**Draft PDS-02**

**Standard RESNET/ICC 1550**

Standard for Quantifying, Verifying and Reporting the Embodied Carbon of Buildings with Dwelling and Sleeping Units

[1 Purpose 3](#_Toc549094673)

[2 Scope 4](#_Toc771827499)

[3 Definitions 4](#_Toc2106844845)

[3.1 General 4](#_Toc1495690364)

[3.2 Definitions 4](#_Toc151990994)

[3.3 Acronyms 9](#_Toc1280489684)

[4 Embodied Carbon Emissions Assessment Requirements 10](#_Toc762174900)

[4.1 Assessment Types 10](#_Toc1161007283)

[5 Embodied Carbon Emissions Data Requirements 11](#_Toc1577839451)

[5.1 Spatial Boundary 11](#_Toc1943705943)

[5.2 Scope of Life Cycle Modules 11](#_Toc460416528)

[5.3 Global Warming Potential (GWP) Data 12](#_Toc896054918)

[5.4 Minimum Assessed Products 13](#_Toc513515588)

[5.5 Establishing a Material Inventory 15](#_Toc1931395398)

[5.6 Existing Dwelling Unit Retrofit Scenarios 15](#_Toc334665244)

[6 Embodied Carbon Emissions Calculations 15](#_Toc354314178)

[6.1 Reference Units for Calculations 15](#_Toc439030879)

[6.2 Calculating Embodied Carbon Emissions and Carbon Storage for Minimum Assessed Products 15](#_Toc1400995711)

[6.3 Optional Embodied Carbon Calculations 16](#_Toc520674364)

[6.4 Total Embodied Carbon Emissions Results 18](#_Toc1311818759)

[6.5 Embodied Carbon Emissions Intensity Results 19](#_Toc1996143252)

[7 Verification Requirements 21](#_Toc1166481379)

[7.1 Verification of Minimum Assessed Products for Projected Assessments 21](#_Toc328842423)

[7.2 Verification of Minimum Assessed Products for Confirmed Assessments 21](#_Toc397546561)

[7.3 Verification of Confirmed Assessment Results for Assessed Dwelling Units 22](#_Toc1768157259)

[8 Reporting Requirements 22](#_Toc1505448897)

[8.1 Project Information 22](#_Toc271237685)

[8.2 Reporting of Minimum Assessed Product Results 23](#_Toc405407377)

[8.3 Reporting of Assessed Dwelling Unit Embodied Carbon Results 23](#_Toc463957247)

[8.4 Reporting of Assessed Dwelling Unit Embodied Carbon Intensity Results 23](#_Toc1934493681)

[8.5 Reporting of Optional Results 24](#_Toc1650312741)

[9 References 24](#_Toc1786462354)

[9.1 Normative References 24](#_Toc1209882579)

[10 Appendix 25](#_Toc456844183)

[10.1 Establishing a Material Inventory (Normative) 25](#_Toc1419031005)

[10.2 Waste Rates for Products (Normative) 34](#_Toc1229648768)

[10.3 Verification Procedures for Confirmed Assessments (Normative) 35](#_Toc569172066)

[10.4 Building Components Exclusions (Normative) 37](#_Toc239809467)

[10.5 Limitations of This Methodology (Informative) 39](#_Toc1658154082)

[10.6 Sample Report for Confirmed Assessment for a Single Detached Dwelling Unit (Informative) 39](#_Toc1995703234)

**Foreword (Informative)**

This Standard provides a methodology for quantifying, verifying and reporting the embodied carbon emissions of Dwelling Units and Sleeping Units in Residential and Commercial Buildings. The methodology does not provide ranking or scoring of the results produced using the Standard. This Standard is intended to enable energy raters and other practitioners to perform embodied carbon calculations leveraging the area-based building models and data inputs they already create, minimizing the number of steps required to complete an embodied carbon report.

Several modules of life cycle assessment are currently excluded from this Standard, including the embodied carbon emissions associated with transportation of products to the construction site, construction-related activities, maintenance, replacement, and end of life/disposal of building products. The technical working group determined that, as of the date of this draft, there was insufficient reliable data on the embodied carbon emissions associated with these stages of a residential building’s life cycle to quantify the impact to a reasonable standard of accuracy and actionability. Therefore, to maintain the technical rigor of the calculations in the rest of the Standard, embodied carbon emissions outside of the cradle-to-gate stages are not calculated in this current Standard. The technical working group intends to include additional life cycle modules as data availability and quality improve.

The embodied carbon emissions included in the Standard consider building products used in the following building elements: structure, enclosure, partitions, mechanical, electrical, plumbing, finishes and garages and therefore address the majority of products that compose a residential building and the majority of emissions arising from homebuilding.

This Standard is intended to work alongside the Carbon Index results achieved by using RESNET Standard 301 to assess operational emissions. By considering the results of both an embodied carbon assessment and the Carbon Index, it is possible to understand a more holistic carbon footprint for an *assessed dwelling unit*. Raters and homebuilders can use the combined results to achieve coordinated decarbonization decisions that support emission reductions of both operational and embodied emissions.

Quality Assurance (QA) measures will be an important aspect of ensuring that reports generated using this Standard are complete and trustworthy. Development of appropriate QA guidelines will be undertaken once this Standard enters the market, and users can collaborate to create such guidance and may be added to the Standard under continuous maintenance.

This Standard contains both normative and informative material. The body of the Standard is normative and shall be complied with to conform to the Standard. Informative materials are not mandatory and are limited to this forward, footnotes, references, and annexes, all of which are clearly marked as informative.

# Purpose

The provisions of this document establish a methodology for quantifying, verifying and reporting embodied carbon emissions associated with building products and *buildings*.

# Scope

This standard is applicable to buildings with Dwelling Units and Sleeping Units in Residential or Commercial Buildings, excepting hotels and motels.

This standard does not set benchmarks or establish levels of building performance.

This standard shall not be used to circumvent any safety, health, or environmental requirements.

# Definitions

## General

Unless stated otherwise, the terms and words in Section 3.2 shall have the meanings indicated therein. Words used in the present tense include the future, words in the masculine gender include the feminine and neuter, and singular and plural are interchangeable. Terms not defined in Section 3.2 shall have ordinary accepted meanings such as the context implies.

## Definitions

**Approved** – Acceptable to an entity adopting and requiring the use of this Standard as a result of investigation and tests conducted by the entity or by reason of accepted principles or tests by nationally recognized organizations.

***Approved Rating Provider*** – An approved entity responsible for the certification of raters working under its auspices and who is responsible for the quality assurance of such Certified Raters and for the quality assurance of embodied carbon assessments produced by such home energy raters.

***Assessed Dwelling Unit –*** The real property evaluated using the procedures specified by this Standard.

***Attached Dwelling Unit*** – A Dwelling Unit sharing demising walls, floors, ceilings or common corridors with another Dwelling Unit or Occupiable Space.

***Bathroom*** – A room with at least one sink and at least one toilet.

***Bedroom*** – For one- and two-family Dwellings and Townhouses, a room or space 70 square feet of floor area or greater, with egress window or skylight, and doorway to the main body of the Dwelling Unit, that can be used for sleeping. For all other Dwelling Units, a room or space that can be used for sleeping. For all Dwelling or Sleeping Units, the number of bedrooms shall not be less than one.

***Biogenic Carbon*** – Carbon derived from plant or animal sources excluding fossil carbon.

***Building*** – Any structure used or intended for supporting or sheltering any use or occupancy, including any mechanical systems, service water-heating systems and electric power and lighting systems located on the building site and supporting the building.

***Building Site*** –A contiguous area of land that is under the ownership or control of one entity.

***Carbon Dioxide (CO2)*** – A naturally occurring gas, CO2 is also a by-product of burning fossil fuels (such as oil, gas, and coal), of burning biomass, of land-use changes and of industrial processes (e.g., cement production). It is the reference gas against which other GHGs are measured and therefore has a global warming potential (GWP) of 1.

***Carbon Dioxide Equivalent (CO2e)*** – Unit for comparing the radiative forcing of a greenhouse gas (GHG) to that of carbon dioxide.

***Certified Rater*** – An individual who has become qualified to conduct embodied carbon assessments through certification by an Approved Rating Provider.

***Commercial Building –*** All buildings not included in the definition of Residential Buildings.

***Comparable Product Type*** – Building products that are identical or equivalent to the reference product in terms of composition, applicable performance attributes, and ability to satisfy applicable code requirements.

***Conditioned Floor Area (CFA)*** – The floor area of the Conditioned Space Volume within a building or Dwelling Unit, not including the floor area of attics or crawl spaces, and basements below air sealed and insulated floors. The following specific spaces are addressed to ensure consistent application of this definition:

* The CFA shall include the floor area of the full width of a wall assembly that is within the Conditioned Space Volume.
  + Exception: If the subject Dwelling Unit shares a wall assembly[[1]](#footnote-2) with another Dwelling Unit, then the CFA of the subject Dwelling Unit shall extend to the midpoint of that shared wall assembly.
* The CFA shall include the floor area of a basement only if it is contiguous with and dedicated[[2]](#footnote-3) to the subject Dwelling Unit and the parting conducting the assessment has either:
  + Obtained an ACCA Manual J, S, and either B or D report and verified that both the heating and cooling equipment are designed to offset the entire design load of the volume; or
  + Verified through visual inspection that both the heating and cooling equipment and distribution system serve the volume and in the judgment of the party conducting evaluations, are capable of maintaining space conditions at 78F (26C) for cooling and 68F (20C) for heating.
* The CFA shall exclude the floor area of a garage even when it is conditioned.
* The CFA shall exclude the floor area of a thermally isolated sunroom.
* The CFA shall exclude the floor area of an attic even when it is Conditioned Space Volume[[3]](#footnote-4).
* The CFA shall exclude the floor area of a crawl space even when it is Conditioned Space Volume.

***Conditioned Space Volume (CSV)[[4]](#footnote-5) –*** The volume within a Dwelling Unit serviced by a space heating or cooling system designed to maintain space conditions at 78F for cooling and 68F for heating. The following specific spaces are addressed to ensure consistent application of this definition:

* If the volume both above and below a floor assembly meets this definition and is part of the subject Dwelling Unit, then the CSV shall include the volume of the full depth of the floor assembly. Otherwise, the volume of the full depth of the floor assembly shall be excluded.
  + Exception: The wall height used to determine the volume shall extend from the finished floor to the bottom surface of the floor decking above the Assessed Dwelling Unit for all floors other than the top floor. For Dwelling Units on the top floor, this dimension shall extend from the top surface of the finished floor to the interior surface of the enclosure air barrier.
* If the volume of at least one of the spaces horizontally adjacent to a wall assembly meets this definition, and that volume is part of the subject Dwelling Unit, CSV shall include the volume of the full width of the wall assembly. Otherwise, the volume of the full width of the wall assembly shall be excluded.
  + Exception: If the subject Dwelling Unit shares a wall assembly[[5]](#footnote-6) with another Dwelling Unit, then the CSV of the subject Dwelling Unit shall include half the volume of the full width of that shared wall assembly.
* The CSV shall exclude the volume of a garage, even when it is conditioned.
* The CSV shall exclude the volume of thermally isolated sunroom.
* The CSV shall include the volume of an attic, crawl space, or a basement only if it is contiguous with and dedicated[[6]](#footnote-7) to the subject Dwelling Unit and the party conducting evaluations has either:
  + Obtained an ACCA Manual J, S and either B or D report and verified that both the heating and cooling equipment and distribution system are designed to offset the entire design load of the volume; or
  + Verified through visual inspection that both the heating and cooling equipment and distribution system serve the volume and, in the judgment of the party conducting evaluations, are capable of maintaining space conditions at 78F (26C) for cooling and 68F (20C) for heating.
* The CSV shall include the volume of an adjacent mechanical closet, regardless of access location, only if it is contiguous with and dedicated to the subject Dwelling Unit, only includes equipment serving the subject Dwelling Unit, and the party conducting assessments has either:

Obtained an ACCA Manual J, S and either B or D report and verified that both the heating and cooling equipment and distribution system are designed to offset the entire design load of the volume; or

Verified through visual inspection that both the heating and cooling equipment and distribution sytem serve the volume and, in the judgment of the party conducting evaluations, are capapble of maintaining space conditions at 78F (26C) for cooling and 68F (20C) for heating.

***Confirmed Assessment –*** An assessment accomplished using data verified by field assessment of installed products.

***Construction documents –*** Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.

***Cradle-to-Gate*** – The life cycle assessment modules inclusive of resource extraction through building product manufacturing inclusive of Raw Material Supply, Transport to Factory, and Manufacturing life cycle modules, captured in life cycle assessment modules A1-A3.

***Detached Dwelling Unit*** – A Dwelling Unit that does not meet the definition of Attached Dwelling Unit.

***Dwelling*** – Any building that contains one or two Dwelling Units used, intended, or designed to be built, used, rented, leased, let, or hired out to be occupied, or that are occupied for living purposes.

***Dwelling Unit*** – A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

***Embodied Carbon*** – The greenhouse gas emissions associated with the life cycle of buildings and building products. For the purposes of this Standard, Embodied Carbon refers to the life cycle modules within the stated boundary.

***Environmental Product Declaration (EPD)*** – A document providing quantified environmental data including *Global Warming Potential* using predetermined parameters and according to life cycle assessment standards such as ISO 14025 and ISO 21930 or EN 15804.

***Existing Dwelling Unit Retrofit*** – The set of energy efficiency and/or product improvements made to an existing dwelling unit to improve its energy performance.

***Fossil Carbon*** – Carbon that is contained in fossilized material. Examples of fossilized material are coal, oil, natural gas, and peat.

***Framing Fraction (FF)*** – The fractional area of walls, ceilings, floors, roofs and other enclosure elements comprising the structural and partition framing elements with respect to the total Gross Area of the component.

***Global Warming Potential (GWP) –*** Index measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of Carbon Dioxide (CO2). For the purposes of this Standard, the GWP for a compound shall be calculated up to a 100-year integrated time horizon.

***Greenhouse Gas (GHG)*** – The release of greenhouse gases into the atmosphere.

***Greenhouse Gas Emissions*** – The release of greenhouse gases into the atmosphere that absorb and emit radiation at specific wavelengths within the range of the electromagnetic spectrum that radiation is emitted by the Earth’s surface, the atmosphere, and clouds.

***Gross Area*** – The area of a building enclosure component that includes the areas of the fenestration areas that are not normally included in the net area of the enclosure component. Normally, the simple area calculated as the overall length times the overall width of the enclosure component.

***Gross Floor Area*** ***(GFA)*** – The sum of the floor areas of all enclosed spaces inside the building. Measurements shall include walls and be taken from their exterior faces. Parking and access roads are excluded, as are air shafts, pipe trenches, chimneys, and penthouse spaces with headroom height of less than 2.2 meters (7.5 feet).

***GWP Factor*** –A representative value that attempts to relate the quantity of greenhouse gas emission in carbon dioxide equivalent with an activity, building element, process or flow associated with the emission. These factors are usually expressed as the weight of carbon dioxide equivalent divided by a unit weight, volume, distance, function, or duration of the activity, building element, process or flow that causes the GHG emission and are used in Environmental Product Declarations.

***Industry-average EPD*** – Environmental Product Declaration (EPD) that declares average GWP factors for products from multiple manufacturers in a clearly defined sector and/or geographical area.

***Life*** ***Cycle Assessment (LCA)*** – The compilation and evaluation of the inputs, outputs, and the potential environmental, social, and economic impacts of an assessed dwelling unit or product throughout its life cycle, from cradle to grave.

***Minimum Assessed Products*** – The products included in an embodied carbon assessment which are the basis for the calculation of global warming potential results for the purpose of an assessment in accordance with this Standard.

***Module A1***– The life cycle information module corresponding to all processes and materials associated with harvesting, extraction, collection, and further processing of raw materials. Also known as life cycle module A1.

***Module A2*** – The life cycle information module corresponding to the transport of raw materials to a product manufacturing facility or to multiple manufacturing facilities. Also known as life cycle module A2.

***Module A3*** – The life cycle information module corresponding to the processes and materials required for the fabrication and production of a product. Also known as life cycle module A3.

***Occupiable Space*** – An enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and equipment rooms, that are only intended to be occupied occasionally and for short periods of time.

***Product-Specific*** – Referring to a single product developed by a single manufacturer.

***Product-specific EPD*** – Environmental Product Declaration (EPD) developed by a single-manufacturer that provides data on a single product.

***Projected Assessment –*** An assessmentaccomplished using GWP factors for Minimum Assessed Products derived from construction documents.

***Quality Assurance*** – The systematic processes intended to ensure reliable compliance with applicable standards.

***Reference Study Period*** – the period over which the time-dependent characteristics of the built structure of assessment are analyzed.

***Residential Building*** – Includes detached one- and two-family dwellings and townhouses as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.

***Reused Material*** –Material recovered from an existing application to be reused in its original form with minimal processing.

***Shall*** – As used in this Standard, the word ‘shall’ means that the action specified is mandatory and must be accomplished by the responsible party.

***Sleeping Unit*** - A room or space in which people sleep, which can also include permanent provisions for living, eating, and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a Dwelling Unit are not Sleeping Units.

***System Boundary*** – The physical, geographical, and temporal scope of the assessment, including life cycle modules, building elements, processes, flows, and activities.

***Threshold Assessment*** – An assessment accomplished using Threshold Specifications to determine the embodied carbon results where verification of all Minimum Assessed Products is accomplished through verification requirements of this Standard.

***Threshold Specifications*** –A set of qualification criteria established based on a Worst–Case Analysis of an explicit design specification.

***Townhouse*** –A building that contains three or more attached townhouse units***.***

***Townhouse Unit*** –A single-family dwelling unit in a townhouse that extends from foundation to roof and that has a yard or public way on not less than two sides.

***Worst-Case Analysis*** – An analysis for which the Minimum Assessed Products of the Dwelling Unit are configured to provide the highest GWP results for building products that are optional selections within Comparable Product Types.

## Acronyms

***ASHRAE*** – originally known as American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

***ASTM*** – ASTM International, originally known as the American Society for Testing and Materials (ASTM)

***BIM*** – Building Information Modeling

***BOM*** – Bill of Materials

***CFA*** – Conditioned Floor Area

***CO2 –*** Carbon Dioxide

***CO2e*** – Carbon Dioxide Equivalent

***DOE*** – U.S. Department of Energy

***EPA*** *–* U.S. Environmental Protection Agency

***EPD*** – *Environmental Product Declaration*

***FF –*** *Framing Fraction*

***GFA*** – *Gross Floor Area*

***GHG*** – Greenhouse Gases

***GWP*** – *Global Warming Potential*

***HUD*** – U.S. Department of Housing and Urban Development

***HVAC*** – Heating, Ventilation and Air Conditioning

***IDR*** – Innovation Design Request

***IRS*** – U.S. Internal Revenue Service

***LF*** – Lineal feet

***LCA*** – Life Cycle Assessment

***LOD*** – Level of Detail

***MEP*** – Mechanical, electrical and plumbing products

***RESNET*** – Residential Energy Service Network, Inc.

# Embodied Carbon Emissions Assessment Requirements

## Assessment Types

Two assessment types may be performed in accordance with Sections 4.1.1 through 4.1.2. *Dwelling units* may have either or both types of assessment.

### **Projected Assessments** are generated prior to construction wherein the actual installed conditions, equipment, and systems are not yet completed or installed. *Projected Assessments* shall be conducted in accordance with Sections 5, 6 and 7.

#### All *Minimum Assessed Products* for a *Projected Assessment* shall be determined from *construction documents* for a new or existing dwelling unit in accordance with Table 5.4.1.

#### *Projected Assessments* shall use *GWP factors* in accordance with Section 5.3.

#### *Projected Assessments* of *detached dwelling units* and *attached dwelling units* shall be calculated according to Section 6.

#### *Projected Assessments* shall be reported according to Section 8.

### **Confirmed Assessments** are conducted, generated, and verified after completion of construction in accordance with Sections 5, 6 and 7.

#### All *Minimum Assessed Products* for a *Confirmed Assessment* shall be determined from *construction documents* and on-site assessments for new or existing *dwelling units* in accordance with Table 5.4.1 and verified according to the requirements in Section 7.

#### *Confirmed Assessments* shall use *GWP factors* in accordance with Section 5.3. Where assessment reveals use of a product different from the *construction documents*, the installed *product specific GWP factor* shall be substituted.

#### *Confirmed Assessments* of *detached dwelling units* and *attached dwelling units* shall be calculated in accordance with Section 6.

#### *Confirmed Assessment* shall be reported in accordance with Section 8.

# Embodied Carbon Emissions Data Requirements

## Spatial Boundary

The spatial boundary shall be a *building,* or a portion of a *building,* represented on the *construction documents and* shall not include the *site* or materials itemized in Table 10.4.1.

## Scope of Life Cycle Modules

The *system boundary* shall address the following tier of life cycle modules[[7]](#footnote-8):

Table 5.2.1 Scope of Life Cycle Modules

|  |  |
| --- | --- |
| **Tier** | **Life Cycle Modules Included** |
| I | Modules A1-A3+ A5.3 |

The *system boundary* shall not include any of the following:

1. Quantification of on-site *biogenic carbon* sequestration where carbon flows occur outside of life cycle modules A1-A3[[8]](#footnote-9),
2. avoided GHG emissions,
3. on-site carbon capture activities,
4. carbon offsets,
5. carbon credits,
6. renewable energy credits, or
7. other environmental attribute crediting mechanisms.

## Global Warming Potential (GWP) Data

The *GWP factors* used to calculate emissions of building products shall be consistent with Sections 5.3.1 through 5.3.7 and the information and scenarios employed in the assessment shall cover the required life cycle modules as defined in Section 5.2.

### Allowable Data Source Types

The following data sources shall be used to determine the most representative *GWP factor* for each building product in accordance with Table 5.3.2.

#### Environmental Product Declarations. EPDs shall be valid, independently verified, according to ISO 14025 and ISO 21930:2017 or EN 15804+A2. EPDs using EN 50693 shall be accepted for electrical equipment. *Product-specific EPDs* and *Industry-average EPDs* shall be the most recently published EPD specific to the product type.

#### Life Cycle Assessments. LCAs shall be third-party verified to comply with ISO 14040 and ISO 14044. The third-party review shall meet the requirements and competencies for what constitutes a critical review of an LCA study according to ISO 14071. LCAs will be considered valid for five years after publication.

#### For MEP products with no EPD or LCA, use the default values provided in Table 10.1.5.

### GWP Data Sources

Allowable *GWP factor* data sources shall be selected in accordance with Table 5.3.2. Data scenarios and *GWP factors* from Table 5.3.2 shall be documented in all reporting according to Section 8.2.

Table 5.3.2 GWP Data Sources

|  |  |
| --- | --- |
| **Scenario** | **GWP Factor** |
| 1. When a specific product and manufacturer has been referenced in the *construction documents* or identified during verification | 1. *Product-specific* *EPD* for the specified product 2. LCA for the specified product |
| 1. When a specific product and/or manufacturer has been referenced in the *construction documents* or identified during verification, but no *product specific EPD* or LCA is available | 1. *Industry-average EPD* for *comparable product type* when product manufacturer is listed on the EPD 2. Benchmarkvaluefor *comparable product type* in accordance with section 5.3.3. 3. LCA for *comparable product type* 4. For MEP products, default values fromTable 10.1.5*.* |

The following requirements shall apply to all GWP data sources in Table 5.3.2(B):

Where multiple data points exist, the data source with the highest *GWP* factor and that is most geographically representative shall be used.

### Benchmark GWP factors

Where no *product-specific EPD* or *LCA* or *industry-average EPD* or *LCA* for *comparable product type* exists to provide a *GWP factor* for a product, a benchmark GWP factor shall be applied using the highest GWP factor from EPDs for comparable product types.

### Quantification of Uncertainty of GWP *Factors*

### No uncertainty factors shall be applied to *GWP factors* from any data source used in calculations.

### Biogenic Carbon

### *Biogenic carbon* flows shall be calculated in accordance with Section 6 and reported for *LCA* modules A1-A3 only.

### Carbonation

### Sequestered carbon from the process of carbonation shall be calculated in accordance with Section 6 and reported for LCA modules A1-A3 only.

### Reused Materials

For *reused materials* installed in the *assessed dwelling unit*, a *GWP factor* of 0 (zero) shall be assumed. Quantities for *reused materials* shall be calculated according to Table 10.1.1 and included in reports according to Section 8.2.

## Minimum Assessed Products

Within the *system boundary*, all applicable building productslisted in Table 5.4.1 shall be identified on the *construction documents* and included in the calculations.

All building products identified as exclusions in Appendix 10.4.1 may be included in the calculations in accordance with Section 6 but shall be reported separately in reports complying with Section 8.

Table 5.4.1 Minimum Assessed Products

|  |  |
| --- | --- |
| **Building Element** | **Minimum Assessed Products** |
| Foundations,  Subgrade Enclosures,  and Slabs-on-Grade | Concrete elements, incl. walls, footings, pads, piers & piles |
| Reinforcement bars and mesh |
| Perimeter frame walls integral to foundation assembly |
| Insulation, exterior & interior |
| Barriers (air tightness, waterproofing, drainage) |
| Aggregate |
| Exterior Walls | Wall structure (framing, SIP, masonry, other) |
| Sheathing |
| Strapping/furring |
| Cladding |
| Windows |
| Exterior doors (glazed and opaque) |
| Insulation (cavity, continuous, band joist, other) |
| Barriers (air tightness, waterproofing) |
| Paint (if site painting required) |
| Roofs | Roof structure (framing, SIP, other) |
| Roof deck sheathing |
| Roof deck strapping |
| Roofing |
| Insulation |
| Barriers |
| Skylights |
| Interior Construction | Floor structure (framing, SIP, other) |
| Floor sheathing/subflooring |
| Walls (framing, masonry, other) |
| Ceiling structure (framing, SIP, other) |
| Structural posts and beams |
| Sound and/or fire insulation |
| Doors |
| Party walls |
| Stairs |
| Shafts |
| Interior Finishes | Wall finish |
| Ceiling finish |
| Flooring |
| Paint |
| Plumbing | Supply and drain piping |
| Fixtures (toilets, sinks, tub/shower) |
| Hot water equipment |
| HVAC | Heating & cooling equipment |
| Mechanical ventilation systems |
| Distribution systems (ducts, tubing) |
| Electrical | Wire, boxes, panels |
| Attached and Detached Garages, excluding accessory dwelling units and all other attached or detached buildings | Assessments of attached and detached garages shall include all Minimum Assessed Products included in this table used to construct the garage. |
| Balconies, decks and porches, excluding those not attached to the *assessed dwelling unit* | Assessments of attached balconies, decks and porches shall include all Minimum Assessed Products included in this table used to construct the balconies, decks and or/porches. |

## Establishing a Material Inventory

Building *construction documents* shall be used to establish a material inventory for all *Minimum Assessed Products* according to Tables 10.1.1 and 10.1.5.

### For prefabricated components, manufacturer specifications and/or bills of materials may be used to determine a material inventory according to the requirements of Table 10.1.1.

## *Existing Dwelling Unit Retrofit* Scenarios

Only newly installed building products shall be included in assessments for retrofit projects. Retained products shall not contribute to the assessment. *Existing dwelling unit retrofit* assessments shall use the calculation procedures in this Standard for all *Minimum Assessed Products* included in Table 5.4.1 applied in the retrofit project.

Emissions attributed to demolition work and disposal of materials removed from an existing dwelling unit retrofit assessment are not required to be reported.

# Embodied Carbon Emissions Calculations

Assessments shall conform with the calculation requirements in Sections 6.1 through 6.5.

## Reference Units for Calculations

The *GWP* of all *Minimum Assessed Products* shall be calculated using kilograms of *carbon dioxide equivalent* (kg CO2e) as per “Unit for Results” column in Table 10.1.1.

Input dimensions used for calculations may be in British Imperial System (IP) units but shall be converted to International System of Units (SI) for GWP calculations.

Results shall be reported in both SI and IP units as per Section 8.2.

## Calculating Embodied Carbon Emissions and Carbon Storage for Minimum Assessed Products

Each *Minimum Assessed Product* shall have calculated the gross *embodied carbon* emissions and carbon storage.

### Gross *embodied carbon* emissions for products

Gross *embodied carbon* emissions for each *Minimum Assessed Product* shall be calculated as follows:

**GECproduct = (Material Quantity + Waste Factor) x GWP Factor**

Where:

GECproduct = GWP for a project-specific quantity of a *building product* for life cycle modules A1-A3 + A5.3 (kg CO2e)

Material Quantity = total quantity of *building product* calculated as per Tables 10.1.1 and 10.1.5.

Waste Factor = product waste factor percentage from Table 10.2.1.

GWP Factor = *global warming potential* (GWP) factor associated with a *building product* for the life cycle modules A1-A3 according to table 5.3.2.

### Carbon storage for products

Carbon storage for each *Minimum Assessed Product* that includes *biogenic carbon* as per Section 5.3.5 and carbonation as per Section 5.3.6 shall be calculated as follows:

**CSproduct = (Material Quantity – Waste Factor) x GWPbiogenic**

Where:

CSproduct = Carbon storage for a project-specific quantity of a *building product* for life cycle modules A1-A3 (kg CO2)

Material Quantity = Total quantity of product calculated as per Tables 10.1.1 and 10.1.5

GWPbiogenic = *Biogenic carbon* or carbonation associated with a *building product* for life cycle modules A1-A3 based on a data source selected according to Table 5.3.2. If the relevant data source does not include a GWPbiogenic factor, the GWPbiogenic factor shall be calculated as follows:

**GWPbiogenic = Material Quantity (mass) x Carbon Content x 3.67**

Where:

GWPbiogenic = Mass of atmospheric *carbon dioxide* stored in the product

Material Quantity = Mass of product calculated as per Tables 10.1.1 and 10.1.5

Carbon Content = Percentage of product mass represented by carbon content x Carbon content of feedstock material

3.67 = Molar mass conversion factor from carbon content to CO2 content

## Optional Embodied Carbon Calculations

### Embodied carbon of photovoltaic systems

The embodied carbon of photovoltaic systems with modules installed on the roof of an assessed building may be estimated using the following calculation[[9]](#footnote-10):

Where:

ECPV = total *embodied carbon* impact from photovoltaic system (kg CO2e).

PVkW= photovoltaic system rated capacity (kW).

GWPPV = 675 kg CO2e/kW

GWPinverter = 0.0033 kg CO2e/kW

GWPwire = 54.4 kg CO2e

The results of this calculation shall not be included in the Total Embodied Carbon Emissions Results as determined in Sections 6.4 and 6.5. The results may be included as a distinct value in a report in accordance with Section 8.5.1.

### GWP of refrigerant leakage

The GWP of refrigerant leakage from heat pumps and/or any HVAC system component connected to a field charged or pre-charged refrigerant line installed in assessed buildings may be estimated using one of the following calculations:

#### When Total Refrigerant Mass is Known (for Equipment and Lineset)

Where:

ECRF = total *embodied carbon* impact from refrigerant (kg CO2e).

GWPRF= refrigerant emission factor (kg CO2e/kg); assume 2,088 kg CO2e/kg for R-410A, 466 kg CO2e/kg for R-454B, 675 kg CO2e/kg for R-32, and 1 kg CO2e/kg for R-744.

WRF,,total = total weight of refrigerant charge in system including lineset distribution (kg)

LR = annual leakage rate (%); assume 4% annual leakage

#### When Only the Refrigerant Mass for Equipment is Known (Mass for the Lineset to Be Determined)

Where:

ECRF = total *embodied carbon* impact from refrigerant (kg CO2e).

GWPRF= refrigerant emission factor (kg CO2e/kg); assume 2,088 kg CO2e/kg for R-410a, 466 kg CO2e/kg for R-454B, 675 kg CO2e/kg for R-32, and 1 kg CO2e/kg for R-744.

WRF,charge = weight of refrigerant charge in equipment only (kg)

Llineset = length of lineset (m)

Dlineset = diameter of lineset (m)

PRF = density of refrigerant (kg/m3); assume 194.4 kg/m3 for R-410A, 189.6 kg/m3  for R-454B, 161.3 kg/m3 for R-32, and 144.9 kg/m3 for R-744[[10]](#footnote-12).

LR = annual leakage rate (%); assume 4% annual leakage

The results of this calculation shall not be included in the Total Embodied Carbon Emissions Results as determined in Sections 6.4 and 6.5. The results may be included as a distinct value in a report as determined in Section 8.5.2.

### Net *embodied carbon* for products

Net *embodied carbon* emissions for each *Minimum Assessed Product* may be calculated as follows:

**NECproduct = GECproduct – CSproduct**

Where:

NECproduct = Net *embodied carbon* for a project-specific quantity of a *building product* for life cycle modules A1-A3+A5.3 (kg CO2e)

GECproduct = GWP for a project-specific quantity of a *building product* for life cycle modules A1-A3+A5.3 (kg CO2e)

CSproduct = Carbon storage for a project-specific quantity of a *building product* for life cycle modules A1-A3 (kg CO2)

## Total Embodied Carbon Emissions Results

Total emissions results shall include the gross *embodied carbon* emissions and carbon storage for the *assessed dwelling unit.* The net embodied carbon may be included distinctly in accordance with Section 8.

For *assessed dwelling units* with *attached dwelling units*, the total *embodied carbon* emissions results shall be calculated according to one of the methods below and stated explicitly in the report according to Section 8:

1. Whole Building Method: summation of the total gross *embodied carbon* emissions and total carbon storage for all *Minimum Assessed Products* for the entire *building* according to Section 5.4 and calculated according to Section 6.3
2. Threshold Method: summation of the total *embodied carbon* emissions and total carbon storage according to Section 6.3 according to the *threshold specifications* for each unique *dwelling unit* type resulting from the *worst-case analysis* for the *Minimum Assessed Products* according to Section 5.4 of that *dwelling unit* type and multiplied by the number of *dwelling units* per unique *dwelling unit* type.[[11]](#footnote-13) This result is summed with the total *embodied carbon* emissions and total carbon storage according to Section 6.3 for the *Minimum Assessed Products* for the foundation system, roof system, and common areas for the total *embodied carbon* results representative of the *assessed dwelling unit.*

### Total gross *embodied carbon* emissions for *assessed dwelling unit.*

The total *embodied carbon* emissions for the *assessed dwelling unit* shall be calculated as follows:

**TGECA1-A3+A5.3 = ∑GECproduct**

Where:

TGECA1-A3+A5.3 = total gross *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

GECproduct = gross *embodied carbon* for each *Minimum Assessed Product*

### Total carbon storage for *assessed dwelling unit*

The total carbon storage for the *assessed dwelling unit* shall be calculated as follows:

**TCSA1-A3 = ∑CSproduct**

Where:

TCSA1-A3 = total carbon storage for the entire *assessed dwelling unit* (kg CO2)

CSproduct = carbon storage for each *Minimum Assessed Product*

### Optional: total net *embodied carbon* emissions for *assessed dwelling unit*

The total net *embodied carbon* emissions for the *assessed dwelling unit* shall be calculated as follows:

**TNECA1-A3+A5.3 = TGECA1-A3+A5.3 – TCSA1-A3**

Where:

TNECA1-A3+A5.3 = Total net *embodied carbon* emissions for the entire *assessed dwelling unit e*

TGCEA1-A3+A5.3 = total gross *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

TCSA1-A3 = total carbon storage for the entire *assessed dwelling unit* (kg CO2)

## Embodied Carbon Emissions Intensity Results

The *embodied carbon* emissions intensity of the *assessed dwelling unit* shall be calculated according to *gross floor area* (m2 or ft2), *conditioned floor area* (m2 or ft2) and either *bedrooms (for* a single *detached dwelling unit)* or *units (*formultiple *attached dwelling units)*.

### Total gross *embodied carbon* intensity by *gross floor area*

The total gross *embodied carbon* intensity of the *gross floor area* shall be calculated as follows:

Where:

TGECA1-A3+A5.3 = total gross *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

GFA = *gross floor area*

### Optional: Net *embodied carbon* intensity by *gross floor area*

The total net *embodied carbon* intensity of the *gross floor area* shall be calculated as follows:

Where:

TNECIGFA = Net *embodied carbon* intensity by *gross floor area*

TNECA1-A3 + A5.3 = Total net *embodied carbon* emissions for the entire *assessed dwelling unit*

GFA = *gross floor area*

### Gross *embodied carbon* intensity by *conditioned floor area*

The total gross *embodied carbon* intensity of the *conditioned floor area* shall be calculated as follows:

Where:

TGECICFA = total gross *embodied carbon* intensity by *conditioned floor area*

TGECA1-A3 + A5.3 = total gross *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

CFA = *conditioned floor area*

### Optional: Net *embodied carbon* intensity by *conditioned floor area*

The total net *embodied carbon* intensity of the *conditioned floor area* shall be calculated as follows:

Where:

TNECICFA = total net *embodied carbon* intensity by *conditioned floor area*

TNECA1-A3 + A5.3 = total net *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

CFA = *conditioned floor area*

### Gross *embodied carbon* intensity per *bedroom*

The total gross *embodied carbon* intensity by number of *bedrooms* shall be calculated as follows:

Where:

TGECIBDR = Gross *embodied carbon* intensity per *bedroom*

TGECA1-A3 + A5.3 = total gross *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

BDR = number of *bedrooms* indicated on the *construction documents*

### Optional: Net *embodied carbon* intensity per *bedroom*

The total net *embodied carbon* intensity by number of *bedrooms* shall be calculated as follows:

Where:

TNECIBDR = total net *embodied carbon* intensity per *bedroom*

TNECA1-A3 + A5.3 = total net *embodied carbon* for the entire *assessed dwelling unit* (kg CO2e)

BDR = number of *bedrooms* indicated on the *construction documents*

### Gross *embodied carbon* intensity per unit

The total gross *embodied carbon* intensity per unit shall be calculated as follows:

Where:

TGECIUNIT = gross *embodied carbon* intensity per unit

CFAUNIT = *conditioned floor area* of unit

TGECA1-A3 + A5.3 = total gross *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

GFABUILDING = *gross floor area* of *assessed dwelling unit*

### Optional: Net *embodied carbon* intensity per unit

The total net *embodied carbon* intensity per unit shall be calculated as follows:

Where:

TNECIUNIT = net *embodied carbon* intensity per unit

CFAUNIT= *conditioned floor area* of unit

TNECA1-A3 + A5.3 = total net *embodied carbon* emissions for the entire *assessed dwelling unit* (kg CO2e)

GFABUILDING = *gross floor area* of *assessed dwelling unit*

# Verification Requirements

## Verification of Minimum Assessed Products for Projected Assessments

For *Projected Assessments*, the verification of *embodied carbon* results calculated as per Section 6 shall be determined by a *Certified Rater* to be an accurate reflection of the dimensions and products represented in the *construction documents*.

## Verification of Minimum Assessed Products for *Confirmed Assessments*

For *Confirmed Assessments*, the verification of *embodied carbon* results calculated according to Section 6 shall be verified and documented by a *Certified Rater* in accordance with Sections 7.2.1 through 7.2.6 and Appendix 10.3.

A *Certified Rater* shall complete all the tasks and gather all the required verification documents specified in Table 10.3.1. If inspection of the *assessed dwelling unit* and/or verification documents results in variations from the *construction documents* used for calculations in Section 6, all variations shall be documented and all required changes made to the dimensions and/or product selection used for the *embodied carbon* assessment. The assessment calculations shall be repeated using verified dimensions and/or products according to Sections 5.3.2 and 6 before a *Confirmed Assessment* report is issued.

### Assessed products shall be verified directly by a *Certified Rater* visually on-site during construction, by reviewing photographs taken during construction, by reviewing material or equipment documentation, or through equivalent methods as appropriate. The date and rater initials shall be included on each accepted document.

### A *Certified Rater* shall obtain documentation of assessed products from the necessary sources. The date and rater initials shall be included on each accepted document.

### Single-source documentation may be used in lieu of lot-specific documentation across multiple *dwelling units* where the same assessed product is installed.

### If data for the *Minimum Assessed Products* set forth in Section 5.4 cannot be obtained by observation or without destructive disassembly of the *assessed dwelling unit*, *GWP factors* for products described on the *construction documents* may be used or replaced with a *GWP factor* for a *comparable product type* based on current and historical local building practice and building codes.

### For prefabricated elements that cannot be inspected by observation or without destructive disassembly of the element, manufacturer documentation may be used to confirm product types and quantities.

## Verification of Confirmed Assessment Results for Assessed Dwelling Units

When a *Certified Rater* verifies the results for all *Minimum Assessed Products*, the totals calculated according to Section 6 shall be deemed verified.

# Reporting Requirements

All reports generated for *Projected Assessments* and *Confirmed Assessments*, including those generated by a Software Rating Tool, shall conform with the reporting requirements specified by Sections 8.1 through 8.4 and, optionally 8.5.

## Project Information

A report shall include the following project details for the *assessed dwelling unit*:

### Property location, including the city, state, zip code and either the street address or the Community Name and Plan Name for the assessment or any unique building identifier accepted by the jurisdiction having authority.

### The *building* typology, including *Detached Dwelling*, *Attached Dwelling* or other (with explanation).

### The name of the *Certified Rater* conducting the assessment and the name of the *Approved Rating Provider* under whose auspices the *Certified Rater* is certified.

### The date the assessment was completed.

### The name and version number of the Software Rating Tool used to perform the assessment.

### *Projected Assessment* reports shall contain the following text in no less than 14-point font at the top of the first page of the report: “*Projected Assessment* Based on Construction Documents.”

### Acknowledgement that the assessment covers life cycle modules A1-A3 + A5.3

### For reports that include carbon storage, the following wording shall accompany these results: “Note that carbon stored in LCA modules A1-A3 is not permanently sequestered and will be subject to some degree of carbon release at the end of the product and/or building’s life cycle which is not captured in this analysis.”

## Reporting of Minimum Assessed Product Results

A report shall, at minimum, itemize each *Minimum Assessed Product* and include the gross emissions and carbon storage according to Section 6.2, and shall include the material quantity as calculated according to Tables 10.1.1 and 10.1.5 and the GWP data source according to Table 5.3.2. Reports shall include product quantities even if the emissions are zero.

The units for results shall be both kilograms of *carbon dioxide* *equivalent* (kg CO2e) and pounds of *carbon dioxide equivalent* (lb CO2e) in reports.

## Reporting of Assessed Dwelling Unit Embodied Carbon Results

A report shall include Total Gross *Embodied Carbon* (TGEC), Total Carbon Storage (TCS) results for the *assessed dwelling unit* according to Section 6.4. The units for results shall be both kilograms of *carbon dioxide equivalent* (kg CO2e) and pounds of *carbon dioxide equivalent* (lb CO2e). The results may be converted SI tonnes or imperial (IP) tons of *carbon dioxide equivalent* as additional results.

For *assessed dwelling units* with multiple *attached dwelling units,* the calculation method as described in Section 6.4 shall be explicitly stated.

## Reporting of Assessed Dwelling Unit Embodied Carbon Intensity Results

A report shall include Total Gross *Embodied Carbon* (TGECI) and Total Carbon Storage (TCSI) intensity results for the *assessed dwelling unit* according to Section 6.5. The units for results shall be reported according to Sections 8.4.1 through 8.4.3. The intensity results for *assessed dwelling unit* may be converted to SI tonnes or imperial IP tons of *carbon dioxide equivalent* as additional results.

### Floor area *embodied carbon* intensity

A report shall include TGEC and TCS per both *gross floor area* and *conditioned floor area* according to Sections 6.5.1 through 6.5.4. The units for results shall be kilograms of *carbon dioxide equivalent* per square meter (kg CO2e/m2) and pounds of carbon dioxide equivalent per square foot (lb CO2e/ft2).

### Bedroom *embodied carbon* intensity

### A report for a *Detached Dwelling* shall include TGEC and TCS per *bedroom* according to Sections 6.5.5 and 6.5.6.

### Unit *embodied carbon* intensity

A report for an *Attached Dwelling* shall include TGEC and TCS per unit according to Sections 6.5.7 and 6.5.8.

## Reporting of Optional Results

### GWP results for photovoltaic systems obtained using the calculation in Section 6.3.1 may be included in a projected and/or confirmed embodied carbon report. The results shall not be included in any total results and shall be accompanied by the text: For informative purposes only.

### GWP results for refrigerant leakage obtained using the calculation in Section 6.3.2 may be included in a projected and/or confirmed embodied carbon report. The results shall not be included in any total results and shall be accompanied by the text: For informative purposes only.

8.5.3 GWP results for net embodied carbon (including NECproduct, TNEC, TNECIGFA, TNECICFA, TNECIBDR and/or TNECIUNIT) may be included in a project and/or confirmed embodied carbon report. The results shall not be included in any total results and shall be accompanied by the text: For informative purposes only.

# References

## Normative References

The normative referenced standards herein and listed in Table 9.1.1 shall be considered part of the requirements of this standard to the prescribed extent of such reference. Where differences occur between the provisions of this standard and referenced standards, the provisions of this standard shall apply.

Table 9.1.1 Normative References

|  |  |
| --- | --- |
| Reference | Title |
| ANSI/RESNET | ANSI/RESNET/ICC 301-2022, Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index |
| CIBSE | CIBSE TM65 Embodied carbon in building services: A calculation methodology (2021) |
| EN | EN Standard 15804:2012+A2:2019, Sustainability of construction works, Environmental declarations, Core rules for the product category of construction products plus amendment 2. |
| EN | EN Standard 15978:2011, Sustainability of construction works. Assessment of environmental performance of buildings. |
| ICC | ICC 2021. International Energy Conservation Code. Washington D.C.: ICC. |
| ISO | ISO 14025:2020 – Environment labels and declarations. |
| ISO | ISO 21930:2017, Sustainability in buildings and civile engineering works- Core rules for environmental product declarations of construction products and services. |
| ISO | ISO 14040:2006, Environmental management — Life cycle assessment — Principles and framework |
| ISO | ISO 14044:2006, Environmental management — Life cycle assessment — Requirements and guidelines |
| ISO/FDIS | ISO/FDIS 14071, Environmental management — Life cycle assessment — Critical review processes and reviewer competencies |

# Appendix

## Establishing a Material Inventory (Normative)

### Detailed dimension takeoff guidance for Minimum Assessed Products is provided in Table 10.1.1. For Minimum Assessed Products for which no specific guidance is provided, appropriate takeoff quantities shall be determined from manufacturer information and EPD data or based on current and historical local building practice and building codes.

### Calculations may be made in SI or imperial (IP) units. Units shall be applied consistently for all calculations. Product level results calculated in imperial (IP) units shall be converted to SI equivalents for calculating embodied carbon emissions and carbon storage for each Minimum Assessed Product according to Section 6.2.

Table 10.1.1 Dimension Takeoff Guidance

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Foundations and Subgrade Enclosures*** | | | | | | | | | | | | | | |
| **Assessed Product** | **Dimension Takeoff Guidance** | | | | | | | | | | | **Unit for result** | | |
| Concrete footings | Total perimeter of centerline of foundation wall x footing width x footing thickness | | | | | | | | | | | Volume, m3 | | |
| Concrete pads | Total perimeter of centerline of footings x footing depth | | | | | | | | | | | Volume, m3 | | |
| Concrete piers & piles | Pier/pile diameter area x pier length | | | | | | | | | | | Volume, m3 | | |
| Foundation walls - concrete | Total wall exterior area x wall thickness | | | | | | | | | | | Volume, m3 | | |
| Foundation walls - CMU | Total wall exterior area, specify block width | | | | | | | | | | | Area, m2 | | |
| Foundation walls – CMU grout fill | Block core area x wall height x number of cores filled | | | | | | | | | | | Volume, m3 | | |
| Reinforcement (mesh) | Total area of concrete wall, slab or pad, specify gauge and wire spacing | | | | | | | | | | | Area, m2 | | |
| Reinforcement (rebar) - footings | Total perimeter of outside edge of foundation wall x number of bar runs x mass factor for bar diameter | | | | | | | | | | | Mass, kg | | |
| Reinforcement (rebar) - pads, piers & piles | Number of rebar runs x length of each run x mass factor for bar diameter | | | | | | | | | | | Mass, kg | | |
| Reinforcement (rebar) - foundation walls | Number of rebar runs x length of each run (length or height of wall, or both) x mass factor for bar diameter | | | | | | | | | | | Mass, kg | | |
| Pressure treated wood foundations | Total wall interior area x framing fraction x framing depth | | | | | | | | | | | Volume, m3 | | |
| Foundation interior walls -  wood frame | Total wall interior area x framing fraction x framing depth | | | | | | | | | | | Volume, m3 | | |
| Foundation interior walls - steel frame | Total wall interior area x framing fraction (see Table 10.1.2) x steel stud weight per area (see Table 10.1.3) | | | | | | | | | | | Mass, kg | | |
| Wall sheathing/cladding | Total wall area (interior and/or exterior), specify product thickness | | | | | | | | | | | Area, m2 | | |
| Insulation (exterior and interior) | Total wall area (- framing fraction for cavity insulation), specify R-value | | | | | | | | | | | Area, m2 (R-value) | | |
| Barriers (air tightness, waterproofing, drainage) | Total wall area (interior and/or exterior) | | | | | | | | | | | Area, m2 | | |
| Aggregate | Total area of outside edge of aggregate base x aggregate base thickness | | | | | | | | | | | Volume, m3 | | |
| ***Slabs on Grade*** | | | | | | | | | | | | | | |
| Concrete (slab floors) | | Total slab floor area x slab thickness | | | | | | | | | | | | Volume, m3 |
| Concrete (slab floor thickened edge beams) | | (Total slab floor area x slab thickness) + (thickened edge area x thickened edge thickness) | | | | | | | | | | | | Volume, m3 |
| Reinforcement (rebar) | | Number of rebar runs x length of each run (length or width of slab, or both) x mass factor for bar diameter | | | | | | | | | | | | Mass, kg |
| Reinforcement (mesh) | | Total slab floor area, specify gauge and wire spacing | | | | | | | | | | | | Area, m2 |
| Barriers | | Total slab floor area | | | | | | | | | | | | Area, m2 |
| Insulation | | Total slab floor area, specify R-value | | | | | | | | | | | | Area, m2 (R-value) |
| Aggregate | | Total slab floor area x aggregate depth | | | | | | | | | | | | Volume, m3 |
| ***Exterior Walls*** | | | | | | | | | | | | | | |
| Wood framing | | | Total frame wall area x framing factor (see Table 10.1.2) x depth of framing members (includes gables, where applicable) | | | | | | | | | | Volume, m3 | |
| Steel framing | | | Total frame wall area x framing fraction (see Table 10.1.2) x steel stud weight per area (see Table 10.1.3) (includes gables, where applicable) | | | | | | | | | | Mass, kg | |
| Masonry/CMU | | | Total wall exterior area, specify block width | | | | | | | | | | Area, m2 | |
| Posts and beams - wood | | | Total volume of each unique product type | | | | | | | | | | Volume, m3 | |
| Posts and beams - steel | | | Total mass of each unique product type | | | | | | | | | | Mass, kg | |
| Sheathing | | | Total treated exterior wall area, specify product thickness | | | | | | | | | | Area, m2 | |
| Cladding | | | Total treated exterior wall area, specify product thickness | | | | | | | | | | Area, m2 | |
| Windows | | | Total window unit area(s), specify # of glazing panes | | | | | | | | | | Area, m2 | |
| Exterior doors (glazed and opaque) | | | Total door unit area(s) | | | | | | | | | | Area, m2 | |
| Insulation (including cavity, continuous, band joist, etc.) | | | Total treated area, specify R-value | | | | | | | | | | Area, m2 (R-value) | |
| Barriers (air tightness, waterproofing) | | | Total treated exterior wall area | | | | | | | | | | Area, m2 | |
| Paint (site applied) | | | Total treated exterior wall area | | | | | | | | | | Area, m2 | |
| Strapping/furring | | | Number of runs x length of each run (length or height of treated wall area, or both) x thickness of product | | | | | | | | | | Volume, m3 | |
| ***Roof*** | | | | | | | | | | | | | | |
| Wood truss | | | | Projected Assessments: See Table 10.1.4  Confirmed Assessments: Total weight of all trusses as specified on truss package / 432 (kilograms per cubic meter of SPF lumber at 15% moisture content) | | | | | | | | | Volume, m3 | |
| Wood framing | | | | Total length of all framing members x depth of framing members x width of framing members | | | | | | | | | Volume, m3 | |
| Sheathing | | | | Total roof surface area, specify product thickness | | | | | | | | | Area, m2 | |
| Strapping | | | | Number of runs x length of each run (length or height of treated roof area, or both) x thickness of product | | | | | | | | | Volume, m3 | |
| Roofing | | | | Total roof surface area | | | | | | | | | Area, m2 | |
| Insulation (incl. cavity, continuous, etc.) | | | | Total treated area (at specified R-value) | | | | | | | | | Area, m2 (R-value) | |
| Barriers | | | | Total treated exterior and/or interior surface area | | | | | | | | | Area, m2 | |
| Skylights | | | | Total unit area(s), specify # of glazing panes | | | | | | | | | Area, m2 | |
| ***Interior Construction*** ***(incl. Party walls)*** | | | | | | | | | | | | | | |
| Interior floor – wood frame | | | | | Total framed floor area x framing factor (see Table 10.1.2) x lumber depth | | | | | | | Volume, m3 | | |
| Interior floor – wood I-joist | | | | | Total length of joists, specify product depth | | | | | | | Length, m | | |
| Interior floor – steel frame | | | | | Total length of joists, specify product depth | | | | | | | Length, m | | |
| Floor sheathing/subfloor | | | | | Total treated floor area x product thickness | | | | | | | Volume, m3 | | |
| Insulation (incl. cavity, continuous, etc.) | | | | | Total treated area (at specified R-value) | | | | | | | Area, m2 (R-value) | | |
| Interior walls – wood frame | | | | | Total wall area x framing factor (see Table 10.1.2) x framing depth | | | | | | | Volume, m3 | | |
| Interior walls – steel frame | | | | | Total wall area x framing fraction (see Table 10.1.2) x steel stud weight per area (see Table 10.1.3) | | | | | | | Mass, kg | | |
| Interior wall cavity insulation | | | | | Total treated interior wall area, specify R-value | | | | | | | Area, m2 (R-value) | | |
| Masonry walls | | | | | Total wall area, specify thickness of walls | | | | | | | Area, m2 | | |
| Posts and beams - wood | | | | | Total volume of each unique product type | | | | | | | Volume, m3 | | |
| Posts and beams - steel | | | | | Total mass of each unique product type | | | | | | | Mass, kg | | |
| Doors | | | | | Total unit area(s) | | | | | | | Area, m2 | | |
| Ceiling framing (if distinct from roof trusses) – wood framing | | | | | Total surface area x framing factor (see Table 10.1.2) x lumber depth | | | | | | | Volume, m3 | | |
| Ceiling framing (if distinct from roof trusses) – wood I-joists | | | | | Total length of joists, specify product depth | | | | | | | Length, m | | |
| Ceiling framing (if distinct from roof trusses) – steel | | | | | Total ceiling framed area x framing fraction (see Table 10.1.2) x steel stud weight per area (see Table 10.1.3) | | | | | | | Mass, kg | | |
| Stairs | | | | | Number of treads x tread width x tread depth | | | | | | | Area, m2 | | |
| ***Interior Finishes*** | | | | | | | | | | | | | | |
| Wall cladding | | | | | | Total treated area (include both sides, where applicable) | | | | | Area, m2 | | | |
| Ceiling cladding | | | | | | Total treated area | | | | | Area, m2 | | | |
| Flooring | | | | | | Total treated area | | | | | Area, m2 | | | |
| Paint | | | | | | Total treated area | | | | | Area, m2 | | | |
| ***Plumbing*** | | | | | | | | | | | | | | |
| **Assessed Products** | | | | | | | **Takeoff Guidance** | | | | | | | |
| Primary DWV stack, water service piping, kitchen sink | | | | | | | Use dwelling unit factor from Table 10.1.5 | | | | | | | |
| DWV and potable distribution piping | | | | | | | Use floor area factor from Table 10.1.5 or provide specific calculations using GWP factors for all pipe from Table 10.1.5 | | | | | | | |
| Fixtures (toilets, sinks, tub/shower) | | | | | | | Number of each type of fixture x value from Table 10.1.5 | | | | | | | |
| Domestic hot water heating equipment & pumps | | | | | | | Define each piece of equipment x value from Table 10.1.5 | | | | | | | |
| ***HVAC*** | | | | | | | | | | | | | | |
| Heating & cooling equipment | | | | | | | | Define each piece of equipment x value from Table 10.1.5 | | | | | | |
| Mechanical ventilation system | | | | | | | | Define each piece of equipment x value from Table 10.1.5 | | | | | | |
| Distribution systems (ducts, tubing, insulation) | | | | | | | | Forced air systems: Total duct surface area in square feet from Table 10.1.5 x value from Table 10.1.5  Hydronic systems: Total heated floor area x value on Table 10.1.5 plus total length of baseboard radiators x value on Table 10.1.5 or provide specific calculations using GWP factors for all pipe and radiators from Table 10.1.5 | | | | | | |
| ***Electrical*** | | | | | | | | | | | | | | |
| Wire, boxes, switches, receptacles | | | | | | | | | Use floor area factor from Table 10.1.5 | | | | | |
| Load center and meter | | | | | | | | | Per unit as per Table 10.1.5 | | | | | |
| ***Attached and Detached Garages*** | | | | | | | | | | | | | | |
| Same required *Minimum Assessed Products* as for *dwelling units.* | | | | | | | | | | Follow dimension guidance per this table. | | | | |

### Reference table for framing fractions noted in dimension guidance Table 10.1.1:

Table 10.1.2 Framing Fractions

|  |  |  |  |
| --- | --- | --- | --- |
| **Assembly Component** | **Framing Spacing** **(inches on center)** | **Framing Type** | **Default Framing Fraction (% total wall area)** |
| Wall | 16 | Standard | 25% |
| 16 | Advanced | 19% |
| 24 | Standard | 22% |
| 24 | Advanced | 16% |
| n/a | Structural insulated panel | 10% |
| Floor | 16 | n/a | 13% |
| 24 | n/a | 10% |
| Ceiling | 16 | n/a | 10% |
| 24 | n/a | 7% |

### Reference table for steel framing calculation in dimension guidance Table 10.1.1:

Table 10.1.3 Weight per Area for Common Steel Studs

|  |  |  |  |
| --- | --- | --- | --- |
| **Nominal Depth** | **Flange** | **Gauge** | **Weight per Area (kg steel/m2)** |
| 6" | 1-3/8" | 20 | 46.2 |
| 18 | 60.1 |
| 16 | 74.8 |
| 1-5/8" | 20 | 42.2 |
| 18 | 54.9 |
| 16 | 68.3 |
| 2" | 20 | 37.8 |
| 18 | 49.0 |
| 16 | 61.5 |
| 4" | 1-3/8" | 20 | 36.4 |
| 18 | 47.0 |
| 16 | 58.2 |
| 1-5/8" | 20 | 33.8 |
| 18 | 43.7 |
| 16 | 54.6 |
| 2" | 20 | 30.8 |
| 18 | 40.1 |
| 16 | 50.1 |

For sizes not listed in this table, manufacturer-specific data shall be used to calculate kilograms of steel per square meter of area.

### Reference table for truss wood volume noted in dimension guidance Table 10.1.1:

Table 10.1.4 Truss Wood Volume

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Roof Loads** | **20 psf (1 kPa)** | | | **40 psf (2 kPa)** | | | **60 psf (3 kPa)** | | |
| **Pitch** | *4/12* | *6/12* | *8/12* | *4/12* | *6/12* | *8/12* | *4/12* | *6/12* | *8/12* |
| **Volume per Horizontal Roof Area** *(ft3 wood per ft2 area)* | 0.13 | 0.13 | 0.14 | 0.14 | 0.15 | 0.15 | 0.16 | 0.16 | 0.16 |

For trusses conditions not covered by this table, wood volume shall be estimated by a licensed truss designer or other qualified designer.

### Reference table for residential MEP component default GWP values.

Table 10.1.5 MEP Components Default GWP Values[[12]](#footnote-14)

|  |  |  |  |
| --- | --- | --- | --- |
| **Division** | **Product** | **kg CO2e** | **Unit** |
| Electrical | Load Center and Metera | 220 | Dwelling Unit |
| Electrical | Electrical distribution wiring, receptacles, switches, boxesb | 0.33 | CFA |
| Plumbing | Kitchen sink, DWV primary stack, water service pipingc | 280 | Dwelling Unit |
| Plumbing | DWV and potable distribution pipingd | 140 | CFA |
| Plumbing | DHW tank heater, gase | 220 | Each |
| Plumbing | DHW tank heater, electricf | 210 | Each |
| Plumbing | DHW tank heater, electric heat pump | 600 | Each |
| Plumbing | DHW tankless heater, gasg | 260 | Each |
| Plumbing | Toileth | 130 | Each |
| Plumbing | Lav Sinki | 58 | Each |
| Plumbing | Bathtubj | 270 | Each |
| Plumbing | Showerk | 44 | Each |
| Plumbing | Water supply distribution - PEXl | 0.09 | LF of ½” pipe |
| Plumbing | Water supply distribution - PEXl | 0.16 | LF of ¾” pipe |
| Plumbing | Water supply distribution - PEXl | 0.29 | LF of 1” pipe |
| Plumbing | Water supply distribution - Copperm | 0.80 | LF of ½” pipe |
| Plumbing | Water supply distribution - Copperm | 1.30 | LF of ¾” pipe |
| Plumbing | Water supply distribution - Copperm | 1.80 | LF of 1” pipe |
| Plumbing | Drain/Waste/Vent distribution – PVCn | 0.68 | LF of 1” pipe |
| Plumbing | Drain/Waste/Vent distribution – PVCn | 1.10 | LF of 1-1/2” pipe |
| Plumbing | Drain/Waste/Vent distribution – PVCn | 1.60 | LF of 2” pipe |
| Plumbing | Drain/Waste/Vent distribution – PVCn | 2.40 | LF of 2-1/2” pipe |
| Plumbing | Drain/Waste/Vent distribution – PVCn | 3.20 | LF of 3” pipe |
| Plumbing | Drain/Waste/Vent distribution – PVCn | 4.70 | LF of 4” pipe |
| Plumbing | Drain/Waste/Vent distribution – ABSo | 0.81 | LF of 1” pipe |
| Plumbing | Drain/Waste/Vent distribution – ABSo | 1.40 | LF of 1-1/2” pipe |
| Plumbing | Drain/Waste/Vent distribution – ABSo | 1.90 | LF of 2” pipe |
| Plumbing | Drain/Waste/Vent distribution – ABSo | 2.90 | LF of 2-1/2” pipe |
| Plumbing | Drain/Waste/Vent distribution – ABSo | 3.80 | LF of 3” pipe |
| Plumbing | Drain/Waste/Vent distribution – ABSo | 5.60 | LF of 4” pipe |
| Plumbing | Pipe Insulationp | 0.05 | LF of ½” |
| Plumbing | Pipe Insulationp | 0.06 | LF of ¾” |
| Plumbing | Pipe Insulationp | 0.07 | LF of 1” |
| HVAC | Metal ductworkq | 6 | Duct area, sq ft |
| HVAC | Flex ductworkr | 0.32 | Duct area, sq ft |
| HVAC | Ductwork insulation, flexibles | 0.16 | Duct area, sq ft |
| HVAC | Ductwork insulation, board | 0.61 | Duct area, sq ft |
| HVAC | Natural Gas Furnacet | 2 | kBtu capacity |
| HVAC | Ducted Heat Pump + Compressoru | 760 | ton cooling |
| HVAC | Mini-Split Heads + Comp.v | 720 | ton cooling |
| HVAC | Central A/Cw | 200 | ton cooling |
| HVAC | Electric Aux Heaterx | 36 | kBtu capacity |
| HVAC | Electric Baseboardy | 3 | kBtu capacity |
| HVAC | Gas boilerz | 6.3 | kBtu capacity |
| HVAC | Air-to-water heat pumpaa | 890 | ton cooling |
| HVAC | Ground source heat pump equipmentbb | 1110 | ton cooling |
| HVAC | Ground source heat pump borehole and loop pipingcc | 19 | per ft |
| HVAC | Hydronic radiant distributiondd | 0.26 | sq ft radiant surface |
| HVAC | Hydronic radiant distributionee | 0.21 | LF of 1/2" |
| HVAC | Hydronic radiant distributionee | 0.26 | LF of 5/8" |
| HVAC | Hydronic radiant distributionee | 0.35 | LF of 3/4" |
| HVAC | Hydronic baseboardff | 13 | kBtu capacity |
| HVAC | Fan coilgg | 1600 | ton cooling |
| HVAC | Fan, exhausthh | 230 | each |
| HVAC | Balanced ventilation with energy recoveryii | 350 | each |
| HVAC | Pump, circulatorjj | 34 | each |
| HVAC | Pump, sump or boosterkk | 220 | each |

**Table 10.1.5 Notes:**

1. Includes standard residential meter socket, loads panel, (24) single-pole standard circuit breakers, (8) single-pole GFI circuit breakers, and (4) 240VAC circuit breakers. No other equipment included.
2. Assumes the following per CFA:
   1. #14 wire: 0.375 feet
   2. #12 wire: 0.3 feet
   3. #10 wire: 0.025 feet
   4. #8 wire: 0.025 feet
   5. #4 wire: 0.025 feet
   6. 3/0 wire: 0.0075 feet
   7. Duplex receptacles: 0.01075
   8. GFI receptacles: 0.0055
   9. 240VAC receptacles: 0.0005
   10. Single-pole switches: 0.00675
   11. 3-way switches: 0.00275
   12. 4-way switches: 0.00075
   13. Junction boxes: 0.02875  
       Wire nuts, fasteners, and other equipment not included.
3. Includes typical two-bay stainless steel kitchen sink with faucet. Assumes the following per building:
   1. Sanitary piping, 4” PVC: 10 feet
   2. Vent piping, 3” PVC: 5 feet
   3. Supply piping, 1” copper: 45 feet  
      Valves, piping, and other equipment not included.
4. Assumes the following per *bathroom*:
   1. DWV piping, 1-1/2” PVC: 12.5 feet
   2. DWV piping, 2” PVC: 35 feet
   3. DWV piping, 3” PVC: 20 feet
   4. Supply piping, ½” PEX: 55 feet
   5. Supply piping, ¾” PEX: 22.5 feet  
      Fittings, caps, drains, hangers, and other equipment not included.
5. Typical residential gas-fired water tank, 34,120 Btu/hr capacity. Valves, gauges, and other equipment not included.
6. Typical residential electric tank, 5 kWh capacity. Valves, gauges, and other equipment not included.
7. Typical residential wall-mount gas-fired boiler, 40,946 Btu/hr capacity. Controls, valves, gauges, and other equipment not included.
8. Represents 80th percentile of 10 typical residential toilet products. Valves, piping, toilet base, and other equipment not included.
9. Represents 80th percentile of 7 typical residential lavatory sinks. Valves, piping, and other equipment not included.
10. Represents 80th percentile of 3 typical residential Bathtub. Valves, piping, and other equipment not included.
11. Typical residential glass-frame shower enclosure system; does not include base or wall surfaces.
12. Typical cross-linked polyethylene (PEX) piping for domestic potable water distribution; fittings, shutoffs, valves, and other equipment not included.
13. Typical Type L copper piping for domestic potable water distribution; fittings, shutoffs, valves, and other equipment not included.
14. Typical Schedule 40 PVC piping for domestic drain/waste/vent service; fittings, caps, drains, hangers, and other equipment not included.
15. Typical ABS piping for domestic drain/waste/vent service; fittings, caps, drains, hangers, and other equipment not included.
16. Typical closed-cell flexible elastomeric foam thermal pipe insulation, ½” thickness.
17. Typical 24-gauge steel ducting; mastic, fittings, hangers, dampers, and other equipment not included.
18. Typical polyethylene with steel wire frame R-8 fiberglass insulated flex ducting with vapor barrier; mastic, fittings, hangers, dampers, and other equipment not included.
19. Typical R-8 fiberglass duct insulation with vapor retarder facing; tapes and adhesives not included.
20. Typical residential gas-fired air handling unit. Unit only; controls, dampers, filters, mounting and other equipment not included
21. Typical residential ducted heat pump air handling unit. Includes outdoor compressor and indoor AHU. Lineset, refrigerant, controls, dampers, filters, mounting and other equipment not included.
22. Typical residential mini-split ductless heat pump. Includes outdoor compressor and two indoor wall-mount cassettes. Lineset, refrigerant, controls, dampers, filters, mounting and other equipment not included.
23. Typical residential split A/C system. Includes outdoor compressor and indoor AHU. Lineset, refrigerant, controls, dampers, filters, mounting and other equipment not included.
24. Typical residential inline auxiliary electric resistance heater. Unit only; controls, filters, mounting and wiring equipment not included.
25. Typical residential electric resistance convector baseboard radiator. Unit only; controls, mounting and wiring equipment not included.
26. Typical residential wall-mount gas boiler. Unit only; controls, valves, gauges, and other equipment not included.
27. Typical residential air-to-water heat pump split system. Includes outdoor compressor and indoor hydronic unit. Lineset, refrigerant, controls, dampers, filters, mounting and other equipment not included.
28. Typical residential ground source heat pump equipment. Unit only; ground loop pump, circulator pump, controls, valves, gauges, and other equipment not included.
29. Assumes 4” borehole with 1” polyethylene pipe loop and grout fill. Piping to building, valves, pumps, and other equipment not included.
30. Assumes ½” PEX-AL-PEX heating piping 12” on center. Piping only; fittings, mounting, valves, manifolds, gauges, and other equipment not included.
31. Typical cross-linked polyethylene (PEX) piping with metal oxygen barrier multilayer pipe (PEX-AL-PEX) for radiant heating distribution; fittings, shutoffs, valves, and other equipment not included.
32. Typical residential hydronic baseboard unit. Unit only; piping, valving, controls, mounting, and other equipment not included.
33. Typical residential inline ducted fan coil unit. Unit only; mounting, piping, and wiring equipment not included.
34. Typical residential bath or range hood exhaust fan, 200 CFM capacity.
35. Typical residential balanced ventilation system with heat recovery core, 400 CFM capacity
36. Typical residential hydronic circulator pump, 40W.
37. Typical residential boost/sump pump, 110 GPM.

Custom calculations for default GWP values of MEP components may be used in lieu of the default values provided in this table. Custom Calculations shall be done according to the data hierarchy and data quality requirements set forth in Section 5.3 and the data sources and assumptions are for equipment of *comparable product types*.

## Waste Rates for Products (Normative)

All products shall have a waste rate added to the total material quantity calculated using Table 10.1.1 according to the percentages in Table 10.2.1. *Confirmed assessments* may use custom waste rates supported by documentation of the specific mass of any product type removed from the site as waste. This mass shall be converted to a percentage of the mass of installed product.

Table 10.2.1 Waste Rates for Products

|  |  |
| --- | --- |
| **Building Product** | **On-site waste rate** |
| Prefabricated assemblies: standardized assemblies and small MEP equipment (400 lbs or less).(a) (b) | 1% |
| Prefabricated assemblies: custom assemblies made to order and large MEP equipment (more than 400 lbs). (a) (c) | 0% |
| Ready-mix concrete delivered by a concrete mixer truck and poured in place | 5% |
| Sprayed cementitious material (shotcrete, sprayed fire resistive material) | 10% |
| Piles: steel piles or casting | 3% |
| Troweled material (mortar, skim coating) | 15% |
| Liquid applied material (paint, self-leveling concrete topping, roof membranes) | 10% |
| Blocks and bricks | 5% |
| Tiles, siding, and carpet flooring | 8% |
| Standard sheets, boards, or panels cut-to-size on site as needed: metal (steel decking, roofing, flashing, welded wire fabric) (d) | 10% |
| Standard sheets, boards, or panels cut-to-size on site as needed: non-metal (gypsum, plywood) (d) | 15% |
| General standard-length elements and trimmed as needed on site to required length (metal studs, light-weight timber framing, plumbing pipes) | 10% |
| Steel rebar | 3% |
| Default waste rate for all other products not listed in this table | 5% |

**Table 10.2.1 Notes:**

Applies to standardized prefabricated assemblies or equipment that are shipped to site ready to be installed without any alterations resulting in wastage such as cutting or trimming or drilling. For example: standard windows, small appliances.

Any additional material to be applied on site such as coatings or connection materials shall be accounted for separately with applicable on-site wastage ratios.

Applies to custom prefabricated assemblies meeting all the following:

Weighs more than 200 lbs per piece

Fabricated to the specific dimensions required for the project.

Shipped to site as a kit of parts or as a single piece ready to be installed without any alterations resulting in wastage such as cutting or trimming or drilling.

For example: unitized curtainwall, volumetric modular construction, structural steel members, glue-laminated beams and CLT panels, 781 architectural precast panels.

Applies to flat products at least 18 inches in two directions. Otherwise use "tiles" or "elements delivered to site in standard length."

## Verification Procedures for *Confirmed Assessments* (Normative)

A *Certified Rater* shall complete all the tasks and gather all the required verification documents specified in Table 10.3.1.

If inspection of the *assessed dwelling unit* and/or verification documents results in variations from the *construction documents* used for calculations in Section 6, all variations shall be documented, and all required changes made to the dimensions and/or product selection used for the *embodied carbon* assessment. The assessment calculations shall be repeated using verified dimensions and/or products according to Sections 5.3.2 and 6 before a *Confirmed Assessment* report is issued.

Verification is only required for all *Minimum Assessed Products* included in Table 10.3.1. All products excluded from this table shall only be assessed according to the *construction documents* and the calculations in Sections 5.3.2 and 6 and do not require further verification or inspection for inclusion in a *verified assessment*.

Table 10.3.1 Verification Requirements for Confirmed Assessments

|  |  |  |
| --- | --- | --- |
| **Assessed Products** | **Task[[13]](#footnote-15)** | **Required verification documents** |
| Concrete | For floors and slabs, measure dimensions of floor to calculate area. For slab-on-grade, also calculate total perimeter and perimeter exposed to other conditioned spaces.  For conditioned basements and crawlspaces, measure dimensions of walls and floor to calculate area.  Where thickness of walls or floors cannot be measured, assume the measurements on the *construction documents*.  Verify foundation wall dimensions and resultant cubic feet of concrete match the *construction documents* to the nearest cubic foot.  Determine and record the concrete supplier and mix design and compare with *construction documents*. | Mix tickets, receipts or other documents noting mix design and volume for each unique concrete pour.  No on-site inspection of the physical characteristics of the concrete is required. |
| Wood and/or steel framing | Measure the dimensions of all framed walls and floors and verify dimensions match the *construction documents* to the nearest foot.  Determine and record the framing member size/gauge and spacing of all framed segments of the *assessed dwelling unit* and ensure each unique framed area matches the *construction documents* to the nearest foot.  Determine and record the brand and product name of all framing members and compare with *construction documents*. | Record of visual confirmation or photographs of each framing type. |
| Masonry | Measure the dimensions of all masonry walls and verify dimensions match the *construction documents* to the nearest foot. Determine and record the sizes and brands and product names of all masonry unit types and compare with *construction documents*. | Record of visual confirmation or photographs of each masonry type and brand and product name and/or verification by receipts or other accepted documentation. |
| Insulation | Measure the dimensions of all insulated areas and verify dimensions match the *construction documents* to the nearest square foot.  Determine and record all unique insulation types, brands, product names, and R-values and compare with *construction documents*. | Record of visual confirmation or photographs of each insulation type and brand and product name and/or verification by receipts or other accepted documentation. |
| Cladding, exterior | Measure the dimensions of all areas covered with unique exterior cladding products and verify dimensions match the *construction documents* to the nearest foot.  Determine and record all unique cladding types, brands, product names, and thicknesses and compare with *construction documents*. | Record of visual confirmation or photographs of each cladding type and brand and product name and/or verification by receipts or other accepted documentation. |
| Sheathing | Measure the dimensions of all wall and floor areas covered with unique sheathing products and verify sheathing dimensions match the *construction documents* to the nearest foot.  Determine and record all unique sheathing types, brands, product names, and thickness for all wall and floor areas and compare with *construction documents*. | Record of visual confirmation or photographs of each sheathing type and brand and product name and/or verification by receipts or other accepted documentation |
| Doors | Count the number of doors and measure the dimensions of each and verify door count and dimensions match the *construction documents*.  Determine and record all door dimensions, types, brands, product names, and quantities and compare with *construction documents*. | Record of visual confirmation or photographs of each door type and brand and product name and/or verification by receipts or other accepted documentation |
| Windows | Count the number of windows and measure the dimensions of each and verify window count and dimensions match the *construction documents*.  Determine and record all window dimensions, types, frame material, numbers of panes, brands and quantities and compare with *construction documents*. | Record of visual confirmation or photographs of each window type and brand and product name and/or verification by receipts or other accepted documentation |
| Roof/Ceiling (framing and roofing) | Measure the linear perimeter of the ceiling area and verify dimensions match the *construction documents* to the nearest foot. When a ceiling is vaulted, it is necessary to calculate dimensions geometrically.  Visually inspect the roof and verify that the roof pitch and overhangs appear to match the *construction documents*. Determine and record:   * All framing size/gauge and spacing * Sheathing * Roofing types and brands and product names   and compare with *construction documents*. | Record of visual confirmation or photographs of each element type and brand and product name and/or verification by receipts or other accepted documentation.  Where prefabricated roof trusses have been used, the truss documents shall be used to confirm framing sizes and spacing and total truss weight. |
| Interior construction | Complete an inspection of all interior walls and floors and verify that locations for all interior construction elements included in Table 5.4.1 match the *construction documents* to the nearest foot.  Determine and record all the following elements, including product names and brands for each:   * Framing size/gauge and spacing (including party walls) * Sound/fire insulation * Doors * Stairs   and compare with *construction documents*. | Record of visual confirmation or photographs of each interior construction element and the brand and product name and/or verification by receipts or other accepted documentation |
| Interior finishes | Complete an inspection of all interior finishes and verify all dimensions match the *construction documents* to the nearest foot.  Determine and record all the following elements, including area, thickness, product names and brands for each:   * Wall cladding * Ceiling cladding * Flooring * Paint   and compare with *construction documents*. | Record of visual confirmation or photographs of each finish type and brand and product name and/or verification by receipts or other accepted documentation |
| Heating and cooling and mechanical ventilation equipment | Inspect all equipment and verify that all equipment matches the *construction documents*.  Determine and document all equipment types, brands, product names, and quantity and compare with *construction documents*. | Record of visual confirmation or photographs of each equipment type and brand and product name and/or verification by receipts or other accepted documentation |
| Heating and cooling distribution | Inspect the heating and cooling distribution system inspection and verify that the distribution system generally conforms to the duct/tubing lengths and diameters on the *construction documents*. | Record of visual confirmation or photographs of general conformation with the *construction documents*. |
| Service hot water equipment | Inspect the hot water equipment and verify that all equipment matches the *construction documents.*  Determine and record all equipment types, brands, product names, and quantities and compare with *construction documents*. | Record of visual confirmation or photographs of each equipment type and brand and product name and/or verification by receipts or other accepted documentation |
| Fixtures | Count the number of fixtures and verify general conformation with the *construction documents*. | Record of visual confirmation or photographs of each fixture |
| Garages and accessory *buildings* | Complete an inspection of all garages included in the assessment and verify general conformation with the dimensions on *construction documents*.  Determine and record all Assessed products included on this table and in accordance with the verification protocol for each assessed product as described in this table. | Record of visual confirmation or photographs of each equipment type and brand and product name and/or verification by receipts or other accepted documentation |

## Building Components Exclusions (Normative)

The following *building* products shall not be included in the minimum *embodied carbon* assessment for compliance with this Standard.

Table 10.4.1 Excluded Building Components

|  |  |
| --- | --- |
| **Building Element** | **EXCLUDED Building Components** |
| Foundations, Subgrade Enclosures, and Slabs-on-Grade | Formwork |
| Ties |
| Fasteners |
| Sub slab drainage pipes |
| Exterior Walls | Fasteners |
| Insulation around window and door units |
| Trim and flashing |
| Exterior shading |
| Insulation around glazing units |
| Roof | Fasteners |
| Gutters |
| Downspouts |
| Fascia |
| Soffit |
| Trim and flashing |
| Interior Construction | Fasteners |
| Sound proofing sealant and gaskets |
| Door hardware |
| Trim |
| Interior Finishes | Fasteners |
| Cabinetry |
| Counters |
| Hardware |
| Trim |
| Plumbing | Taps |
| Valves |
| Fittings |
| Controls |
| HVAC | Controls |
| Wire |
| Hardware |
| Mounts/supports |
| Electrical | Hardware |
| Finishes |
| Light fixtures |
| Panels |
| Solar/PV systems |
| Accessory Structures[[14]](#footnote-16) | ADUs, sheds, storage units, ramps and other detached structures |
| Communications | All components |
| Electronic Safety and Security | All components |
| Integrated Automation | All components |
| Fire suppression | All components |
| Equipment & Furnishings | All components |
| Special Construction & Demolition | Special Construction |
| Facility Remediation |
| Demolition |
| Sitework & Landscape | Site preparation |
| Site improvements (hardscape, softscape) |
| Liquid and Gas Site Utilities |
| Electrical site improvements |
| Site communications |
| Misc. site construction |
|  |  |

## Limitations of This Methodology (Informative)

This Standard calculates the *embodied carbon* of building products for *assessed dwelling units* for life cycle *modules A1-A3* + A5.3. This standard does not provide guidance for calculating *embodied carbon* emissions from other life cycle modules and interpretations of the results achieved using this Standard must be understood in this context.

Emissions from modules A1-A3 + A5.3 for building products typically represent the largest proportion of total life cycle emissions, enabling this Standard to calculate and report on these substantially impactful life cycle modules.

Including only life cycle modules A1-A3 results in reporting of carbon storage in products that will, to some degree, be emitted back to the atmosphere at the end of the product’s life cycle. Without the inclusion of B and C modules, no estimates regarding the timing or extent of these emissions are included in this Standard. By requiring reporting of stored carbon as a distinct A1-A3 result, the Standard enables users to transparently identify and quantify stored carbon at the product and building level, but the Standard does not attempt to ascribe any value to this stored carbon. The source of the stored carbon and the duration for which the carbon is stored in the product will have important ramifications for any valuation of the carbon storage and it is not within the scope of this Standard to provide this type of guidance.

Modules A4 (emissions from transportation of products to the construction site) and A5 (emissions from construction activities) are important contributors to the embodied carbon of an *assessed dwelling unit*. These have not been included in this standard (with the exception of A5.3) due to the inherent difficulty in trying to estimate these emissions for a large and geographically diverse industry like homebuilding which features complex supply chains and widely differing site conditions.

Reports generated using this Standard make it clear that only life cycle modules A1-A3 + A5.3 have been considered. This should be communicated clearly in any reporting extending from this Standard.

## Sample Report for Confirmed Assessment for a Single Detached Dwelling Unit (Informative)

A document with text and numbers

AI-generated content may be incorrect.

A screenshot of a graph

AI-generated content may be incorrect.

1. (Informative note) For example, a common or demising wall. [↑](#footnote-ref-2)
2. Informative note) That is, it does not span multiple Dwelling Units undivided. [↑](#footnote-ref-3)
3. (Informative note) Conditioned Space Volume that is intended for human activities (e.g., for living, sleeping, dining, or cooking; as well as toilets, closets, halls, utility areas, and laundry areas) and above the main Dwelling Unit, such as in a ‘Cape Cod’ home, is not considered Attic space and can be included in the Conditioned Floor Area. [↑](#footnote-ref-4)
4. (Informative note) Informative Annex A of Standard ANSI/RESNET/ICC 380 contains a table that summarizes parts of a Dwelling Unit that are included in Conditioned Space Volume. [↑](#footnote-ref-5)
5. (Informative note) For example, a common or demising wall. [↑](#footnote-ref-6)
6. (Informative note) That is, it does not span multiple Dwelling Units undivided. [↑](#footnote-ref-7)
7. (Informative Note) Subsequent tiers incorporating additional life cycle modules are intended to be added in future versions of this Standard. [↑](#footnote-ref-8)
8. (Informative Note) Examples of this include the carbon sequestered by trees planted on site and other landscaping. [↑](#footnote-ref-9)
9. (Informative Note) This calculation assumes 41.1 m (135 ft) of #10 copper wire and an inverter sized to meet at least 80% of the capacity of the photovoltaic module; racking, battery systems, disconnections, and other balance of system components are not included. This estimation is most appropriate for elevated roof mounted panels and is not representative of building-integrated photovoltaics (BIPV) systems. [↑](#footnote-ref-10)
10. To get PRF, a weighted volumetric average of liquid to vapor was calculated based on assumed lineset of ¼”-3/8” liquid and 5/8”-3/4” vapor (suction) line sizes, or 2.5x diameter of suction to liquid line. Since pipe volume is proportional to diameter squared, Vsuction/Vliquid = (Dsuction/Dliquid)2. This yields 6.7 x greater volume in vapor line compared to liquid line, or 87% vapor and 13% liquid. These percentages were then used to confirm a weighted average for each refrigerant assuming the following values: (R-410A: 1040 kg/m3 liquid density and 68 kg/m3 vapor density, R-454B: 960 kg/m3 liquid density and 42 kg/m3 vapor density, R-454B: 1050 kg/m3 liquid density and 61 kg/m3 vapor density, and R-744: 1101 kg/m3 liquid density and 2 kg/m3 vapor density). [↑](#footnote-ref-12)
11. (Normative Note) Dwelling Units with the same construction type, same envelope systems, same number of bedrooms, same number of stories within the unit, same window area (+ 10 percent), same conditioned floor area (+10 percent, not to exceed +100 square feet), and same ceiling height (+0.5 feet) are permitted to be the same unit type. [↑](#footnote-ref-13)
12. See [reference forthcoming] for documentation on the calculation of these default values. [↑](#footnote-ref-14)
13. Inspections conducted in accordance with RESNET 301 Normative Appendix B (and Appendix A for insulation products) shall be considered compliant with the requirements of this table unless otherwise noted in the table. [↑](#footnote-ref-15)
14. (Normative Note) Roof structures connected to the building and extended to cover accessory structures shall be included in the assessment. [↑](#footnote-ref-16)