Georgia
Carbon Sequestration Registry

Protocols for Carbon Accounting of Sustainable Products in Buildings

Prepared by the Sustainable Building Materials Technical Advisory Committee

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Section 1: Overview

The purpose of the amendment to the Georgia Carbon Registry is to promote the use of building products used in construction in Georgia that sequester carbon and/or reduce carbon emissions and to issue carbon credits to the participant for carbon sequestered and reductions in embodied carbon as compared to conventional building practice. The details of the project are recorded in the Georgia Carbon Registry and credits are issued to participants – typically building owners. Participation is voluntary.

The guidelines provided in this document strive to meet established criteria compatible with global carbon credit and offset markets, with the goal of producing high-quality, auditable carbon credits through a rigorous process ensuring that projects in the registry are making meaningful reductions to atmospheric carbon. These criteria include robust carbon accounting, additionality, and 100-year permanence to ensure that carbon removals remain in place during this critical period of transition from carbon-emitting to carbon-neutral energy technologies.

The provisions of the protocol are mandatory, meaning that to qualify for carbon credits, the participant must comply with all provisions outlined in the document. The boundary definitions of the LCA's which underlie these carbon calculations include optional provisions for some life cycle stages, e.g., for calculating carbon associated with on-site construction, that some registrants may wish to pursue. Other participants may choose to simplify their calculations or may not have the data required to assess construction site-specific energy flows.

Some sections of this document end with a sub-section titled *Commentary*. The commentary sections are non-mandatory and are included to inform the user of background information, provide references to similar efforts such as this registry, and guide in further development of the protocol in the future.

Section 2: Terminology

Additionality – in the context of this protocol, additionality describes avoided carbon emissions and/or carbon removals through the use of low-carbon and carbon sequestering (biogenic) materials that would not occur without a change in the materials and practices of building construction that is facilitated by this protocol.

Baseline Building – an equivalent building with the same function as the sustainable material building but constructed of conventional materials and through conventional processes. The requirement for additionality is met by comparing the sustainable materials building to the baseline building.

Biogenic Carbon – carbon that is chemically bound in solid building materials through natural biological processes, often photosynthesis.

Building Model Scope – the set of materials which are considered in the life cycle assessment of the sustainable building and the baseline building, and by omission, those which are not considered. The intent is that all materials which are of considerable quantity or which are of modest quantity but of high environmental impact (either positive or negative) be considered in the scope. The scope of the sustainable building and the baseline building must match. For more information, see the NRC Report NRCC-CONST-56588E, National Guidelines for Whole-Building Life Cycle Assessment, Appendix B.

Building System – major systems of a building that are to be considered in the assessment of the sustainable and the baseline building. Per the protocol, the building foundation system, the building structural system and the building envelope system must be considered.

Building Structural System – the primary loading bearing elements of the structural frame including columns, walls, beams, joists, floors/slabs, roofs, etc. Exterior wall elements that do not carry gravity loads but are intended to seal the building and which may carry local wind loads are part of the building envelope system.

Building Envelope System – includes insulation, external walls, glazing, and non-structural roof of the building.

Building Foundation System – elements intended to transfer loads from the building structure into the load-bearing strata beneath the building.

Carbon Credit – a unit of avoided carbon emissions equivalent to one metric ton of carbon dioxide or 1000 kg CO2e, often denoted tCO2e, and meeting all requirements for verification, additionality and permanence as described in this document. See Global Warming Potential.

Issued Credits – credits issued by the registry to participants after submission and evaluation according to this protocol and thus available to be retained by the participant, transferred to another party, or retired to offset carbon emissions. Owners of issued credits must notify the registry when a transaction of their credits occurs.

Cancelled Credits – voluntary credits converted to California Air Resources Board offset credits.

Retired Credits – credits used to offset carbon emissions and thus no longer available for use or transfer. Holders of issued credits must notify the registry when credits are retired.

Transferred Credits – credits transferred from the original participant (or a subsequent credit holder) to a new credit holder. The holder of the credit must notify the registry when credits are transferred to a new holder.

Buffer Pool Credits – carbon credits which are automatically retired by the registry to ensure permanence and protect against the loss of issued credits due to natural disaster, remodeling or demolition and carbon-producing disposal of the building components before the assumed 100-year service life. See section

Permanence – carbon credits granted under this protocol are intended to be for the sum of avoided carbon emissions and biogenic carbon storage in building components and the registry grants credits with the intention of storing said carbon for a minimum of 100 years.

Sustainable Building Material – a building material manufactured from low-carbon or carbon sequestering sources which regenerate in relatively quick time scales, typically from forest products or agriculture.

Georgia Carbon Registry – a non-profit program established by Georgia Senate Bill 356 in 2004 and amended in 2021 by House Bill 355 and administered by the Georgia Forestry Commission (GFC) and the Georgia Superior Court Clerks Cooperative Authority (GSCCCA). The purpose of the registry is to provide forest landowners, municipalities, and public and private entities with an official mechanism for the development, documentation, and reporting of carbon sequestration projects undertaken in Georgia. Participation in the registry is completely voluntary.

Embedded Carbon – carbon that is chemically bound in solid building materials, often through natural processes (biogenic carbon) but possibly also through manufacturing techniques that capture atmospheric carbon and convert it to a solid substance. Embedded carbon is often referred to as sequestered carbon.

Embodied Carbon – carbon that is released into the atmosphere as a consequence of sourcing, extracting, manufacturing, transporting, erecting and using a building material.

DOE Baseline Building – defined by the U.S. Department of Energy as conventional building types serving a defined occupancy category (for example, office building or school) with a defined usage pattern so that operational energy can be computed and used for normative assessments of energy use in other buildings of the same type. The DOE Baseline Buildings are being extended to include calculations of embodied and embedded energy in the building systems, but that work is underway and incomplete at this time.

Sustainable Building Materials – materials that embed carbon and/or have reduced embodied carbon on a functional unit basis relative to conventional building materials.

Global Warming Potential (GWP) – one metric ton (1000 kg) of equivalent carbon dioxide emissions, typically denoted tCO2e.

Life Cycle Assessment (LCA) – the systematic analysis of the potential environmental impacts of a product or service over the entire life cycle of that product or service, or over a defined portion of the lifecycle

Product Stage – cradle to gate
Construction Stage
Use Stage
End of Life Stage
Benefits and Loads Beyond the Life Cycle
Wood-Based Sustainable Building Materials
Environmental Product Declaration
System Boundary

Whole Building Life Cycle Assessment – the use of LCA methods to assess the environmental impact of a building during the product, construction, operation and end of life stages.

Section 3: Program Overview and General Provisions

3.1 Legal Basis and Administrative Authority

The Georgia Carbon Sequestration Registry was established by the provisions of Senate Bill 356 in 2004. This legislative act provides for the creation of an official mechanism for the registration of eligible terrestrial carbon sequestration activities undertaken in the state of Georgia.

The Georgia Forestry Commission (GFC) is responsible for the implementation, administration, and oversight of the Registry. The Georgia Superior Court Clerks Cooperative Authority is responsible for the documentation of eligible projects in an online-accessible database.

In 2021 House Bill 355, the Georgia Sequestration Registry Act, passed by the House and Senate, amended the code relating to the Georgia Carbon Sequestration Registry to provide for the inclusion of building products in construction on the registry; to provide for definitions; to allow participants in the registry to voluntarily report the utilization of carbon sequestration and embodied carbon results; to provide for an advisory committee; to provide for certified third-party organizations to measure the amount of carbon sequestered from building materials that sequester carbon dioxide; to require the State Forestry Commission to publish a list of certified organizations; to provide for related matters; to repeal conflicting laws; and for other purposes.

3.2 Registry Scope

For a building or part of a building, including the foundation and structural skeleton, building envelope, including insulation, external walls, glazing, and roof. The purpose is to assess the environmental impacts of building-related materials and processes within an appropriate functional unit, scope, and boundary.

3.3 Participant Eligibility

The basic unit of participation in the registry shall be a natural person or a legal entity in its entirety such as a corporation or other legally constituted body, a city or county, or a state government agency.

3.4 General Project Definition

Construction of buildings in this state that store additional carbon in
building products relative to the building baseline established by the Sustainable Building Material Technical Advisory Committee pursuant to Code Section 12-6-224.1.
'Embodied carbon results' means the participant's applicable data on the reduction in building embodied carbon emissions resulting from the construction of buildings in the State of Georgia that have lower building embodied carbon relative to the building baseline established by the Sustainable Building Material Technical Advisory Committee pursuant to Code Section 12-6-224.1.

3.5 Project Location Requirements

Within the borders of the State of Georgia.

3.6 Qualified Project Types

Commercial Buildings containing sustainable building materials constructed in the State of Georgia after January 1, 2021 and registered on the Georgia Carbon Registry.

3.7 Project Reporting

See Section 11 for Reporting Requirements

3.8 Project Reporting Deadlines

None at this time.

3.9 Project Quality Control, Monitoring, and Verification

(A) Developing a list of the minimum technical and organizational capabilities and other qualification standards that approved third-party organizations shall meet. Those qualifications shall include the ability to sign an opinion letter, for which they may be held financially at risk, and certifying the participant-reported carbon sequestration results as provided in this article.

(B) Occasionally, and on a random basis, provide for commission employees to accompany third-party verifying organizations on scheduled visits to observe and evaluate, during any certification visits, both of the following:
(1) Whether the participant has a program, consistent with commission approved procedures and protocols, in place for the preparation and submittal of the information required under this article; and
(2) The reasonableness of the carbon sequestration information being reported for a sample of estimates or calculations.

Section 4: Requirements for Additionality

4.1 Background

Additionality in markets for tradable greenhouse gas emission reductions (carbon credits) is provided when a project or activity reduces carbon emissions as compared to a common practice or business-as-usual scenario. To offer the carbon emission reduction as a credit, the project must meet additionality requirements. Additionality means that the carbon sequestered or avoided is in addition to what would otherwise have happened. The project developer needs to have engaged in this activity with extra effort for the purpose of sequestering carbon and/or avoiding carbon emissions.

Common practices for construction of commercial buildings in Georgia have been utilizing carbon intensive building materials such as structural steel, concrete, and steel reinforcement bar. If the choice to use wood or other sustainable building materials in commercial construction results in the substitution of more emission intensive materials, and net reduction of greenhouse gases occurs, additionality has been provided.

4.2 Protocol Overview

To be eligible for participation in the Georgia Carbon Registry, the participant must have substituted sustainable materials for common practice materials in the commercial construction of a building or buildings. Eligible building components are limited to the foundation, structural skeleton, and building envelope, including insulation, external walls, glazing, and roof.

The utilization of sustainable building materials may have reduced embodied carbon emissions and/or increased embedded carbon storage as compared to the baseline common materials.

Section 5: Requirements for Permanence

5.1 Background

"Long-term Permanence" is a commonly agreed upon outcome for ensuring that a carbon removal has the equivalent impact on the atmosphere as an avoided emission.

The protocol for the Georgia Carbon Registry for Sustainable Materials for embedded carbon will meet established criteria compatible with global carbon credit and offset markets by establishing 100-year permanence equivalence with discounting for uncertainty and risk of storage for less than 100 years.

5.2 Building Lifetimes

USFS data show that that half-life of a single family residential wood home is 80 years (Skog 2008). Research on non-residential wood buildings show higher longevity relative to concrete or steel. For example, O'Connor (2004) found that in a survey conducted in Minneapolis, more than 65% of demolished wood buildings were older than 75 years, while 60–80% of concrete and steel buildings were demolished at less than 50 years old. Sampo et al (2022), a Finnish study, report the average life span for timber in construction is actually 175 years, with a range from 30 to 330.

Based on the above review, the Georgia Carbon Registry Protocol assumes that the pool of buildings addressed by this protocol will have an assumed life, as follows:

1. Light wood frame: Determined by BUILDING OCCUPANCY TYPE
2. Mass timber frame: 100 years
3. Other sustainable material buildings: To be determined by material type

Finally, recent research indicates that the material in mass timber buildings will have a higher likelihood of reuse than traditional lumber. Finally, of the amount of wood that is landfilled 40.5% percent is permanently stored (GA Carbon Registry Appendix B, Table 3).
Due to the longer building life span and the higher recycle rate it is projected that the mass timber in a building will remain in use for at least 100 years.

5.3 Building embedded carbon non-permanence discount method

The embedded carbon in the eligible building materials will be assessed for risk of reversal back to the atmosphere over 100 years. Published studies on building service lives and end-of-life fates will be used to determine the proportion of embedded carbon that will remain after 100 years for each building type and material (see Appendix of GA Carbon Registry for wood products values). This value will be used to adjust the upfront embedded carbon value.

Buffer for Uncertainty: some embedded carbon in sustainable building materials of a building may be lost before the end of the life of the building due to remodeling. A discount of 5% will be

the buffer pool to address this risk of reversal. We apply a permanence factor of 100*.0095 = 0.95
Because the permanence required by this protocol is 100 years, the carbon stored in all the sustainable building materials will be discounted by 5% as a buffer to account for possible shortfalls/risk of reversal of one or more participating buildings.

Temporary Storage: if the building/landfill is expected to last less than 100 years, wood product carbon storage discounted using the risk of the reversal according to the expected service life plus any additional reuse. This is equivalent to using the Lashof radiative forcing International Life Cycle Data (ILCD) system simplified approximation (.01 x length of storage in years). For example, for a building lifetime of 60 years with immediate emissions upon building removal, permanence factor would be 0.6 tons of CO2 for each ton of embedded carbon (sequestered biogenic carbon) in the building.

Research on mass timber building life spans and end-of-life recycling rates suggest that the wood will be stored in mass timber buildings for >100 years. In this case, the permanence factor would be applied at (100*.0095 = 0.95).

5.4 Commentary

Carbon offset protocols also differ in how harvested wood products (HWP) carbon storage is accounted for- the California Forest Offset Protocol and one of the VCS standards use the 100-year average method (which approximates radiative forcing), while the ACR improved forest management protocol values only the proportion of carbon that remains in a product or landfill after 100 years. The Georgia Carbon Registry reports HWP fate up to 100 years after harvest, which does not account for the climate value of temporary storage.

There is also a known recognition that there is a climate impact of temporary storage or delayed emissions. It is understood that there is a climate benefit of storing carbon in a wood product, even if the storage is not permanent. The ILCD Handbook General Guide for LCA Detailed Guidance states “The logic behind accounting for biogenic carbon storage is that for the duration of storage the CO2 is not exerting a radiative forcing. This makes sense only in case near-term radiative forcing is considered more relevant than future radiative forcing, as the later re-emitted biogenic CO2 will still exert its full radiative forcing effect, only later. That is reflected by the commonly used one hundred years perspective for GWP100: the higher radiative forcing per unit (kg) of e.g. Methane and Nitrous oxide is weighted higher than the relatively lower radiative forcing per unit of CO2, always for 100 years. To reward the temporary removal of CO2 from the atmosphere is fully equivalent to the effect of avoided radiative forcing due to delayed emission of fossil carbon dioxide, methane, nitrous oxide, and other greenhouse gases.” A number of methods have been proposed to calculate temporary storage, such as using different dynamic radiative forcing calculations (e.g. Lashof or Moura-costa) or simplified versions (e.g. ILCD 1% or 100-year average).

Section 6: Timber Products Embodied and Embedded Carbon Estimation Method

6.0. Section Purpose

A main purpose of House Bill 355, the Georgia Sequestration Registry Act is to provide for the inclusion of building products that sequester carbon used in commercial construction in Georgia onto the Georgia Carbon Registry. The purpose of this section is to define the protocol by which the carbon sequestration for building products that sequester carbon will be calculated.

6.1 Background

Although the total benefits of a project building must be assessed on a functionally equivalent whole building level, the customized information on building materials can be gathered on a product basis.

6.2 Protocol Overview

Timber products used for building structural components will be evaluated as embodying the full greenhouse gas emissions resulting from production and transportation of the material. We call these product embodied carbon, or the supply chain emissions.
In addition, the products will be allocated the amount of carbon in the product, that is, the natural carbon in the timber, which has been absorbed from the atmosphere. This will be called the product carbon sequestration, or embedded carbon

6.3 Baseline for building products

The supply chain emissions and biogenic carbon of building *materials or products* (e.g. cross-laminated timber) shall be measured from the United States Department of Energy's Commercial Prototype Building Models in effect on January 1, 2021, to establish baseline categories using prototype building occupancies and structural systems using a weighted average based on market share of building material types. Building materials or products that are not exact functional equivalents should not be directly compared.

6.4. Net embodied carbon of structural timber products.

Current factors to convert various primary wood products to carbon mass are listed in Appendix B, Table 1 of the Georgia Carbon Registry. These can be replaced with more current or customized information from an LCA or third party verified EPD in compliance with ISO 21930.

Participants of the Georgia Carbon Registry for sustainable building materials are required to provide product-specific EPDs and report on the materials used in the project.

For example:

SmartLam CLT = 126 kg CO2e per cubic meter of product
Mercer CLT = 124.02 kg CO2e per cubic meter of product
SmartLam Glulam = 132 kg CO2e per cubic meter of product

6.5. Net embedded carbon of structural timber products.

The amount of carbon stored in wood varies depending on species density, resin content, and moisture content of the wood product. Roughly 50% of the dry weight of wood is carbon. Carbon must be converted to carbon dioxide (CO2) for calculation of registry carbon credits, 1,000 kg of carbon dioxide (CO2) equals one carbon credit.

Current carbon equivalents for various structural timber products are listed in Appendix B, Table 1 of the Georgia Carbon Registry.

Wood Product	Embedded Carbon/unit (CO_2e/m^3)	Source
Softwood Lumber	443 kg per thousand board feet	GA Carbon Registry

The net embedded carbon of structural timber products is the carbon stored in the building product x the permanence factor (see Section 5.3)

Section 7: Non-Timber Structural Materials Embodied Carbon Estimation Method

7.0. Section Purpose

Participants may need to evaluate the embodied carbon for non-timber structural materials. These non-timber products embodied carbon values may be useful in calculating the whole building embodied carbon and may in some limited circumstances be useful in calculating the embodied carbon in a mass timber building compared to a building constructed with non-timber structural materials.

7.1 Background

Participants will provide carbon accounting of materials not listed in the Georgia Carbon Registry. Eligible sustainable building materials may continue to emerge. Third party verification of carbon accounting is required.

7.2 Protocol Overview

Calculation of carbon footprint of materials displaced by mass timber

The carbon footprint of materials displaced by mass timber will be evaluated with the values from commercially available Life Cycle Assessment (LCA) tools or stated in the table accompanying this section through year 2024 and are subject to periodic update by the authority.

- Cement. Each metric ton of Portland Cement counts as 0.922 metric tons CO2e as of 2022 and will be updated periodically based on LCA or EPA calculations or other source as decided by the Registry authority.
- Steel reinforcement bar
- Structural steel framing

Section 8: Whole Building Embodied and Embedded Carbon Estimation Method

8.0. Section Purpose

A main purpose of House Bill 355, the Georgia Sequestration Registry Act is to allow participants in the registry to voluntarily report the utilization of carbon sequestration and embodied carbon results.

8.1 Background

HB 355 specifies that the DOE Commercial Prototype building embodied carbon values be used in calculating the baseline building. DOE has 16 building types in various climate zones. The Atlanta Climate Zone applies to this Registry.

8.2 Protocol Overview

The scope of the Whole-Building Embodied and Embedded Carbon will encompass the foundation, structure, and enclosure of the building being analyzed.

If the participating building has multiple uses, the proportionate floor area of each use type shall be used from the DOE values.

8.3 A/E Designs Building

Projects will need to create a bill of materials, listing material types and quantities for the following parts of the building: foundation and structural skeleton, building envelope (including insulation, external walls, glazing, and roof)

8.4 A/E Designs Equivalent Baseline Building

HB 355 specifies that the DOE Prototype building embodied carbon values be used as the baseline; however, these embodied carbon results are not yet available. Until these results are available, projects must calculate their project specific baseline using the following steps.
Functional Equivalence is defined as developing a proposed baseline building and must serve the same function and have the same gross floor area, orientation, and operational energy usage as the proposed building. Both baseline and proposed buildings must be located in the same ASHRAE 90.1-2010 climate zone and assumed to be on the same site.

The participant and third party verifier must use the same LCA software and data sets for both baseline and proposed buildings.
Justification of baseline building material can be done by surveying similar buildings over last five years and providing three examples of comparable buildings.
Square footage is adjusted by comparing kg $CO2e/m^2$. See Section 2.1 of NRC-CNRC National guidelines for whole-building life cycle assessment.

To create a baseline building if there is no existing equivalent DOE baseline (or if the results aren't available yet), provide functional equivalent quantities of eligible materials.

Consider a performance pathway that follows LEED v4.1 Whole-building LCA Materials and Resources credit. Credits can be based on WBLCA calculations and the differential between a user-defined baseline building and the Project building.

8.5 Calculate Embodied (Supply Chain) Carbon in Proposed and Baseline Buildings

This will include the product cradle to gate [A1 (raw material supply), A2 (transport), A3 (manufacturing)]. Include all A2 and A3 carbon if multiple manufacturing sites are utilized.

This will include the construction process stage A4 (transportation of building materials to site). It does not need to include A5 (construction process) but may if the project participant chooses to include A5.

This Registry does not consider operational energy use, the calculations included do not include B6 (operational energy use) or any other use phase stage (B1-B7).

The calculation of embodied carbon must include end of life (C1-C4). This will typically be calculated using a WBLCA tool.

8.6 Calculate Embedded (Sequestered) Carbon in Proposed and Baseline Buildings

See section 6.5 (carbon embedded per unit product * volume product * permanence factor.

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Section 9: Net Carbon Savings Estimation Protocol

9.0. Section Purpose

Sections 7 and 8 describe how to calculate product embodied carbon and embedded carbon. Section 9 describes how to calculate the Project's embodied and embedded carbon and the Baseline building embodied and embedded carbon. The net benefit (in terms of total carbon savings/sequestration) is described in this section.

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9.1 Background

Several WBLCAs have found GHG savings comparing mass timber buildings to functionally equivalent steel or concrete buildings. A study by Duan, Huang, and Zhang (2022), *Life cycle Assessment of Mass Timber Construction,* summarized 62 studies comparing mass timber to functionally equivalent alternative (mostly reinforced concrete).

9.2 Protocol Overview

The full embodied carbon of the building containing the eligible building materials shall be estimated. This includes the full supply chain emissions of all of the eligible building materials, plus the biogenic carbon contribution as explained in the section above. This calculation will be carried out using calculation methods approved by the Georgia Forestry Commission. These methods may include use of standard LCA building software such as Talley, Athena Impact Estimator and possibly other platforms.

The net project carbon will be the embodied carbon for the project building minus the embodied carbon for the baseline building, MINUS the sequestered (embedded) carbon for the project building minus the sequestered carbon for the baseline building.

9.3 Buffer Pools

Buffer pools provide protection against several types of risks and the following uncertainties:

1. A buffer pool is used to account for the net project carbon for possible uncertainties in metering inaccuracies, losses of the CO2 storage after production, or other losses that may occur.

2. During lifespan: The amount of emissions of CO2 in the normal use of the sustainable building material (SBM).

An automatic withholding and retirement of 5 percent of a projects embedded carbon credits is used to reflect the uncertainty and to reduce the volume of CO2 removal to be certified. i.e. net project carbon *(100% - 5% buffer).

Section 10: Verification

10.0. Summary

The Georgia Forestry Commission will qualify Validation and Verification Bodies (VVB) to verify compliance with the requirements of the SBM protocol and International Standards Organization 14064-3, which specifies principles and requirements and provides guidance for verifying and validating greenhouse gas statements. Per the requirements of IS 14063-4, prior to submitting a completed project report with information about eligibility, quantification of embodied and embedded carbon, and a request for credits, the Participant will retain a VVB to verify the project's compliance with this protocol.

Reporting requirements for verification are described in Section 11.

10.1 Detailed Requirements for Verification

Verification by a VVB is described in more detail below.

• The Registry will maintain independence from the activities of projects and will treat all projects equally with regard to verification.

• The Registry requires a reasonable level of assurance in the accuracy of the asserted embodied carbon removals and embedded carbon within the eligible components of the building.
• The reporting items identified in Section 12 are all mandatory and any asserted embodied carbon removals and embedded carbon must be free of errors or omissions.
• The Registry will record and store all quantification and verification data.
• The Georgia Forestry Commission (GFC) will audit a portion of the projects that participate in the Registry. This process will consist of validation by the GFC to ensure that the Verification Report for each project is consistent with the project reporting documents submitted by the Participant.
• Credits will be issued upon receipt of Certificate of Occupancy for the building.
• Validate Project Application eligibility under the protocol eligibility requirements

The verification and validation process will suffice as proof that an actual practice change occurred in accordance with this Protocol methodology.

Section 11: Reporting Requirements

11.0. Summary

Each project to be submitted to the registry shall be accompanied by two reports. The first report shall be submitted by the building owner and the associated project team (architect, engineer and general contractor), delineating the building materials used in the building and calculating the carbon credits claimed according to the procedure outlined in this protocol. The second report shall come from the third-party verification agent (VVB), who will review the report submitted by the owner and verify that the carbon credits claimed are valid and meet the protocol requirements for additionality and permanence.

11.1 Reporting by Project Teams

1. Overall Reporting Requirements
    a. Name, address, email and contact of the participant (typically the building owner) and their primary consultant (typically the architect or green building consultant).
    b. Address of the building to be added the registry.
    c. Description of standards, methods and/or software tools used in the calculation of bill of materials (BOM) for the three building systems: foundation, structure, and enclosure.
    d. Description of standards, methods and/or software tools used in the calculation of embodied and embedded carbon of the building materials.
2. Reporting Requirements for the Sustainable Materials Building (SBM)
    a. Sustainable building products claimed by type, volume or weight as applicable.
    b. Embedded carbon claimed for the sustainable building material per unit weight or volume as appropriate and references to the associated EPD or LCI data. For wood products Table X in the Georgia Carbon Registry may be used for these values.
    c. For each wood product claimed, information as necessary to calculate the embodied carbon from the Product Stage (A1 to A3).
        i. Sources of the primary timber harvested to make the wood product [forest]
        ii. Location of the primary wood product mills for each wood product [mill]
        iii. Location(s) of the secondary wood product processing location(s), if relevant [laminator, CNC machining]
        iv. Methods and distances of transportation between forest and processing locations.
        v. LCI reference information used to establish embodied carbon.
        vi. As an alternate to steps i. to v. above, the participant may reference and provide a product specific EPD that contains the above information.
        vii. The claimed embodied carbon of the product on a per volume/weight basis as appropriate.
    d. For each non-wood sustainable product claimed, information necessary to calculate the embodied and embedded carbon created during the Product Stage (A1 to A3) for that product.
        i. Source of the sustainable raw material (e.g. plant species and farm/forest locations)

ii. Methods and distances of transportation between farm/forest and manufacturing location(s)
iii. LCI information (EPD information as alternate) used to establish embodied and embedded carbon of the wood product. - the references for the data used in the calculation
iv. As an alternate to steps i to iii above, the participant may reference and provide a product specific EPD that contains the above information.
v. The claimed embodied and embedded carbon of the product on a per volume/weight basis as appropriate.

e. Optionally, method(s) and distance(s) of transportation from the final manufacturing facility to the project location (Construction Stage, A4). Calculation of embodied carbon based on transportation of products from the manufacturing location to the project location.
f. Optionally, provide calculation of construction, installation and process energy (A5). If calculations of A5 energy are made for the SB, then parallel calculations must be made for the baseline building, as described below.
g. For non-SBM that are included in the SB and that are part of the building foundation, structure and enclosure system, calculate the quantity of these materials used in the building and the embodied and embedded carbon of these materials in the manufacturing (A1 to A3) and transportation (A4) stages.
h. Optionally, calculate the construction, installation and process energy (A5) for the non-SBMs that are part of the building foundation, structure and enclosure systems.

3. Descriptions of the baseline building and source of baseline embodied and embedded carbon calculations following the process steps described in Sections 12.1 and 12.2 above for sustainable and non-sustainable building materials. Provide evidence that baseline building systems chosen represent the prevailing practice for the location and occupancy of the building –noting that the baseline building may contain both sustainable and non-sustainable building materials.
4. Summary of embedded and embodied carbon by building and material system as shown in Table 12.1 below.
5. Calculation of difference in GWP in SBM and baseline building and carbon credits claimed according to the provisions of Section 10 of this protocol.

System	Material	Quantity	LCI/EPD Source Data	Unit Embodied GWP	Unit Embedded GWP	Total Embodied GWP	Total Embedded GWP
Sustainable Materials Building							
Foundation							
Structural							
Envelope							
Total GWP, Embodied and Embedded, Sustainable Materials Building						B	A
Baseline Building							

Foundation							
Structural							
Envelope							
Total GWP, Embodied and Embedded, Baseline Building						D	C

Total Credits Claimed = (A - B) - (C - D)

11.2 Reporting by Verification Agent

11.2.1 Contact the Georgia Forestry Commission for list of qualified Verification Agents also called Validation and Verification Bodies (VVB) having the expertise to complete third party reviews of participant's submissions to verify compliance with the requirements of the SBM protocol.

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11.2.2 The Verification Agent will verify the reporting of embodied and embedded carbon results arising from construction of commercial buildings in this state. Upon completion of the project, participants shall seek the review of a certified third-party organization that will verify the building embodied carbon and certify that they agree with the carbon credits claimed.

Section 12: Registry Operation

12.0 Section Purpose

To define the process of issuing carbon credits to participants of the Registry and the process of reporting transactions of the credits.

12.1 Background

Carbon credits will be issued to participants for the verified difference in embodied emission reductions and embedded carbon in eligible sustainable building materials such as mass timber elements including glued laminated timber (glulam), cross-laminated timber (CLT), laminated veneer lumber (LVL), dowel laminated timber (DLT), other timber or lumber elements, and possibly other eligible sustainable building materials and used for the construction of commercial buildings in the State of Georgia.

Only projects that have been completed after January 1, 2019, shall be considered. After such projects have been verified and validated by a certified third-party organization, the Director shall be authorized to determine, charge, and may retain an administrative fee from developers

for awarding carbon credits to provide for the cost of administering the provisions of this Registry.

12.2 Project Registration onto the Registry

12.3 Credit transactions in the Registry

Registry credits for certified carbon sequestration results may be sold, purchased, or otherwise transferred in whole or in part without any regard to or effect on or being affected by ownership of other personal property or any real property, and such credits may be retained in whole or in part without any regard to or effect on or being affected by any sale, purchase, or other transfer of other personal property or any real property.

12.4 Credit certificate transactions in the Market

Participants shall report to the Registry any sales, purchases, or other transfers of registry credits for certified carbon sequestration results, in whole or in part, within ten days after the completion of such transaction, and participants' registry accounts shall be updated to reflect such transfers. The basic unit of participation in the registry shall be a natural person or a legal entity in its entirety such as a corporation or other legally constituted body, a city or county, or a state government agency.

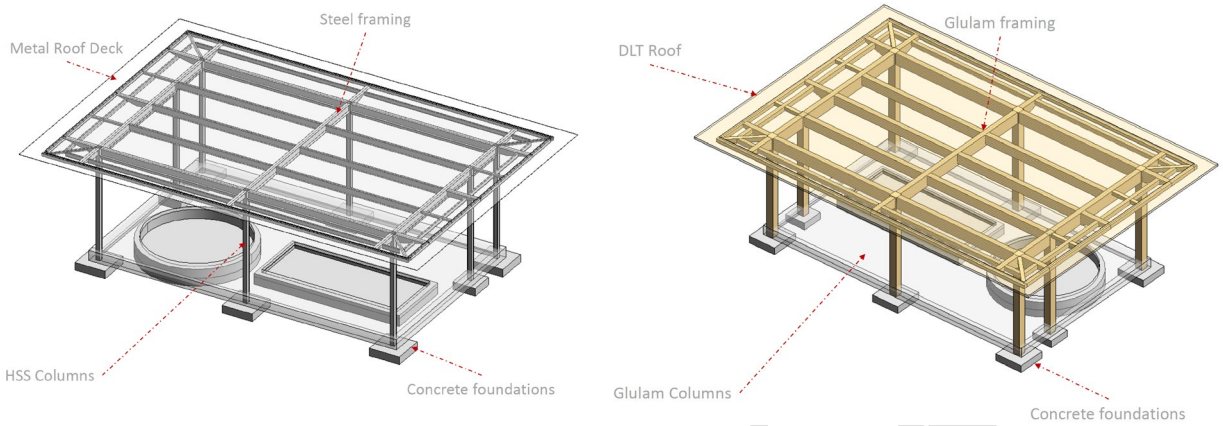
Appendix 1: Worked Example

A1.0. Summary

A brief example is provided in this section to demonstrate the application of the protocol. The example is based on a small one-story building recently erected at the Georgia Institute of Technology in Atlanta. An additional example based on a four story office building is being prepared as an additional example.

A1.1. Glulam Frame Example

This first example consists of a structural steel frame with a light-gage metal roof. The functionally equivalent sustainable materials building consists of a glued-laminated timber frame with an exposed, nail-laminated timber roof deck.



Baseline Building **Sustainable Materials Building**

Figure A1.1 – Worked Example: Baseline and Sustainable Building Functional Equivalent

The general workflow is depicted in Figure A1.2. Currently there exists no DOE baseline for embodied and embedded energy of this building type. Therefore, a design for a baseline building is completed to establish the embodied and embedded carbon for the reference case.

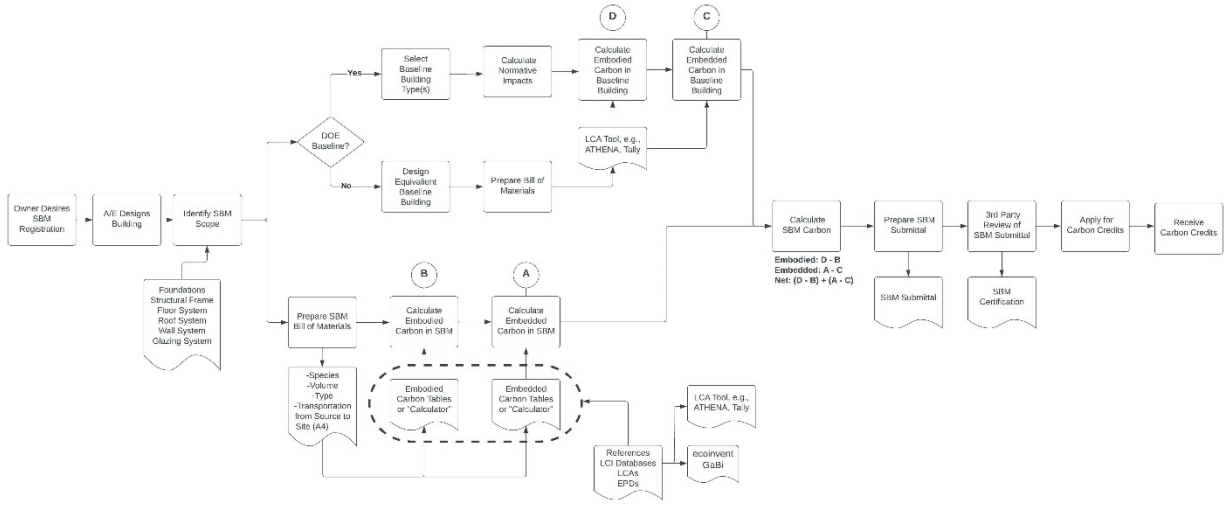


Figure A1.2 – Flowchart for calculating carbon credits for the sustainable materials building.

For both the baseline and sustainable materials building, the first step in the process is to calculate the quantity of the materials in the building foundation, structural frame and building enclosure systems. If it can be demonstrated that one or more of these systems is exactly the same in both cases, then that sub-system does not need to be assessed, as the calculation will net to zero when the two systems are compared. The example buildings were modeled in Revit which allows for automated calculation of bills of materials. Early versions of the models were assessed using Tally software, which automates the calculation of embodied carbon for the baseline and sustainable building materials. But a separate calculation was made for embedded carbon, as Tally, and other whole-building LCA tools, are inconsistent in the way that the treat embedded (biogenic) carbon. As is shown in Figure A1.3, the "benefits" or biogenic carbon are often included in "Module D" according to EN 18578 (Hoxha et al. 2020). The protocol

therefore requires that embedded carbon be calculated separately and distinctly from the embodied carbon, and it is important for those using whole-building LCA tools to understand how the individual tools calculate embedded carbon. Figure A1.3 depicts the two modules where the embodied and embedded carbon calculations reside, and the optional calculation for transportation energy (A4). In this worked example, transportation energy A4 is not calculated.

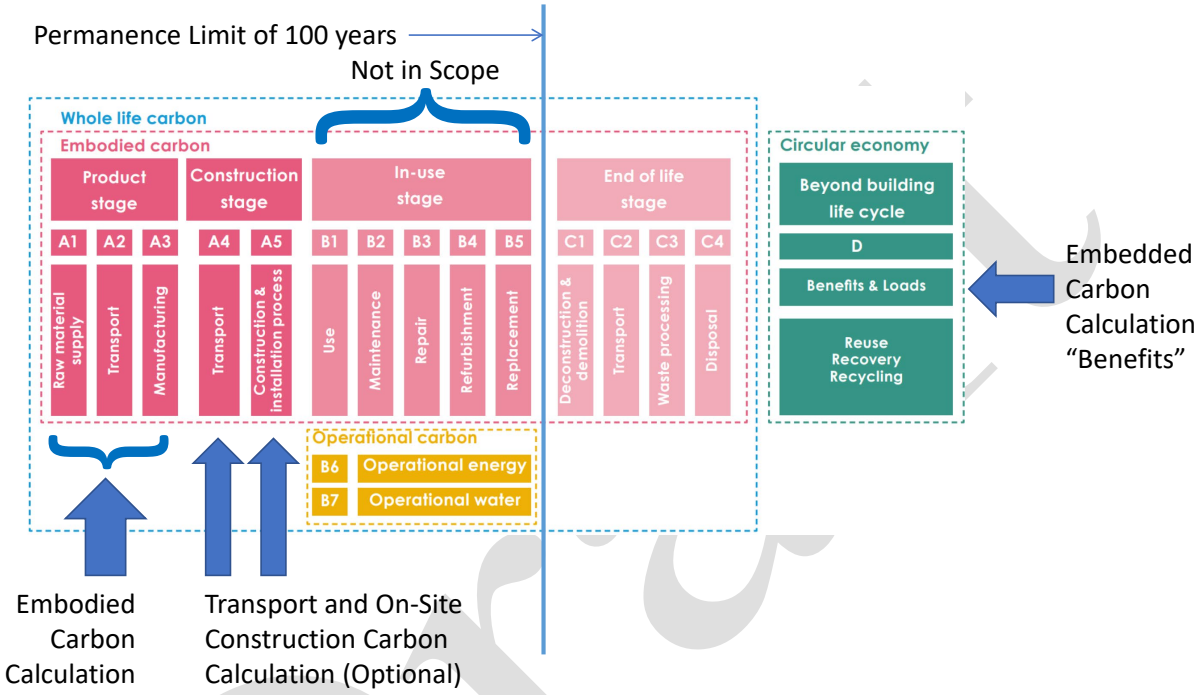


Figure A1.3 – Embodied and embedded carbon calculation relative to whole-building LCA system boundaries.

The results of the calculations are summarized in the table below following the requirements of Section 11 of the protocol. The small building generates a total of 19 carbon credits, which is the difference between the carbon footprint of the baseline building relative to the sustainable materials building. Per the requirements of the protocol, 5% of the credits or in this case 1 credit, are allotted to the buffer pool to ensure for permanence and durability of the carbon credits.

Table A1.1 – Carbon credit accounting for the example building.

System	Material	Quantity	Unit	LCI/EPD Source Data	Unit Embodied GWP	Unit Embedded GWP	Total Embodied GWP	Total Embedded GWP
Sustainable Materials Building								
Foundation	Concrete	22.9	m3	Ready-Mix Concrete Association (NRMCA) Industry-wide EPD.	0.4	0.0	9.9	0.0
	Rebar	1.6	metric Ton	Steel rebar worldsteel (2014)	1.2	0.0	2.0	0.0
Structural	Glulam	15.1	m3	American Wood Council EPD	0.7	0.77	10.9	11.6
	DLT	15.8	m3	American Wood Council EPD	0.7	0.71	10.5	11.2
Envelope								
							33.3	22.8
Total GWP, Embodied and Embedded, Sustainable Materials Building							B	A
Baseline Building								
Foundation	Concrete	22.86	m3	Ready-Mix Concrete Association (NRMCA) Industry-wide EPD.	0.43	0	9.9	0.0
	Rebar	1.60	metric Ton	Steel rebar worldsteel (2014)	1.25	0	2.0	0.0
Structural	Hollow Structural Steel	3.16	metric Ton	American Institute of Steel Construction	1.68	0	5.3	0.0
	Flange Section-Hot Rolled Structural Steel	3.70	metric Ton	American Institute of Steel Construction	1.73	0	6.4	0.0
	Steel Plate	1.21	metric Ton	American Institute of Steel Construction	2.83	0	3.4	0.0
	Metal Deck	1.49	metric Ton	Steel deck - Steel deck institute (SDI)	1.75	0	2.6	0.0
Envelope								
							29.62	0
Total GWP, Embodied and Embedded, Baseline Building							D	C

Carbon Credit Calculation

A-B	-10.55
C-D	-29.62
Sum	19.07
Total Whole Credits	19
Credits Alloted to Buffer Pool	1
Total Credits Issued to Registrant	18

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