limited and as a result they are commonly excluded from building life cycle assessments.[3] In addition, MEP materials and systems are installed multiple times over the lifetime of building leading to higher recurrent impacts by increasing material quantities and embodied carbon.[4]

With the development of ASHRAE Standard 240P, *Evaluating Greenhouse Gas (GHG) and Carbon Emissions in Building Design, Construction and Operation*, there is a need for a more detailed and practical process for calculating WLC for Building Systems that provides relevant default data and case studies for typical buildings and installations that serve buildings in different climate zones.

While Standard 240P is currently in draft/review form, it is possible that the work of this project may provide a path to meeting requirements of Table 6.3.1, Section 6.3.2, and the informative note of 6.3.2.2 (based on the Public Review document issued in June 2025). While not intended to impact the initial approval or release of Standard 240P, this work may also help to address Uncertainty Calculations called out in Section 6.4 of the draft document.

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[1] https://www.ashrae.org/file%20library/about/ashrae_building_decarbonization_pd_2022.pdf

[2] Architecture2030 https://architecture2030.org/2030_challenges/embodied/

[3] Dixit, M.K. Life cycle embodied energy analysis of residential buildings: A review of literature to investigate embodied energy parameters. Renew. Sustain. Energy Rev. 2017, 79, 390–413. https://doi.org/10.1016/j.rser.2017.05.051

[4] Rodriguez B.X., M. Huang, H. Woo Lee, K. Simonen, J. Ditto, Mechanical, electrical, plumbing and tenant improvements over the building lifetime: Estimating material quantities and embodied carbon for climate change mitigation, Energy and Buildings 2020, 226:110324. https://doi.org/10.1016/j.enbuild.2020.110324

Available data for embodied carbon emissions of Building Systems vary significantly as a result of different calculation approaches, system boundaries, and other uncertainties.[5] Based on a recent systematic literature review of 37 studies, six of them used Environmental Product Declarations (EPDs) to perform the impact assessment of the MEP systems.[6] However, EPDs are descriptive by nature and are intended to guide comparisons within a defined product category rule (PCR). Furthermore, there are also comparability issues with reporting deterministic values in product-specific EPDs and need to cautiously aggregate them with manufacturer- or industry-specific EPDs in order to perform system or building scale assessments following the data sources hierarchy specified in ASHRAE 240P to comply with the data uncertainty calculations. Finally, EPDs are not readily available for all system components in all parts of the world, which mandates the need for some default values to serve for at least preliminary calculations.

Guidance on how to use EPDs to assess WLC of building services equipment and where EPDs are not available, it provides guidance on how to estimate the embodied carbon, is available from Technical Memorandum TM65 by CIBSE.[7] In addition, local addenda can be used to assess embodied carbon of building services equipment for locations outside the UK (TM65LA).[8]

Justification and Value to ASHRAE

ASHRAE members and other professionals turn to ASHRAE looking for practical guidance and data that can be used or integrated in their design and construction practices. Thus, it is imperative that ASHRAE provides the practical methods with the necessary data that are necessary to quantify the WLC footprint of Building Systems and complement building calculations. As this is particularly challenging for diverse systems with many small components, such as MEP systems, development of these calculations and processes should be completed or overseen by an independent organization like ASHRAE. In addition, the case studies that will be prepared using the developed method and default data for representative case studies (e.g. for a medium-office, primary school, large hotel, mid-rise apartments) will be presented to demonstrate the process and present results for three distinctively different climate zones that are representative for the majority of ASHRAE Members.

ASHRAE Standard 240P includes requirements for including building systems in consideration of building life cycle GHG emissions. The draft standard does not, nor is it intended to, provide default values for all embodied and WLC calculations for all Building Systems components. Some of these components may have significant variations in embodied carbon and may also be furnished from multiple sources for a single facility (e.g., piping, conduit, sheet metal). In addition, the draft standard also does not provide guidance for quantifying materials or components that may vary significantly throughout a facility while being difficult to quantify during design or construction (e.g., conduit, wiring, supports, valves). Producing a consistent calculation methodology that is also supported by necessary default values for various building types, using various system types, in different climate zones, along with criteria to ensure consistency for EPDs and other values, can help the potential implementation of Standard 240P.

This research will provide new information for various stakeholders to perform practical calculations, and be integrated as informative appendices in ASHRAE standards, guidelines, and handbook chapters. The project results along with other relevant ASHRAE research projects (e.g. “2025-SP, Whole Building MEP Benchmarking Data Research” and “1977-SP, Expand and update the ASHRAE Service Life Table in the HVAC Applications andbook”), will help close the gap of existing knowledge on LCA of MEP systems and strengthen WLC emissions calculations.

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[5] Vilches, A.; Garcia-Martinez, A.; Sanchez-Montanes, B. Life cycle assessment (LCA) of building refurbishment: A literature review. Energy Build. 2017, 135, 286–301. https://doi.org/10.1016/j.enbuild.2016.11.042

[6] Roberts, M., C. Ouellet-Plamondon, P. Raftery, Embodied carbon in mechanical, electrical, and plumbing systems: A critical literature review. Building and Environment 2025, 275: 112823. https://doi.org/10.1016/j.buildenv.2025.112823

[7] https://www.cibse.org/knowledge-research/knowledge-portal/embodied-carbon-in-building-services-a-calculation-methodology-tm65

[8] https://www.cibse.org/knowledge-research/knowledge-portal/tm65la-using-the-tm65-methodology-outside-the-uk-pdf-2022/

Objectives

Overall, this project aims to establish a practical methodology guide for calculating the whole life carbon of Building Systems across various building and system types. The project shall develop practical guidelines that can be used to facilitate professionals in building design and construction by providing practical information and guidance. The project shall be focused on meeting the needs of practitioners.

The objectives of this project are to:

1. Develop a calculation guide that will specify the necessary practical steps that allow stakeholders to apply the developed framework to projects of varying sizes and complexities. The guide will include the necessary default data that can be used to perform initial calculations.
2. Collect and analyze data from multiple sources, including EPDs, North America TM65, and supplier reports. Include an annotated bibliography for the available resources since it is expected that the availability relevant data will continue to grow and more information will continue to become available. The intent is to ensure that high-quality input data can be identified and used for accurate carbon calculations and facilitate transparency and reliability in reporting. The guide should provide default industry averages and statistical ranges of embodied carbon for equipment and components, or, pointers to available EPDs to assist users in calculating total embodied carbon of Building Systems. Providing proper justification, may not include specific building element categories or OmniClass or provide well documented average data that can be used as baselines, if necessary. For example, electronic safety and security, low voltage communications, alarms, etc. The specific categories are included in the OmniClass table in section "**Other Information for Bidders".**
3. Prepare representative case studies to demonstrate the calculation process and present results for at least four representative buildings and Building Systems (e.g. medium-office, primary school, large hotel, mid-rise apartments) at three distinctively different climate zones, which are properly justified. Interact with actual project stakeholders for the selected case studies to collect their feedback on the calculation steps and data availability, use this feedback and lessons learned to refine methodologies, address challenges, and improve accuracy.
4. Document the entire process, method and supporting data, the results and lessons learned from the case study implementations. Provide insights for broader application and need for future adjustments considering the needs and challenges that may emerge from implementation at different parts of the world. Include recommendations from a more global perspective.

Scope:

The contractor shall demonstrate that they have good knowledge of Building Systems and existing WLC studies. If the contractor has or plans to seek collaborators (funded or voluntary), those collaborators should be identified in the proposal. If the contract has or plans to support this project with independent funding, that should be identified in the proposal.

Review Existing Standards and Documents: Review current standards/guidelines/references, including CIBSE TM65 *Embodied Carbon in Building Services: A Calculation Methodology*, ICC/ASHRAE 240P (depending on availability), MEP 2040 *A Beginner's Guide to MEP Embodied Carbon*, other CEBD related research currently being undertaken, etc.

Develop Comprehensive Procedures for calculating whole life carbon, ensuring consistency in data collection and application of emission factors. Incorporate all lifecycle stages from manufacturing to end-of-life, providing a complete view of carbon impacts associated with MEP systems. Provide default numbers for calculation with different equipment and distributions.

Frame the 2030 and the 2050 Targets: provide the framework to establish calculation procedures to achieve 2030 and 2050 carbon targets per the ASHRAE Position Document on Building Decarbonization

Pilot Implementation and Validation

- Choose "Mid-rise Apartments," "Primary Schools," "Large Hotels," and "Medium Office" in DOE Building Energy Code Program[9] as pilot projects to test the standardized methodologies and tools, ensuring applicability.

[9] https://www.energycodes.gov/prototype-building-models#Commercial

- Collect feedback from pilot project stakeholders to refine methodologies, address challenges, and improve accuracy.
- Document the results and lessons learned from pilot implementations, providing insights for broader application and potential adjustments.

Scope Limitations

- Issues related to refrigerant leakage and PCR determination are beyond the scope of this work as it is understood that they are currently being covered by other ASHRAE work.

Deliverables:

Results of this work are initially intended to be published as a Research Project Report. The contents of this report may be used for development into one of the following:

- Presentation of research results and associated Technical or Conference Paper at ASHRAE Conference (Winter or Annual) and at ASHRAE Decarbonization Conference
- Center of Excellence for Building Decarbonization Publications
- ASHRAE Guideline, suitable for use as a reference for Standard 240P, but not incorporated into the standard
- Appendix (normative or informative) for Standard 240P
- ASHRAE Handbook(s)
- Informing other research projects (Staff to coordinate information with other relevant projects - Updated Equipment Service Life Tables, Whole Life Carbon Gap Analysis)

A key consideration for the report will be to include recommendations for research related to the systems excluded from this project, if needed, based on the process and results from this project.

A synopsis of the report will be presented to the CEBD and co-sponsoring Technical Committees (TCs) at an ASHRAE meeting as agreed-upon by the CEBD and TCs.

a. Progress and Financial Reports

Progress and Financial Reports, in a form approved by the Society, shall be made to the Society through its Manager of Research and Technical Services at quarterly intervals; specifically, on or before each January 1, April 1, June 10, and October 1 of the contract period.

The following deliverables shall be provided to the Project Monitoring Subcommittee (PMS) as described in the Scope/Technical Approach section above, as they are available:

Furthermore, the Institution's Principal Investigator, subject to the Society's approval, shall, during the period of performance and after the Final Report has been submitted, report in person to the sponsoring Technical Committee/Task Group (TC/TG) at the annual and winter meetings, and be available to answer such questions regarding the research as may arise.

b. Final Report

In support of all Objectives, the researcher shall produce a final written report for the project detailing all work undertaken in the project, including data collection, methodologies used, raw data collected, data analysis, and results. Create a simplified summary table (1-2 standard paper size pages) for inclusion in the ASHRAE Handbook – HVAC Applications that includes final results from the analysis. Additionally, recommendations for further research and continuous development & updating of this table shall be provided.

A written report, design guide, or manual, (collectively, "Final Report"), in a form approved by the Society, shall be prepared by the Institution and submitted to the Society's Manager of Research and Technical Services by the end of the Agreement term, containing complete details of all research carried out under this Agreement,

including a summary of the control strategy and savings guidelines. Unless otherwise specified, the final draft report shall be furnished, electronically for review by the Society's Project Monitoring Subcommittee (PMS).

Tabulated values for all measurements shall be provided as an appendix to the final report (for measurements which are adjusted by correction factors, also tabulate the corrected results and clearly show the method used for correction).

Following approval by the PMS and the TC/TG, in their sole discretion, final copies of the Final Report will be furnished by the Institution as follows:

-An executive summary in a form suitable for wide distribution to the industry and to the public.
-Two copies; one in PDF format and one in Microsoft Word.

d. *Science & Technology for the Built Environment* or ASHRAE Transactions Technical Papers

One or more papers shall be submitted first to the ASHRAE Manager of Research and Technical Services (MORTS) and then to the "ASHRAE Manuscript Central" website-based manuscript review system in a form and containing such information as designated by the Society suitable for publication. Papers specified as deliverables should be submitted as either Research Papers for HVAC&R Research or Technical Paper(s) for ASHRAE Transactions. Research papers contain generalized results of long-term archival value, whereas technical papers are appropriate for applied research of shorter-term value, ASHRAE Conference papers are not acceptable as deliverables from ASHRAE research projects. The paper(s) shall conform to the instructions posted in "Manuscript Central" for an ASHRAE Transactions Technical or HVAC&R Research papers. The paper title shall contain the research project number (2026-SP) at the end of the title in parentheses, e.g., (2026-SP).

All papers or articles prepared in connection with an ASHRAE research project, which are being submitted for inclusion in any ASHRAE publication, shall be submitted through the Manager of Research and Technical Services first and not to the publication's editor or Program Committee.

e. Data

Data is defined in General Condition VI, "DATA"

f. Project Synopsis

A written synopsis totaling approximately 100 words in length and written for a broad technical audience, which documents 1. Main findings of research project, 2. Why findings are significant, and 3. How the findings benefit ASHRAE membership and/or society in general shall be submitted to the Manager of Research and Technical Services by the end of the Agreement term for publication in ASHRAE Insights

The Society may request the Institution submit a technical article suitable for publication in the Society's ASHRAE JOURNAL. This is considered a voluntary submission and not a Deliverable. Technical articles shall be prepared using dual units, e.g., rational inch-pound with equivalent SI units shown parenthetically. SI usage shall be in accordance with IEEE/ASTM Standard SI-10.

Level of Effort
$250,000 over 16 months

Other Information for Bidders".
Prepare representative case studies to demonstrate the calculation process and present results for at least four representative buildings and Building Systems (e.g. medium-office, primary school, large hotel, mid-rise apartments) at three distinctively different climate zones, which are properly justified. Interact with actual project stakeholders for the selected case studies to collect their feedback on the calculation steps and data availability, use this feedback and lessons learned to refine methodologies, address challenges, and improve accuracy.

Document the entire process, method and supporting data, the results and lessons learned from the case study implementations. Provide insights for broader application and need for future adjustments considering the needs and challenges that may emerge from implementation in different parts of the world. Include recommendations from a more global perspective.

Project Milestones:

No.	Major Project Completion Milestone	Deadline Month
1	Convene team and establish connections with appropriate groups for coordination	1
2	Define project methodology, including comprehensive list of relevant standards, guidelines, and references that will be reviewed, along with approach for collecting and documenting information used to determine default WLC values for components and equipment. Matrix of expected components and equipment to be developed, along with approach to determining default quantities of components and equipment for different building types.	3
3	Develop preliminary default values and methodology and analyze pilot projects to be used as case studies (mid-rise apartment, primary school, large hotel, and medium office) for three climate zones to validate or adjust values as appropriate. Collect data from multiple sources, including EPDs, North America TM65, and supplier reports.	6
	Develop final draft default values for building systems components and equipment along with methodology for final report. Analyze the available data from multiple sources. Justify the exclusion of specific building element categories or OmniClasses or provide well documented average data, if necessary.	12
	Develop final draft default values for building systems components and equipment along with methodology for final report. Analyze the available data from multiple sources. Justify	16
	Monthly progress meetings with PMS and CEBD representative(s)	Monthly

Proposal Evaluation Criteria

Proposals submitted to ASHRAE for this project should include the following minimum information:

No.	Proposal Review Criterion	Weighting Factor
1	Understanding of the work statement	15%
2	Quality of proposed personnel: project manager and assistant project manager; proposed team and collaborators	25%
3	Proposed methodology	20%
4	Probability of meeting objectives in scheduled timeframe	15%
5	Demonstrated performance with related projects or subject matter	20%
6	Ability to convene a multidisciplinary team to achieve objectives	5%

References

1. https://www.ashrae.org/technical-resources/research/research-strategic-plan
2. https://www.ashrae.org/file%20library/about/ashrae_building_decarbonization_pd_2022.pdf
3. https://www.ashrae.org/file%20library/about/ashrae_building_decarbonization_pd_2022.pdf
4. Architecture2030 https://architecture2030.org/2030_challenges/embodied/
5. Dixit, M.K. Life cycle embodied energy analysis of residential buildings: A review of literature to investigate embodied energy parameters. Renew. Sustain. Energy Rev. 2017, 79, 390–413. https://doi.org/10.1016/j.rser.2017.05.051
6. Rodriguez B.X., M. Huang, H. Woo Lee, K. Simonen, J. Ditto, Mechanical, electrical, plumbing and tenant improvements over the building lifetime: Estimating material quantities and embodied carbon for climate change mitigation, Energy and Buildings 2020, 226:110324. https://doi.org/10.1016/j.enbuild.2020.110324

7. Vilches, A.; Garcia-Martinez, A.; Sanchez-Montanes, B. Life cycle assessment (LCA) of building refurbishment: A literature review. Energy Build. 2017, 135, 286–301. https://doi.org/10.1016/j.enbuild.2016.11.042
8. Roberts, M., C. Ouellet-Plamondon, P. Raftery, Embodied carbon in mechanical, electrical, and plumbing systems: A critical literature review. Building and Environment 2025, 275: 112823. https://doi.org/10.1016/j.buildenv.2025.112823
9. https://www.cibse.org/knowledge-research/knowledge-portal/embodied-carbon-in-building-services-a-calculation-methodology-tm65
10. https://www.cibse.org/knowledge-research/knowledge-portal/tm65la-using-the-tm65-methodology-outside-the-uk-pdf-2022/
11. https://www.energycodes.gov/prototype-building-models#Commercial
12. Draft ASHRAE Standard 240P