Carbon Leadership Forum

Report Summary Document

Washington State Department of Transportation Greenhouse Gas Emissions Inventory from Roadway Construction

Carbon accounting for the Washington State Department of Transportation (WSDOT) typically focuses on Scope 1 and 2 greenhouse gas (GHG) emissions (i.e., the carbon footprint of direct and indirect energy usage). This project uses life cycle assessment (LCA) to estimate WSDOT's upstream Scope 3 emissions inventory (i.e., embodied carbon), focusing on the emissions from the construction materials used to build its wide network of roadways. We further develop decarbonization scenarios and recommendations for WSDOT to drive down its emissions. This is a summary report of the full research report submitted to WSDOT in January 2023.

Introduction

State and federal procurement policies (e.g., the Federal Buy Clean Initiative) have started requiring actions from transportation agencies to limit the greenhouse gas (GHG) emissions from the manufacturing and installation of construction materials - also referred to as *embodied carbon* - from their capital projects. "Buy Clean" is a policy approach that incorporates low-carbon purchasing requirements into government procurement of construction materials. State departments of transportation (DOT) can prepare and possibly shape future policies by considering agency policies and practices in advance of newer legislation. Getting ahead on anticipated regulations will allow DOTs time to identify the most cost-effective routes to adopting lower-carbon material procurement and construction practices.

To date, the Washington State Department of Transportation (WSDOT) has not yet conducted a comprehensive assessment of its upstream construction-related GHG emissions. This research project uses WSDOT data to estimate the embodied carbon from WSDOT's current purchasing practices and explore opportunities to drive down these emissions.

Transportation agency GHG emission sources

GHG emissions from agency (e.g., WSDOT) operations can be broken down into three categories or scopes:

- **Scope 1 emissions**: Direct emissions from sources that are owned or controlled by WSDOT (e.g., emissions from on-site combustion of fuels in boilers, furnaces, vehicles, etc. to generate electricity, heat, or power vehicles.)
- **Scope 2 emissions**: Indirect emissions from purchased electricity. WSDOT can directly control the purchases but cannot control the processes used to generate the electricity at source.
- **Scope 3 emissions**: All other indirect emissions not captured in Scope 2. Scope 3 emissions are a consequence of WSDOT activities while the emissions are generated by sources not under WSDOT's control. Examples include employee commute and business travel, transmission and distribution (T&D) losses due to electricity purchase, contracted solid waste, contracted wastewater treatment, and emissions due to the production, transportation, and placement of materials (also known as *upstream Scope 3 emissions* or *embodied carbon*).

Research scope and objectives

This report focuses on upstream Scope 3 emissions, including cradle-to-placement GHG emissions from construction materials (see Figure 2). These emissions are also referred to as embodied carbon (the GHG emissions arising from manufacturing, transportation, installation, maintenance, and disposal of construction materials). We will be primarily using the term upstream Scope 3 emissions in this report, as this is the term most commonly used by other DOTs.

Specifically, this research project aimed to achieve the following:

1. **Establish an upstream Scope 3 emissions baseline** to help WSDOT understand its current footprint, set targets, and measure future emissions reduction progress.
2. **Develop recommendations** for reducing upstream Scope 3 emissions in WSDOT's standard operating procedures based on available carbon reduction strategies.
3. **Propose decarbonization roadmaps** by applying identified reduction strategies to the dataset created in this study to assess their potential in reducing WSDOT's upstream emissions.

Data Collection

Interviews. The research team began with a series of interviews with WSDOT staff and representatives from the Oregon DOT, the National Asphalt Pavement Association (NAPA), and the Washington Asphalt Pavement Association (WAPA). Bi-monthly virtual meetings were also held with a WSDOT research panel to discuss questions and provide research progress updates.

Material Inventories. To understand the full scope of WSDOT's GHG emissions, the research team endeavored to collect a wide variety of data, focusing on material-related inventories. We limited the data's temporal range to contracts advertised between January 2017 – December 2021 (5 years). The team collected this data by either 1) downloading what was publicly available on WSDOT's website, or 2) reaching out to WSDOT staff from various Divisions/Offices, who then provided the requested data. The team also collected information about other sources of emissions in order to understand the relative significance of WSDOT's Scope 3 emissions.

The final dataset used in this research (i.e., reference flow data in LCA terminology) is a modified and reinforced form of the original unit bid analysis dataset, which is referred to as the *modified pay item list* dataset (see Figure 1). The dataset contains 27,419 rows of data representing 609 contracts. Several data attributes were added to the original pay item list data using the data obtained from WSDOT.

Whole roadway life cycle assessment (LCA)

Our choice to include the entire roadway construction scope of work (i.e., all items on the pay item list) necessitated a new, internally developed LCA framework. The research team therefore used an internally developed LCA framework that follows standardized procedures outlined in ISO 14040 and 14044 and adheres to other conventions seen in several published reports or journal articles. Existing vetted roadway LCA tools are typically limited to pavement structure only or were not based on editable pay item lists and life cycle emission factor data.

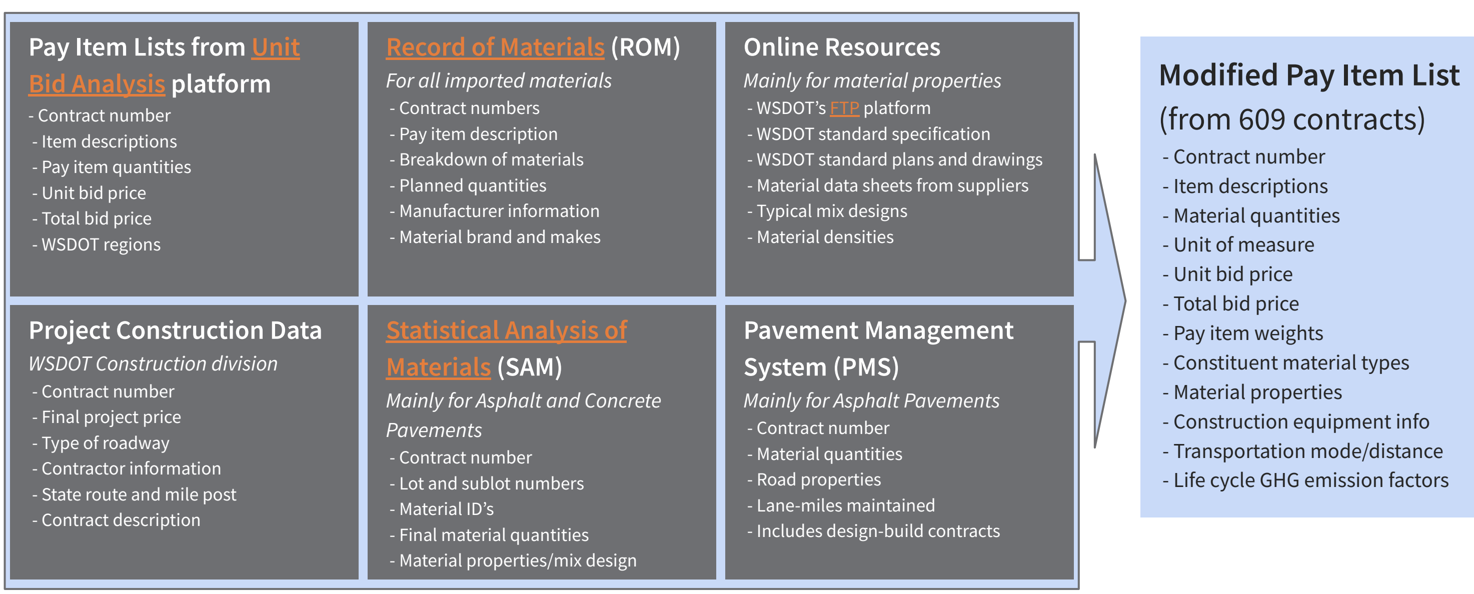

Figure 1. Primary data sources used to create the modified pay item list dataset used in this research to perform life cycle assessment (LCA). The main attributes of this dataset are pay item price, material weights, compositions, typologies, and life cycle GHG emission factors.

LCA Goal and scope definition

The goals of our whole roadway LCA was to:

1. quantify the embodied carbon of an entire roadway construction project as defined by its contract specification,
2. investigate the correlation between LCA results and bid price,
3. establish carbon baselines for future roadway construction projects, and
4. perform uncertainty analysis associated with life cycle emission factors using Monte Carlo simulations.

Declared unit. Although a variety of declared units are defined for roadway or pavement LCAs (e.g., a lane-mile of pavement construction, square foot or square meter of construction, etc.), we define a declared unit as "constructing a roadway project that meets specifications." This definition is well aligned with our use of pay item lists to build the LCA framework on, in that all pay items in a contract need to be delivered to complete the project.

System boundary. Our LCA is cradle-to-placement (see yellow in Figure 2) meaning that it includes 1) raw material extraction and processing, 2) electricity and fuel consumption at each stage, 3) upstream (from plants to suppliers) and downstream (from suppliers to construction sites) transportation of materials, and 4) on-site construction activities.

Exclusions: Items bid as lump sums (e.g., design-build contracts, lump sum traffic control), electrical and mechanical systems (e.g., signals, traffic control cabinets, irrigation systems), and equipment mobilization are mostly excluded because we could not find enough data for meaningful analysis.

Life cycle inventory analysis (LCIA). The life cycle data sources consist of two components:

- ***Reference flow*** data contains information about the weight, type, and composition of materials produced, the transportation mode used, the hauling distance for those materials, and the construction activities required to install/place them. Reference flows were sourced from the modified pay item list illustrated in Figure 1.
- ***Life cycle emission factor*** data includes environmental impact multipliers (i.e., global warming potentials (GWP) measured in units of CO_2eq) of items described in the reference flows. Life cycle emission factor data were obtained from a variety of sources.

Life cycle emission factors uncertainty analysis. Life cycle emission factors are inherently uncertain and the use of average values can raise questions about the reliability of deterministic approaches in performing LCA. Temporal and geographical technology variations, regional supply chain variability, differences in electricity grid mix, variable raw material properties and production processes, among other factors, are the main sources of uncertainty. To better capture the variability in input parameters, we used Monte Carlo simulations to investigate the impacts of uncertainty on final LCA outcomes.

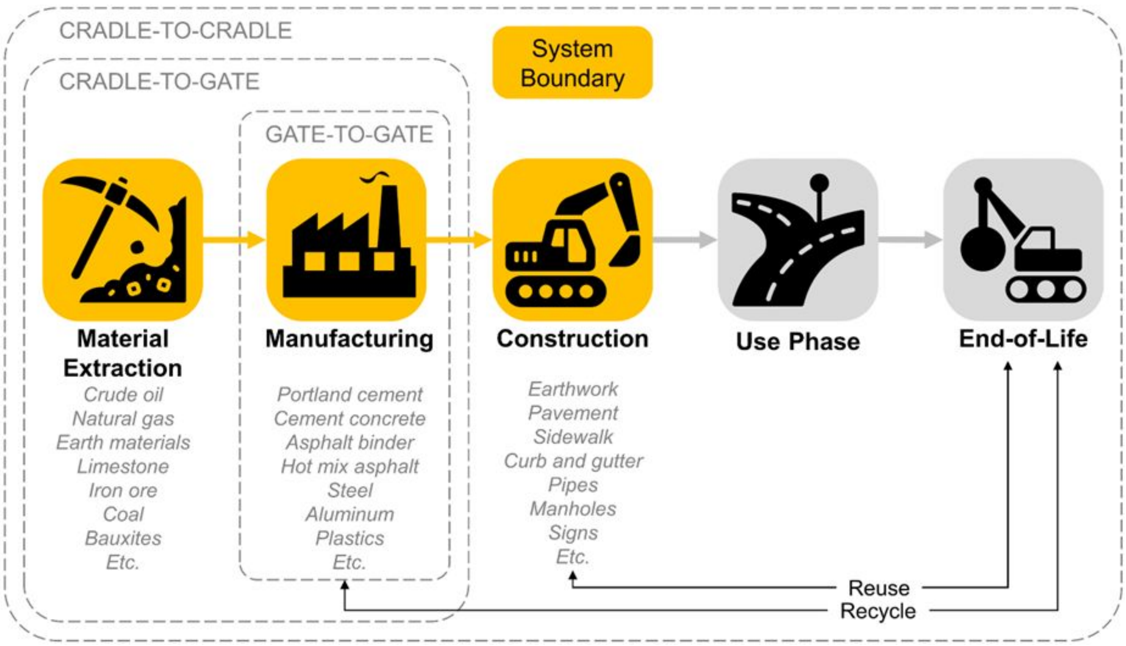

Figure 2. Cradle-to-placement system boundary for the life cycle assessment framework in this study. Material extraction, manufacturing, and construction phases (yellow) were included, whereas use and end-of-life phases (grey) were excluded.

Findings

Estimating the total upstream Scope 3 emissions from contracts advertised from 2017 to 2021 required multiple steps to fill gaps in data.

Step 1: Whole roadway LCA

First, the whole roadway LCA described on page 3 was completed, resulting in an initial upstream Scope 3 emissions estimate using pay item lists and emission factors. The LCA results provided an emissions estimate that covered a median of about 55% of a project's total bid price (i.e., we were not able to estimate the emissions from about 45% of project costs).

For the remaining emissions, the research team used mathematical simulations to estimate the emissions for projects where accurate material inventory information was not available.

Step 2: Developing WSDOT-economic emission factors

We first developed a series of greenhouse gas emission factors specific to WSDOT projects by dividing the total embodied carbon for each project by the project's total bid price. To produce more reliable factors, only projects with more than 50% of their bid price included as part of the LCA (totaling 356 contracts) were considered. This resulted in a distribution of emission factors depicted in Figure 3.

After developing the factors, we used a Monte Carlo simulation approach, similar to what was used for the life cycle emission factors uncertainty analysis. In this type of analysis, WSDOT emission factors are randomly selected and assigned to each contract number where good data is not available. The simulation then repeats this process for 1,000 iterations, sums up emissions per year, and calculates statistical summaries (e.g., average, median, standard deviation) for the sum of emissions per year.

Step 3: Total upstream Scope 3 emissions estimate

The research team merged the results from step 1 (LCA on pay item materials using GHG emission factors) and step 2 (LCA on projects using economic GHG emission factors) to estimate WSDOT's total upstream Scope 3 emissions, which is summarized in Figure 4.

At this point, we are unable to provide any more insights into the types of materials that constitute the "Not Specified" category, but it may contain emissions stemming from a variety of sources such as material production, construction activities, and direct or indirect fuel consumption (such as petroleum or gasoline for transportation purposes). However, given that the "Not Specified" category includes emissions from large design-build projects that do not provide pay item lists because of their method of delivery, we can speculate that asphalt, concrete, and steel would still make up for a large fraction of pay items not available in our original dataset.

Although the total annual emissions seemed to have dropped in 2020 and 2021, this likely reflects the impact of COVID-19 and does not necessarily mean that more sustainable materials and practices were implemented during those times.

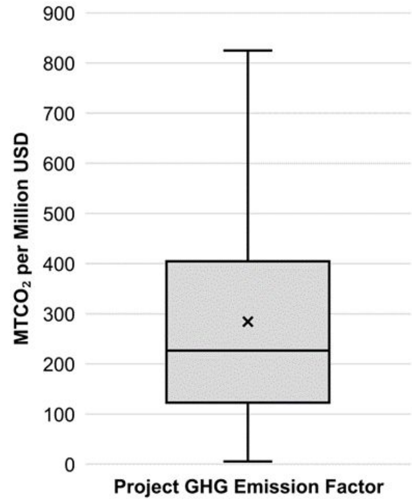

Figure 3. The distribution of economic greenhouse gas emission factors based on a project's total bid price obtained from projects included in the initial LCA. Only projects with more than 50% of the bid price covered by the LCA are included in this distribution (356 contracts).

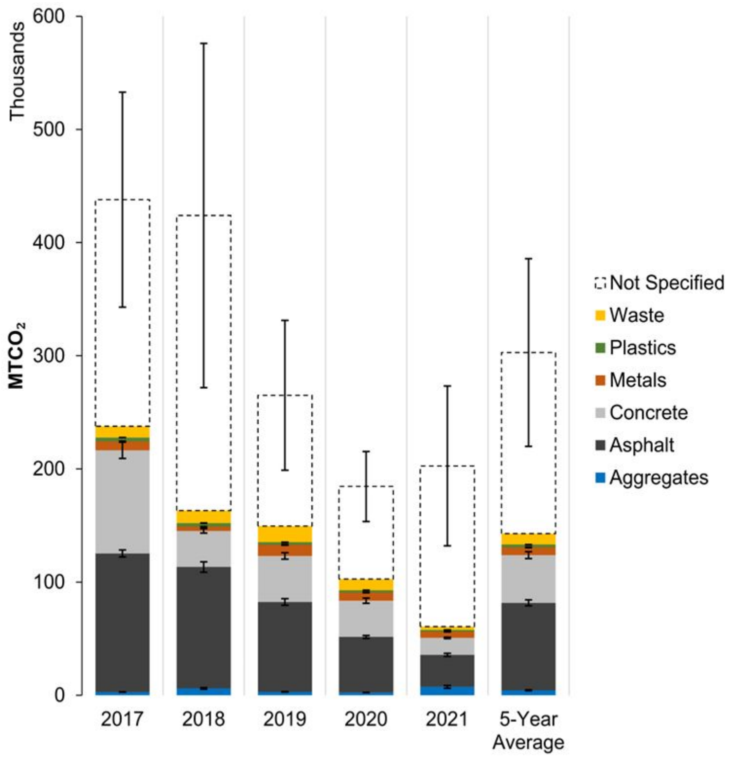

Figure 4. Estimated upstream Scope 3 emissions from WSDOT roadway construction with error bars denoting standard deviations. This graph represents the emissions calculated from the LCA on the pay item lists and the estimated emissions from the economic emission factors.

Primary material categories

The following six material type categories are the primary source of emissions for WSDOT, in order of average contribution:

1. **Asphalt**: Hot, warm, or cold bituminous mixtures used in pavement applications and asphalt cement used as sealing and coating compounds.
2. **Concrete**: Portland cement concrete (PCC) used in horizontal surfaces (e.g., concrete pavements and sidewalks) and structures (e.g., walls and bridges, pipes, catch basins, etc.).
3. **Metals**: All metals used including steel, cast iron, aluminum, copper, and more. Steel, which is most prevalent, is used as a stand-alone structural element (e.g., bridge girders), as rebar in concrete structures, as dowel bars, tie bars, and rebar in concrete pavement, or in other roadside features (e.g., poles, guardrails). Other metals are typically used in roadside features/signs (e.g., aluminum), pipes (e.g., cast iron), and electrical systems (e.g., copper).
4. **Wastes**: Materials removed from the construction site for landfilling, recycling offsite, or reuse within the project boundaries. The largest contributors are clearing and grubbing, demolition, and earthwork activities.
5. **Aggregates**: Crushed stone, sand, and gravel that are commonly used as fill material, pavement sub-layers, pipe beddings, wall backfills, landscaping, etc. Aggregate as a constituent of hot mix asphalt (HMA) or portland cement concrete is included in the asphalt or concrete category instead of this category.
6. **Plastics**: Polyvinyl chloride (PVC) and high-density polyethylene (HDPE) are used for pipes and geotextiles, polyethylene (PE) for coverings or moisture barriers, thermoplastic paint for pavement markings, and other plastic products such as traffic cones, trash cans, and other appurtenances.

Figure 5 summarizes the average contribution to emissions by the six primary construction materials, described below. Asphalt and concrete materials alone are responsible for *at least* 40% of the total Scope 3 emissions from WSDOT roadway construction.

Comparing upstream Scope 3 with Scope 1 and 2 emissions

Last, the team compared our findings to the Scope 1 and 2 emissions for WSDOT (as reported by the Washington State Department of Ecology), summarized in Figure 6.

We believe findings from Figure 6 are significant because on an average basis, upstream Scope 3 emissions seem to outweigh Scope 1 and 2 emissions. This is particularly significant as WSDOT's Scope 1 and 2 emissions are among the highest in the nation due to the Washington ferry system being the largest.

Upstream Scope 3 emissions are not well understood and accounted for within DOT environments. Our findings indicate that collecting better data (in the form of material data and environmental product declarations (EPDs)) for high-impact construction materials could be worth the administrative burden to measure and track reductions of this large source of emissions.

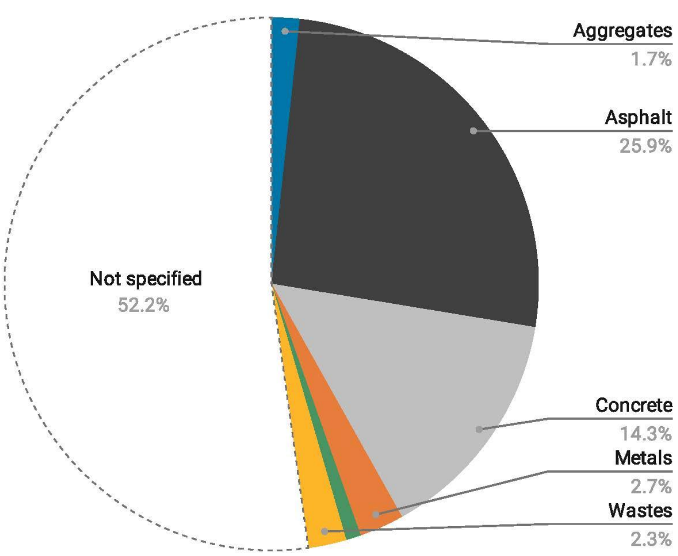

Figure 5. Average contribution to emissions by material. On an average basis, aggregates, asphalt, concrete, metals, plastics, and wastes contribute to at least 1.7%, 25.9%, 14.3%, 2.7%, 0.9%, and 2.3% of total upstream Scope 3 emissions, respectively.

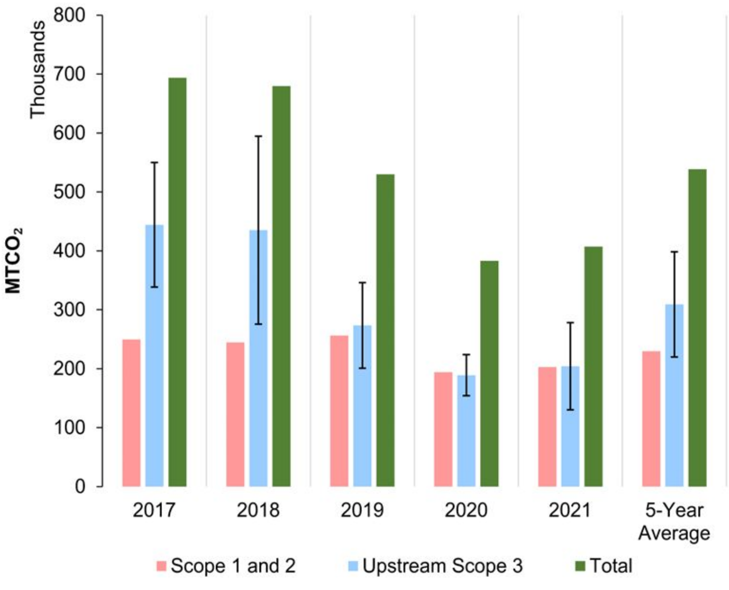

Figure 6. Comparison of Scope 1 and 2 emissions with upstream Scope 3 emissions estimated for WSDOT as an agency. Scope 3 emissions outweigh Scope 1 and 2 emissions. The vertical error bars indicate standard deviation.

Recommendations and implementation

This section starts with a review of existing work around emerging policies, best practices, and strategies to reduce greenhouse gas emissions for departments of transportation with an emphasis on upstream Scope 3 emissions from material production supply chains.

We then perform scenario analyses using the data collected in this study to showcase how different strategies would lead to GHG reductions. Finally, based on the literature review and data analysis results, we provide recommendations for WSDOT on best practices to progress toward decarbonization.

Background

Many states have considered GHG emission reduction targets to tackle climate change impacts. A reduction target is a way to focus mitigation actions and provide foundations for tracking progress toward that goal and is the first step to establishing a carbon reduction plan. These reduction targets can be set for different emission scopes per agency or can adhere to statewide goals.

Most carbon reduction targets envision a [near] net-zero GHG emissions by the year 2050. In Washington the revised RCW 70A.50 lists the following targets:

- 15% GHG reduction below 2005 levels by 2020
- 45% GHG reduction below 2005 levels by 2030
- 70% GHG reduction below 2005 levels by 2040
- 95% GHG reduction below 2005 levels by 2050

WSDOT has a role to play in reducing two critical sectors of GHG emissions: transportation and industrial emissions. These sectors are of growing importance as the urgency to reduce GHG emissions shifts the global focus from just power generation to include other critical sectors in emerging policies and initiatives.

Buy Clean

The federal government through the Bipartisan Infrastructure Law and the Inflation Reduction Act has secured historic investments to upgrade nationwide infrastructure while growing the clean energy economy. In particular, the Federal Buy Clean Initiative and Task Force has recently secured $4.5 billion in funding for the General Services Administration (GSA), Department of Transportation (DOT), and Environmental Protection Agency (EPA) to usher in the manufacturing of construction materials with substantially lower GHG emissions. The Buy Clean initiatives also support the new Carbon Reduction Program (CRP) announced in early 2022 that unlocks funding for state and local governments. State Buy Clean programs that include DOTs also exist in California, Colorado, and Oregon.

Departments of Transportation

The quantification of upstream Scope 3 emissions using life cycle assessment approaches currently requires extensive effort and has rarely been conducted for DOT inventories. California and Oregon departments of transportation (Caltrans; ODOT) are among the few state DOTs that have done more extensive research on their GHG emissions inventory including Scope 1, 2, and 3.

Identifying carbon reduction strategies

In this section, we explore opportunities to reduce upstream Scope 3 GHG emissions based on the baseline emissions analysis conducted for WSDOT, focusing on the three primary construction materials identified in this study that contribute the most to overall emissions (i.e., asphalt, portland cement concrete, and steel), material transportation, and construction activities.

Although these emissions can be attributed to both WSDOT and contractors building the roadways, there are still several avenues for WSDOT to influence cleaner material purchases, modify or establish specifications to allow more aggressive sustainable solutions, and inform research-based decision-making strategies.

For a complete list of strategies and their current state of implementation and reduction potential, refer to the full project report.

Figure 7 (on the following page) illustrates the range of potential GHG emission reductions due to the adoption of technologies and practices categorized into the primary materials and processes used in roadway construction. A collection of sources from the literature and research reports is used to produce this figure.

It is worth noting that this analysis does not consider the magnitude of technology adoption per strategy (the temporal aspect of technology advancement is not considered). For example, GHG emission reduction in HMA production due to the use of reclaimed asphalt pavement (RAP) highly depends on its content in the mix design. Therefore, the variability in carbon reduction represents the variability in the extent of technology adoption and the variability in the reported reduction potentials.

This is considered in the next section, where we propose scenarios and make assumptions about the technology adoption rates and assess their impacts.

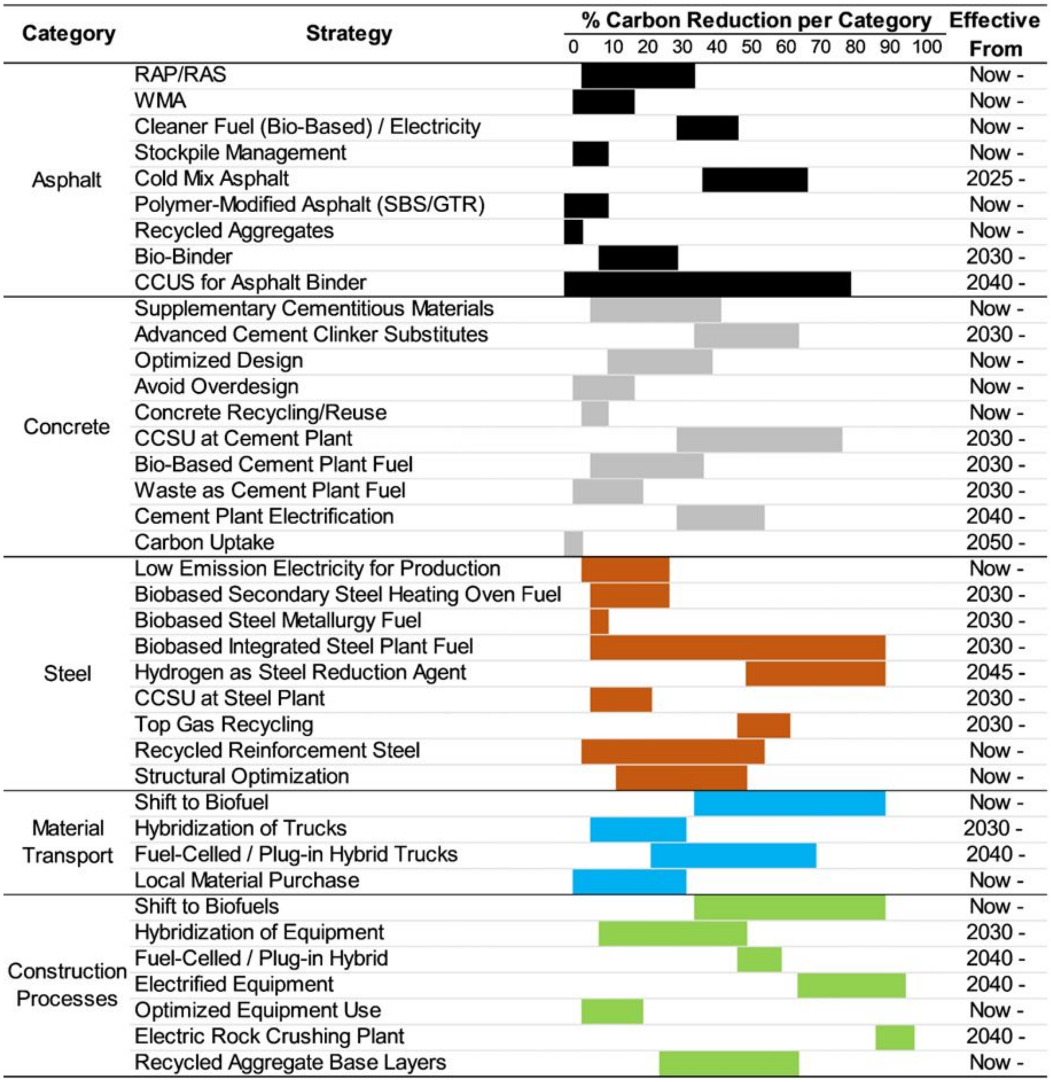

Figure 7. Upstream Scope 3 emission reduction potentials per category and strategy, based on existing literature and research reports. This figure does not consider the magnitude of technology adoption per strategy (the temporal aspect of technology advancement is not considered). The variability in carbon reduction represents the variability in the extent of technology adoption and the variability in the reported reduction potentials.

WSDOT decarbonization strategies

Next, the research team applied the carbon reduction potential strategies (summarized in Figure 7) to the upstream Scope 3 emissions estimate to perform scenario analyses and propose a near net-zero decarbonization roadmap for WSDOT.

Decarbonization scenarios

We developed five decarbonization scenarios. In each scenario, a series of carbon reduction strategies are assumed to be effective. Scenario 1 relies on the most conservative assumptions and tries to capture the business as usual (sometimes referred to as best available technologies – BAT) and the state of the practice as of the time of this writing. The subsequent scenarios 2 thru 5 become more progressive, with scenario 5 being the most progressive. Scenario 5 assumes the highest ends of the carbon reduction potentials, due to a higher level of technology implementation.

Next, we used a quantitative approach to evaluate the impact of carbon reduction strategies per decarbonization scenarios. We used the 5-year average baseline GHG values summarized in Figure 5 (based on the modified pay item list dataset and average life cycle emission factors) to perform scenario analyses. The results of all five scenarios are summarized in Figure 8 (see next page).

Scenario 5 is the only scenario that approaches net-zero, and can be considered an aggressive decarbonization scenario for WSDOT. Figure 9 illustrates the GHG emission reduction of each carbon reduction strategy under Scenario 5.

While this analysis does not directly address the challenges in the adoption of each carbon reduction strategy, this analysis is still helpful in suggesting which decarbonization strategies can be prioritized for WSDOT based on their carbon reduction potentials.

Based on this analysis, the strategies with the largest potential (i.e. greatest contributors to GHG emission reductions) are:

- Use of recycled materials in asphalt mixes,
- Use of cleaner energy sources to operate plants (asphalt and concrete),
- Use of warm and cold mix asphalt,
- Use of SCMs in concrete mixes,
- Cement content reduction approaches, and
- Shift to bio-fuels and/or electrification of construction equipment and transportation fleet.

For more details about the assumptions made to develop decarbonization scenarios, please refer to the final report document.

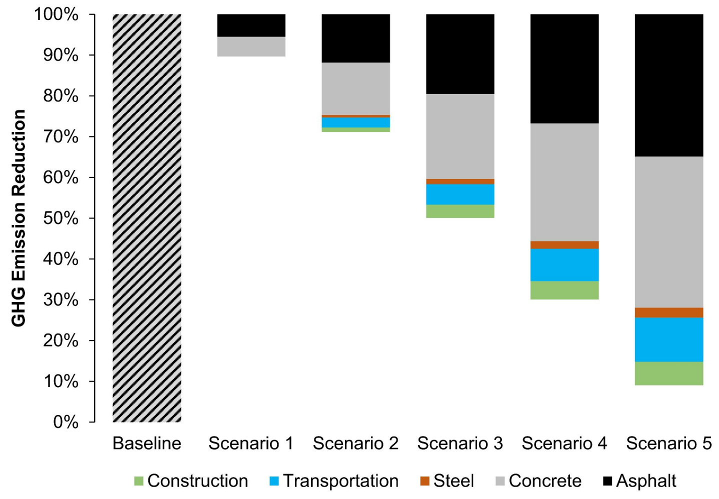

Figure 8. Results of five decarbonization scenarios. Each scenario assumes an increasing number of carbon reduction strategies are applied and successfully implemented, with Scenario 5 representing maximum implementation and maximum realized potential.

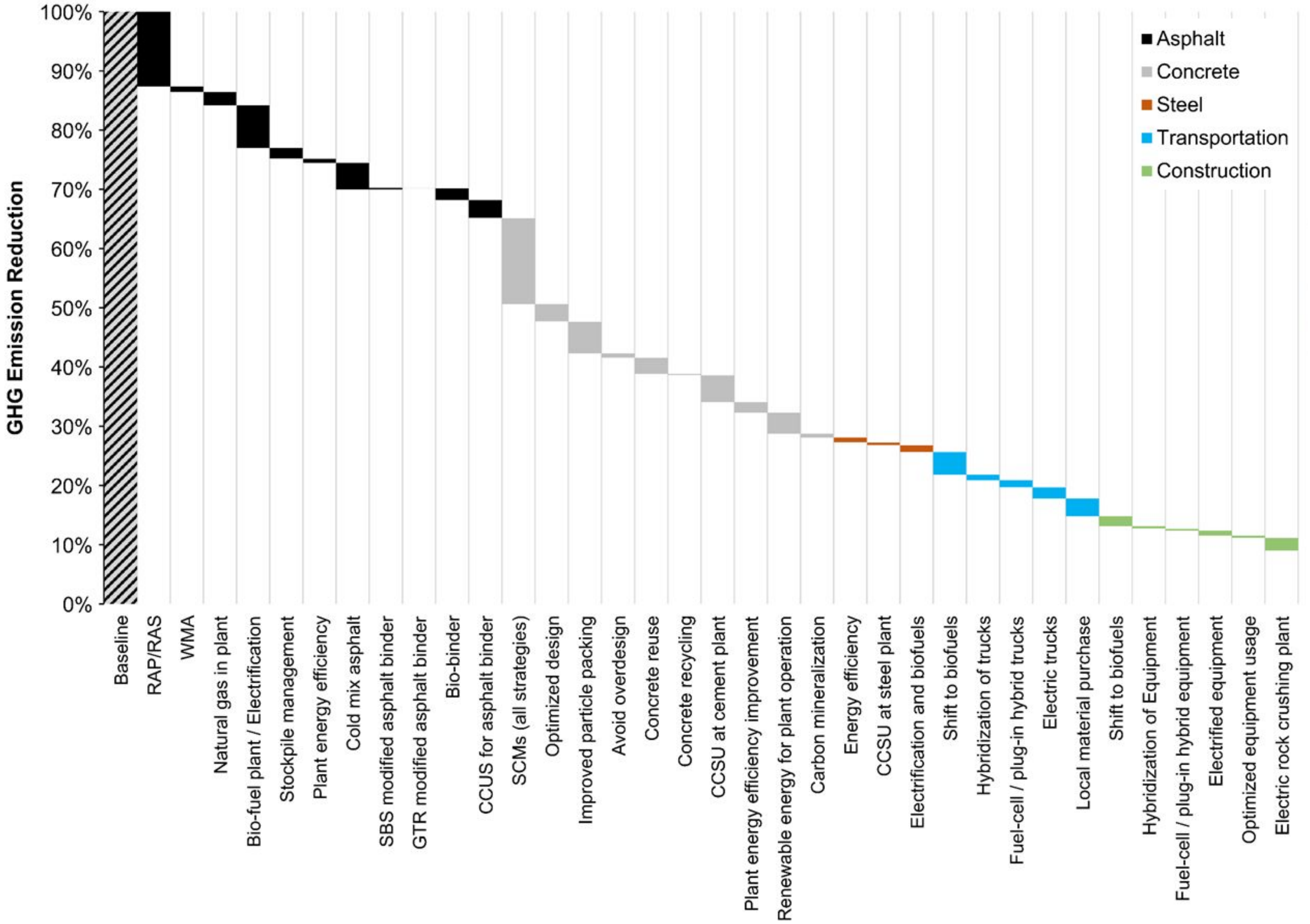

Figure 9. WSDOT decarbonization Scenario 5 (near net-zero) broken down by carbon reduction strategies and categories. Based on this analysis, the largest contributors to GHG emission reductions include use of recycled materials in asphalt mixes, the use of cleaner energy sources to operate plants, the use of SCMs in concrete mixes, cement content reduction approaches, and the shift to bio-fuels and electrification of construction equipment and transportation fleet.

Recommendations to WSDOT

This section summarizes our top ten recommendations to help WSDOT reduce its upstream Scope 3 GHG emissions, based on the research summarized in this report. These recommendations cover a variety of action items that can be pursued as early as the time of this writing.

1. **Establish carbon reduction targets**. Using the five-year upstream Scope 3 GHG emission average between 2017 and 2021 with a value of 310 thousand $MTCO_2$ as a baseline, we recommend the following upstream Scope 3 carbon reduction targets, which are in alignment with RCW 70A.50:
    - 50% below baseline by 2030,
    - 70% below baseline by 2040, and
    - 90% below baseline by 2050.

2. **Data collection**. The quality of upstream Scope 3 GHG emissions estimates relies heavily on the quality and extent of data available. WSDOT should collect high quality data for the following key data attributes to better estimate GHG inventories of WSDOT roadway construction and maintenance operations:
    - material quantity take offs (e.g., weight, volume),
    - material compositions (e.g., mix designs for asphalt and concrete including recycled contents),
    - fuel usage by trucks and construction equipment, and
    - life cycle environmental impact data (e.g., EPDs).

3. **Early engagement**. Implementation of sustainable best practices that reduce GHG emissions are most successful when considered early, during the project design phase. Alternative project delivery methods that help streamline project design and construction can increase the potential of integrating sustainable best practices into project scopes.

    We also recommend engagement with industry and trade organizations to better understand the state of the practice for specific products, and development of training programs for contractors to help increase awareness of and use of carbon reduction strategies.

4. **Allow and encourage higher RAP / SCM contents in asphalt / concrete**. When locally available, the use of RAP in HMA shows significant carbon reduction advantages. Contractors with prior experience with high RAP contents may show increasing interest to modify their plant operations for continuous production of high RAP mixes if provided incentives. We recommend modifying the agency specifications to remove limits on the use of RAP and other recycled materials, with the aid of economic incentives such as tax credits, grants, rebates, and project-level incentives to encourage higher use. Similarly, supplementary cementitious materials show the most significant carbon reduction potential for concrete. We recommend continuous modification of current standard specifications to increase maximum allowable contents as performance-based mix design procedures replace the traditional volumetric design methods.

5. **Plant energy and fuel transition**. Energy in both asphalt and cement plants is primarily sourced from fossil fuels like coal and natural gas. To begin, WSDOT could request information about plant energy efficiency through the EPA's Energy Star program and certification, and track overall plant performance via facility-specific EPDs.

6. **Use local materials**. Encouraging/incentivizing the use of local material supplies not only can stimulate local economic growth, but also reduces fuel consumption by trucks. Incentives can be in place to reward projects that use locally sourced materials based on minimum limits. These limits can be based on the weighted average of transportation distance for materials used in a project according to either the weight or the price of materials.

7. **Mandate minimum recycled/alternative material contents**. Currently, there are no minimum requirements for recycled and alternative material contents in specifications related to asphalt and concrete. Once minimum requirements are in place, the average recycled or alternative material contents would increase as a consequence.

8. **Require EPDs**. Start requiring the submission of EPDs with material delivery. Once sufficient EPD data are collected and analyzed, these can either be used to set regionally-specific GWP targets per product or to encourage selection of the lowest carbon product available for a specification. Similar efforts are undergoing research for Washington State thru the Buy Clean and Buy Fair Washington project partnered with the Washington State Department of Commerce. We recommend piloting a Buy Clean policy for WSDOT as soon as possible with two major goals: program development and implementation.

9. **Performance-based specification**. Switch from concrete and asphalt specifications that rely on volumetric measures or limited performance tests to verify products to specifications based on combined volumetric and performance parameters for alternative selection. For instance, the concept of balanced mix design for asphalt pavements. We further recommend WSDOT conduct more in-depth research into the potential of introducing new testing protocols for asphalt and concrete materials.

10. **Emissions-based bid incentives**. Establish emissions reduction incentives in the form of bid discounts to drive competition on carbon, in addition to cost, during the bid process. This would not threaten the performance criteria of materials: only materials that meet the required specifications would be evaluated in the bid and given the chosen bid discount.

Conclusions

This report outlined the progress made in an effort to estimate the upstream supply chain GHG emissions associated with construction of Washington roadway network owned and operated by WSDOT, using a modified pay item list dataset from 609 WSDOT contracts between 2017 and 2021. Some key findings:

- The five-year average upstream Scope 3 emissions for WSDOT roadway construction was estimated at about 310 thousand metric tons of CO_2eq.
- Emissions associated with materials production dominate the source of GHG emissions by an average of 85% and are followed by materials transportation at 11% and construction activities at 4%.
- Among different material types, asphalt and concrete are the main contributors to emissions with at least 40% of the total. Moreover, pavement construction is found to be the most carbon-intensive category in roadway construction.

Furthermore, we used the Washington State's Department of Ecology report to suggest that upstream Scope 3 emissions for WSDOT as an agency outweighs Scope 1 and 2 emissions. Given that WSDOT owns the largest ferry system in the country, our findings suggest that the upstream Scope 3 emissions would be even larger compared to Scope 1 and 2 in other states. This finding highlights the importance of developing programs to account for upstream Scope 3 emissions from building roadway networks and eventually mitigate these emissions.

Upon analyzing data and reviewing existing literature on carbon reduction strategies, we developed five decarbonization scenarios based on potential carbon reduction of each strategy and provided a series of recommendations that would help reduce agency-wide GHG emissions for WSDOT. Our top ten recommendation were to: (1) establish carbon reduction targets for upstream Scope 3 emissions (i.e. embodied carbon); (2) improve data collection for material quantities and characteristics, fuel usage, and EPDs; (3) engage early with design teams, contractors, and trade associations with material expertise; (4) allow and encourage higher RAP / SCM contents in asphalt / concrete; (5) seek efficient, low-carbon plants for asphalt and cement; (6) incentivize the use of local materials; (7) mandate minimum recycled/alternative material contents; (8) require EPDs for asphalt, concrete, and steel; (9) use performance-based specifications for concrete and asphalt; and (10) use emissions-based bid incentives.

Authors

The primary individuals from the **Carbon Leadership Forum** at the University of Washington College of Built Environments who contributed to this project are:

- Milad Ashtiani, Researcher
- Meghan Lewis, Senior Researcher
- Monica Huang, Researcher
- Kate Simonen, Executive Director

The primary individuals from the **Washington State Department of Transportation** who contributed to this project are:

- Jon Peterson, Research Manager
- Jonathan Olds, Senior Policy Specialist
- Kurt Williams, Construction Materials Engineer
- Steve Davis, State Materials Engineer
- Kim Schofield, previous State Pavement Engineer
- Jim Weston, Roadway Operations Manager
- Anthony Mizumori, Bridge & Structures Engineer

Acknowledgments

Many additional individuals contributed to this study. Their names can be found on the WSDOT GHG Project website.

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Read the Full Report for this study here.