C40 CITIES

Building Greener Cities:
Green Job Opportunities in Clean Construction

Seattle Policy Report

JANUARY 2025

C40 CITIES

BURO HAPPOLD

NEW ECONOMICS FOUNDATION

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Contents

Acknowledgements

This research has been conducted by C40 Cities, Buro Happold and the New Economics Foundation and is generously funded by the City of Oslo. We would like to thank the Office of Sustainability & Environment of the City of Seattle, whose work was fundamental to the project. The work is independent and has not been commissioned or influenced by any business, government or other institutions.This research is made publicly available under an Attribution-ShareAlike 4.0 International Creative Commons Licence. CC BY-SA 4.0. You can cite this research as: "C40-Cities, Buro Happold and New Economics Foundation, 2025"

Core project team

C40 CITIES

Dan Firth, Director of Knowledge and Learning & Programmes
Rachel Huxley, (former) Director of Knowledge and Learning
Cécile Faraud, Head of Clean Construction
Rebecca Ilunga, (former) Interim Head, Adaptation Research and Performance
Snigdha Garg, Head, Adaptation Research and Performance
Henrique Goes, Research Manager, Clean Construction

BURO HAPPOLD

Duncan Price, Partner, Sustainability and Climate Change
Fergus Anderson, Associate, Sustainability and Climate Change
Nicoletta Michaletos, Senior Consultant, Sustainability and Climate Change
Alexandra Jonca, Senior Consultant, Sustainability and Climate Change
Arturo Reyes, Senior Consultant, Sustainability and Climate Change
Alex Couling, Consultant, Sustainability and Climate Change

NEW ECONOMICS FOUNDATION

Christian Jaccarini, Senior Consultant
Emmet Kiberd, Consultant

Contributors and interviewees

TURNER & TOWNSEND

Mark Rogers, Head of Net Zero Carbon, Cost Management

CITY OF SEATTLE TEAM

Ani Krishnan, Climate Data and Policy Manager, City of Seattle
Lylianna Allala, Climate Justice Director, City of Seattle
Gus Williams, Climate & Workforce Development Advisor, City of Seattle

INTERVIEWEES

Anna Pavlik, Labor Equity Program Manager, City of Seattle
Ashima Sukhdev, Climate Mitigation and Circular Economy Policy Advisor, City of Seattle
Brandon Anaya, Managing Director of Policy and Consulting, Seattle Jobs Initiative
Christine Bunch, Climate and Energy Advisor, City of Seattle
Dave Bennink, Reuse Consulting
Dave Walsh, Dave Walsh Consulting
Elodie Marlet, Senior Research Analyst, Seattle Jobs Initiative
Irina Rasputnis, Building Electrification Portfolio Manager, City of Seattle
Jeanna Fulcher, Labour Equity Analyst, City of Seattle
Jess Harris, Green Building Program Manager, City of Seattle
John Persak, Manufacturing and Maritime Policy Adviser
Kate Simonen, Director, Carbon Leadership Forum
Kathleen Carson, Senior Research Analyst, Seattle Jobs Initiative
Katie Kennedy, Waste Diversion Lead, City of Seattle
Luke Lombardi, Senior Sustainability Consultant, Buro Happold
Megan Kalsman, Researcher, Carbon Leadership Forum
Michiko Starks, Apprenticeship Manager, City of Seattle
Rosalund Jenkins, Service Equity Program Manager, City of Seattle
Stella Wayman, Strategic Advisor, City of Seattle
Tracy Nguyen, Research Analyst Intern, Seattle Jobs Initiative
Vincent Valent, City of Seattle

Executive Summary

Introduction

Urban populations are growing, with an additional 2.5 billion people projected to inhabit the world's cities by 2050. Consequently, demand for new housing and infrastructure is set to skyrocket. This will require the construction of a city the size of Milan every week to 2050. At the same time, the construction sector accounts for more than 23% of CO2 emissions and consumes more than 30% of global resources. Continuing with traditional construction methods, however, will exacerbate environmental degradation and hinder efforts to limit global temperature increases to 1.5°C. Against this backdrop, "clean construction" is a critical paradigm shift. It aims to decarbonize, enhance resource efficiency and foster resilience and equity in the built environment. This report explores the potential of transitioning to clean construction practices in Seattle, United States, focusing on job creation, labor quality and associated costs. The findings are based on quantitative modeling, stakeholder interviews and a comprehensive literature review.

Understanding clean construction

Clean construction takes a holistic approach to minimizing the environmental footprint of built environment activities. This includes reducing embodied carbon throughout the lifecycle of assets, from material extraction and manufacturing to assembly, maintenance and eventual demolition. The transition to clean construction encompasses several key actions, known as "shifts", which are essential to transforming the industry from high-carbon to low-carbon practices. For methodological and data availability reasons, this report focuses on eight of the multiple existing clean construction shifts. Likewise, this report has modeled results considering the residential building sector only, not including infrastructure.

The clean construction shifts

The report identifies eight critical shifts to transition Seattle's construction sector to clean construction:

- **Maximizing Building Occupancy:** Use smart management and city planning to ensure buildings are fully utilized, reducing the need for new spaces. Promote reduction of vacancy in buildings.
- **Regular Repair and Maintenance of Buildings:** Prolong building lifespan and improve living conditions through regular maintenance and repairs, using durable materials designed for longevity.
- **Supporting Building Retrofit and Encouraging Adaptive Reuse:** Retrofit buildings to improve energy efficiency, reduce consumption and waste generation, and increase the quality and performance of the space. Repurpose existing structures for new functions instead of demolishing them.
- **Prioritizing Industrialized Construction:** Adopt off-site prefabrication and modular design to enhance efficiency, reduce waste, and standardize construction processes for better material use.
- **Encouraging Timber and other bio-based materials:** Use sustainably sourced wood and bio-based materials for primary frames and façades, replacing traditional steel, concrete, and aluminum.
- **Specifying Low-Carbon Products:** Use low-carbon construction materials like sustainable cement alternatives to reduce carbon intensity in manufacturing.
- **Reusing Materials and Structural Components:** Advance design and recovery methods to increase the use of reused and recycled materials, supporting a circular economy and reducing embodied impacts.
- **Promoting disassembly and deconstruction:** Design buildings for easy deconstruction to recover materials and parts, minimizing waste and supporting circular economy principles.

The Seattle context

Seattle boasts a considerable market and skilled workforce in timber and retrofits. The city supports clean construction through initiatives like the Building Tune-Ups program, Home Repair Program, and Building Emissions Performance Standard (BEPS), aiming to enhance building efficiency and reduce emissions. However, challenges include high land values favoring new builds over retrofits, a limited supply chain for industrialized construction and low-carbon cement. Despite these barriers, Seattle's retrofit programs, local timber industry, and existing regulations offer significant opportunities to scale up clean construction practices. For example,

commercial building vacancy provides an opportunity for adaptive reuse, while the city's strong local timber supply chain could support the expansion of cross-laminated timber (CLT) construction, which could contribute to reducing prices. In addition, policy actions such as the Buy Clean Buy Fair bill (HB 1103) and the 2022 Solid Waste Comprehensive Plan Update could drive progress on using low-carbon materials.

Key findings: job creation and quality

Shifting to clean construction in Seattle over the next 20 years could generate approximately 1,207,492 job years, which is about 30,445 (2.6%) more than continuing with current high-carbon practices. Regular repairs and maintenance, which require a large workforce, have the greatest job-year creation potential. Industrialized construction methods and timber use are also expected to grow significantly. About 73.5% of these new jobs will be within Seattle, with the remainder in surrounding cities, boosting the regional economy. Existing programs like BEPS and the Building Tune-Ups program will help facilitate this transition.

Clean construction in Seattle offers a chance to improve equity, diversity, and inclusion in the sector through intentional policy actions, fostering equitable careers. However, achieving a more inclusive workforce requires dedicated efforts beyond existing initiatives. The transition provides an opportunity for collaboration between the municipality, unions, and stakeholders to define labor terms and conditions. New methods like industrialized construction and CLT, though less labor-intensive than retrofitting and maintenance, still generate significant job years and are compatible with local skills. Industrialized construction also improves worker safety with controlled environments mitigating risks like heat stroke and smoke inhalation. Seattle's workforce, particularly in timber, retrofitting, and industrialized construction, is well-positioned due to the region's forestry sector and seismic retrofitting experience. Additionally, the clean construction scenario could slightly increase average annual wages by creating higher-paid occupations, with the right market and policy environment.

Key findings: economic impacts and environmental and social benefits

Clean construction in Seattle generates significant social, economic, and environmental benefits compared to carbon-intensive practices. It leads to less waste, improved air quality, reduced energy and material use, enhanced climate resilience, and a lower carbon footprint. By maximizing the use of existing buildings through retrofits, adaptive reuse, and maintenance, and by employing prefabrication and modular construction, homes can be produced more quickly and affordably. For instance, mass timber construction can reduce build time, traffic, and pollution. Integrating industrialized construction into a local supply chain can accelerate homebuilding and improve permitting processes, addressing the housing deficit. Health benefits include better air quality and fewer construction site accidents.

Adopting clean construction practices would require just 2.12% more investment than current practices, primarily for building maintenance and industrialized construction. This investment would be shared among sector stakeholders and could lead to economic savings through economies of scale, logistics and transport efficiencies, waste reduction, and less congestion from construction activities. Clean construction presents a substantial business opportunity for the private sector, necessitating collaboration between public and private entities to establish local supply chains.

Key barriers for Seattle

- High Land Values and Financial Incentives: High land values can make demolition and new construction more financially attractive than retrofitting existing buildings, which poses a challenge for promoting clean construction practices.
- Supply Chain Issues for Industrialized Construction and Low-Carbon Cement: An absence of a local supply chain for industrialized construction components forces design teams to import materials, leading to compliance challenges with local building codes and increasing costs. Washington's sole cement plant can only meet one-third of the state's demand, requiring the import of cement from abroad, which complicates efforts to reduce carbon emissions.
- Perceptions of Quality and Cultural Barriers: There are strong cultural barriers within the general public, who often perceive industrialized and modular construction methods as lower quality, and within construction unions, who have legitimate concerns about industrialized construction being job-threatening due to automation.
- Economic Disincentives for Existing Homeowners: Retrofitting and maintaining existing homes can be economically burdensome for homeowners and tenants, especially if the costs are not managed fairly or supported by financial incentives.

Key Recommendations

- Develop Clear Targets: Create specific targets for adopting clean construction methods and materials.
- Expand Training Programs: Partner with educational institutions and unions to expand apprenticeships and training for displaced workers.
- Prioritize Diversity in Procurement: Include diversity measures in municipal procurement to attract and train marginalized workers.
- Public Procurement: Use public procurement to foster private clean construction markets and attract new suppliers.
- Subsidized Financing: Provide subsidized public financing for retrofits and maintenance.
- Reduce Vacancy Rates: Consider implementing an empty homes tax.
- Demand Environmental Product Declarations (EPDs): Collaborate with stakeholders to create EPDs and promote timber and low-carbon materials.

Conclusion

Accelerating the transition to clean construction is an economic, social, and environmental opportunity for Seattle. Embracing clean construction can lead to job creation, socio-economic improvements, and sustainability. Despite challenges like high land values and limited supply chains, Seattle's skilled workforce, robust retrofit programs, and strong local timber industry offer significant opportunities. Building on initiatives like the Building Tune-Ups program and policies such as the Buy Clean Buy Fair bill can further drive progress. By addressing these barriers and leveraging these strengths, Seattle can also meet its social goals such as improving housing affordability in the city.

Building Greener Cities: Green Job Opportunities in Clean Construction

Policy Report

What is this report about?

This research project aims to understand the opportunities of low-carbon construction practices in cities and how they will affect jobs, workers and the costs of construction. It looks at the number, quality and kinds of jobs that might come from such a shift, focusing on seven cities: Seattle, Bogotá, Mexico City, Nairobi, London, Madrid and Oslo. This report details the results for Seattle.

The analysis is based on quantitative modeling, interviews with city departments and stakeholders, and a literature review. It projects two scenarios for the period from 2023 to 2044:

- Construction continues in its current form, generating emissions, waste, air, noise and soil pollution (through the use of high-carbon steel, concrete and in-situ practices); and
- A gradual transition towards cleaner construction practices, such as retrofits, local low-carbon materials, and industrialized and modular construction.

Using the available data, this research identifies the job potential, challenges and opportunities of each scenario. For a more comprehensive dive into the results and the precise methodologies used in this study, please see the full report and accompanying methodology statement.

What is clean construction?

By 2050, an additional 2.5 billion people are anticipated to live in urban areas globally (United Nations, 2018). This will require massive infrastructure and building construction, equivalent to a city the size of Milan every week over the next 25 years (C40 Cities, 2023a). At the same time, national governments have embraced infrastructure and construction as a primary engine of economic recovery, supported by higher public funding and stimulus packages.

Today, the construction sector is responsible for more than 23% of global greenhouse gas emissions, while consuming more than 30% of global resources (Global Construction Perspectives and Oxford Economics, 2015). Meeting the projected demand for built assets in urban areas using current methods of construction would lock in further greenhouse gas emissions and resource extraction.

C40 defines clean construction as decarbonized, resource-efficient, resilient and socially just construction systems for thriving and healthy communities, workers and cities. In other words, clean construction tackles the negative impacts of our current built environment practices in terms of emissions, resource depletion, pollution, climate risks and unequal urban division. That means for example, investing in building retrofits, switching to low-carbon materials and construction practices (such as low carbon cement, bio-based materials and modular construction), prioritizing repurposing and preferring deconstruction over demolition. Socially just means providing safe and good quality jobs for all and providing affordable, accessible and sustainable infrastructure and buildings for all people, especially the most vulnerable and marginalized groups and communities. This presents an opportunity for cities such as Seattle to meet its housing and infrastructure needs, whilst generating good green jobs and reducing environmental impacts. Cities have a critical role to play in supporting and accelerating the adoption of clean construction.

Clean construction shifts discussed in this report

For the purposes of this project, we organise For the purposes of this project, we are organizing clean construction into “shifts”, or key overarching actions required to transition the construction industry from a “business-as-usual” to a “clean construction” scenario. An outline of the shifts can be found below. It is important to note that these are not the totality of the existing clean construction alternatives. As clean construction is a broad field, this work has opted to prioritize a set of key shifts so that the research was feasible and relevant.

Table 1. Construction shifts

Clean construction topic	Shift	Description
Prioritize existing assets	Maximizing building occupancy	Many existing buildings are used infrequently, are left empty or are underused. Smart building management and city planning can be used to ensure that buildings are used more effectively, reducing demand for new spaces. Space-sharing arrangements between organizations, taking action on building vacancies and flexible space management are all ways to tackle this.
	Regular repair and maintenance of buildings	The regular maintenance and repair of existing buildings can prolong their lifespan, increase quality of living conditions, and improve efficiency and performance. Regular maintenance means buildings last longer, reducing the need for demolition or extensive retrofit. This shift is further supported by designing for material and building longevity (for example, durable materials that weather well and can handle use).
	Supporting building retrofit and encouraging adaptive reuse	Existing buildings can require more substantial work with the installation of new systems like insulation and HVAC. Retrofits prolong building lifespans and improve the quality and energy performance of spaces. Retrofits are usually undertaken to substantially improve energy efficiency, and indoor thermal comfort and can add climate resilience measures. 'Adaptive reuse' refers to occasions when existing buildings are modified for a new purpose or function, as opposed to being demolished and a new building constructed on the original site.
Use materials efficiently and switch to low-carbon materials	Prioritizing industrialized construction	Industrialized construction combines actions such as off-site prefabrication (components manufactured off-site in controlled environments then transported to site for final assembly) and modular design (specification of repetitive elements and components). Industrialized construction methods can improve the efficiency of logistics to transport and assemble buildings components, as well as reduce material use and waste. Supporting the adoption of a more standardized approach to construction (rather than bespoke elements) can facilitate efficient, repetitive and low-waste processes, with greater materials efficiency.
	Encouraging timber construction	The use of bio-based materials in construction refers to 100% sustainably sourced wood or bio-sourced materials (such as bamboo, straw or earth) for primary frame and façade, rather than traditional steel, concrete and aluminum alternatives.
	Specifying low-carbon products	The carbon intensity of construction products depends on the material used and the processes involved in manufacturing them and transporting them to site. Low-carbon concrete, cement and aggregates can use more sustainable cement alternatives or recycled binders, or contain recycled and locally sourced aggregates. Some new products have been developed to absorb carbon in use. Globally, a range of low-carbon construction materials has been developed, many based on the resources available to particular regions or innovation hubs.
	Reusing materials and structural components	Keeping materials and products in use by re-using and recycling them reduces the embodied impacts of sourcing and producing construction materials. As design and recovery methods advance, we can expect to see a higher proportion of reused materials in construction. Like many of the measures set out in this table, prioritizing reused and recycled materials is key to supporting the transition to a circular economy.
Plan, design and build for the future	Promoting disassembly and deconstruction	Most materials are installed with the expectation of demolition at end of life or without considering how they could be disassembled for reuse. This prevents further uptake of material reuse and results in higher embodied carbon, difficulty in implementing circular economy policies and high levels of waste. Designing for disassembly will ensure buildings are deconstructed with materials, equipment and parts recovered, instead of being demolished and turned to waste. Like many of the measures set out in this table, deconstruction is key to supporting the transition to a circular economy.

Context: Construction in Seattle

Clean construction is not new to Seattle. Indeed, the city has a considerable market and workforce related to clean construction practices, primarily in timber and retrofits. Likewise, the city government has been using its powers to support clean construction actions, such as the maintenance of existing buildings, building retrofits, deconstruction, and material reuse. The city has implemented several programs and regulations, such as the Building Tune-Ups program, the Home Repair Program, and the Building Emissions Performance Standard (BEPS), among other things, which aim to improve energy efficiency, reduce emissions and prolong the useful life of buildings.

However, Seattle still faces significant barriers to clean construction practices. For example, high land values which can boost the financial case for demolition and new build over retrofit, and a perception that homes built using industrialized construction methods are of lower quality.

Despite the challenges, Seattle has a strong foundation for adopting and scaling up clean construction practices. Its history of retrofitting buildings to be resilient to seismic activity and its ability to draw on a local timber industry give it a pool of skilled workers. and companies with significant potential to upscale these practices. There are also opportunities to capitalize on existing regulations and programs to accelerate the uptake of clean construction practices. For example, commercial building vacancy provides an opportunity for adaptive reuse, while the city's strong local timber supply chain could support the expansion of cross-laminated timber (CLT) construction, which could contribute to reducing prices. In addition, policy actions such as the Buy Clean Buy Fair bill (HB 1103) and the 2022 Solid Waste Comprehensive Plan Update could drive progress on using low-carbon materials.

KEY TAKEAWAYS AND RECOMMENDATIONS (SUMMARY)

Key Takeaways	Key Recommendations
1. In the next 20 years, clean construction could generate slightly more jobs than current carbon-intensive construction, primarily by increasing the uptake in maintenance of buildings. Shifting to clean construction in Seattle could generate approximately 1,207,492 job years[1] by 2044, some 30,445 (approx. 2.6%) more than if it continued with current high-carbon practices. Under the clean construction scenario, approx. 73.5% of these new job years will be generated within the city of Seattle.	• Develop clear, detailed and action-driven targets for the adoption of each clean construction shift (see table 1). • Incentivize the adoption of regular repair and maintenance and retrofits, as these are the best ways to avoid and reduce the emissions associated with new and existing construction. • As the expected increase in job years provides an opportunity to grow Seattle's construction sector workforce, the city should work with partners to expand its strong network of apprenticeships, and existing programs to draw more people into the sector. • Seattle should adopt an integrated set of policies that ensure that those displaced from carbon-intensive construction practices (such as concrete and steel production) can access new, good green jobs.
2. Clean construction offers the opportunity to improve equity, diversity and inclusion in the sector through intentional policy action, fostering good and equitable careers. A transition to clean construction practices will not automatically create a more equitable or inclusive workforce. Concerted and dedicated efforts are needed to improve sectoral working conditions, decency and equity. Seattle's construction workforce is well positioned to transition to clean construction practices, particularly in timber, retrofitting and industrialized construction, due to the region's established forestry sector and historical experience with retrofitting buildings to cope with seismic activity.	• The municipality could use alternative delivery organizations for municipal projects, such as direct labor organizations (DLOs) or arm's length construction (ALC) companies to directly employ underrepresented groups. • The municipality can attract a more diverse and inclVusive workforce and reorientate apprenticeships by intentionally prioritizing marginalized and underrepresented groups in their training programs and public procurement contracts.
3. At similar levels of investment, clean construction generates far more benefits than current carbon-intensive practices. Adopting clean construction practices would require just 2.12% more investment than current carbon-intensive practices. Clean construction generates numerous social, economic and environmental co-benefits. For example, a shift to sustainably sourced mass timber construction (including mass timber using reclaimed lumber) has the potential to significantly reduce build time. Similarly, air pollution would decrease, improving the health of construction workers. The transition to clean construction and the emergence of new sectors in Seattle's construction sector present a substantial business opportunity for the private sector.	• The municipality has a crucial role in organizing and incentivizing the private sector to move away from socially and environmentally damaging practices. Public procurement of clean construction projects, for example, can be a powerful tool for nurturing and expanding nascent private markets such as industrialized construction. • The municipality should consider expanding Seattle's infrastructure for circular economy for reused and recycled construction materials, which could address sourcing issues and reduce industry costs.
4. Mainstreaming clean construction (primarily by reducing the number of empty homes, boosting retrofitting and maintenance, and adopting modern methods of construction and timber) is part of addressing the housing crisis. Clean construction provides opportunities to produce more housing more efficiently, with less embodied carbon.	• Maximizing the use of the existing housing stock is the best way to reduce the housing gap and construction emissions at the same time. • The city could explore raising capital-gains or property taxes or introducing an empty homes tax. • The city should start implementing the transition in neighborhoods that have the greatest need in terms of housing, building-stock conditions and socioeconomic disparity.

[1] A job year can be defined as one year of a full-time job, and it is preferred for this research as it is a more specific measure than just "jobs" (which have an undefined length). For example, three job years could mean that there will be three full-time jobs available for one year, or that there will be one full-time job available for three years. More information about how jobs were calculated is available in the full technical report and the methodological statement.

5. Seattle can be a leader in timber and industrialized construction in North America Adopting more timber construction will support job creation, as well as Seattle's climate commitments to become carbon neutral by 2050.	• Seattle could use public procurement and support the development of industry roadmaps to attract new suppliers to the industrialized timber sector and improve market competition. • The municipality could engage with groups such as the American Institute of Architects (AIA) Seattle Mass Timber Committee, unions, local industry and academia to develop region-specific environmental product declarations (EPDs) and improve understanding of the embodied emission impacts of timber. • The municipality needs to understand the wider supply-chain impacts outside the city that will accompany a shift to clean construction and the expansion of the local timber industry. Partnering with programs such as the US Department of Agriculture (USDA) Forest Service's Forest Health Monitoring program could be one such action (Greenpeace, 2018). • The municipality can build on existing interaction with unions to understand their concerns about industrialized construction and ensure a just transition for their members.

KEY TAKEAWAYS AND RECOMMENDATIONS (FULL TEXT)

1. In the next 20 years, clean construction can generate slightly more jobs than current carbon-intensive construction, primarily by increasing the uptake in maintenance of buildings.

- **Shifting to clean construction in Seattle can generate approximately 1,207,492 job years by 2044, some 30,445 (approx. 2.6%) more than if it continued with current high-carbon practices.** A job year can be defined as one year of a full-time job, and it is preferred for this research as it is a more specific measure than just "jobs" (which have an undefined length).
- **Regular repairs and maintenance have the greatest job-year creation potential.** This is due to two reasons: first, maintenance is projected to be carried out extensively as most buildings will need some form of repair during their lifetime; second, regular repair and maintenance are activities that require a large workforce per output (that is, it is a shift with high job intensity). Industrialized construction methods (also known as prefabricated or modular construction) and timber, although less job-intensive than regular repairs and maintenance, are also expected to grow substantially due to the large uptake in this practice in the clean construction scenario. Over the next 21 years, Seattle could generate 45,241 more maintenance job years and 14,900 more industrialized construction job years with clean construction than if it remained on its current high-carbon construction pathway.[2] Some of these job years may be generated through the city's existing programs, such as BEPS and the Building Tune-Ups program.
- **Under the clean construction scenario, approx. 73.5% of these new job years will be generated within the city of Seattle,** with the remainder being created outside the city. This means that in addition to strengthening the city's workforce, clean construction could contribute to the regional economy by

[2] See Appendix A for a breakdown of the ISCO-08 occupational categories modelled in this study.

creating jobs in surrounding cities. Most regional jobs would come from the broader adoption of timber as a construction material, underscoring the growing importance of good relationships with the state government and other cities.

Table 2.
Modelling results for jobs in two scenarios

	Total full-time equivalent job years by 2044	
Construction shifts	**If the current carbon-intensive construction trend continues (business as usual)**	**If the city adopts clean construction**
Regular repair and maintenance of buildings	955,559	1,000,800
Supporting building retrofit and encouraging adaptive reuse	8,246	15,173
Prioritizing industrialized construction	234	15,134
Encouraging timber construction	4,660	7,094
Promoting disassembly and deconstruction[3]	17	90
Demolition	1,050	1,577
Prioritizing reused materials and structural components (including landfill and recycling)	1,759	1,577
Current carbon-intensive construction practices (that is, business as usual, such as standard cement and concrete, in-site construction, etc.)	205,522	166,936
	1,177,046	**1,207,492**


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[3] Why would disassembly and the reuse of materials create fewer jobs in the clean construction scenario? At the end of life of a building, there are two main options available for developers: demolition or deconstruction/disassembly. While the former essentially destroys most of the building components, transforming them into waste, the latter seeks to preserve building materials whenever possible – so that they can be reutilized in other constructions in the future. In deconstruction/disassembly, less waste and less air pollution are generated, for which this is considered a clean construction practice.

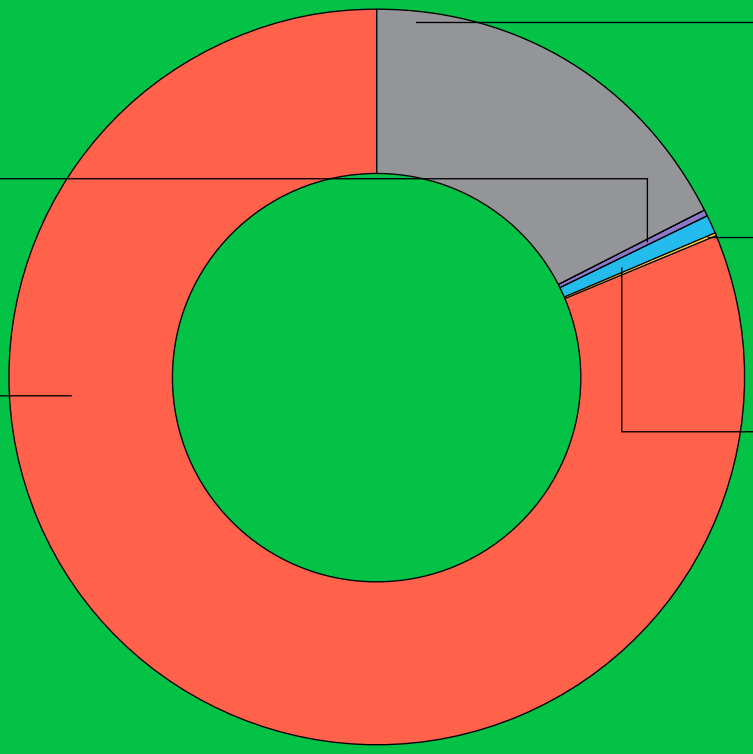
According to literature, deconstruction/disassembly tends to create more jobs per building than demolition, as more workers are needed for that type of work. As such, initially, one would assume that when it comes to the building end-of-life activities, a clean construction scenario (deconstruction/disassembly) would create more jobs than a high-carbon construction scenario (demolition). However, that was not the case in this analysis, for the reasons explained below.

The first step in the transition to clean construction is to maximise the city's use of existing assets. Typically, some of a city's buildings are typically vacant, uninhabitable or abandoned. Making the most of what already exists is the best way to avoid and reduce the high carbon impact associated with demolition and new construction. Measures to prioritise existing assets include increasing occupancy, repurposing assets to increase their use, engaging in adaptive reuse, undertaking preventive maintenance, and conducting repairs and retrofits.

In a clean construction scenario, therefore, existing assets are maximised and optimised, reducing the amount of new, more carbon-intensive construction required. That means that we will destroy fewer buildings to build new. In the short term, it is anticipated that the adoption of deconstruction would create more jobs, as buildings are disassembled rather than demolished. In the long run, however, there is less and less need for deconstructing buildings (since the city is retrofitting, maintaining and repurposing them), therefore fewer jobs will be needed for deconstruction overall.

While this may sound negative, it is important to highlight that clean construction is expected to have a long-term positive impact on Seattle's employment overall. Thus, the limitations on jobs in disassembly will be offset by jobs in other areas, such as retrofit and maintenance. Either way, deconstruction remains a critical strategy for Seattle in the transition to a clean construction scenario.

Job-years distribution
High-carbon scenario



17.5%
Current carbon-intensive construction

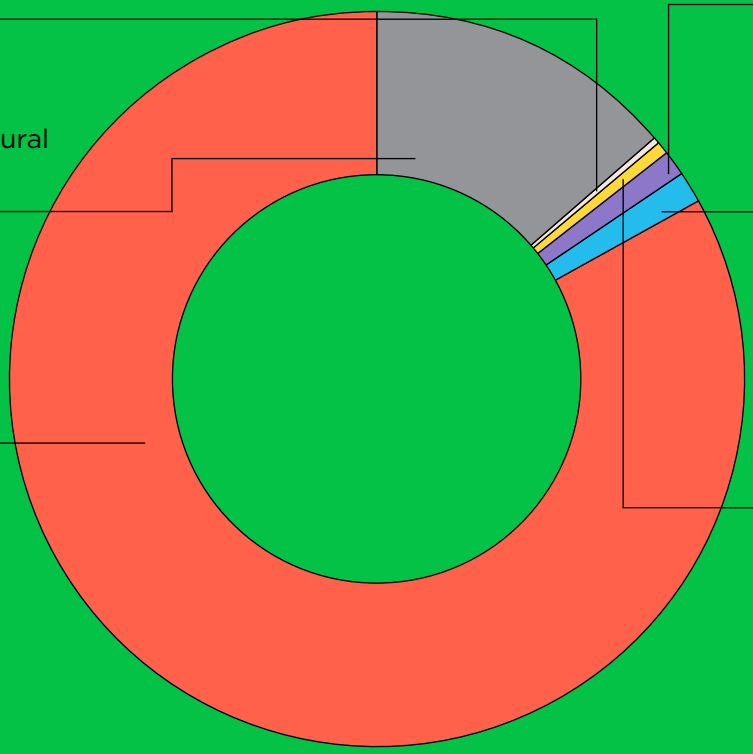
0.1%
Prioritizing reused materials and structural components

0.7%
Supporting building retrofit and encouraging adaptive reuse

0.4%
Encouraging timber construction

81.2%
Regular repair and maintenance of buildings

Job-years distribution
Clean construction scenario



0.1%
Prioritizing reused materials and structural components

13.8%
Current carbon-intensive construction practices

82.9%
Regular repair and maintenance of buildings

1.3%
Prioritising industrialised construction

1.3%
Supporting building retrofit and encouraging adaptive reuse

0.6%
Encouraging timber construction

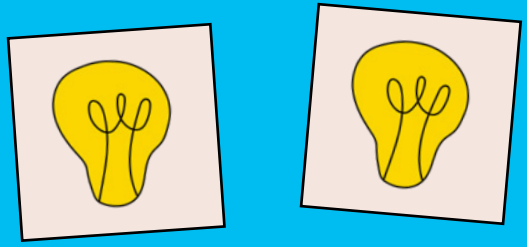
FAQ : Why do current carbon-intensive construction practices persist in the clean construction scenario?

While we expect an ambitious uptake of clean construction in the second scenario, the transition will have to be gradual to be achievable, accepted and socially just. Consequently, throughout the analysis period, even in the clean construction scenario, a percentage of carbon-intensive construction will remain, declining gradually to around 14% of all new construction in 2044. Cities could, of course, choose to set more aggressive targets or be encouraged by greater-than-expected market uptake. This would further reduce the percentage of carbon-intensive construction practices by 2044.

C40 Recommendations

Transitioning to clean construction will require political will and inclusive, equitable and transparent policies to bring about the shifts identified in Table 1-1. To build confidence and gain buy-in from both the public and private sectors, the municipality could:

- **Develop clear, detailed and action-driven targets for the adoption of each clean construction shift (see table 1).** These plans could include specific commitments regarding future construction methods (for example, industrialized construction) and materials (such as timber), clarifying the path forward. This could be achieved by implementing uniform policy across permitting and zoning, in line with an updated, comprehensive plan. Ad hoc policy measures could be implemented by: 1) organizing an implementation plan for clean construction in the city, with clear guidance to achieve shifts; 2) updating building codes and planning/development controls where Seattle has the authority to limit carbon-intensive construction and defining standards for clean construction; and 3) using financial incentives to support pilot projects that help the city meet those targets. These should be done with participation of union stakeholders to make sure their needs and concerns are addressed, what would improve the quality of the targets and well as increased the social adherence to them - speeding up the process of a just transition.
- **Incentivize the adoption of regular repair and maintenance and retrofits, as these offer the best ways to avoid and reduce the emissions associated with new construction.** These practices can also make housing more energy efficient, directly reducing energy bills. Seattle could use its current Housing and Building Maintenance Code and its Building Tune-Ups Ordinance to accelerate the regular repair and maintenance of residential buildings. Currently, the Building Tune-Ups Ordinance and support programs focus on buildings larger than 50,000ft^2, ignoring single-family homes, which make up 38% of the residential building stock. The municipality could consider ways to encourage (such as financial incentives), require (such as ordinances) or support (such as guidance) energy efficiency improvements in all residences. Financial mechanisms, such as grants or tax incentives from state or federal sources, have proven effective in other cities, while ordinances targeted at private landlords could also be trialed. Measures must be taken to ensure increased repair and maintenance costs do not increase living costs for those least able to afford them.



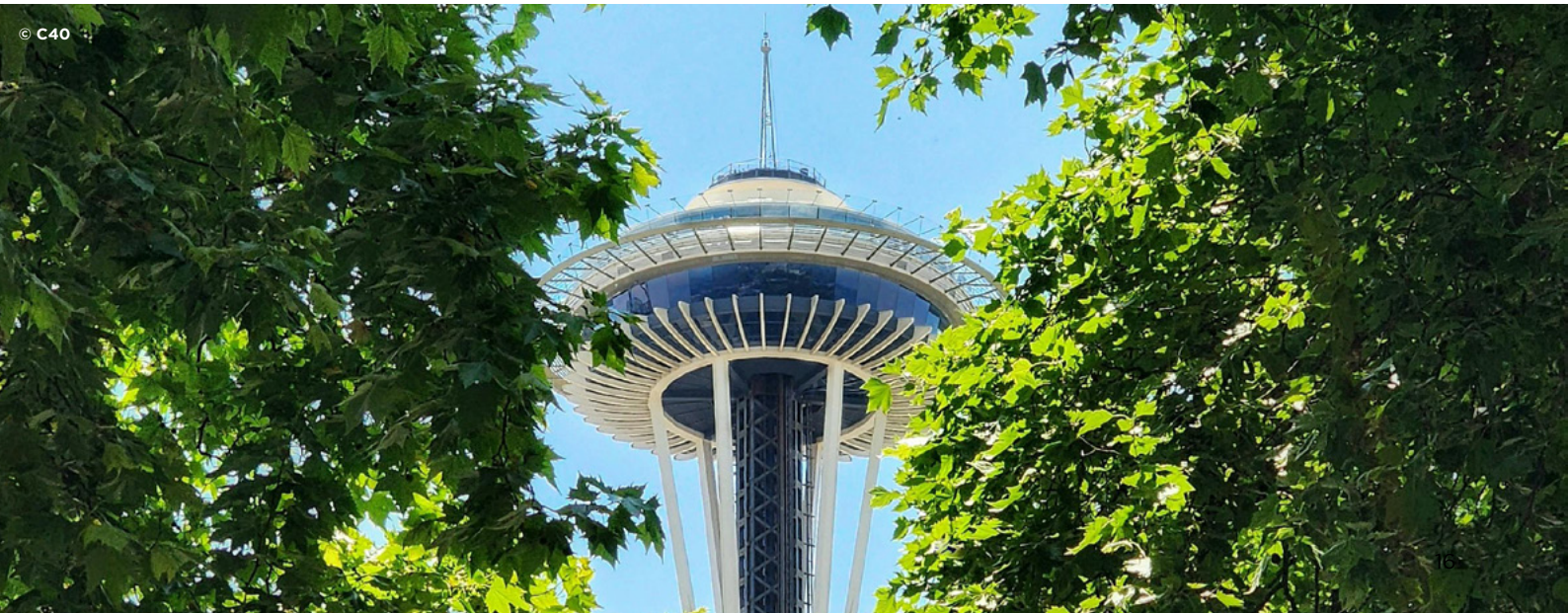
- **As the expected increase in job years provides an opportunity to grow Seattle's construction sector workforce, the city should work with partners to expand its strong network of apprenticeships, and existing programs to draw more people into the sector.** While the city has significant power and capacity to support this, complementary funding sources (such as the federal Inflation Reduction Act) and additional partnerships with Seattle community colleges, local universities and community-based organizations and labor unions could further enhance these efforts. According to interviews, clean construction is an opportunity to attract young and new workers as young workers are increasingly valuing sustainability when choosing their careers.
- **Seattle should adopt an integrated set of policies that ensure that those displaced from carbon-intensive construction practices (such as concrete and steel production) can access new, green jobs.** This needs to be accompanied by robust training and inclusion policies to ensure that those people negatively affected by the transition are not left behind. These workers have extensive experience in the construction sector and have multiple skills sets that will be useful for the new green positions, thus including them in new positions is not just socially just but economically efficient. Policy development should be transparent and involve social participation to build trust and engage stakeholders.

Low-carbon task force (Yorkshire and the Humber Region, UK)

The Yorkshire and Humber region has the UK's highest concentration of high-carbon-intensive industries and coal- and gas-fired power plants. For years, the local arm of the Trades Union Congress has been engaged in the low-carbon transition process. It set up a Low Carbon Task Force in 2018, bringing together the region's unions, businesses, enterprise partnerships and environmental non-governmental organizations (NGOs) with a view to organizing the workforce upwards, strengthening consultation between stakeholders and promoting a just transition for workers (European Trade Union Confederation, 2018). Seattle could take a similar approach to onboarding and co-defining the organization of labor in these new, emerging industries. This could be done by expanding existing organizations in the city, such as the Green New Deal Oversight Board.

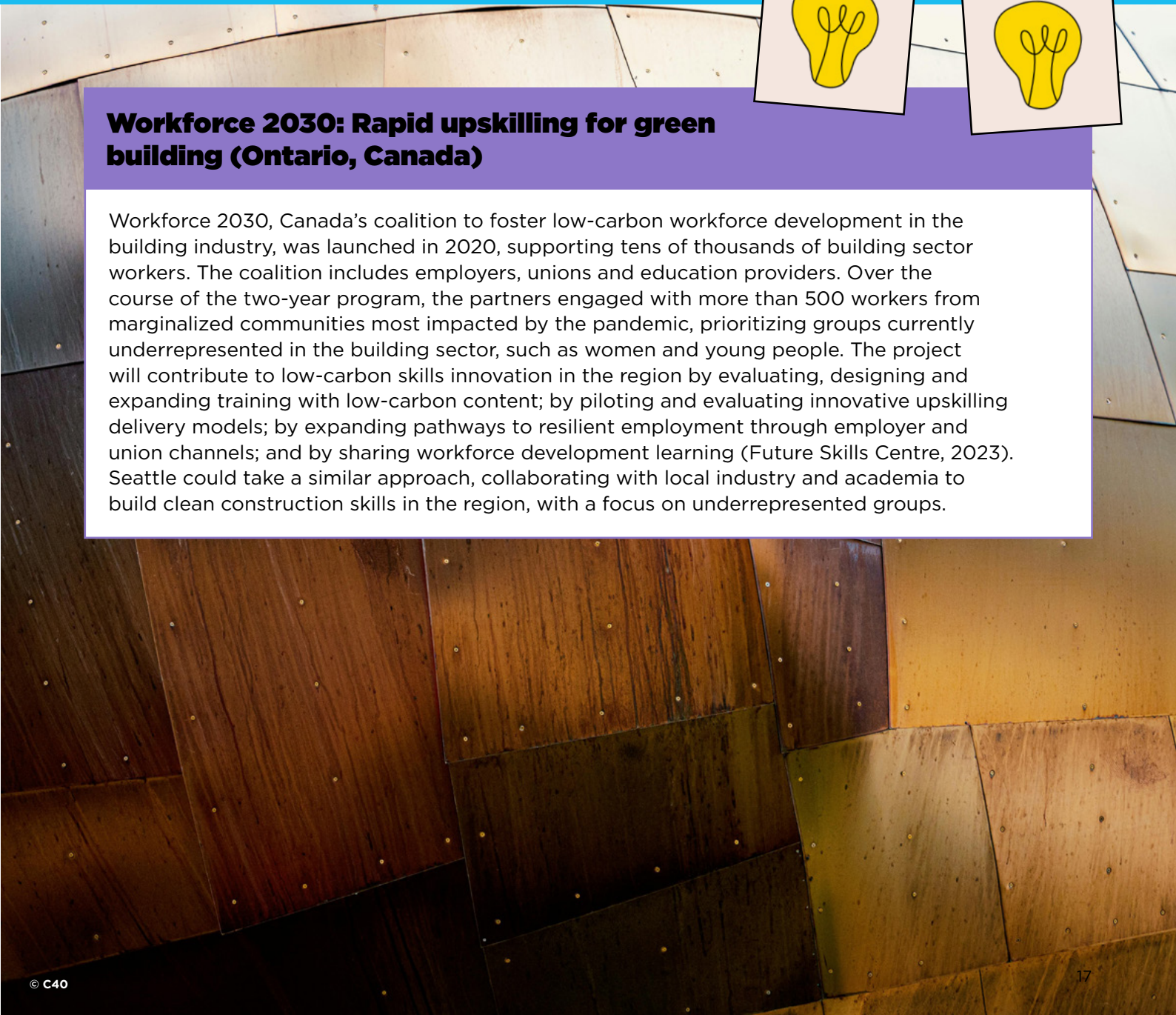
2. Clean construction offers the opportunity to improve equity, diversity and inclusion in the sector through intentional policy action, fostering good and equitable careers.

- **A transition to clean construction practices will not automatically create a more equitable or inclusive workforce.** Concerted and dedicated efforts are needed to improve sectoral working conditions, decency and equity beyond existing initiatives such as RISE UP and Culture of Care by the Associated General Contractors of America and of Washington.
- **The creation of new or expanded clean construction industries in Seattle, such as industrialized construction and reused or recycled materials, is an opportunity for the municipality** to work with unions and other stakeholders to co-define the terms and conditions of labor.
- **Seattle's construction workforce is well positioned to transition to clean construction practices, particularly in timber, retrofitting and industrialized construction.** This is due to the region's established forestry sector and historical experience with retrofitting buildings to cope with seismic activity. While retrofitting and industrialized construction are slightly less labor-intensive than current practices, they still generate a significant number of full-time equivalent (FTE) job years per million dollars invested. Interviewees indicated that the skills required for these new construction methods are largely compatible with those of the existing local workforce.
- **Industrialized construction can improve worker safety through more controlled and standardized processes** (Lu, 2009). On-site construction workers are exposed to harsher conditions. Hotter temperatures put them at risk of heat stroke and dehydration and, during the summer wildfire season, they are at higher risk of inhaling wildfire smoke than the wider population, due to their prolonged outdoor working hours. Industrialized construction in factories can protect workers against the elements with appropriate cooling and heating measures.
- **Under the clean construction scenario, average annual wages increase slightly across the construction sector,** as more people are working in higher-paid occupations.



C40 Recommendations

- **The municipality could use alternative delivery organizations for municipal projects, such as direct labor organizations (DLOs) or arm's length construction (ALC) companies to directly employ underrepresented groups.** Establishing an ALC partly owned by the municipality would enable the city to demand higher standards when procuring services, with fewer financial risks than a DLO. For example, an ALC would allow Seattle to proactively establish favorable working conditions for women (such as introducing flexible working hours and addressing male-dominated cultures on construction sites), as well as for ethnic minorities. Such an approach is similar to the city's current Priority Hire program, which uses city-funded and public-private partnership projects to prioritize the hiring of residents from economically distressed areas (City of Seattle, 2023).
- Systemic racism has shaped the construction sector in Seattle (University of Washington, 2020). **The municipality can attract a more diverse and inclusive workforce and reorientate apprenticeships by intentionally prioritizing marginalized and underrepresented groups.** Municipal procurement requirements should include diversity and inclusion measures, in turn creating demand for newly trained workers from underrepresented groups.



Workforce 2030: Rapid upskilling for green building (Ontario, Canada)

Workforce 2030, Canada's coalition to foster low-carbon workforce development in the building industry, was launched in 2020, supporting tens of thousands of building sector workers. The coalition includes employers, unions and education providers. Over the course of the two-year program, the partners engaged with more than 500 workers from marginalized communities most impacted by the pandemic, prioritizing groups currently underrepresented in the building sector, such as women and young people. The project will contribute to low-carbon skills innovation in the region by evaluating, designing and expanding training with low-carbon content; by piloting and evaluating innovative upskilling delivery models; by expanding pathways to resilient employment through employer and union channels; and by sharing workforce development learning (Future Skills Centre, 2023). Seattle could take a similar approach, collaborating with local industry and academia to build clean construction skills in the region, with a focus on underrepresented groups.

3. At similar levels of investment, clean construction generates far more benefits than current carbon-intensive practices.

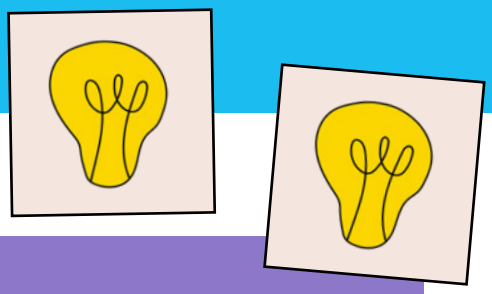
- **Clean construction generates numerous social, economic and environmental co-benefits.** While this study does not calculate benefit values, clean construction practices bring about important improvements for a city, such as less waste, better air quality, a decline in energy and materials use, greater resilience to climate risks and an overall reduction in the city's carbon footprint. Moreover, clean construction can maximize the use of existing buildings by stepping up retrofits, adaptive reuse and maintenance, in tandem with prefabrication and modular construction to produce homes in a quicker and more affordable way. Consequently, clean construction could present a significant opportunity for Seattle's economy, climate action and housing challenges.
- **A shift to sustainably sourced mass timber construction (including mass timber using reclaimed lumber) has the potential to significantly reduce build time,** as well as reduce construction-related traffic and associated pollution in Seattle, thanks to reduced delivery requirements (Arup, C40 Cities and University of Leeds, 2019). Integrating industrialized construction into a transparent[4], complete local supply chain may offer opportunities to accelerate homebuilding and improve permitting processes, helping the city to address the current housing deficit.
- **Similarly, clean construction can improve the health of construction workers and decrease air pollution.** Clean construction practices emit less greenhouse gas emissions and air pollutants than high-carbon constructions ones when it comes to both the production of materials and their transport (World GBC, 2021; World GBC, 2023). The health benefits of cleaner air and the reduction in accidents on construction sites (Nahmens and Ikuma, 2009; Court et el., 2009; Acharya, Boggess and Zhang, 2018) could save lives and reduce pressure on the city's healthcare services, while the environmental benefits of less-polluting material extraction and processing would support both the city and region's ecosystem services.
- **Adopting clean construction practices would require just 2.12% more investment than current carbon-intensive practices, which is well compensated by the environmental, social and economic benefits clean construction will create.**[5] Most of the investment would go towards building maintenance and industrialized construction. The investment presented in this analysis is sector wide, so the cost would be shared among sector stakeholders.
- **Further potential economic savings exist that could not be estimated in this study.** By developing or upscaling locally-sourced and sustainably-managed timber, industrialized construction and secondary materials marketplaces, a number of cost savings could be achieved. These include, but are not limited to, economies of scale, logistics and transport efficiencies, a reduction in waste and fewer city areas being blocked or congested by construction-site activities (due to both less construction and reduced construction times). This model has not estimated these savings. Cities are also likely to see economies of scale as these markets mature, as well as the direct economic benefits of material efficiency, better building utilization (Arup, C40 Cities and University of Leeds, 2019) and energy savings from high-performing buildings.
- **The transition to clean construction and the emergence of new sectors in Seattle's construction sector present a substantial business opportunity for the private sector.** To this end, the public and private sectors need to establish such supply chains in Seattle and take advantage of the emerging market (see Section 5.3 of the full report).

[4] Transparency of the supply chain means that reliable and continuous data about suppliers and products are provided, so that there is a guarantee of sustainability in timber management and fairness in work within the supply chain.

[5] Details and methodological limitations of the investment estimates can be found in the full report. Costs have been based on proxy cost data and do not consider the time or capital expenditure required for training or establishing new supply chains. See the method statement for a detailed explanation of how costs have been modelled in this study.

C40 Recommendations

- **The municipality has a crucial role in organizing and incentivizing the private sector to move away from socially and environmentally damaging practices.** Public procurement of clean construction projects, for example, can be a powerful tool for nurturing and expanding nascent private markets such as industrialized construction. The same goes for providing the private sector with specifications for low embodied materials and reuse applications, such as the embodied carbon guidance for commercial and residential buildings developed by the Low Energy Transformation Initiative (LETI) for construction in the UK (LETI, 2020).
- **The transition to clean construction must be stewarded to avoid unmanageable costs to residents.** Building retrofit and preventative maintenance costs should not be allowed to disproportionately or unfairly fall to homeowners and tenants, especially where new construction is built to minimum standards rather than with longevity of materials in mind. The city could explore reducing housing costs for citizens (see Vienna example below) and support citizens in carrying out retrofits and maintenance with subsidized public financing programs for this purpose.
- **The municipality should consider expanding Seattle's infrastructure for circular economy for reused and recycled construction materials, which could address sourcing issues and reduce industry costs.** The creation of shared infrastructure, such as a materials bank, would facilitate materials supply, while the development of deconstruction policies, as well as public procurement policies requiring building materials to contain reused and recycled content, would demonstrate their potential and catalyze market development.



Affordable housing (Vienna, Austria)

Vienna has some of the lowest-cost housing of Europe's capital cities. There, 60% of the population lives in subsidized housing financed by taxes on land, rents and luxury goods (Lang, 2022), and new housing built by the municipality is rented out long term at affordable rates, enshrining long standing affordability in housing. More than half of its residents live in subsidized housing, with 220,000 affordable units owned by the municipality. A further 200,000 have been privately developed with municipal subsidies and support and are owned by cooperative, not-for-profit housing associations. Vienna's affordable housing was initially financed through the progressive taxation of private property and land. Today, 1% of income is taxed for the specific purpose of constructing and maintaining affordable housing (Haglund, 2022).

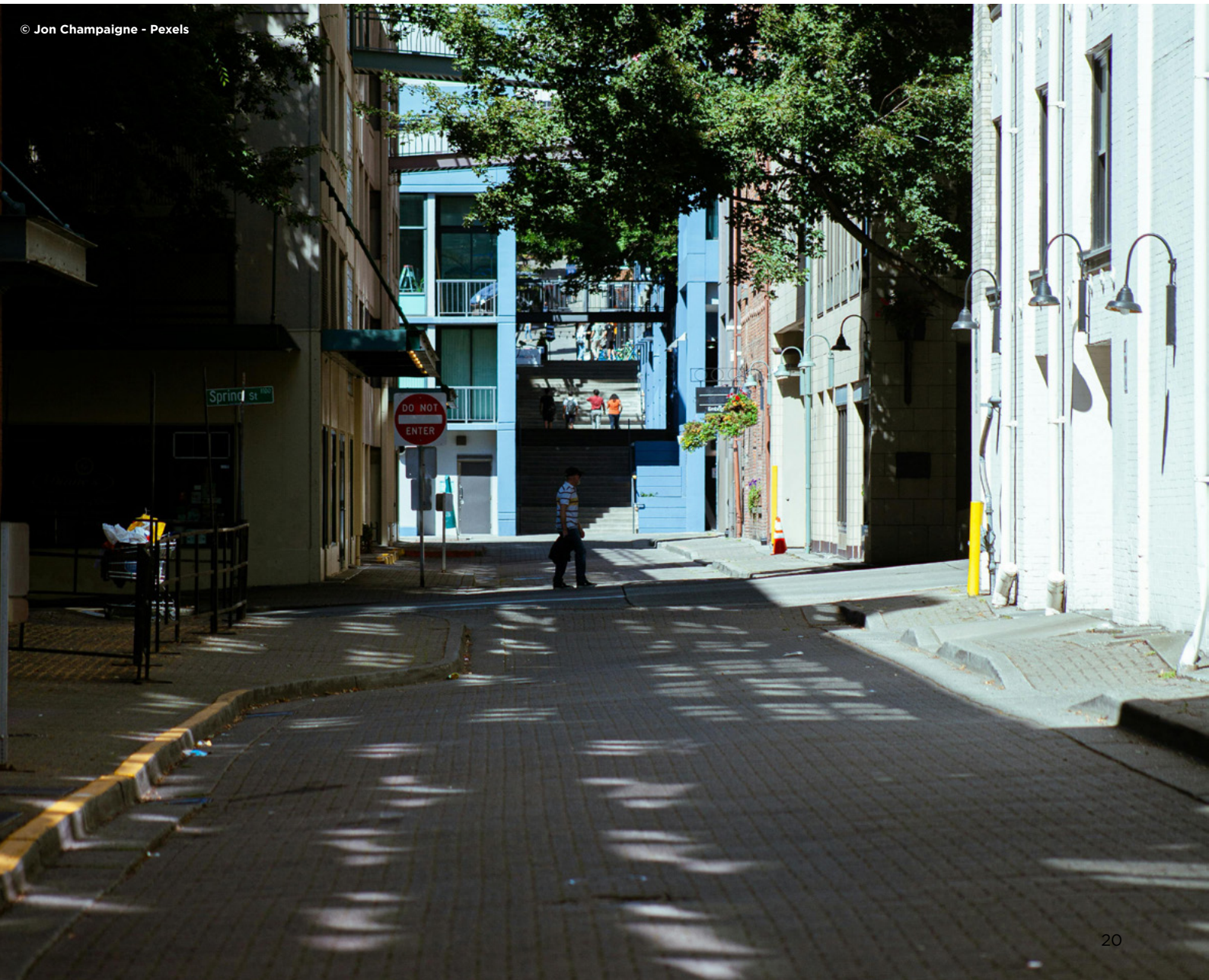
While this may be considered a radical approach to the housing crisis, similar models have emerged more recently in cities such as York, UK (City of York, 2020) and Barcelona, Spain (UCL IIPP, 2022). This approach reduces the overall cost of housing for citizens, allowing for more out-of-pocket resources to be used in maintenance, for example. Seattle's municipality could prioritize housing development by cooperatives and housing associations on the condition that they are rented out at affordable rates. Such a policy would support the long-term maintenance of Seattle's housing stock and could be explored through its existing workgroup on additional revenue streams (Housen, 2023). More locally, Seattle has invested in affordable housing, such as the Rainier Valley Affordable Homeownership Initiative, providing affordable housing units to low-income households at risk of displacement (City of Seattle, 2023).

Multiple benefits of deep retrofit (Milan, Italy)

Milan's stationary sector (buildings, industry and energy) accounts for over 60% of the city's emissions. The city has an old and inefficient building stock. As part of the European-wide Sharing Cities program, Milan ran a pilot project to retrofit five multi-family residential buildings, covering around 24,000m2. It had the following benefits (C40 Cities, Buro Happold and Rockwool, 2020):

- A 34% reduction in greenhouse gas emissions.
- A 3.5% reduction in the number of households experiencing energy poverty.
- A net present value of USD 790,000, with a payback period of 15 years.
- A 23% reduction in annual operating energy costs.
- A 2.5% reduction in asthma rates among building occupants, due to decreased mold and dampness.

Raising awareness of the range of benefits that can be achieved through retrofit - either from examples in Seattle or global evidence, such as C40's reporting - may help the municipality advance the uptake of retrofitting in the city.



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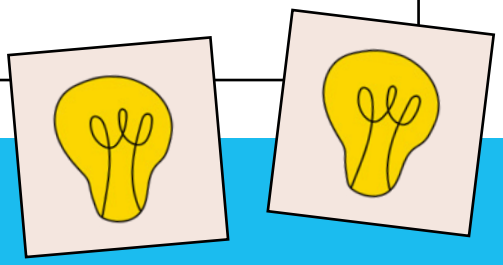
4. Mainstreaming clean construction (primarily by reducing the number of empty homes, boosting retrofitting and maintenance, and adopting modern methods of construction and timber) is part of addressing the housing crisis.

- **Better use of existing homes could provide an important tool in addressing the city's housing shortage.** Along with the rest of the US, the Seattle metro area is facing a housing crisis, with an estimated housing deficit of 4.9% in 2019 (Up For Growth, 2022). At the same time, many of Seattle's homes stand empty. In 2021, the city had a residential vacancy rate of 8.6% (US Census Bureau, 2023). In Seattle, the majority of vacant properties are rentals, with a 4.9% vacancy rate in the Seattle metro area in 2022 compared with a 0.7% vacancy rate for homeowners (US Census Bureau, 2023).[6]
- **Clean construction provides opportunities to produce more housing more efficiently, with less embodied carbon.** There is extensive evidence that modular and CLT construction can be completed faster than regular construction. In 2023, for example, Barcelona delivered safe, high-quality social housing units with timber in half the time needed for regular construction (Munoz, 2023). Retrofitting and maintenance, meanwhile, are cheaper than building new and could generate numerous safer, decent, long-term jobs in Seattle.



C40 Recommendations

- **Maximizing the use of the existing housing stock is the best way to reduce the housing gap and construction emissions at the same time.** Introducing policies such as rent controls and tenant protections, similar to California's new Tenant Protection Act (AB 1482) (City and County of San Francisco, 2023), could reduce evictions and move-outs and improve the occupancy rates of Seattle's rental sector (Kholodilin, 2024). This would build on the city's already progressive renter protection policy, adopted in 2019 as an anti-discrimination measure, which requires landlords to accept the first qualified applicant (Beekman, 2019).
- **The city could explore raising capital-gains or property taxes or introducing an empty homes tax**, a policy widely adopted globally, as in Vancouver, Canada (City of Vancouver, 2023) or Oakland, California (City of Oakland, n.d.), to reduce vacancy rates, discourage speculative investment and raise revenue for the city.
- **Seattle has an opportunity to become a more equitable low-carbon city by transitioning to clean construction.** The city should start implementing the transition in neighborhoods that have the greatest need in terms of housing, building-stock conditions and socioeconomic disparity. Policy measures, inclusive municipal procurement and incentives geared towards improving building maintenance and home retrofits are viable ways of alleviating the economic and health burdens on Seattle's most vulnerable communities.

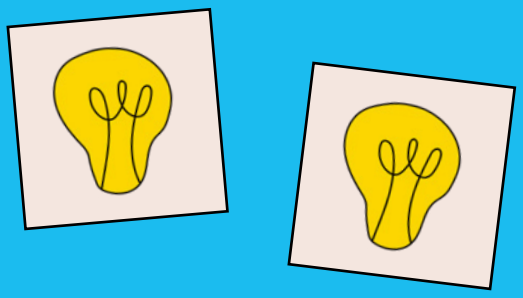
[6] US Census Bureau Definition: "A housing unit is vacant if no one is living in it at the time of the interview, unless its occupants are only temporarily absent. In addition, a vacant unit may be one which is entirely occupied by persons who have a usual residence elsewhere. New units not yet occupied are classified as vacant housing units if construction has reached a point where all exterior windows and doors are installed and final usable floors are in place. Vacant units are excluded if they are exposed to the elements, that is, if the roof, walls, windows, or doors no longer protect the interior from the elements, or if there is positive evidence (such as a sign on the house or block) that the unit is to be demolished or is condemned (US Census Bureau, 2023d).

Empty Homes Tax (Vancouver, Canada)

Since 2017, Vancouver homeowners have been required to submit a declaration each year to determine whether their property is subject to the city's Empty Homes Tax. The aim of the tax is to return empty or underutilized properties to use as long-term rental homes and relieve pressure on the city's rental housing market, as the city has one of the lowest rental vacancy rates in Canada (City of Vancouver, 2023b). Properties deemed to be empty are subject to a tax of 3% of the property's 2022 assessed taxable value (City of Vancouver, 2023a). Seattle could take a similar approach to encourage better occupancy of the city's vacant buildings.

5. Seattle can be a leader in timber and industrialized construction in North America.

- **Adopting more timber construction will support job creation, as well as Seattle's climate commitments to become carbon neutral by 2050.** As a bio-based material, sustainably harvested timber emits significantly fewer emissions than the most commonly used, carbon-intensive construction materials. It also has the potential to act as a carbon store (Arup, C40 Cities and University of Leeds, 2019). For timber to be a feasible option, it is imperative to have a sustainable ecosystem stewardship to ensure the sustainable, low-impact production of timber and bamboo.
- **Seattle is well placed to capitalize on its competitive advantage and become a leader in timber construction in North America.** The city is home to a strong local supply chain and an ambitious design community. Timber construction is already widely used in Seattle's single-family residential construction sector, and the use of CLT on mid-height (4-6 story), mixed-use buildings is emerging, such as Northlake Commons (Moffatt, 2023). The city could use the recent adoption of the new Tall Building Provisions set out in the 2021 International Building Code (IBC) into Washington State's Building Codes (WoodWorks, 2023) to drive larger-scale timber construction in the city.
- **A lack of supplier competition and the resulting higher costs are a barrier to the more widespread use of timber in Seattle's construction sector.**
- **Industrialized construction offers an important opportunity to create higher-quality jobs both within and outside Seattle.** Industrialized construction could create more than 15,000 job years over the period and support the rapid construction of affordable, low-carbon homes to address the city's housing needs. Moreover, it could provide safer, more stable, longer-term jobs than onsite construction, as workers are less subject to harsher onsite conditions (such as high temperatures) and the job volatility of regular construction projects. Yet, interviewees reported that strong cultural barriers to industrialized construction exist among Seattle's construction unions, who sustain a legitimate concern around automation in industrialized construction, which can lead to fewer jobs in the sector. on another note, according to interviews, the general public perceives modular housing to be low-quality housing, primarily due to poorly executed projects in the past.



C40 Recommendations

- **Seattle could use public procurement and support the development of industry roadmaps to attract new suppliers to the industrialized timber sector and improve market competition.** The municipality could also support training pathways, creating a highly skilled timber workforce in the city; update existing apprenticeship programs; and offer up-skilling programs for workers already in the construction sector.
- **The municipality could engage with groups such as the American Institute of Architects (AIA) Seattle Mass Timber Committee, unions, local industry and academia to develop region-specific environmental product declarations (EPDs) and improve understanding of the embodied emission impacts of timber.** Likewise, it could engage with local stakeholders to develop an industry roadmap and build trust with the private sector. Seattle could also develop public awareness campaigns and lead by example with municipal pilot projects to demonstrate the benefits of timber.
- **The municipality needs to understand the wider supply-chain impacts outside the city that will accompany a shift to clean construction and the expansion of the local timber industry.** This shift could support sustainable local logging practices, but critically, the municipality will need to collaborate to monitor and address any negative impact industrial logging might have on the region's ecosystem services. Partnering with programs such as the US Department of Agriculture (USDA) Forest Service's Forest Health Monitoring program could be one such action (Greenpeace, 2018). Also, the municipality should consider where these supply-chain jobs may be generated and work with the stakeholders who regulate and are responsible for them (such as other municipalities and the Washington State government).
- **The municipality must avoid the potential unintended consequences of using timber.** For example, while increased wood supply would drive down prices, the rise in demand would need to be managed carefully to avoid pressure on natural forests that should not be used as building materials (Warman, 2019). A robust environmental protection and sustainable forestry management plan should be developed and used to establish the uptake of timber.
- **The municipality can build on existing interaction with unions to promote social dialogues and understand their concerns about industrialized construction and ensure a just transition for their members.** Laborers and construction-site workers represent the majority of workers who are reportedly resistant to change, particularly towards industrialized construction, a legitimate concern given the smaller job intensity of such activity. However, job opportunities in other clean construction shifts, as well as the expected benefits, such as improved working conditions and less waste, could address concerns and galvanize union support. Industrialized construction and timber are relatively small industries currently in Seattle, providing an opportunity for the city to improve work conditions with unions and other key stakeholders.
- **To tackle negative perceptions about modular construction and industrialized methods, Seattle could raise awareness and demonstrate their benefits to communities and workers,** for instance, via neighborhood canvassing campaigns, local one-stop shops where property owners can access technical assistance, standards for reused materials, or pilot projects.

Conclusion

Accelerating the transition to clean construction is an economic, social, and environmental opportunity for Seattle. Embracing clean construction can lead to job creation, socio-economic improvements, and sustainability. Despite challenges like high land values and limited supply chains, Seattle's skilled workforce, robust retrofit programs, and strong local timber industry offer significant opportunities. Building on initiatives like the Building Tune-Ups program and policies such as the Buy Clean Buy Fair bill can further drive progress. By addressing these barriers and leveraging these strengths, Seattle can also meet its social goals such as improving housing affordability in the city.

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