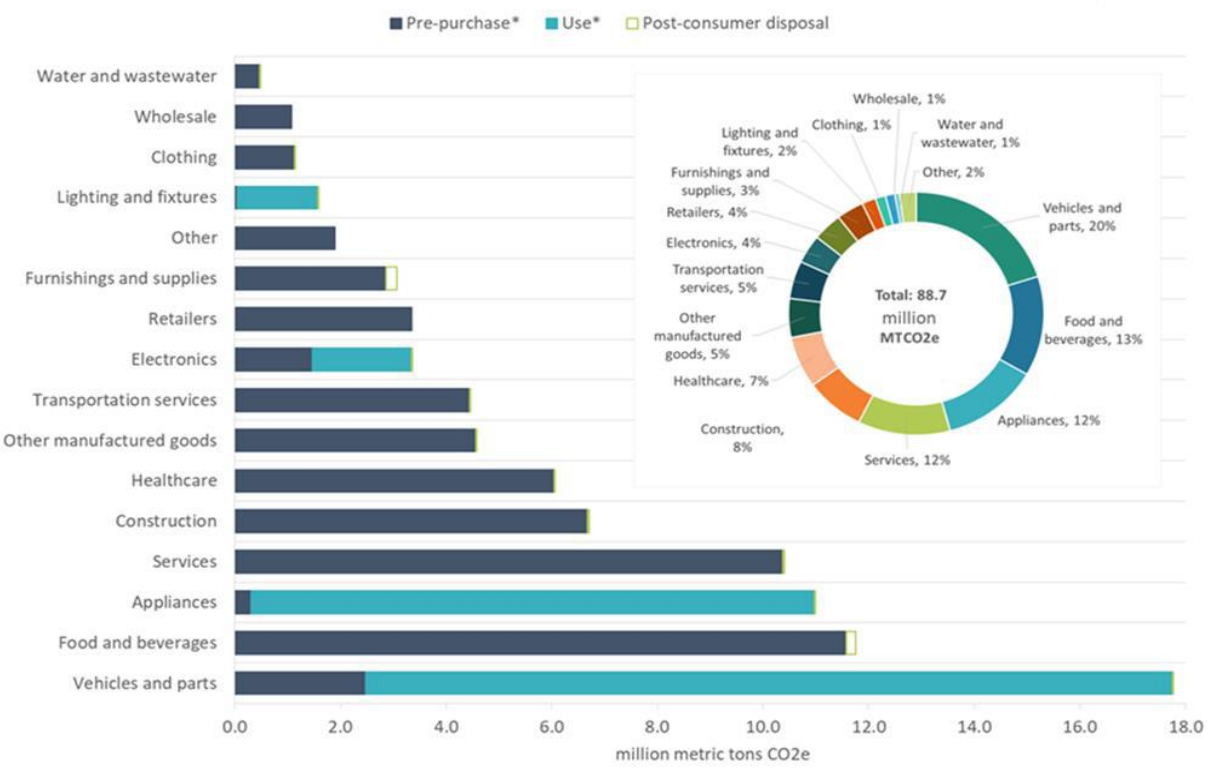
Reducing Embodied Carbon: Options for the Oregon Global Warming Commission

Executive Order 20-04 updates Oregon's goals to reduce greenhouse gas emissions to 45 percent below 1990 levels by 2035 and 80 percent below 1990 levels by 2050. To evaluate progress towards these goals and make recommendations to the Legislature, the Oregon Global Warming Commission utilizes data on sector-based emissions that reflect emissions that occur within the state (with the exception of emissions from electric generation). Yet a significant portion of Oregon's collective carbon footprint results from the lifecycle emissions of goods and services outside of Oregon that Oregonians end up using or consuming. Looking at sources of these "consumption-based" or "embodied" emissions in the materials we use reveals significant opportunities for reducing greenhouse gas emissions that complement efforts focused on emissions within Oregon. A complete report on both types of emissions in Oregon is available here.

Oregon's consumption-based greenhouse gas emissions in 2015 were 88.7 million $MTCO_2e$. These emissions occur during the extraction, manufacturing, transport, use, or disposal of commodities (energy, materials, and services). "Consumption" includes purchases by households and governments, and capital investments by Oregon businesses.

2015 Oregon consumption-based greenhouse gas emissions, by category and life-cycle stage



* "Pre-purchase" are all emissions that occur prior to final purchase, including production, supply chain, transport, retail and wholesale. "Use" refers to emissions resulting from the use of vehicles, appliances, electronics and lighting. Other categories (e.g., food and clothing) have use phase emissions that are accounted for elsewhere. For example, emissions from cooking and laundering are both assigned to the category of "appliances", which include ranges and clothes dryers.

Despite de-carbonization efforts in Oregon and elsewhere, these emissions continue to rise, increasing approximately 11.4 percent in Oregon between 2005 and 2015. The production and use of vehicles, food and appliances (primarily for heating and cooling) are the largest types of consumption-based emissions, followed by emissions from construction, healthcare and other services. Traditional consumer goods including electronics, furnishings, clothing and other manufactured goods also account for a significant portion of emissions.

While households contribute most of Oregon's consumption-based emissions, not all households are the same. Not surprisingly, lower-income households consume less, and their average carbon footprint is also lower. Higher-income households on average generate more consumption-based emissions.

This raises issues of equity and environmental justice. Lower-income households are more vulnerable to the effects of climate change, while higher-income households have greater ability to adapt to and cope with such impacts. Higher-income households also have greater ability (both in terms of real potential and financial resources) to reduce emissions, as well as greater responsibility to do so, by virtue of their proportionately larger contribution to this problem.

Assessing embodied emissions in the materials we use is a relatively new practice, yet local governments in Oregon are increasingly addressing these emissions in their climate action plans. This is helping to drive new action on emission reductions in food production and waste, construction materials and building practices, local government purchasing, reuse and repair of common consumer goods, and shifts to low-carbon consumption practices.

Options for State Action

The analysis of embodied emission sources reveals a wide array of opportunities for emission reductions. The DEQ Materials Management program has led the development of the state's consumption-based emissions inventory (CBEI), an important tool for identifying the most significant emission sources. This has guided focused efforts on preventing the wasting of food, de-carbonization of construction materials and the broader built environment, extending the useful life of consumer durable goods, promoting space-efficient housing, and other program elements.

Many of the potential actions to reduce embodied emissions extend beyond the regulatory purview of DEQ. Effective implementation requires collaborative effort with partners such as the Oregon Department of Administrative Services (DAS), the Oregon Department of Transportation (ODOT), the Oregon Department of Energy (ODOE), the Oregon Department of Land Conservation and Development (DLCD), the Oregon Building Codes Division (BCD) and other state and local agencies working to meet the state's climate goals.

<u>Food waste prevention and recovery</u>

Wasted food is an important source of embodied emissions specifically called out in EO 20-04 and the focus of ongoing work within DEQ Materials Management. Under the order, DEQ is directed to take actions necessary to:

1. Prevent and recover food waste, with the goal of **reducing food waste by 50 percent by 2030**, and

2. Reduce greenhouse gas emissions resulting from such waste, including but not limited to engaging with states and other jurisdictions, industry, food retailers, and brand manufacturers to develop and implement strategies to prevent and recover food waste.

To fulfill this directive, DEQ has outlined a two-phased approach that focuses on expanding current efforts under the 2017 Food Waste Reduction Strategy and engaging in new research and scoping to identify the next generation of actions. Some of the near-term activities already underway include:

- Commercial outreach: continued partnership with Oregon Restaurant and Lodging Association; increased and enhanced technical assistance to businesses.
- Systemic/institutional causes of food waste: expanding regional efforts through the Pacific Coast Collaborative beyond grocers to other segments of the food supply chain to reduce systemic and institutional contributors to waste.
- Schools: working in partnership with Oregon Green Schools, prevent food waste through improved cafeteria practices.
- Residential campaigns and initiatives: augment DEQ's planned statewide campaign and associated local campaign materials, increasing outreach and technical assistance across the state.
- State Procurement: embed food waste prevention in state-run food service (prisons, educational institutions).

Building materials, manufactured goods and other sources of embodied emissions

While food waste was the focus of Executive Order 20-04, the state is in a unique position to capture embodied emission reductions in several other important areas.

Procurement: State agencies purchase a significant amount of carbon-intensive goods and services including food, concrete, asphalt and other construction materials, furniture, electronics, and professional services. Procurement policies and programs that specify low-impact alternatives from vendors can drive changes in product design and formulation and leverage a broader market response. This is also an opportunity to capture equity outcomes through the promotion of minority and women-owned businesses that supply products and services to the state. Some options* include:

- Goals, measurement and tracking of embodied emissions that align with the statewide emission reduction goals in EO 20-04.
- Standards for embodied carbon in construction materials purchased for state buildings, transportation and other infrastructure projects.
- Tools and guidance for low-carbon food purchasing by schools, prisons and other institutions.
- Expanded scope for new Sustainable Building Standards that address embodied emissions in addition to energy performance.
- Extended product lifespan through changes in replacement schedules.

**DEQ is collaborating with DAS to develop several of these options for inclusion in its EO 20-04 report due September 2020.*

Reuse and Repair: The rapid turnover in manufactured goods represents a growing source of embodied emissions. While driven in part by innovation and technological advances, many products can be kept in service longer, reducing the environmental impacts of upstream production. Making repair and reuse

convenient and cost effective choices for households helps to rebuild the repair economy, provide access to affordable goods, and preserve important capacity for resilience in times of supply chain disruption. Some immediate actions include:

- Grants to support and expand reuse and repair businesses and non-profit organizations in Oregon.
- Right to Repair policy that removes barriers to consumer repair of the products they own.

Building materials and the built environment: Reducing embodied emissions in the construction and renovation of housing and commercial buildings is essential to meeting the state's climate goals. According to the UN, over 2.5 trillion square feet of new buildings will be constructed by 2060, with embodied emissions equaling roughly 50% of the total emissions from those building projects. A comprehensive approach is needed to address material choices, building size, whole-building design, and building reuse. Some options include:

- Measurement and disclosure of carbon impacts from building materials.
- Use of low-impact alternatives to high-impact building materials such as concrete, steel, roofing, and insulation.
- Whole-building carbon disclosure that reveals impacts from construction materials, products and systems.
- Building and zoning codes for smaller housing.
- Mandatory deconstruction ordinances in cities.
- Producer responsibility for recovery of building materials.

Refrigerants: Chemicals used in refrigeration and heating and cooling systems ("HCFCs" and "CFCs") are both short-lived and extremely potent greenhouse gases. Systems that use these chemicals release an estimated 25-35% of their capacity to the atmosphere annually. Most of the current generation refrigerants persist in the atmosphere for only 10 – 20 years, so it's critical to reduce the release of these compounds and shift to lower impact alternatives as quickly as possible. Options include:

- Restrictions on the use of refrigerants in new products sold in Oregon and incentives for the use of low-impact alternatives.
- Comprehensive inspection and enforcement program to reduce leaks in refrigeration and heating and cooling systems.

Aviation emissions: Emissions associated with the aviation industry are an important source that often goes unaddressed because of the national and international nature of freight and passenger air travel. Opportunities to alter ground operations and substitute alternative low-carbon jet fuel need further exploration and support. Expanding Oregon's Clean Fuels Program is a potential mechanism but this approach is currently hampered by limited production of alternative jet fuels and other market barriers. Other options that may be revealed as market conditions evolve should be pursued.

- Regulatory and incentive programs to reduce emissions from aviation operations and provide incentives for the use of low-carbon alternatives.

The following table provides additional detail on these opportunities with building materials, manufactured goods and other sources of embodied emissions.

Category	Options for GWC	Actions Under EO 20-04	Actions Under EO 17-20	Existing Programs	Additional Resources and Authority Needed
Procurement	(1) Limit embodied carbon emissions in the state's purchase of specific building materials (e.g. concrete, steel, re-bar, wood, insulation) and provide incentives for the purchase of low-carbon alternatives.*	DEQ is collaborating with DAS to develop this option for inclusion in the DAS EO 20-04 report due in September.	EO 17-20 directs DAS and ODOE to work with DEQ to lower the embodied carbon of building materials in the construction of new state buildings. Work to date has focused on identifying materials with lower embodied emissions. There are currently no requirements limiting embodied emissions for specific materials and no mechanism in place to monitor and reduce these over time.	DAS is in the process of establishing a Sustainable Purchasing Program. This action could be included in that portfolio of work. The Department of Environmental Quality has been working to measure, disclose, and reduce embodied carbon at the material and building scale. Examples include developing carbon disclosure of concrete mixes through environmental product declarations (EPDs) and assisting City of Portland with its Concrete EPD requirement and carbon limits. Cement is the second most used substance in the world, generating 5-6% of annual global emissions. Alternatives, like fly ash and slag, can significantly reduce the GWP of concrete.	DAS will likely need additional resources to implement this action. DAS's September 20-04 report may elaborate on these needs.
	(2) Set goals for carbon emissions from state spend that align with state	DEQ is collaborating with DAS to develop this for inclusion in the DAS EO 20-		DAS is in the process of establishing a Sustainable Purchasing Program. This	Additional resources may be needed to build out the

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	emission reduction goals, measure and report.*	04 report due in September.		action could be included in that portfolio of work. DAS is developing a new e-procurement system called "Oregon Buys". The current spend tracking system does not allow for carbon reporting. DAS is exploring options to include carbon reporting in the future build out of the new Oregon Buys system.	Oregon Buys system.
	(3) Limit embodied emissions in construction materials purchased for infrastructure projects (e.g. concrete, asphalt, steel, drainage pipe) and provide incentives for the purchase of low-carbon alternatives.*	ODOT included evaluation of embodied carbon in construction products and materials in their 20-04 report.	EO 17-20 addresses building materials but not the materials used in transportation infrastructure projects (roads, bridges, etc.).	ODOT has no current requirements or review process for evaluating the carbon impacts of construction materials. EPDs are one mechanism for disclosure of embodied emissions in construction materials. Oregon DEQ has been working with concrete producers to develop EPDs to promote low-carbon concrete mixes. Cement is the second most used substance in the world, generating 5-6% of annual	

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				global emissions. Alternatives, like fly ash and slag, can significantly reduce the GWP of concrete.	
	(4) Encourage schools, universities, state agencies and other large institutional food purchasers to reduce the GHG intensity of major food purchases.	This option may be included in the DAS 20-04 report.		Discussions have begun with other state agencies on opportunities to reduce food waste and purchase lower carbon foods.	Additional resources may be required.
	(5) Create Sustainable Building Standards for state buildings that incorporate embodied carbon.*	DEQ is collaborating with DAS to develop this option for inclusion in the DAS EO 20-04 report due in September.	Inter-agency work under EO 17-20 helps to inform options for developing Sustainable Building Standards.	DAS is in the process of establishing a Sustainable Purchasing Program. This action could be included in that portfolio of work. DAS has been planning to explore options for developing Sustainable Building Standards.	Additional resources may be required to avoid delays in developing these standards.
	(6) Adjust equipment replacement schedules to extend product lifespan.*		DEQ is collaborating with DAS to develop this option.	DAS is in the process of establishing a Sustainable Purchasing Program. This action could be included in that portfolio of work.	
Reuse and Repair	(1) Expand DEQ Reuse and Repair Workforce Development grant program**			DEQ launched a pilot grant program in 2017 for small reuse and repair businesses and non-profits. In the current	Additional resources needed for implementation.

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				2020 grant cycle, the program received 54 applications from around the state. The grant program can be expanded beyond workforce development (e.g. marketing, infrastructure, technology and other business development). This could be done in collaboration with the network of economic development organizations in the state.	
	(2) Adopt Right to Repair policy			DEQ's Materials Management 2050 Vision and the Reuse and Repair Strategic Plan identify Right to Repair as a valuable strategy to promote repair, reuse and product life extension.	Recent attempts at legislation for Right to Repair have been unsuccessful. A coalition of statewide partners is looking to introduce legislation in the next session.
Building Materials and the Built Environment	(1) Measure and disclose carbon impacts for building products and materials (using Environmental Product Declarations).		The Department of Environmental Quality has been working to measure, disclose, and reduce embodied carbon	DEQ is collaborating with the City of Portland on Sustainable Procurement standards for Concrete. As of January 1, 2020 an EPD is	Embodied carbon is not currently regulated by energy or building code, though embodied emissions from the building sector

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			at the material and building scale. DEQ has taken similar actions to reduce embodied carbon on select state projects associated with the directive from EO 17-20 to lower the embodied carbon of building materials in new construction of state buildings.	required for all City concrete purchases. The Department of Environmental Quality has been working to measure, disclose, and reduce embodied carbon at the material and building scale. Examples include developing carbon disclosure of concrete mixes using EPDs and assisting City of Portland with Concrete EPD requirement and carbon limits. Cement is the second most used substance in the world, generating 5-6% of annual global emissions. Alternatives, like fly ash and slag, can significantly reduce the GWP of concrete.	make up 11% of annual global GHG emissions. Potential joint role for DEQ, ODOE, and Building Codes Division using HB 4024 (2020) as example.
	(2) Restrict high impact material choices for construction like insulation, roofing, concrete, and refrigerants through building code and provide incentives for the		The Department of Environmental Quality has been working to measure, disclose, and reduce embodied carbon	DEQ is collaborating with the City of Portland on Sustainable Procurement standards for Concrete. By April/May 2021 maximum Global Warming Potential	Embodied carbon is not currently regulated by energy or building code, though embodied emissions from the building sector

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	use of low-carbon alternatives.		at the material and building scale. DEQ has taken similar actions to reduce embodied carbon on select state projects associated with the directive from EO 17-20 to lower the embodied carbon of building materials in new construction of state buildings.	(GWP) thresholds will be published.	make up 11% of annual global GHG emissions. Potential joint role for DEQ, ODOE, and Building Codes Division using HB 4024 (2020) as example.
	(3) Measure and disclose carbon impacts using Whole Building LCA for both residential and commercial developments, including tenant improvement projects.		EO 17-20 directs DAS and ODOE to analyze feasible options with the Department of Environmental Quality that would lower the embodied carbon of building materials in new construction in state buildings. DEQ is analyzing new, retrofit, and tenant improvement projects using WBLCA to measure, disclose, and reduce material and product impacts.		Embodied carbon is not currently regulated by energy or building code, though embodied emissions from the building sector make up 11% of annual global GHG emissions. Potential joint role for DEQ, ODOE and Building Codes Division using HB

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					4024 (2020) as example.
	(4) Expand small housing provisions through zoning and building code to include additional development requirements for maximum home size, parking, minimum density for development of oversized lots, narrow lots, etc. **			DLCD is implementing House Bill 2001 (2019), which aims to provide Oregonians with more housing choices, especially housing choices more people can afford. The law lets people build certain traditional housing types, like duplexes, in residential zones. These housing types already exist in most cities, but were outlawed for decades in many neighborhoods. These limitations contribute to increased housing costs and fewer choices HB 2001 could be expanded to increase options for smaller, less carbon-intensive housing.	Legislation required to expand House Bill 2001 (2019).
	(5) Adopt mandatory deconstruction ordinances for residential and/or commercial buildings.			City of Portland Deconstruction Ordinance requires a house or duplex built in 1940 or earlier to deconstruct using a Certified Deconstruction Contractor.	Oregon communities would need to pass local ordinances that require deconstruction. Successful

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					implementation requires appropriate infrastructure to support the industry.
	(6) Increase recovery through Product Stewardship for building materials (ceiling tiles, wallboard, carpet, etc.)			Legislative models include Oregon's Electronics Recycling Law (ORS 459A.300-.365), Oregon's Paint Product Stewardship Law (House Bill 3037 (2009)), and California's Carpet Stewardship Law (AB 115).	Legislation required. Additional resources needed to implement.
Refrigerants	(1) Restrict the use of refrigerants with high global warming potential in new products sold in Oregon and provide incentives for the use of low-impact alternatives.			Several states are implementing new programs – Oregon (DEQ) is part of the US Climate Alliance, which is convening states to coordinate their efforts in developing model rule language. Initial legal review suggests the state does not have the authority to regulate refrigerants or products manufactured outside Oregon.	New legislation is needed to clarify and expand DEQ's authority. HB 4024 in 2020 would have created this authority. The bill may be re-introduced in the next session. Additional resources needed to implement.
	(2) Establish inspection and enforcement program			DEQ's authority is limited to inspection of air conditioning	New legislation is needed to update,

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	for existing sources of refrigerant emissions			units in autos, and only for CFC refrigerants not used since the 1990s.	clarify and expand DEQ's authority to regulate existing sources (stationary and mobile). Additional resources needed to implement.
Aviation emissions	(1) Pursue new requirements to reduce emissions from aviation operations and provide incentives for the use of low-carbon alternatives.			The Clean Fuels Program currently allows credits for renewable aviation fuels. Broad scale production and use may not be feasible under current market conditions.	Continue to explore incentives and regulatory mechanisms to reduce aviation emissions as market conditions improve.

Note: * demarcates measures that are also addressed in Governor's Executive Orders 17-20 and 20-04. ** indicates measures that can be linked with equity outcomes.