Resilient Efficient Buildings Task Force – (SB 1518)

Response to Questions about embodied carbon impacts of building materials
Compiled by Oregon DEQ

Question #1:

What are the top 10 highest GHG emitting building products in Oregon (for Residential / for Commercial)?

Answer #1:

DEQ is responding to this question with the highest GHG emitting building products produced and consumed in Oregon.

From a production perspective, the ranked lists below were developed based on total direct greenhouse gas emissions data reported to DEQ's Greenhouse Gas Reporting Program by facilities producing building materials in Oregon for 2020. The lists include two categories, one based on total emissions by building product type produced and the other listing the highest emitting facilities producing building materials in Oregon. The emissions data includes total emissions by category, not emissions per unit product produced. For this reason, a product may rank higher on the list because a lot of it is produced in Oregon or because it is an emissions intensive product to produce.

The categories include lists ranked in two different ways. First, by anthropogenic emissions and second by total emissions. Total emissions are a combination of both anthropogenic and biogenic emissions. The major source of biogenic emissions reported (and major difference in the list) is biogenic carbon dioxide emissions from the combustion of biomass, including wood and wood waste.

Anthropogenic emissions = GHG emissions caused by human activities, typically from fossil fuel sources
Biogenic emissions = GHG emissions from short term biological sources (plants, trees, grasses)

Top 12 Highest GHG Products Produced in Oregon by Product Type

Products Ranked by Anthropogenic Emissions	
1	Cement Manufacturing
2	Polystyrene Foam Product Manufacturing
3	Softwood Veneer and Plywood Manufacturing
4	Rolled Steel Shape Manufacturing
5	Sawmills
6	Reconstituted Wood Product Manufacturing
7	Iron and Steel Mills and Ferroalloy Manufacturing
8	Hardwood Veneer and Plywood Manufacturing
9	Gypsum Product Manufacturing
10	Asphalt Paving Mixture and Block Manufacturing
11	Engineered Wood Member (except Truss) Manufacturing
12	Plastics Material and Resin Manufacturing

Products Ranked by Total Emissions (anthropogenic + biogenic)	
1	Softwood Veneer and Plywood Manufacturing
2	Cement Manufacturing
3	Sawmills
4	Reconstituted Wood Product Manufacturing
5	Polystyrene Foam Product Manufacturing
6	Hardwood Veneer and Plywood Manufacturing
7	Rolled Steel Shape Manufacturing
8	Iron and Steel Mills and Ferroalloy Manufacturing
9	Gypsum Product Manufacturing
10	Asphalt Paving Mixture and Block Manufacturing
11	Steam and Air-Conditioning Supply; Sawmills; Reconstituted Wood Product Manufacturing
12	Other Millwork (including Flooring)

Top 12 Highest GHG Emitting Facilities Producing Building Products in Oregon

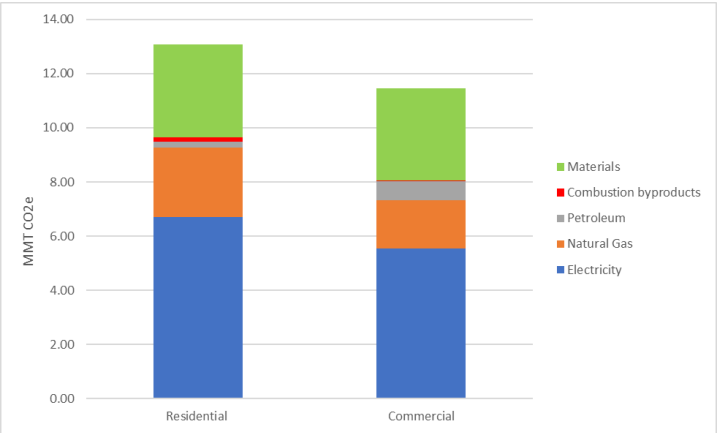
Facilities Ranked by Anthropogenic Emissions	
1	Ash Grove Cement Company
2	Owens Corning Corp.
3	EVRAZ Inc. NA
4	Cascade Steel Rolling Mills, Inc.
5	Roseburg Forest Products Co.
6	United States Gypsum Company
7	Woodgrain Millwork, Inc.
8	Arauco North America, Inc.
9	Murphy Company dba Murphy Veneer
10	Timber Products Co. Limited Partnership
11	Sanders Wood Products, Inc.
12	Murphy Company

Facilities Ranked by Total Emissions (anthropogenic + biogenic)	
1	Ash Grove Cement Company
2	Roseburg Forest Products Co.
3	Douglas County Forest Products
4	Boise Cascade Wood Products, L.L.C.
5	Swanson Group Mfg. LLC
6	Owens Corning Corp.
7	Freres Lumber Co. Inc.
8	Hampton Lumber Mills dba Tillamook Lumber
9	Murphy Company
10	EVRAZ Inc. NA
11	Cascade Steel Rolling Mills, Inc.
12	JELD-WEN, Inc.

High GHG emitting building products <u>consumed</u> in Oregon:

Many of the building materials produced in Oregon are exported to markets beyond state boundaries. Conversely, many of the building materials consumed in Oregon come from other states and countries. Oregon DEQ publishes a consumption-based emissions inventory[1] to track the GHG impacts associated with the consumption of Oregon's households and governments. Using data from this inventory allows a more complete view of the greenhouse gas impacts of buildings in Oregon, as shown in Figure 1. Through this inventory, we learn that building material consumption in Oregon comprises 8% of total emissions and building operations comprises 20% of all GHG emissions in 2018. Below is more information on the GHG impacts of building materials consumed in Oregon:

1. Building material consumption associated with public and private buildings in Oregon is roughly ~6 MMT CO2e/year. Roadway and bridge construction adds an additional ~1 MMT CO2/year. Impacts from refrigerant use are estimated at ~0.74 MMT CO2e/year
2. Overall, Oregon is a net importer of embodied carbon emissions for building materials. Our total emissions from producing building materials (~3.8 MMT CO2e/year) is less than our consumption related embodied carbon emissions of building materials (~6 MMT CO2e/year).
3. Location of consumption based GHG emissions.



<u>Figure 1</u> – Consumption Based GHG emissions from Oregon's Building Sector [data year: 2018 (fuels), 2015 (materials)]

[1] https://www.oregon.gov/deq/FilterDocs/OregonGHGreport.pdf

    a. In Oregon = ~30%
    b. In other states = ~40%
    c. In Foreign countries = ~30%
4. Top emitting industries in consumption-based emissions
    a. Concrete
    b. Steel
    c. Carpet
    d. See note in #6 for additional materials
5. Commercial vs Residential
    a. Emissions split roughly 50/50
6. High Impact Materials
    a. The CBEI consumption data is able to identify concrete, steel, and carpet as high impact materials but has less accuracy in the other commodity categories. Many "final demand" purchases used in the consumption-based emissions inventory are categories like "residential building services" and "commercial building services". How money gets spent by contractors is best reflected in actual project LCAs in the commercial and residential sectors to identify high impact materials.
    b. Project level LCA based estimates for high GHG impact materials
        i. Commercial buildings[2]
            1. Concrete/rebar
            2. Steel
            3. Aluminum
            4. Insulation
            5. Flat Glass
            6. Timber
            7. Refrigerants
            8. Cladding
            9. MEP
            10. Furniture + Carpet (for tenant improvement projects)
        ii. Residential single / duplex dwellings[3]
            1. Concrete/rebar
            2. Insulation
            3. Cladding
            4. Roofing
            5. Carpeting
            6. Timber

Sources:

- https://www.oregon.gov/deq/aq/programs/Pages/GHG-Emissions.aspx
- https://www.oregon.gov/deq/FilterDocs/OregonGHGreport.pdf
- https://www.oregon.gov/deq/ghgp/Pages/GHG-Inventory.aspx

[2] https://rmi.org/insight/reducing-embodied-carbon-in-buildings/
https://www.arup.com/perspectives/publications/research/section/net-zero-buildings-where-do-we-stand
[3] https://www.passivebuildings.ca/_files/ugd/833b9c_f872cdf803c34eec9acc7f0ef3840efc.pdf
https://www.oregon.gov/deq/FilterDocs/ADU-ResBldgLCA-Report.pdf

Question #2

What do we know can be done right now to reduce embodied carbon and what needs more research or isn't fully understood?

Answer #2

What can be done right now?

- Materials
    - Lower carbon ready mix concrete with an EPD upon request/specification. These products are durable and typically cost neutral on projects.
    - Lower carbon asphalt mixes with EPDs upon request/specification. These products are durable and have little effect on cost.
    - Lower carbon insulation choices with EPDs (cellulose) that have comparable R value in the residential market. Lower carbon exterior insulation (wood fiber board) is only available for European import.
    - Lower carbon carpet choices with EPDs in the commercial market
    - Lower carbon drywall options with EPDs for cost competitive prices
    - Some lower carbon steel products with EPDs are available regionally (Pacific Northwest)
    - HVAC equipment that uses lower GWP refrigerants
    - Material reuse, even for structural materials.
    - Reducing onsite construction waste
    - Recovering onsite construction waste
- Buildings
    - Building smaller structures
    - Requiring less parking can reduce embodied carbon of significant foundation systems
    - Whole building reuse / retrofit
    - Make buildings lighter using structural timber instead of concrete/steel, which then reduces embodied carbon of foundation systems
    - Avoid structural systems like cantilevers and transfer beams, which increase embodied carbon
    - Whole building life cycle assessment to model and reduce material related impacts

What needs more research?

- Biogenic carbon in wood products measurement
- Mechanical, electrical, and plumbing (MEP) materials and systems
- Resiliency of structures in a changing climate and seismic zone. Seismically stable buildings take more materials but have the potential for future material savings.
- Modelling tools for materials used during tenant improvement projects
- More comprehensive publicly available Life Cycle Inventory database
- Better embodied carbon building baselines are needed for comparison of material use intensity metrics

What isn't fully understood?

- Emerging carbon storing materials and technologies that make buildings into carbon sinks rather than carbon sources.
- The degree to which industrial decarbonization is possible in the next 10-15 years

Question #3

Are there studies of alternatives / lower carbon products?

Answer #3

1. Local concrete infrastructure case studies
    a. Sidewalks
    b. Pole footings
    c. Type 1L cement
    d. Park / playground
    e. Pavement + early strength
2. Local commercial buildings low carbon concrete case studies
    a. Mill creek resiliency Building – Salem, OR
    b. Measuring and Reducing Embodied Carbon in Concrete – Olympia, WA
3. Local residential buildings low carbon concrete case studies
    a. Upcoming in July 2022 fromOregon DEQ
4. Regional case studies
    a. RMI report
    b. Building Transparency Case studies
    c. MEP / TI study of 5 OR/WA buildings
    d. Residential LCA study of 503 homes in Ontario
    e. Ontario office buildings LCA findings – foundations, insulation, and parking drives carbon
    f. United States Forest Service Wood Innovation Report (Mahlum Architects)
5. Existing building LCA case studies
    a. Whole Building Reuse - Philadelphia
    b. Edith Green Federal Building – Portland, OR
6. Other case studies / resources for alternative low carbon materials
    a. Concrete High-rise LCA study – Vancouver, BC
    b. Emissions of Materials Benchmark Assessment for Residential Construction, Ontario
    c. Toronto area benchmarking studies video (part 3 + 9)
    d. Toronto area embodied carbon benchmark survey results
    e. CLF – Carbon Storing Materials
    f. CLF – LCA of Katerra CLT building
    g. CLF – LCA of a WeWork TI project
    h. CLF – Transformative Carbon Storing Materials
    i. Refrigerants in Residential Heat Pumps
    j. Carbon Smart Materials Palette

Question #4

Does DEQ have a finger on the pulse of other municipalities enacting policies on embodied carbon?

Answer #4

All state and local government embodied carbon policies in N. America are tracked at the CLF Embodied Carbon Policy Toolkit. Highlights include:

1. Public Procurement
    a. State / Federal
        i. Buy Clean Oregon
            1. EPDs for concrete, steel, asphalt on select ODOT projects only.
        ii. Buy Clean Colorado
            1. EPDs for concrete, cement, steel, asphalt, wood, and glass for buildings and roadway projects. Carbon limits for buildings only.
        iii. Buy Clean California
            1. EPDs and carbon limits for mineral wool insulation, flat glass, structural steel, and rebar steel.
        iv. New York State Low Carbon Concrete Leadership Act
            1. Develop guidelines for low carbon purchasing and consider incentives
        v. Washington State Buy Clean Buy Fair pilot projects
            1. Evaluate the feasibility of data reporting and identify areas for improvement
        vi. GSA Federal Buildings Buy Clean
            1. EPDs for concrete + asphalt; carbon limits for concrete
    b. City
        i. City of Portland
            1. Concrete EPDs required + carbon limits by strength class
        ii. City of Bend Climate Action plan
            1. Strategy W2 – Utilize low carbon concrete mixes in City Projects and create incentives for private market
        iii. City of Eugene Climate Action plan
            1. Multiple actions related to lower carbon construction materials
        iv. City of Vancouver, BC - embodied carbon requirements
            1. Requirements for whole building LCA measurement and carbon limits of properties requesting rezoning. Future measurement and carbon limits for broader set of buildings planned for 2023 and beyond.
2. Building Codes
    a. Marin County
        i. Only building code in the country to have carbon limits on concrete
    b. Code proposals (EPD requirements + carbon limits) currently at:
        i. IBC; WA IBC: Denver Green Code
3. Zoning Code
    a. City of Portland Residential Infill Project
        i. Limits house size and allows 2 ADUs
4. Other
    a. City of Portland Deconstruction Policy
    b. City of Portland Design Overlay Amendments
        i. Points for low-carbon concrete and for using wood products from sustainably managed forests

Question #5

Suggest additional policy resources we should be looking at to educate ourselves?

Answer #5

1. CLF Embodied Carbon Toolkit
2. Implementing Buy Clean Report
3. The Embodied Carbon Review - Global
4. Lifecycle GHG Impacts in Building Codes
5. North American PCR catalog:
6. City Policy Framework for Dramatically Reducing Embodied Carbon – Carbon Neutral Cities Alliance
7. Policy Research on Reducing the Embodied Emissions of New Buildings in Vancouver
8. CLF – Developing an Embodied Carbon Policy Reduction Calculator
9. CLF - Template: Embodied Carbon Reduction Checklist for City Projects (V1)

Other resources:

1. Mass Timber Through a Life Cycle Lens