STANDARD

ANSI/ASHRAE Standard 105-2021
(Supersedes ANSI/ASHRAE Standard 105-2014)

Standard Methods of Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emissions

Approved by the ASHRAE Standards Committee on October 19, 2021, by the ASHRAE Board of Directors on November 10, 2021, and by the American National Standards Institute on December 6, 2021.

ASHRAE® Standards are scheduled to be updated on a five-year cycle; the date following the Standard number is the year of ASHRAE Board of Directors approval. The latest edition of an ASHRAE Standard may be purchased on the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 180 Technology Parkway NW, Peachtree Corners, GA 30092. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2021 ASHRAE ISSN 1041-2336

Approved American National Standard
ANSI
www.ansi.org

Includes Web-based access to building and site energy-use forms. (Requires Microsoft® Word®.)

ASHRAE Standard Project Committee 105
Cognizant TC: 7.6, Building Energy Performance
SPLS Liaison: Richard T. Swierczyna

J. Patrick Carpenter*, *Chair*
Keith I. Emerson*, *Secretary*
Donald M. Brundage*
Drury B. Crawley*
Michael P. Deru*
Bruce D. Hunn*
Dennis R. Landsberg
Neil P. Leslie*
Frank J. Pucciano*
Steven Rosenstock*
Arunabha Sau*
Bruce J. Swiecicki*

** Denotes members of voting status when the document was approved for publication*

ASHRAE STANDARDS COMMITTEE 2020–2021

Drury B. Crawley, *Chair*
Rick M. Heiden, *Vice Chair*
Els Baert
Charles S. Barnaby
Robert B. Burkhead
Thomas E. Cappellin
Douglas D. Fick
Walter T. Grondzik
Susanna S. Hanson
Jonathan Humble
Srinivas Katipamula
Gerald J. Kettler
Essam E. Khalil
Malcolm D. Knight
Jay A. Kohler
Larry Kouma
Cesar L. Lim
James D. Lutz
Karl L. Peterman
Erick A. Phelps
David Robin
Lawrence J. Schoen
Steven C. Sill
Richard T. Swierczyna
Christian R. Taber
Russell C. Tharp
Theresa A. Weston
Craig P. Wray
Jaap Hogeling, *BOD ExO*
William F. McQuade, *CO*

Connor Barbaree, *Senior Manager of Standards*

SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus Standard developed under the auspices of ASHRAE. *Consensus* is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this Standard as an ANS, as "substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution." Compliance with this Standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.

ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

ASHRAE Standards are prepared by a Project Committee appointed specifically for the purpose of writing the Standard. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Project Committees.

The Senior Manager of Standards of ASHRAE should be contacted for

a. interpretation of the contents of this Standard,
b. participation in the next review of the Standard,
c. offering constructive criticism for improving the Standard, or
d. permission to reprint portions of the Standard.

DISCLAIMER

ASHRAE uses its best efforts to promulgate Standards and Guidelines for the benefit of the public in light of available information and accepted industry practices. However, ASHRAE does not guarantee, certify, or assure the safety or performance of any products, components, or systems tested, installed, or operated in accordance with ASHRAE's Standards or Guidelines or that any tests conducted under its Standards or Guidelines will be nonhazardous or free from risk.

ASHRAE INDUSTRIAL ADVERTISING POLICY ON STANDARDS

ASHRAE Standards and Guidelines are established to assist industry and the public by offering a uniform method of testing for rating purposes, by suggesting safe practices in designing and installing equipment, by providing proper definitions of this equipment, and by providing other information that may serve to guide the industry. The creation of ASHRAE Standards and Guidelines is determined by the need for them, and conformance to them is completely voluntary.

In referring to this Standard or Guideline and in marking of equipment and in advertising, no claim shall be made, either stated or implied, that the product has been approved by ASHRAE.

CONTENTS

ANSI/ASHRAE Standard 105-2021
Standard Methods for Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emissions

SECTION	PAGE
Foreword	2
1 Purpose	3
2 Scope	3
3 Definitions	3
4 Compliance	5
5 Measurement and Expression of Building Energy, Site Energy, and Energy Cost Performance	5
6 Determination and Expression of Primary Energy Performance	8
7 Expression of Greenhouse Gas Emissions	9
8 Additional Normalized Expressions of Building Energy Performance or Greenhouse Gas Emissions	9
9 Comparison of Building Energy Performance or Greenhouse Gas Emissions	10
Normative Appendix A: Form 1A—Building Characteristics	15
Form 1B—Building Energy Characteristics	16
Normative Appendix B: Form 2—Site Energy Performance Summary	17
Normative Appendix C: Form 3—Primary Energy Performance Summary	19
Normative Appendix D: Form 4—Greenhouse Gas Emissions Summary	21
Normative Appendix E: Form 5—Additional Expressions of Energy Performance or Greenhouse Gas Emissions	23
Normative Appendix F: Form 6—Comparison of Energy Performance or Greenhouse Gas Emissions	24
Informative Appendix G: Fuel Heat Content Conversion Values—Other Fuels	25
Informative Appendix H: Measuring Energy Use	26
Informative Appendix I: Adjusting Energy Use to a 365-Day Year	28
Informative Appendix J: Boundary Specifications and Conversion Factor Options	29
Informative Appendix K: Example Conversion Factors for Comparisons	40
Informative Appendix L: References and Bibliography	50

Download Appendix A, B, C, D, E, and F forms at https://www.ashrae.org/105-2021

NOTE

Approved addenda, errata, or interpretations for this standard can be downloaded free of charge from the ASHRAE website at www.ashrae.org/technology.

© 2021 ASHRAE

180 Technology Parkway NW · Peachtree Corners, GA 30092 · www.ashrae.org · All rights reserved.

ASHRAE is a registered trademark of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ANSI is a registered trademark of the American National Standards Institute.

(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

ANSI/ASHRAE Standard 105 was originally published in 1984 and dealt primarily with on-site energy use in buildings. Subsequent editions expanded the scope to more comprehensively address overall building energy performance in addition to energy use. Recognizing the potential impact of building performance on greenhouse gas emissions, the 2014 edition of Standard 105 extended the evaluations to source energy use and allowed for the evaluation of greenhouse gas emissions associated with the required primary energy generation.

This revised 2021 edition of Standard 105 is written in code-intended language so that it may be referenced or adopted by enforcement authorities to provide standardized methods for determining, expressing, and comparing the energy performance of and greenhouse gas emissions associated with the operation of buildings.

The standard provides consistent methods for the following:

a. Determining building energy use, site energy use, and primary energy use
b. Expressing building energy performance in terms of the various imported, exported, and produced energy forms
c. Expressing greenhouse gas emissions produced by building operation based on the various imported, exported, and produced energy forms
d. Expressing normalized building energy performance, building energy cost, and greenhouse gas emissions for comparing (1) design options for individual buildings, (2) similar buildings, and (3) changes in building performance over time based on effectiveness of energy efficiency measures for changes in the building, the systems, and operational strategies.

The standard is intended for evaluations of building energy performance and their potential impacts on greenhouse gas emissions both during design of new buildings and for existing operational buildings to assess retrofits and changes in operational strategies.

The standard incorporates an expanded list of energy forms to account for individual renewable and nonrenewable sources of both imported and exported energy to allow specific allocation of site-to-source conversion and greenhouse gas emissions based on the source of primary energy. This expanded list also incorporates transportation vehicle energy to isolate this energy use from actual building energy use.

The standard incorporates an accounting of all flows of energy imported, energy produced, energy stored, energy exported, and net energy use associated with a given building and site. Those flows are subdivided into multiple renewable and nonrenewable components to allow for better determination of associated primary energy and greenhouse gas emissions. The standard recognizes that building energy—especially that produced by renewable energy sources on-site—may be applied to multiple buildings within a site. The standard provides consistent methods and accounting to identify and allocate the energy use, energy cost, and associated greenhouse gas emissions, according to the needs of an individual building. While the standard can be applied to a site with multiple buildings, it does not explicitly provide methods to allocate the energy use of campus-based energy and utility systems from one or more central plants, external to individual buildings. Such allocation is most effectively achieved through individual metering of energy flows.

The informative appendices of the standard incorporate revised reference tables for site-to-source conversion with options that now include both captured energy and infinite energy as an efficiency approach and are now based upon eGRID 2018 data. Some of the primary energy factors differ significantly from the previous edition of the standard, owing to both improvements in technology and an increasing portion of renewable sources. The greenhouse gas emissions factors have also been updated and expanded to include both 20-year and 100-year time horizons as a way to assess emissions.

The committee discussed and evaluated the impact of developing methods for determining, expressing, and comparing the impact of building performance on water use in buildings. The committee decided that the interactions between building energy performance, building use and occupancy, and source energy generation options were too complex to easily characterize the relationships between building performance and building water use. While the committee agreed

that building performance does impact water use and that alternative approaches to building design, retrofit, and operation can have significant impact on water use, this standard does not currently address that aspect of building performance.

The standard provides flexibility for adopting agencies and authorities to incorporate localized considerations when accounting for greenhouse gas emissions associated with the source energy requirements. The basis for all energy measurements is the annual energy flow across the building and site boundaries. This edition of the standard supplements site energy measurements with methods for determining primary energy and greenhouse gas emissions produced at the option of the adopting authority. Because primary energy and greenhouse gas equivalence conversion factors will vary internationally, regionally, and even locally, they have been left to the discretion of the adopting authority. The standard contains a nonmandatory, informative appendix of source energy factors that may be used by the adopting authority as desired.

This standard is accompanied by supplemental files that include the forms shown in Normative Appendices A, B, C, D, E, and F. These forms can be downloaded at https://www.ashrae.org/105-2021.

1. PURPOSE

1.1 This standard provides consistent methods for determining and reporting the energy performance of buildings to facilitate (a) the comparison of design and operation strategies in new and existing buildings, (b) the development of building energy performance standards, and (c) the reporting of greenhouse gas emissions associated with building operation.

1.2 This standard provides consistent methods for determining, expressing, and comparing the energy performance of and the greenhouse gas emissions associated with the design of new buildings and with improvements to, or changes in, the operation of existing buildings.

2. SCOPE

2.1 This standard covers

a. new buildings and existing buildings or portions thereof;
b. the determination and expression of building energy performance and the estimate of greenhouse gas emissions associated with that energy use; and
c. techniques for the comparison of the energy performance and associated greenhouse gas emissions between different buildings or between alternative designs or operation strategies for the same building.

2.2 This standard does not

a. establish building energy performance or greenhouse gas emissions goals or limits;
b. present a method for certification of prediction methodology, such as computer programs;
c. address embodied energy of building materials and systems; or
d. incorporate transportation energy or associated greenhouse gas emissions for building functions, including commuting, business travel, and process transportation.

3. DEFINITIONS

adopting authority: the agency or agent that adopts this standard.

avoided energy: energy not consumed based on the last units of energy subtracted from a system. The energy subtracted is established based on comparisons between alternative design or operational strategies or energy efficiency measures.

avoided greenhouse gas emissions: greenhouse gas not emitted based on the last units of energy subtracted from a system. The energy subtracted is established based on comparisons between alternative design or operational strategies or energy efficiency measures.

building: a structure wholly or partially enclosed within exterior walls, or within exterior and party walls, and a roof, affording shelter to persons, animals, or property.

building energy: energy consumed as measured or estimated at the building boundary (E_{bld}).

building energy performance: building energy, site energy, or primary energy divided by one or more normalization parameters.

building site: a building, or group of buildings, and surrounding area of land that is contiguous or separated only by public rights of way, all of which are under the same ownership or control.