

## CHAPTER 2: POLICY REVIEW

### 2.1 INTRODUCTION

This chapter presents findings from a policy review of current embodied carbon initiatives led or adopted by governments around the world. It summarizes key components of relevant programs, legislation, building codes, standards and rating systems, and discusses common themes related to introducing new policy goals, policy development and implementation.

#### A. BACKGROUND

Under increasing global pressure, governments worldwide are deploying policy as a catalyst to transform markets and accelerate carbon emissions reduction across all sectors. Generating nearly 40% of annual global carbon emissions,<sup>1</sup> the building sector has become a significant component of government-led initiatives, including climate action plans, emissions reduction targets, regulatory legislation and calls-to-actions aiming to integrate environmental sustainability principles into standard industry practice. Government programs focused on the building sector often promote uptake of renewable energy sources, and set targets related to energy and water consumption for operating buildings – all common measures considered pivotal for meeting emissions reduction targets.

Such policies have helped significantly reduce emissions generated by building operations (e.g. buildings operating at zero-net energy); however, the ‘hidden’ carbon emissions emitted at various stages during a building’s lifecycle – beyond the operational phase – remain a growing issue. Emissions resulting from the manufacturing and construction of building materials (often termed ‘embodied carbon’) account for 11% of annual global carbon emissions and 28% of building sector emissions<sup>2</sup> – emissions which must be phased out by 2050.<sup>3</sup>

National and local governments across the European Union (EU) have set a precedence for embodied carbon policy, implementing programs that require or incentivize building industries to measure, report and reduce environmental impacts occurring throughout the lifespan of construction materials. In nations with well-established embodied carbon policies, green building associations and other industry stakeholder groups played a key role to develop and standardize life cycle assessment (LCA) methodology, tools and data, and worked closely with governments to align existing industry-led initiatives and resources with new policy.

In the United States (US) at national, state and local levels, government-led embodied carbon programs with mandatory standards are less prevalent and established compared to legislation adopted by EU counterparts. Non-regulatory green building programs and industry-led initiatives have evolved to promote measurement of embodied carbon; however, industry and policy experts commonly express that improved standardization and availability of data, tools and guidelines is needed to develop

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<sup>1</sup> UNEP and IEA, “Global Status Report 2017: Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector,” 2017.

<sup>2</sup> Architecture 2030, “Why The Building Sector? | Architecture 2030,” 2017, [http://architecture2030.org/buildings\\_problem\\_why/](http://architecture2030.org/buildings_problem_why/).

<sup>3</sup> Intergovernmental Panel on Climate Change, “Summary for Policymakers — Global Warming of 1.5 °C,” 2018, <https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/>.

regulatory guidelines and performance targets, and to support industry capability to meet compliance standards.

While regulation focused on embodied carbon reduction is sparse across federal, state and local levels, US-based industries, businesses, governments and environmental groups are increasingly becoming more aware of the potential environmental and health impacts of construction materials. Several green building codes, standards and rating systems adopted by governments have evolved to include LCA and whole building life cycle assessment (WBLCA) pathways for project teams to assess and report environmental impacts of materials – some of which include optional performance targets for buildings to meet as an alternative pathway to mandatory, prescriptive standards.

Furthermore, some US jurisdictions are exploring procurement policies to reduce embodied carbon, which would position government bodies to directly regulate materials purchased for public works projects. Upon passing the Buy Clean California Act in 2017, the state of California established a precedent for US-based procurement policy, becoming the first state government to require submission of facility-specific environmental product declarations (EPDs) for an eligible list of materials used on state-funded construction projects.<sup>4</sup> In 2021, California will also require manufacturers to meet global warming potential (GWP) thresholds established by the state for each eligible material category. Following California's lead, the states of Oregon and Washington both introduced similar legislation in 2017 and 2018, respectively. While the proposed bills in Oregon and Washington did not move forward, policymakers in both states continue to explore options for future policies with similar goals.

In March 2018, based on a modified, substitute version of House Bill 2412: Creating the Buy Clean Washington Act,<sup>5</sup> the Washington State Legislature commissioned the University of Washington's College of Built Environments to conduct a Buy Clean Washington Study in collaboration with Central Washington University and the Washington State University. The study included the embodied carbon policy review presented in this chapter to inform potential policy options and recommendations for Washington State (see **Chapter 5: Policy Evaluation**).

## B. SCOPE

The policy review occurred over a four-month period. It considered policies that require or incentivize building industries to measure, report and/or reduce greenhouse gas (GHG) emissions attributed to construction materials (emissions often termed 'embodied carbon'). Its scope did not include a comprehensive assessment of all international policies with embodied carbon components. Rather, the review focused on recent US-based policy initiatives (particularly state-level) and nations with multi-faceted government programs that often include and align multiple embodied carbon policy standards and support systems (e.g. national EPD databases).

This chapter summarizes both policies that consider embodied carbon occurring throughout the lifespan of construction materials and policies that focus on a defined lifecycle stage, such as product manufacturing or recycling and reuse. Commonly, policies reviewed aim to address embodied carbon

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<sup>4</sup> California Legislative Information, "Buy Clean California Act [3500 - 3505]," 2017, [https://leginfo.ca.gov/faces/codes\\_displayText.xhtml?division=2.&chapter=3.&part=1.&lawCode=PCC&article=5](https://leginfo.ca.gov/faces/codes_displayText.xhtml?division=2.&chapter=3.&part=1.&lawCode=PCC&article=5).

<sup>5</sup> Washington State Legislature, "HB 2412 - 2017-18 Creating the Buy Clean Washington Act," 2018, <https://app.leg.wa.gov/billsummary?BillNumber=2412&Year=2017>.

through four target areas: (1) materials selection, (2) materials reuse, (3) existing buildings, and/or (4) new buildings.

This chapter applies the term ‘policy’ broadly to encapsulate government and non-government mechanisms to address embodied carbon. Government mechanisms include: (1) procurement policies for public-funded facilities and infrastructure, (2) measures to regulate private sector commercial and residential development within a jurisdiction, and (3) city planning to optimize use of building materials (e.g. through waste management measures such as recycling). Non-government mechanisms include a range of initiatives, such as voluntary green building codes, standards and rating systems, as well as technical resources (e.g. LCA tools) often used to support policy implementation.

US-based public policies summarized in this chapter were developed by state and city governments in California, Oregon, Minnesota and Washington. International policy examples are from Austria, Belgium, Canada, France, Germany, Japan, the Netherlands, Singapore, Sweden, Switzerland, and the United Kingdom.

## 2.2 KEY CONSIDERATIONS

Through review of current embodied carbon policies around the world (particularly initiatives led by national governments in Europe), several themes emerged as key components or strategies policymakers adopted to build support for, develop and implement new policy. The subsections below discuss these themes.

### A. HARMONIZED TECHNICAL RESOURCES SUPPORT POLICY IMPLEMENTATION

Government-led development or sponsorship of technical tools and resources that support the building industry’s capacity to meet regulation is common across the European countries reviewed.

Governments often align multiple technical resources – such as guidelines, tools and databases – under a single system or program, providing standard, consistent methodology and tools that complement compliance standards. Examples of technical resources used to support policy include: WBLCA or LCA methodology guidance documents, WBLCA or LCA tools/software, LCA and EPD databases, and prescriptive guides that support decision-making.

### B. NEW POLICY ALIGNS WITH GOVERNMENT LEGISLATION, PROGRAMS AND PLANS

Where there is opportunity and relevance, governments often cite and align new policy language with official international and/or national programs, connecting proposed requirements to pre-existing goals, standards and targets already recognizable by building industries, other governments and environmental stakeholder groups. The EU and national governments such as the United Kingdom (UK) have developed common language and technical guidance for smaller jurisdictions to apply in their own policymaking. Other examples include integrating new requirements into future editions of building code (France) or introducing building permit guidelines that require new projects to demonstrate low environmental impact (the Netherlands).

In the US, green building programs such as the United States Green Building Council’s (USGBC) Leadership in Energy and Environmental Design (LEED) standards (which include WBLCA and EPD credits) are commonly understood across industry, providing an opportunity for governments at all levels to align new policy goals and language with recognizable, established guidelines. Numerous cities

have developed pathways for policy compliance to count toward green building credit(s), through incorporating LEED in building codes<sup>6</sup> and zoning rules.<sup>7</sup>

### C. GOVERNMENTS PROVIDE INCENTIVES OR RECOGNIZE NON-GOVERNMENT INCENTIVE PROGRAMS

Governments often support or provide incentives during early implementation of a new policy, sometimes through a voluntary, trial period. Types of incentives include financial support, technical support and training, density bonuses, approval fast-tracking and green building labels that firms can use for environmental marketing purposes.

In California, USGBC – Los Angeles (USGBC-LA) is helping product manufacturers prepare for the Buy Clean California Act through providing a financial incentive program. USGBC-LCA will offer incentives of up to \$15K to manufacturers of steel, flat glass, and mineral insulation to help them publish EPDs, before the mandatory EPD requirement begins in January 2020.<sup>8</sup>

In Oregon, while there is no state-level requirement for EPD reporting, the Oregon Department of Environmental Quality (DEQ) provides a program to help concrete manufacturers measure and report environmental impacts of concrete mixes through EPDs. The program provides a web-based tool, reimbursement incentive, and direct technical assistance to manufacturers.

### D. GOVERNMENTS ENGAGE WITH INDUSTRY STAKEHOLDER GROUPS DURING POLICY DEVELOPMENT AND IMPLEMENTATION

European policymakers worked closely with their local building industries, consulting stakeholder groups, and supporting and integrating existing industry-led initiatives into policy programs. The importance of industry engagement was notable in the Netherlands, where the Dutch government worked closely with industry groups to gain support for – and pass – legislation in 2013 that included similar standards previously opposed by stakeholders when first introduced.

### E. POLITICIANS CAN ‘CHAMPION’ POLICY BY DELIVERING KEY MESSAGES TO CULTIVATE POLITICAL AND PUBLIC WILL

Embodied carbon policies target a complex, nearly ‘invisible’ issue and propose multifaceted, technical-based solutions not widely understood beyond experts, advocates, and researchers from industry and academic groups focused on environmental sustainability. This complexity gives rise to barriers affecting regulatory-based proposals throughout legislative processes that often prioritize policies widely understood and supported by – and often immediately impacting – politicians, industry representatives, advocacy groups, and the general public. Therefore, political ‘champions’ in the form of engaged politicians who can translate a complex topic into clear, simple messaging are key advocates who can help secure the buy-in needed from other policymakers and stakeholder groups.

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<sup>6</sup> Everblue, “Cities Requiring LEED New Construction & LEED Compliance | Everblue Training,” 2018, <https://www.everbluetraining.com/blog/cities-requiring-or-supporting-leed-2015-edition>.

<sup>7</sup> Seattle, “Living Building & 2030 Challenge Pilots,” accessed December 31, 2018, <https://www.seattle.gov/sdci/permits/green-building/living-building-and-2030-challenge-pilots>.

<sup>8</sup> USGBC-LA, “Buy Clean California – USGBC LA,” accessed December 12, 2018, <https://usgbc-la.org/programs/buy-clean-california/>.

This is an important factor to consider in the US, where there is not yet an established foundation of embodied carbon legislation. Policy advocates cannot readily leverage policy case studies or frameworks from other US jurisdictions. In California, as plans solidified to propose a state-procurement regulation, California State Assemblyman Rob Bonta emerged as the ‘political champion’ for the Buy Clean California Act, delivering targeted messaging and maintaining engagement with key stakeholders throughout bill development. When describing buy clean policy goals at a 2018 Global Climate Action Summit public event, Bonta used ‘call-to-action’ language that invoked a sense of urgency, connecting policy solutions to recent extreme weather events directly affecting Californians. Bonta also called upon the state to ‘walk the walk’ in terms of upholding its environmental values and commitments through government-led action.

#### F. AN INTERDISCIPLINARY COALITION TO INFORM BILL DEVELOPMENT AND DEMONSTRATE BROAD SUPPORT FOR POLICY GOALS

As noted, government-industry partnership is important to inform policy development and foster industry support for compliance standards. In California, non-government policy advocates established a multi-sector partnership or ‘coalition’ to signal broad (and bipartisan) support for proposed regulation. Policy advocates established the coalition during the early stages of California’s buy clean proposal, recruiting members representing government, labor union groups, product/industry businesses, and environmental advocacy organizations. The coalition identified shared goals that the bill would support, and members later reflected that the group composition was a “head turner.” A united front between environmentalists and industry representatives helped capture political and public attention and build interest to move the bill forward.

#### G. IDENTIFY, LEVERAGE, AND SUPPORT SUSTAINABILITY-FOCUSED INDUSTRY GROUPS AND/OR EXISTING INDUSTRY-LED INITIATIVES

In Europe, many policies built upon or leveraged existing progress made by national green building councils and other building industry groups. In Germany, the German Sustainable Building Council (DGNB) led efforts to track and reduce embodied carbon, forming a close partnership with federal agencies to establish policies, while in the UK, the UK Green Building Council worked closely with industry to publish guidance and provide educational resources to move the market toward embodied carbon measurement.

In California, during development of the Buy Clean California Act, industry groups such as ClimateWorks and companies such as Central Concrete provided technical input and drafted key messages used to encourage stakeholder support for the bill. Since passing of the Act, state agencies have worked closely with external LCA/EPD subject matter experts, as well as USGBC-LA, which has participated in educational workshops. Further, USGBC-LA is exploring options with California State to have Buy Clean compliance count toward the LEED EPD credit.

Relevant to Washington State, there are several current state- and regional-based industry groups and initiatives that policymakers could leverage as the State assesses similar embodied carbon policy options. These include the Bay Area Materials Working Group, the West Coast Climate & Materials Management Forum, the Embodied Carbon Network, and the SE 2050 Initiative. **Section A.10 Regional Initiatives** provides more detail on these programs.

## H. CASE STUDIES USED TO DEMONSTRATE SUCCESS

Where jurisdictions attempt to implement policies with unprecedented goals and new compliance guidelines, a common barrier is apprehension of the unknown, resulting in risk-aversion from politicians and government bodies to introduce new measures. Concerns include potential for adverse outcomes that undermine initial environmental goals; posing undue burden to industry; and disrupting local product markets and economies. To counter these concerns, policy proponents identify and communicate ‘success stories’ from building projects that followed principles similar to proposed regulation.

In the Washington State, the new, LEED Platinum-certified Helen Sommers Building serves as a case study to support Buy Clean policy goals (collection of EPDs and reduction of embodied carbon). For this project, the design-build team, led by firm Sellen Construction, focused on concrete as a source of significant embodied carbon reduction, redesigning concrete mixes to reduce emissions and producing EPDs for nearly all mixes. Sellen estimates that the project reduced overall embodied carbon of concrete by 27% compared to regional averages, and 31% compared to national averages.<sup>9</sup> In this case study, the general contractor required product-specific EPDs for the project and pursued embodied carbon performance reduction goals. This requirement led to publication of ninety new concrete EPDs. Shortly after, other suppliers decided to publish EPDs for their ready-mix products, which serve for broad use by architects, engineers and owners in the Seattle/Olympia regions.

## I. IMPLEMENTATION PLANS WITH AN INCREMENTAL TIMELINE

Similar to the Buy Clean California Act, the Washington State considered a two-pronged policy requirement: (1) manufacturers of eligible construction materials would need to collect and submit facility-specific EPDs; and (2) EPDs would need to demonstrate that embodied carbon impact falls below a pre-established GWP threshold. Throughout Europe, jurisdictions approaching similar regulatory goals often phase in requirements, and include a voluntary trial period that precedes mandatory compliance scheduled for a future date known to the industry. This allows product markets and other affected industry groups time to build capacity to meet compliance standards, and for government regulators to assess and refine requirements before mandatory implementation.

California has planned a staged approach to implement the Buy Clean California Act. In year one (2019), the State will request (but not require) facility-specific EPDs from state construction projects. In year two (2020), project teams will be required to submit facility-specific EPDs in order to be considered in the bidding process. In year three (2021), the State will publish the GWP thresholds for each product category, a standard that successful bidders will be required to meet beginning in June 2021.

## J. PERFORMANCE-BASED PATHWAYS

Embodied carbon policies generally include either prescriptive-based or performance-based standards, or a combination of both. Prescriptive-based approaches establish requirements on *how* a material is produced, whereas performance-based approaches set a measurable target or threshold that a material to measure performance against, allowing design teams flexibility to determine how to achieve the required outcome.

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<sup>9</sup> Dave Walsh, “Measuring and Reducing Embodied Carbon in Concrete,” accessed December 12, 2018, <https://www.sellen.com/wp-content/uploads/Measuring-and-Reducing-Embodied-Carbon-Dave-Walsh.pdf>.

Prescriptive guidelines and incentives can simplify decision-making and improve specific practices (e.g. drive product markets to publish EPDs), while policies tied to measurable performance outcomes are likely more complex and costly to implement. However performance-based embodied carbon policies have benefits since environmental impact targets can enable creative problem solving by product manufacturers, help quantify the impacts of construction materials, and support establishment of standard metrics for embodied carbon.

France's voluntary national building pilot program (*Energie Positive et Réduction Carbone*) includes a performance-based approach, which establishes life cycle performance benchmarks for carbon emissions and provides incentives for meeting targets. The program accounts for embodied carbon, establishing indicators (called 'Carbon Levels') for emissions arising from the whole life cycle of a building, and carbon emissions attributed to construction products and building equipment.

In the US, the International Green Construction Code (IgCC) and the United States Green Building Council (USGBC) set both prescriptive and performance standards. Prescriptive standards include setting minimum recycled content rates and performance standards use whole building LCA to assess options.

#### K. CONSIDER THE CIRCULAR ECONOMY OF CONSTRUCTION MATERIALS

Increasingly, there is emphasis on the need to consider the 'circular economy' of construction materials to develop policy that assesses and minimizes environmental impact occurring over the whole lifecycle of building products to reduce reliance on natural resource extraction and decrease toxic material waste.

The life cycle of embodied carbon resulting from construction materials includes four main stages: (A) production and construction, (B) use, (C) end-of-life, and (D) beyond system boundary. LCA is typically applied to assess impacts occurring throughout all stages (cradle-to-grave) or occurring during one defined phase (e.g. cradle-to-gate). A 'circular economy' approach would consider 'cradle-to-cradle' or 'closed-loop system' impacts, accounting for and promoting sustainable end-of-life practices such as recycling, repair and reuse of materials.<sup>10</sup>

#### L. ASSESS LOCAL 'READINESS' TO DEVELOP AND IMPLEMENT POLICY

As noted, policymakers should assess factors unique to their local context and shape policy accordingly. Key considerations include the capability of product markets and industry groups potentially affected; prevalence and maturity of existing environmental policies relevant to local context; environmental policy knowledge of policymakers championing bill; capacity and capability of state agencies to implement and regulate legislation; and political and public will to pass legislation that addresses a technical, complex issue.

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<sup>10</sup> Stopwaste and ARUP, "Circular Economy in the Built Environment: Opportunities for Local Government Leadership," 2018, [http://www.stopwaste.org/sites/default/files/Circularity in the Built Environment-20180619.pdf](http://www.stopwaste.org/sites/default/files/Circularity%20in%20the%20Built%20Environment-20180619.pdf); Carbon Leadership Forum, "Life Cycle Assessment of Buildings: A Practice Guide," 2018, <https://doi.org/http://hdl.handle.net/1773/41885>.

## 2.3 CURRENT POLICIES, PROGRAMS AND INITIATIVES

This section outlines key features from embodied carbon policies, programs and initiatives at national and subnational levels. **Section A** describes recent national and sub-national efforts in the US, **Section B** outlines initiatives from European countries with established embodied carbon policies, and **Section C** outlines new or emerging activities in other international countries.

### A. UNITED STATES

In the US, several voluntary national-based programs (e.g. LEED and Living Building Challenge) have evolved to strengthen focus on embodied carbon, but regulatory policies are sparse across federal, state and local levels. Some state and city jurisdictions view procurement-based policy as a key opportunity to reduce carbon emissions. In the US, 55% of emissions attributed to public institutions are a result of government-purchased goods and products.<sup>11</sup> Implementation of Buy Clean California procurement policy may provide a model to inform other jurisdictions considering similar embodied carbon regulation.

#### A.1 LEED

The USGBC manages LEED,<sup>12</sup> a green building rating program that provides multi-level, point-based certifications. Since its establishment in 1993 as a single standard, LEED has evolved to become the most widely adopted and recognized green building rating system in the world. Through LEED v4, USGBC introduced Building Product Disclosure and Optimization (BPDO) credits to encourage transparency and use of products that disclose and optimize whole life-cycle impacts. Three new credits were established under BPDO: (1) the Environmental Product Declarations (EPD) credit,<sup>13</sup> (2) the Sourcing of Raw Materials (Sourcing) credit,<sup>14</sup> and (3) the Material Ingredients credit,<sup>15</sup> as well as a Low Emitting Materials credit<sup>16</sup> established under Indoor Environmental Quality. The EPD credit is widely used by industry and accredited with helping move the market toward understanding and addressing embodied carbon. LEED v4 also offers a credit for conducting a WBLCA that demonstrates environmental improvements compared to a baseline building. These credits are intended to encourage manufacturers to disclose the full life cycle environmental impacts of building products.

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<sup>11</sup> West Coast Climate and Materials Management Forum, "Climate Friendly Purchasing Toolkit," accessed December 12, 2018, <https://westcoastclimateforum.com/cfpt>.

<sup>12</sup> USGBC, "LEED," accessed December 12, 2018, <https://new.usgbc.org/leed>.

<sup>13</sup> USGBC, "LEED BD+C: New Construction | v4 - LEED v4: Building Product Disclosure and Optimization - Environmental Product Declarations," accessed December 12, 2018, <https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-healthca-22>.

<sup>14</sup> USGBC, "LEED BD+C: New Construction | v4 - LEED v4: Building Product Disclosure and Optimization - Sourcing of Raw Materials," accessed December 12, 2018, <https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-healthca-23>.

<sup>15</sup> USGBC, "LEED BD+C: New Construction | v4 - LEED v4: Building Product Disclosure and Optimization - Material Ingredients," accessed December 12, 2018, <https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-healthca-24>.

<sup>16</sup> USGBC, "LEED BD+C: Schools | v4 - LEED v4: Low Emitting Materials," accessed December 12, 2018, <https://www.usgbc.org/credits/schools-new-construction-healthcare/v4-draft/eqc2>.

## A.2 INTERNATIONAL LIVING FUTURE INSTITUTE

The International Living Future Institute (ILFI) operates the Living Building Challenge,<sup>17</sup> a program widely considered as the most rigorous green building standard in the world. Launched in 2014, the Living Product Challenge<sup>18</sup> requires building teams accepting the challenge to assess the lifecycle of construction materials from cradle-to-grave and meet standards established to reduce a product's impact on energy consumption, water use, and human health. It includes a "Materials Petal" component, which requires project teams to estimate and offset embodied carbon footprint (using an approved carbon offset provider.)<sup>19</sup>

ILFI also operates the Zero Carbon Certification program<sup>20</sup>, launched in 2018 to establish a standard requiring projects to offset (1) 100% of operational energy through new renewable energy sources, and (2) the total embodied carbon impact of construction.

## A.3 ARCHITECTURE 2030

Architecture 2030 is a US-based nonprofit organization that has worked closely with the building industry and governments over the past decade to integrate zero net carbon (ZNC) standards and carbon reduction targets into policy. It is well known for its 2030 Challenge, which establishes energy consumption and emissions performance standards, leading to carbon neutrality by 2030.

It also operates the 2030 Challenge for Products, which provides a set of GWP reduction targets for each decade until 2050. The reduction targets start at 35% below a product category average, and incrementally increase until GWP reduction is 75% (or higher) by 2040 and 100% by 2050.<sup>21</sup>

Further, Architecture 2030 recently launched the Carbon Smart Materials Palette<sup>22</sup>, a decision-making tool that provides designers with attribute-based guidelines for (1) designing buildings with low- or zero embodied carbon, and (2) specifying construction materials with low- or no- embodied carbon. Designed to support and complement LCA and EPDs, the Carbon Smart Materials Palette is a prescriptive method that identifies key attributes that contribute to a material's environmental impact, and offers guidelines and options for emissions reductions.

## A.4 INTERNATIONAL GREEN CONSTRUCTION CODE (IGCC)

Established in 2010 through a collaborative effort led by the International Code Council (ICC), the American Institute of Architects (AIA), and ASTM International, the International Green Construction Code (IgCC) regulates construction of new and existing commercial buildings by setting mandatory and optional, performance- and prescriptive- based targets for local jurisdictions to adopt as code. Under Section 303, the IgCC includes a voluntary WBLCA project elective that if met, waives the need to

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<sup>17</sup> International Living Future Institute, "Living Building Challenge | Living-Future.Org," accessed December 12, 2018, <https://living-future.org/lbc/>.

<sup>18</sup> International Living Future Institute, "Living Product Challenge | Living-Future.Org," accessed December 12, 2018, <https://living-future.org/lpc/>.

<sup>19</sup> International Living Future Institute, "Materials Petal | Living-Future.Org," accessed December 12, 2018, <https://living-future.org/lbc/materials-petal/>.

<sup>20</sup> International Living Future Institute, "Zero Carbon Certification | Living-Future.Org," accessed December 12, 2018, <https://living-future.org/zero-carbon-certification/>.

<sup>21</sup> Architecture 2030, "2030 Challenge for Products," accessed December 12, 2018, [https://architecture2030.org/2030\\_challenges/products/](https://architecture2030.org/2030_challenges/products/).

<sup>22</sup> Architecture 2030, "Carbon Smart Materials Palette – Actions for Reducing Embodied Carbon at Your Fingertips," 2018.

comply with a mandatory section of the code that sets prescriptive standards for materials selection (Section 505).

Project teams opting to meet Section 303 must submit a WBLCA report based on comparable, alternative building designs that shows the building project achieves at least a 20% improvement in environmental performance for global warming potential. The building project must also achieve a 20% reduction for at least two of five other categories: primary energy use, acidification potential, eutrophication potential, ozone depletion potential, or smog potential. The pathway is intended for state and local jurisdictions to adopt into their own building codes to reduce embodied carbon.<sup>23</sup>

An updated version of the IgCC was recently released in October 2018, developed collaboratively with more industry organizations – the ICC, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), USGBC, AIA, and the Illuminating Engineering Society (IES). It is ‘powered’ by ASHRAE Standard 189.1, “Standard for the Design of High-Performance Green Buildings.”<sup>24</sup>

## A.5 GREEN GLOBES

Operated by the Green Building Initiative (GBI), Green Globes is a green building certification program established in 2004. Within their materials section there are two pathways for assessing the performance of a building core and shell. Path A (performance path) requires a whole building LCA comparing a minimum of two different core and shell designs based on LCA to demonstrate at least 20% decrease in GWP as well as including other required performance thresholds for other common LCA impact metrics.<sup>25</sup>

## A.6 CALIFORNIA

California is a state leader in establishing green building regulations and standards. The 2012 amendment of the California Green Building Standards Code (CALGreen)<sup>26</sup> includes an optional LCA pathway that requires emissions reduction against a baseline, and several performance measures related to energy efficiency. The LCA pathway offers an alternative approach to prescriptive requirements on materials selection. Building projects can use CALGreen to pursue other sustainability initiatives such as LEED.

## BUY CLEAN CALIFORNIA

In October 2017, California passed the Assembly Bill (AB) 262: Buy Clean California Act,<sup>27</sup> a new law requiring state-funded building projects to consider the global warming potential (GWP) of certain construction materials during procurement. The bill requirements are two-pronged: manufacturers of

<sup>23</sup> International Code Council, “Synopsis: International Green Construction Code. Public Version 1.0,” 2010, <http://media.iccsafe.org/IGCC/docs/IGCC-Synopsis.pdf>; International Code Council, *International Green Construction Code™ Public Version 2.0*, 2010, <http://www.iccsafe.org/cs/IGCC/Pages/PublicVersionDevelopment.aspx>.

<sup>24</sup> ASHRAE, “2018 International Green Construction Code® Powered by Standard 189.1-2017,” 2018, <https://www.ashrae.org/technical-resources/bookstore/standard-189-1>.

<sup>25</sup> GBI, “Green Globes for New Construction Technical Reference Manual Version 1.50,” 2018, [https://www.thegbi.org/files/training\\_resources/Green\\_Globes\\_NC\\_Technical\\_Reference\\_Manual.pdf](https://www.thegbi.org/files/training_resources/Green_Globes_NC_Technical_Reference_Manual.pdf).

<sup>26</sup> California Building Standards Commission, *2016 California Green Building Standards Code California Code of Regulations, Title 24, Part 11* (International Code Council, 2016), [https://www.ladbs.org/docs/default-source/publications/code-amendments/2016-calgreen\\_complete.pdf?sfvrsn=6](https://www.ladbs.org/docs/default-source/publications/code-amendments/2016-calgreen_complete.pdf?sfvrsn=6).

<sup>27</sup> California Legislative Information, “Bill Text - AB-262 Public Contracts: Bid Specifications: Buy Clean California Act,” 2017, [https://leginfo.ca.gov/faces/billTextClient.xhtml?bill\\_id=201720180AB262](https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB262).

eligible materials must submit facility-specific EPDs, and the eligible materials must demonstrate (through submitted EPDs) GWP below the product-specific compliance limits defined by the Department of General Services (DGS), which will regulate policy implementation. The eligible materials include structural steel, carbon steel rebar, flat glass and mineral wool insulation.

An amendment (Assembly Bill 1817) to the original Buy Clean California Act passed in June 2018, extending the timeline for compliance. In January 2019, awarding state agencies will request voluntary submission of facility-specific EPDs and in January 2020, successful bidders must submit facility-specific EPDs. By January 2021, DGS will establish and publish the ‘maximum acceptable’ GWP for each product category – a two year extension from the original bill – which bidders must meet for eligible materials to be used for state-funded projects.

While many industry groups and leaders support the intent of California’s new Buy Clean policy, some stakeholders from affected product markets view the bill as inequitable due to its limited eligible materials list, most notably the omission of concrete and cement. Product market representatives highlighted that exclusion of a carbon-intensive material (concrete) was not congruent with the policy goal to cut emissions. Product market stakeholders also expressed concern that inclusion of some materials and not others could affect competition. Recognizing these limitations, California policymakers and government implementation partners have expressed interest to integrate concrete and other materials into the law.

As mentioned, the USGBC-LA is administering a Buy Clean Incentive Program to assist manufacturers from affected product markets develop facility-specific EPDs.

At a 2018 Global Climate Action Summit public event, a panel of representatives from a coalition that championed the Buy Clean proposal identified key features that helped pass the law:

- Establishment of a diverse coalition that was a ‘trifecta’ of business, labor, and environmental groups with shared values toward environmental stewardship
- Engagement with industry representatives who viewed regulation as an opportunity to be rewarded and gain competitive advantage for having environmental manufacturing processes
- A policy ‘champion’ from state legislation, described as someone ‘who knows how to work a bill’ and ensure legislative support to move the bill forward
- Grassroots effort to communicate the policy to different stakeholder groups and the public in “language that people understood”
- Simplicity and flexibility in bill language
- Early and frequent engagement with – and support from – people representing state procurement and government agencies, and representatives from industry groups with subject-matter expertise. Representatives provided a ‘sounding board’ throughout bill development and helped make the ‘best case’ for signing the bill into law.

## STOPWASTE AND SAN FRANCISCO BAY AREA CONCRETE CODE PROJECT

StopWaste is a public agency in Alameda County, California that focuses on reducing waste in homes, at work, and in schools. StopWaste also has a focus on embodied carbon in the built environment.<sup>28</sup>

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<sup>28</sup> StopWaste, “Materials-Climate Nexus,” accessed December 12, 2018, <http://www.stopwaste.org/preventing-waste/business/built-environment/climate/materials-climate-nexus>.

StopWaste and Marin County were recently funded by the Bay Area Air Quality Management District (BAAQMD) for a collaborative project to increase demand for low-carbon concrete through policy.<sup>29</sup> The project consortium will produce model code language for local governments to adopt low embodied-carbon concrete specifications for residential and non-residential applications. The project will also provide technical assistance to four pilot projects to apply the specifications, and will also form a Bay Area Materials Working Group.

## CALTRANS

Prior to adoption of the Buy Clean California Act, the California Department of Transportation (Caltrans) had been evaluating the use of LCA and EPDs in evaluating material use. In parallel with the Buy Clean California Act, Caltrans has established the Caltrans Environmental Product Declaration (EPD) Implementation Project to begin collecting EPDs for materials used in construction projects. In addition to the materials specified in Buy Clean California Act (carbon steel rebar, structural steel, flat glass, and mineral wool board insulation), the Caltrans project includes materials used extensively in transportation (concrete, asphalt and aggregate). For pilot projects this is identified as a separate bid item. This process fits into a roadmap aimed to eventually integrate into full life cycle assessment (cradle to grave) with future phases addressing construction, use and end of life as well as developing strategies to lower GHG emissions from project and testing implementation in pilot projects. This process is introduced on the department website<sup>30</sup> and explained in presentation slides posted on Buy Clean California's website.<sup>31</sup>

## CALIFORNIA HIGH SPEED RAIL

Prior to adoption of the Buy Clean California Act, the California High Speed Rail project had begun using EPDs as part of their procurement process. The High Speed Rail Sustainability Report<sup>32</sup> identifies that the construction projects will: 1) Require Environmental Product Declarations (EPDs) for construction materials, including steel products and concrete mix designs, 2) Require 'optimized life-cycle scores for major materials' and include additional strategies to impacts across the life cycle of the project.

## A.7 WASHINGTON STATE

Washington State has a longstanding reputation for its environmental stewardship and an established foundation of state, city, and county-level green building and energy efficiency policies. The 2015 version of the Washington State Energy Code (WSEC) is considered among the most stringent energy codes in the nation, and the LEED rating system is widely adopted across the state, due in part to a law passed in 2011 that required public agency facilities and state-funded projects to attain at least LEED

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<sup>29</sup> Alice Zanamiller, "Low Carbon Concrete Project - County of Marin," accessed December 30, 2018, <https://www.marincounty.org/depts/cd/divisions/sustainability/low-carbon-concrete-project>.

<sup>30</sup> Caltrans, "Environmental Product Declarations," 2018, <http://www.dot.ca.gov/mets/ab-262/>.

<sup>31</sup> DGS, "Buy Clean California Act (AB 262)," accessed December 30, 2018, <https://www.dgs.ca.gov/pd/Programs/Engineering/AB262.aspx>.

<sup>32</sup> HSR, "California High Speed Rail Sustainability Report," 2016, [https://www.hsr.ca.gov/docs/programs/green\\_practices/sustainability/Sustainability\\_Report\\_Dec\\_2016.pdf](https://www.hsr.ca.gov/docs/programs/green_practices/sustainability/Sustainability_Report_Dec_2016.pdf).

silver certification.<sup>33</sup> In its 2017 annual list of ‘Top States’ for LEED, the USGBC ranked Washington as the 11<sup>th</sup> place state in terms of square feet of LEED space per capita.<sup>34</sup>

## BUY CLEAN WASHINGTON

In 2018, Washington State policymakers demonstrated commitment to embodied carbon reduction policy, signaling to the market government commitment to transition state procurement toward low-carbon materials selection.

On January 16, 2018, Washington Governor Jay Inslee signed Executive Order 18-01 “State Efficiency and Environmental Performance” which mandated state agencies to consider and account for GHG emissions during decision-making, stating, “where cost-effective and workable solutions are available...decision makers shall select the lower-emissions options” and “...include consideration of net-embodied carbon.”<sup>35</sup>

On January 8, 2018, Representative Beth Doglio of the House Capital Budget Committee introduced to the Washington State legislature House Bill (HB): 2412 – Creating the Buy Clean Washington Act.<sup>36</sup> Modeled after the Buy Clean California Act, the draft bill would require state-funded building projects to report environmental impact data through facility-specific EPDs for an eligible list of materials that function as part of a structural system or assembly, including concrete, unit masonry, metal of any type, and wood of any type. The environmental impact would need to fall below a GWP threshold established by the State in order for eligible materials to be considered in the bidding process. HB 2412 received a public hearing<sup>37</sup> and passed out of its original committee, but ultimately did not advance in the 2017 legislative cycle.

## KING COUNTY

At the local level, King County has considered embodied carbon in recent policies. Its 2015 Strategic Climate Action Plan<sup>38</sup> highlights consumption and materials management as a priority (‘Goal Area 4’), outlining strategies, measures, and targets for minimizing GHG emissions attributed to the production, transport, use, and disposal of locally consumed products.

Following its climate action plan, King County conducted a consumption-based inventory of sources and quantities of GHG emissions occurring over a one-year period (2015). The consumption-based inventory reviewed embodied carbon associated with production, transport, use and disposal of goods, foods and services consumed in King County (regardless of where goods were produced), and isolated construction as an emissions category in its models (separating it from a homes and buildings category).<sup>39</sup> In 2015,

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<sup>33</sup> Washington State Legislature, “RCW 39.35D.030: Standards for Major Facility Projects—Annual Reports.,” 2011, <https://app.leg.wa.gov/rcw/default.aspx?cite=39.35D.030>.

<sup>34</sup> USGBC, “Honorable Mentions for 2017 Top States for LEED,” 2018, <https://www.usgbc.org/articles/honorable-mentions-2017-top-states-leed>.

<sup>35</sup> Jay Inslee, “Executive Order 18-01 State Efficiency and Environmental Performance” (Office of the Governor, State of Washington, 2018).

<sup>36</sup> Washington State Legislature, “HB 2412 - 2017-18 Creating the Buy Clean Washington Act.”

<sup>37</sup> Washington State’s Public Affairs Network TVW, “House Capital Budget Committee,” (2018), <https://www.tvw.org/watch/?eventID=2018011119>.

<sup>38</sup> King County, “2015 Strategic Climate Action Plan,” 2015, [https://your.kingcounty.gov/dnrp/climate/documents/2015\\_King\\_County\\_SCAP-Full\\_Plan.pdf](https://your.kingcounty.gov/dnrp/climate/documents/2015_King_County_SCAP-Full_Plan.pdf).

<sup>39</sup> Cascadia Consulting Group and Hammerschlag & Co. LLC, “King County Greenhouse Gas Emissions Inventory 2015 Update,” 2017, <https://your.kingcounty.gov/dnrp/climate/documents/2015-KC-GHG-inventory.pdf>.

nearly 90% of construction emissions occurred during the production phase of materials. While overall emissions attributed to construction decreased by four percent since 2008, the inventory found that government demand for construction increased. Further, it highlighted that government demand on foreign production increased by 94% during this time, estimating that emissions associated with foreign production are twice the amount of emissions associated with domestic production.<sup>40</sup>

The decrease of local emissions attributed to King County in tandem with the increased reliance on foreign production is a dichotomy that reflects a growing, global trend of developed countries ‘offshoring’ carbon-intensive manufacturing practices to developing countries. While governments from developed countries report progress against national or local emissions targets, recent research shows that global GHG emission rates have stagnated and recently increased due to product manufacturing in – and exportation from – developing countries. The trend is worth noting and considering in future policy development to ensure effort to reduce local emissions does not result in increased emissions overseas.

## A.8 OREGON

In 2017, state representatives introduced HB 3161 and HB 3162 to the Oregon State legislature.<sup>41</sup> The bills proposed a pilot program for the Oregon Department of Transportation, which would require EPD collection and GHG emissions inclusion into contract pricing for projects. Neither bill advanced, but some Oregon legislators may continue pursuing similar policy options. Further, in November 2017, Governor Kate Brown signed Executive Order 17-20,<sup>42</sup> outlining a number of energy efficiency measures for Oregon’s building sector, including a requirement to establish carbon neutral operations for new state buildings, which included a directive for Oregon state agencies to analyze feasible options for lowering embodied carbon of construction materials.

Over the past decade, the Oregon Department of Environmental Quality’s (DEQ) Materials Management Program has increasingly sought to understand and reduce the emissions attributed to materials. More recently, Oregon’s Environmental Quality Commission directed DEQ to 1) urge climate programs to acknowledge the limitations of the incomplete traditional sector-based inventory; 2) develop an accounting solution that would tell a more comprehensive story; and 3) encourage other jurisdictions and programs to follow this example.

Oregon’s accounting solution is the consumption-based GHG emissions inventory (CBEI),<sup>43</sup> which shows that over 40% of Oregon’s GHG emissions are attributed to material-related purchases. About 8% of total emissions are from construction services, which includes the production of building materials. Overall, using a consumption lens has allowed Oregon DEQ to more easily communicate the impacts of materials, and develop policies and programs to reduce those impacts. One key aspect of Oregon’s ability to focus on the lifecycle impacts of materials was a recent statutory change that now explicitly states that funding received from solid waste disposal fees can be used to reduce the impacts of

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<sup>40</sup> Cascadia Consulting Group and Hammerschlag & Co. LLC.

<sup>41</sup> Oregon State Legislature, “HB3161 2017 Regular Session,” 2017, <https://olis.leg.state.or.us/liz/2017R1/Measures/Overview/HB3161>; Oregon State Legislature, “HB3162 2017 Regular Session,” 2017, <https://olis.leg.state.or.us/liz/2017R1/Measures/Overview/HB3162>.

<sup>42</sup> Kate Brown, “Executive Order No. 17-20” (Office of the Governor, State of Oregon, 2017), [https://www.oregon.gov/gov/documents/executive\\_orders/eo\\_17-20.pdf](https://www.oregon.gov/gov/documents/executive_orders/eo_17-20.pdf).

<sup>43</sup> Oregon Department of Environmental Quality, “Consumption-Based Greenhouse Gas Emissions Inventory for Oregon,” accessed December 12, 2018, <https://www.oregon.gov/DEQ/mm/Pages/Consumption-based-GHG.aspx>.

materials across their entire lifecycle.<sup>44</sup> This was a key change to help DEQ shift resources and staff to seek opportunities for reduction across the entire lifecycle. This shift has also allowed Oregon DEQ to hire staff who specialize in life cycle assessment and focus on “upstream” work with material producers and business.

Oregon’s state and city governments have implemented other initiatives, including:

- **Oregon Concrete EPD Program:**<sup>45</sup> As a partnership between Oregon DEQ and the Oregon Concrete Aggregates Producer Association (OCAPA), the program helps concrete manufacturers measure and report environmental impacts of concrete mixes through EPDs. This program includes a web-based tool, a reimbursement incentive, and direct technical assistance to manufacturers. As of October 2018, there are three manufacturers enrolled in the program. Two companies have completed EPDs for seven plants in the Portland, Oregon area. Over 500 individual mixes EPDs have been published.

**City of Portland Deconstruction Requirements:** In July 2016, Portland City Council adopted an ordinance (including code language) that established deconstruction (selective dismantlement of building components for reuse, recycling and waste management) requirements for house or duplex structures built before 1917 or are considered designated historic resources, mandating that projects seeking demolition permits for historic building structures ensure that valuable materials are salvaged for reuse instead of disposal. Portland became the first US city to pass a deconstruction ordinance, presenting the opportunity to save an estimated 4,000 annual tons of materials waste for reuse.<sup>46</sup>

- **Eugene Community Climate and Energy Action Plan:**<sup>47</sup> The 2010 climate action plan prioritizes a “Consumption and Waste Action Area,” underpinned by objectives and actions to (1) promote recycling, reuse and repurposing of materials and (2) reduce GHG emissions throughout the life cycle of products and goods, including construction materials.
- **City of Portland/Multnomah County Climate Action Plan:**<sup>48</sup> The City of Portland’s 2015 Climate Action Plan performed a consumption-based emissions inventory and identified the purchasing of goods (materials) as comprising over half of the emissions. Many actions in the plan focus on reducing consumption-related emissions. The city expects an update to the plan in 2019 with potential actions to further reduce the embodied carbon of building materials.

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<sup>44</sup> Oregon State Legislature, “Chapter 459A -- Reuse and Recycling, 2017 Edition,” 2017, [https://www.oregonlegislature.gov/bills\\_laws/ors/ors459A.html](https://www.oregonlegislature.gov/bills_laws/ors/ors459A.html).

<sup>45</sup> Oregon Concrete & Aggregate Producers Association, “Oregon Concrete EPDs,” accessed December 13, 2018, [https://www.ocapa.net/index.php?option=com\\_content&view=article&id=247:oregon-concrete-epds&catid=20:site-content&Itemid=201s](https://www.ocapa.net/index.php?option=com_content&view=article&id=247:oregon-concrete-epds&catid=20:site-content&Itemid=201s).

<sup>46</sup> City of Portland, “Deconstruction Requirements,” 2016, <https://www.portlandoregon.gov/bps/70643>.

<sup>47</sup> City of Eugene, “A Community Climate and Energy Action Plan for Eugene,” 2010, <https://www.eugene-or.gov/Archive/ViewFile/Item/80>.

<sup>48</sup> City of Portland and Multnomah County, “Climate Action Plan: Local Strategies to Address Climate Change,” 2015, <https://www.portlandoregon.gov/bps/article/531984>.

- **Oregon Global Warming Commissions Interim Roadmap to 2020:**<sup>49</sup> In 2010, Oregon’s Global Warming Commission published a roadmap to reaching the state’s 2020 carbon reduction goals. This is Oregon’s most complete “plan” to address greenhouse gas reductions. There is a substantial focus on materials in the report and some specific recommendations related to building materials to include “carbon footprinting of products” and the development of a net-zero carbon standard that includes the embodied impacts of building materials.

## A.9 MINNESOTA

In 2017, Minnesota introduced the Buildings, Benchmarks, and Beyond (B3) program,<sup>50</sup> described as “like a LEED system for Minnesota State only.”<sup>51</sup> Under Guideline M.1, the B3 program includes a WBLCA component with two requirements: (1) submit documentation of GWP reduction, which can be met through three different pathways and (2) select at least five different permanently installed products with sources from at least five different manufacturers that meet disclosure criteria (either product-specific declaration or an industry-wide or product-specific EPD). Guideline M.1 is required for new buildings and major renovation projects.

The primary goal of Guideline M.1 is to improve data collection and increase submission of EPDs, and thus improve documentation and disclosure, but not necessarily drive measurable, embodied carbon reduction. Minnesota’s government developed Guideline M.1 (and the overall B3 program) in close consultation with the design community (i.e. architects, engineers, etc.) through focus group sessions. Whereas government procurement policies such as Buy Clean California aim to improve manufacturing standards, the B3 program was developed to improve practices and decision-making at the design level.

Guideline M.1 is supported by an Excel-based LCA Material Selection Calculator and requires use of approved WBLCA software tools (Tally and Athena Impact Estimator, though other methods can be used upon vetting and approval). It was developed to align with and/or adapt language from established standards such as LEED v4, IgCC, and ANSI/ASHRAE/USGBC/IES Standard 189.1.<sup>52</sup>

While implementation is still in its early phase, this program has the potential to establish a model that other states and cities could adopt.

## A.10 REGIONAL INITIATIVES

Based throughout the US West Coast, several collaborative initiatives work to bring building industry, government, nonprofit, and academic partners together to measure and reduce embodied carbon.

Examples include:

- **The West Coast Climate and Materials Management Forum (the Forum):**<sup>53</sup> a collaborative of state, local, and tribal governments working to institutionalize sustainable materials

<sup>49</sup> Oregon Global Warming Commission, “Interim Roadmap to 2020,” 2010, <https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/5a0a0ea14192029150c02f93/1510608553554/2010-10-28+Interim+Roadmap+to+2020.pdf>.

<sup>50</sup> Minnesota B3, “B3 – Buildings Benchmarks and Beyond,” accessed December 13, 2018, <https://www.b3mn.org/>.

<sup>51</sup> West Coast Climate & Materials Management Forum, “2017 10 12 10 03 Built Environment and Embodied Carbon Emissions - YouTube,” 2017, <https://www.youtube.com/watch?v=nkDj3VzQyYs&feature=youtu.be>.

<sup>52</sup> Minnesota B3, “Guideline M.1: Life Cycle Assessment,” n.d., [https://www.b3mn.org/guidelines/3-0/m\\_1/](https://www.b3mn.org/guidelines/3-0/m_1/).

<sup>53</sup> West Coast Climate and Materials Management Forum, “West Coast Climate and Materials Management Forum,” accessed December 13, 2018, <https://westcoastclimateforum.com/>.

management practices. The Forum identifies and shares effective strategies that reduce greenhouse gas emissions and improve how communities source, use, and recover materials throughout their life cycles. Its leadership team includes government representatives from regional EPA agencies, and state and county agencies in California, Oregon, and Washington. The Forum provides webinars, research summaries, toolkits, and other resources for sustainable materials management.

- **Embodied Carbon Network (ECN):**<sup>54</sup> a Washington-based initiative convened by the University of Washington's Carbon Leadership Forum that brings together building sector professionals, researchers, and environmental advocates focused on reduction of carbon emissions caused by construction materials. The ECN comprises ten topical work groups focused on specific focus areas related to embodied carbon, including a Policy Focus Group. Currently, there are over 360 members based throughout the world representing industry, academia, nonprofits, governments and businesses.
- **Structural Engineers (SE) 2050 Commitment Initiative:** The SE 2050 Initiative challenges structural engineers to meet embodied carbon benchmarks and increasingly higher reduction targets by 2050. The initiative aims to enlarge the collection of structural material quantities data from buildings projects to help determine an embodied carbon baseline. The American Institute of Civil Engineers Structural Engineer's Institute Sustainability Committee is exploring the potential benefit and impact of tracking structural material quantities and embodied carbon with the aim to establish and promote embodied carbon reduction targets for a variety of building types and structural systems over time. The Committee includes members from all across the US.
- **Embodied Carbon Construction Calculator (EC3):** The EC3 tool is a pilot program hosted at the University of Washington's Carbon Leadership Forum that is developing an open-source EPD/LCA database in consultation with architecture, engineering, construction and manufacturing stakeholders, as well as academic researchers and certification representatives. The database will align with and support existing building sector initiatives that would benefit from integrated data and tools. As of the time of this writing, phase 1 of the database and tool has been fully funded through the Charles Pankow Foundation with sponsorship from diverse industry organizations. The plan is to have an open access EPD database available for public use by the end of 2019.

### A.11 FEDERAL HIGHWAY ADMINISTRATION (FHWA)

The FHWA regulates construction, maintenance and preservation of US highways bridges and tunnels, and conducts research and provides technical assistance to state and local agencies, including environmental sustainability. Specifically, FHWA is working on initiatives to assist states in moving toward 'green' public procurement or applying LCAs to pavements.<sup>55</sup> This effort includes the creation of

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<sup>54</sup> Embodied Carbon Network, "Embodied Carbon Network," accessed December 13, 2018, <http://embodiedcarbonnetwork.org/>.

<sup>55</sup> FHWA, "FHWA Order 4460.3A Green Procurement Planning," 2010, <https://www.fhwa.dot.gov/legsregs/directives/orders/44603a.cfm>.

tools to support the sustainability of pavement construction operations<sup>56</sup> as well as an LCA framework specific to pavements.<sup>57</sup>

## B. EUROPEAN COUNTRIES LEADING EMBODIED CARBON POLICY

In 2014, the EU adopted the 2030 Climate and Energy Framework,<sup>58</sup> which established a shared goal for EU member states to cut GHG emissions by at least 40% by 2030 (from 1990 levels).

In 2017, to boost the building sector's role in meeting EU-established emissions reduction targets by 2030, the European Commission published Level(s),<sup>59</sup> a voluntary reporting framework for building assessment. Level(s) provides a common EU approach and technical guidance to inform policymaking across Europe that helps Member States meet both national and EU-wide goals. The framework provides a set of common indicators and metrics for measuring environmental performance of buildings throughout their lifecycle, including life cycle tools. The toolset includes four scenario tools and one data collection tool, accompanied by simplified LCA methodology.

Guided by leadership at the EU level, national and subnational jurisdictions across Europe have implemented sustainable building policies aligned with EU-wide policy frameworks and goals, targeting energy efficiency, renewable energy and whole-building life cycle emissions (operational and embodied).

This section outlines and describes key components of embodied carbon policies in Austria, Belgium, France, Germany, the Netherlands, Sweden, Switzerland, and the United Kingdom. It is not a comprehensive assessment or holistic view of all European-based policies with embodied emission components. Rather, it highlights nations with systems or programs that include (and often align) multiple embodied carbon policy initiatives.

For a holistic assessment of global policies addressing embodied carbon, please access the recent *Embodied Carbon Review*<sup>60</sup> (November 2018). For additional detail and analysis on country-specific policy components listed throughout this section, please refer to *Embodied Carbon of Buildings and Infrastructure: International Policy Review*<sup>61</sup> (September 2017).

### B.1 AUSTRIA

Austria's national government has worked alongside industry groups to accelerate adoption of green building methods, supporting a market that applies LCA to both public and commercial construction

<sup>56</sup> FHWA, "How Do We Assess Pavement Sustainability?," accessed December 12, 2018, <https://www.fhwa.dot.gov/pavement/sustainability/how.cfm>.

<sup>57</sup> FHWA, "Pavement Life Cycle Assessment Framework," 2016, <https://www.fhwa.dot.gov/pavement/sustainability/hif16014.pdf>.

<sup>58</sup> European Commission, "2030 Climate & Energy Framework," accessed December 13, 2018, [https://ec.europa.eu/clima/policies/strategies/2030\\_en](https://ec.europa.eu/clima/policies/strategies/2030_en).

<sup>59</sup> Joint Research Centre and European Commission, "Level(s) - A Common EU Framework of Core Sustainability Indicators for Office and Residential Buildings Part 3: How to Make Performance Assessments Using Level(s) (Beta v1.0)," 2017, <https://doi.org/10.2760/95143>.

<sup>60</sup> Bionova Ltd, "The Embodied Carbon Review - Embodied Carbon Reduction in 100+ Regulations and Rating Systems Globally," 2018, <https://www.oneclicklca.com/embodied-carbon-review/>.

<sup>61</sup> Ryan Zizzo et al., "Embodied Carbon of Buildings and Infrastructure, International Policy Review," 2017, [https://www.bcfii.ca/system/files/reports/public/embodied\\_carbon\\_in\\_construction\\_and\\_infrastructure\\_-\\_international\\_policy\\_review.pdf](https://www.bcfii.ca/system/files/reports/public/embodied_carbon_in_construction_and_infrastructure_-_international_policy_review.pdf).

projects. Austria has implemented multiple certification systems with embodied carbon standards. The government also provides a cash bonus incentive through its social housing program linked to overall environmental performance.<sup>62</sup>

Several Austrian states and cities have developed other policy requirements and incentives specific to their jurisdictions.

Key initiatives in Austria include:

- **OI3 - Ökoindex 3**<sup>63</sup> is a nationally-adopted evaluation methodology developed by IBO, the Austrian Institute for Healthy and Ecological Building (*Österreichisches Institut für Baubiologie und –ökologie*). The methodology is a weighted score of three environmental criteria (GWP, primary energy used, and acidification potential). Methods to calculate OI3 performance measures are not open-source. Industry stakeholders are pushing IBO to make the calculation methods publicly available and revise the methodology to align with EN 15804.
- **IBO ÖKOPASS**<sup>64</sup> is a widely used assessment system that provides certification (“building pass”) for residential building projects. It applies the Ökoindex 3 methodology.
- **Klimaaktiv**<sup>65</sup> is a national rating system that also applies the Ökoindex 3 methodology to assess environmental impacts of building materials. The assessment is a mandatory component of certification. Based on level of performance against the assessment, residential building projects may be eligible for environmental subsidies. The certification has been applied to over 500 buildings in Austria.
- **ÖGNB / TQB**<sup>66</sup> is a building assessment system operated by ÖGNI - the Austrian Sustainable Building Council (ASBC).<sup>67</sup> It provides points toward an optional component for embodied carbon.

## B.2 BELGIUM

At its national and regional levels, Belgium has focused on developing embodied carbon policy underpinned by LCA. Key initiatives include national legislation aligned with a standard EPD program, and a region-led collaboration that established a framework for LCA methodology:

- **Belgium EPD program (B-EPD)**:<sup>68</sup> The national B-EPD provides a framework for developing and reporting EPDs in accordance with mandatory requirements established by legislation passed in 2014 (The Royal Decree on Environmental Messages).<sup>69</sup> Launched in early 2017, B-EPD includes a national EPD database aligned with international standards. Manufacturers are required to

<sup>62</sup> Bionova Ltd, “The Embodied Carbon Review - Embodied Carbon Reduction in 100+ Regulations and Rating Systems Globally.”

<sup>63</sup> Austrian Institute for Healthy and Ecological Building, “Ökoindex 3,” 2011, [https://www.baubook.at/m/Daten/Bilder/Infos/k4\\_OI3\\_Folder.pdf](https://www.baubook.at/m/Daten/Bilder/Infos/k4_OI3_Folder.pdf).

<sup>64</sup> <https://www.ibo.at/en/building-assessment/ibo-oekopass/>

<sup>65</sup> Federal Ministry for Sustainability and Tourism (Austria), “Klimaaktiv,” n.d., <https://www.klimaaktiv.at>.

<sup>66</sup> Austrian Sustainable Building Council, “Total Quality Building Assessment,” accessed December 21, 2018, <https://www.oegnb.net/en/tqb.htm>.

<sup>67</sup> Austrian Sustainable Building Council, “ÖGNI,” accessed December 21, 2018, <https://www.ogni.at/>.

<sup>68</sup> Federal Public Service (FPS), “The Belgian EPD Programme B-EPD | FPS Public Health,” 2017, <https://www.health.belgium.be/en/belgian-epd-programme-b-epd>.

<sup>69</sup> Federal Public Service (FPS), “Royal Decree on Environmental Messages | FPS Public Health,” 2017, <https://www.health.belgium.be/en/royal-decree-environmental-messages>.

conduct LCAs and submit EPDs for all construction products in order to make environmental marketing claims. Submitted EPDs must be verified by an approved inspector before publication.

- **LCA methodology and tool developed by regions:** Flanders’ public waste agency (OVAM) led a five-year collaboration with Belgian universities, engineering firms and government agencies from the nation’s three regions to develop LCA framework for calculating and communicating environmental performance of construction materials.<sup>70</sup> The project resulted in voluntary LCA calculation methodology applicable to building elements and whole-buildings, and TOTEM<sup>71</sup> (formerly called ‘MMG’), an LCA tool released in February 2018 to support manufacturing and construction professionals assess environmental impacts of building projects during the design phase.

### B.3 FRANCE

In August 2015, France passed the Energy Transition for Green Growth Law,<sup>72</sup> setting energy consumption and fossil fuel use targets for its construction sector to meet by 2030. The national strategy established GHG emissions targets for the building sector: a 50% reduction by 2030 and 87% reduction by 2050. Key features of the law and other French programs considering embodied carbon include:

- **A voluntary pilot program incentivizing compliance:** *Énergie Positive et Réduction Carbone*<sup>73</sup> incentivizes builders and developers to achieve energy and carbon performance-based targets. Incentives include financial support toward LCA studies, additional construction/zoning rights, and/or an Energy-Plus & Carbon Reduction Certificate (E+C- label) for complying with energy and life cycle carbon performance benchmarks. The trial period aims to assess the economic and technical feasibility of regulation to ensure that compliance standards are realistic to the capabilities (financial and technical) of manufacturing firms. The program accounts for embodied carbon, establishing indicators (called ‘Carbon Levels’) for emissions resulting during the whole life cycle of a building, and carbon emissions attributed to construction products and building equipment.<sup>74</sup>

France intends for the pilot program to become mandatory in 2020 – this transition would remove incentives and require building projects to meet life cycle carbon-performance standards. In the meantime, manufacturers voluntarily participating in the pilot phase must submit data to a national “observatory” or inventory of information assessing technical and economic feasibility of the program standards, as well as general feedback and recommended best practices.

<sup>70</sup> OVAM, “Totem: A New Tool to Improve the Environmental Performance of Buildings (MMG) - OVAM,” 2018, <https://www.ovam.be/materiaalprestatie-gebouwen-0>.

<sup>71</sup> TOTEM, “TOTEM: Tool to Optimise the Total Environmental Impact of Materials,” accessed December 13, 2018, <https://www.totem-building.be/>.

<sup>72</sup> Legifrance, “LOI N° 2015-992 Du 17 Août 2015 Relative à La Transition Énergétique Pour La Croissance Verte | Legifrance,” 2015, <https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031044385&categorieLien=id>.

<sup>73</sup> Ministère de la Transition Écologique et Solidaire and Ministère de la Cohésion des Territoires, “Bâtiment à Énergie Positive & Réduction Carbone,” accessed December 13, 2018, <http://www.batiment-energiecarbone.fr/fr/>.

<sup>74</sup> Ministère de la Transition Écologique et Solidaire and Ministère de la Cohésion des Territoires, “LA RÉGLEMENTATION ÉNERGÉTIQUE ET ENVIRONNEMENTALE DE DEMAIN Construire Ensemble Bâtiment et Climat,” 2017, <http://www.batiment-energiecarbone.fr/documents/plaquette-eprc-2017-11-27.pdf>.

As of April 2018, over 120 building projects were participating in the trial scheme, 45 of which received E+C- labels. At this time, a Deputy Director involved in implementation reflected that the lower carbon indicator (C1) was more accessible compared to the second (C2), which led program participants to recommend establishing an intermediate level between C1 and C2. Other participants recommended establishing an even more demanding, third level. France estimates that over 800 projects will have participated by the end of 2018.<sup>75</sup>

- **National EPD database:** Launched in 2004, the “*environmental and health reference data for buildings*” (INIES) is a national database with datasets provided voluntarily by manufacturers and trade associations.<sup>76</sup> Datasets include Environmental and Health Declaration Sheets (FDES) for building products, Product Environmental Profiles (PEP) for equipment, material life cycle inventories, and building services (e.g. water) information. LCA is a prerequisite for submitted data. Datasets must comply with the European standard EN 15804 “Sustainability of construction works – Environmental product declarations – Core rules for the construction products category,” which France adopted in 2014 and subsequently published complementary national standards, which INIES data must also comply with.
- **Software requirements for LCA tools:** Software used to calculate EPD data must be verified by France’s Ministry of Environment. This builds upon a standardized background life cycle inventory dataset and methodology similar to the initiatives proposed for Canada and the North America in **Appendix C**.

#### B.4 GERMANY

In 2007, construction and real estate industry stakeholders in Germany founded the German Sustainable Building Council (DGNB),<sup>77</sup> a non-profit membership group that led national progress to track and reduce emissions including the use of LCA. Through a two-year collaboration with the Federal Ministry of Transport, Building and Urban Development (BMVBS), DGNB developed a voluntary certification system (DGNB System) to assess sustainable construction of a building, awarding points based on a building’s overall performance. Similar to LEED, the DGNB System includes three levels awarded based on number of points. LCA is included as a criterion under the system’s Ecological Quality assessment category. For each criterion, the DGNB System outlines how it aligns to national and international standard and legislation, such as the Germany Sustainability Strategy and the United Nations Sustainable Development Goals.<sup>78</sup>

Building from the foundation established with DGNB, the German government established mandatory measures for federal buildings through the Assessment System for Sustainable Building (BNB).<sup>79</sup> In effect

<sup>75</sup> batiactu, “Réglementation Environnementale 2020 : L’Etat Donne Des Précisions,” 2018,

<https://www.batiactu.com/edito/re2020-un-socle-unique-minimal-energie-carbone-sera-52796.php>.

<sup>76</sup> INIES, “INIES | Environmental and Health Reference Data for Building,” accessed December 13, 2018,

<http://www.inies.fr/home/>.

<sup>77</sup> DGNB, “DGNB – German Sustainable Building Council,” accessed December 13, 2018, <https://www.dgnb.de/en/index.php>.

<sup>78</sup> DGNB, “The Most Important Changes to Version 2018 of the DGNB System,” 2018,

[https://static.dgnb.de/fileadmin/en/dgnb\\_system/system/The-most-important-changes-to-Version-2018-of-the-DGNB-System.pdf](https://static.dgnb.de/fileadmin/en/dgnb_system/system/The-most-important-changes-to-Version-2018-of-the-DGNB-System.pdf).

<sup>79</sup> Federal Ministry of Transport, Building and Urban Development, “Assessment System for Sustainable Building Administration Buildings Economical Quality Ecological Quality Process Quality Technical Quality Socio-Cultural / Functional Quality,” 2011, [https://www.nachhaltigesbauen.de/fileadmin/pdf/Sustainable\\_Building/Assessment\\_System\\_Sustainable\\_Building1.pdf](https://www.nachhaltigesbauen.de/fileadmin/pdf/Sustainable_Building/Assessment_System_Sustainable_Building1.pdf).

since 2011, BNB specifies minimum benchmarks for performance, requiring new federal building projects to conduct WB, similar to the voluntary DGNB System approach.

Established within the framework of BNB, Germany also has the national EPD/LCA database ÖKOBAUDAT and provides a free one-source LCA tool (openLCA) and eLCA software supported by ÖKOBAUDAT's interface.<sup>80</sup>

Key features include:

- **Mandatory green rating system:** Assessment System for Sustainable Building (BNB) requires WBLCA for new federal building projects (office and administrative buildings) costing over 2M EUR (\$2.35 million USD). BNB allocates points based on LCA performance against pre-determined standard benchmarks set at 'low', 'medium', and 'high' – the higher the benchmark, the more points awarded. Other features include alignment with Germany's Guidelines for Sustainable Buildings and a database of BNB-certified buildings.
- **Industry-led voluntary rating system:** The DGNB Certification System includes an LCA benchmark component similar to BNB, and maximum embodied carbon threshold – points are awarded based on performance relevant to the ceiling. It encourages non-government building projects to pursue embodied carbon standards.<sup>81</sup>
- **National LCA EPD database:** ÖKOBAUDAT provides free company-specific EPDs and generic (average) datasets publicly available for LCA application. The platform includes data from over 1000 construction products. Its interface also supports (through authorized LCA software tools) direct import of EPD datasets. ÖKOBAUDAT was developed through a funded project with partnering research institutes and sustainability software companies, who consulted stakeholders from Germany's construction materials industry throughout development.<sup>82</sup>
- **Free LCA tool and software:** Germany provides free access to the LCA tool openLCA and eLCA, software developed specifically for application on federal building projects. eLCA is taught and used in universities to familiarize building professionals.<sup>83</sup> For non-federal building projects, other market-based tools are commonly used. Both openLCA and eLCA are supported by the national EPD database.<sup>84</sup>
- **Life Cycle Assessment Guide:** In April 2018, DGNB published a basic guide on LCA – its benefits, uses, and how to perform an LCA and communicate results.<sup>85</sup>

## B.5 THE NETHERLANDS

The Netherlands attempted to pass embodied carbon policy in 2003, an effort that failed in part due to strong opposition from industry. In 2013, the nation passed a whole-building LCA requirement for non-

<sup>80</sup> ÖKOBAUDAT, "ÖKOBAUDAT," accessed December 13, 2018, <https://www.oekobaudat.de/>.

<sup>81</sup> DGNB, "DGNB Criteria 'Building Life Cycle Assessment,'" 2018, <https://www.dgnb-system.de/en/system/version2018/criteria/building-life-cycle-assessment/index.php>.

<sup>82</sup> ÖKOBAUDAT, "ÖKOBAUDAT."

<sup>83</sup> Zizzo et al., "Embodied Carbon of Buildings and Infrastructure, International Policy Review."

<sup>84</sup> Zizzo et al.; ÖKOBAUDAT, "ÖKOBAUDAT."

<sup>85</sup> DGNB, "Life Cycle Assessments - A Guide on Using the LCA," 2018, [https://static.dgnb.de/fileadmin/en/dgnb\\_ev/reports/LCA-guide.pdf](https://static.dgnb.de/fileadmin/en/dgnb_ev/reports/LCA-guide.pdf).

government buildings, after a decade of close engagement and collaboration with industry stakeholders, including those who opposed the original policy proposal. During this period, LCA use also increased as availability of tools and methodology evolved. Through increased uptake of LCA practice, manufacturers used multiple private Dutch EPD programs to publish EPDs. In an effort to align the various EPD programs and standardize LCA practice, the Dutch government commissioned Stichting Bouwkwiteit (SBK) to develop a standard LCA framework, which resulted in a national database and standard LCA methodology currently managed and operated by SBK.<sup>86</sup>

Key components include:

- **Whole building LCA for non-government buildings:** Building Code 2012 (Bouwbesluit 2012) – enacted in 2013 – became the first known legislative measure mandating WBLCA for non-government buildings, requiring new residential and office buildings over 100 m<sup>2</sup> to submit an ‘environmental profile’ which included a component for estimating embodied carbon in order to receive a building permit. As of 2018, the policy requires a building’s total environmental profile to fall below a threshold.<sup>87</sup> Relative to other embodied carbon measures, this new component to the policy is unique, since it requires building projects to go a step further than measurement and reporting only, and requires meeting an established emissions target in order to receive a building permit.
- **National EPD database:**<sup>88</sup> The National Environmental Database (NMD) is a single database operated by SBK with whole life cycle assessment data. It includes environmental data (producer- and branch- specific) of materials and products, which are vetted according to the SBK Verification Protocol. SBK engages industry to ensure transparency and ongoing improvements to the database through an Environmental Policy Committee (MGB) and Technical Content Committee (TIC).
- **Standardized WBLCA methodology:**<sup>89</sup> The Assessment Method: Environmental Performance Construction and Civil Engineering Works (GWW or the Dutch Assessment Method) is a single, national methodology for WBLCA. This method is based on the European Assessment Method for environmental declarations of construction products (EN 15804) and aligns with EN 15978, and includes scenarios relevant to the Netherlands. The Dutch Assessment Method is “inseparably connected” to the national EPD database, and is required per Building Code 2012 Article 5.9.<sup>90</sup>
- **WBLCA software/tools aligned with methodology:** The NMD and Dutch Assessment Method align with a SimaPro database, LCA software commonly used in the Netherlands with standardized LCI background database and LCA methodology similar to the programs proposed for Canada and North America in **Appendix C**.

<sup>86</sup> Zizzo et al., “Embodied Carbon of Buildings and Infrastructure, International Policy Review.”

<sup>87</sup> Zizzo et al.

<sup>88</sup> Stichting Bouwkwiteit, “Nationale Milieudatabase,” accessed December 13, 2018, <https://www.milieudatabase.nl/>.

<sup>89</sup> Stichting Bouwkwiteit, “Assessment of the Environmental Performances of Constructions and Civil Engineering Works,” 2015, [https://www.milieudatabase.nl/imgcms/Brochure\\_Assessment\\_Method\\_Environmental\\_Performance\\_\\_TIC\\_versie.pdf](https://www.milieudatabase.nl/imgcms/Brochure_Assessment_Method_Environmental_Performance__TIC_versie.pdf).

<sup>90</sup> Stichting Bouwkwiteit.

## B.6 SWEDEN

In 1991, Sweden was the first nation to pass a carbon tax, setting precedence for sustainability practices adopted by Swedish industries today. Specific to embodied carbon, Sweden’s carbon tax has focused on tracking and reducing emissions from construction of transportation infrastructure projects. More recently, Sweden has worked to incorporate LCA into building industry practice, through a new version of its national green building rating system, and through effort by the Swedish Board of Housing (Boverket).

Key features include:

- **Carbon accounting of transportation infrastructure construction:** Since 2015, new transportation infrastructure projects over 50 million SEK (\$5.6 million USD) are required to calculate and disclose embodied carbon impacts. The program offers financial incentives for embodied carbon emissions reduced relative to a pre-defined target.<sup>91</sup>
- **National LCA-based tool:** Klimatkalkyl<sup>92</sup> is a web-based tool or ‘climate calculator’ that includes a database of embodied energy and GHG emissions of different transportation infrastructure types.
- **Voluntary environmental certification system:** Miljöbyggnad<sup>93</sup> is a green building rating system, providing certification based on performance against 16 indicators. The Sweden Green Building Council recently published a new version of Miljöbyggnad, which includes a voluntary LCA performance target.<sup>94</sup>
- **LCA guidelines:** In summer 2018, Boverket – the Swedish Board of Housing (Boverket) responsible for writing building code – published new guidelines on LCA, including methodology for calculating environmental impacts over the whole lifecycle of a building. The document provides guidance on how to conduct an LCA, LCA analysis, and environmental certification.
- **Stockholm LCA calculation guideline:** In 2014, Stockholm launched the program “Routine environmental calculations of larger construction projects with LCA.” This guideline is not required/enforced.<sup>95</sup>

## B.7 SWITZERLAND

Switzerland has several rating systems including WBLCA language. Notable features in Switzerland include strong leadership from its corporate community to hold itself accountable to emissions tracking and reduction; leadership at the city level to require voluntary standards set at the national level; and strong industry support for its national building rating system.

<sup>91</sup> Zizzo et al., “Embodied Carbon of Buildings and Infrastructure, International Policy Review.”

<sup>92</sup> “Start - Klimatkalkyl,” n.d.

<sup>93</sup> Sweden Green Building Council, “Miljöbyggnad,” n.d., <https://www.sgbc.se/certifiering/miljobyggnad/>.

<sup>94</sup> Zizzo et al., “Embodied Carbon of Buildings and Infrastructure, International Policy Review.”

<sup>95</sup> Zizzo et al., “Embodied Carbon of Buildings and Infrastructure, International Policy Review.”

Key features include:

- **National green building rating system:** The program Minergie<sup>96</sup> sets WBLCA-based performance targets for embodied carbon through the Minergie – Eco standard.<sup>97</sup> Minergie – Eco compliance is voluntary in Switzerland, with a few exceptions: the City of Zurich requires new government building projects to achieve Minergie – Eco, while other public and private organizations (e.g. the Zurich Cantonal Bank) require compliance for both new buildings and major renovation projects, or offering density incentives and subsidies to buildings voluntarily achieving certification.<sup>98</sup> Minergie is similar to LEED in that it requires documentation at two stages – at design completion and construction completion.
- **Other rating systems:** Switzerland also uses other voluntary rating systems with similar methodology and data for WBLCA calculation. These include the Swiss Sustainable Building Council (SGNI; based on the German DGNB system), Standard for Sustainable Construction Standard (SNBS), and 200-Watt-Areale.<sup>99</sup>
- **National dataset:** The Association of Public Builders of Switzerland (KBOB) – a body of Swiss federal building authorities – provides a dataset that is used by most Swiss energy-calculation tools aligned with regulatory requirements.<sup>100</sup> Ecoinvent, a non-profit association founded with the mission to “promote the use and good practice of LCI within Switzerland and worldwide.”<sup>101</sup> The ecoinvent Life Cycle Inventory database is one of the leading global sources of the background data used to create LCAs.
- **Standard LCA Tool:** Lesosai<sup>102</sup> uses the list of impacts maintained by KBOB (extracted from EcoInvent database) to calculate lifecycle environmental impact of buildings and construction materials. The tool methodology conforms to Swiss Standard SIA 2032.<sup>103</sup>
- **Call-to-action:** First introduced in 1998, Switzerland’s 2000-Watt Society<sup>104</sup> is an environmental call-to-action, aiming to limit per-capita energy consumption and lifecycle GHG emissions. The vision is referenced in several national and local government programs seeking to align their language with the vision’s goals. The City of Zurich aligned its municipal code with the 2000-Watt Society and set a 2050 target for reducing embodied carbon emissions from residential buildings.<sup>105</sup>

<sup>96</sup> Minergie, “MINERGIE Schweiz,” accessed December 13, 2018, <https://www.minergie.ch/>.

<sup>97</sup> Minergie, “Minergie-ECO | Ecolabel Index,” accessed December 13, 2018, <http://www.ecolabelindex.com/ecolabel/minergie-eco>.

<sup>98</sup> Zizzo et al., “Embodied Carbon of Buildings and Infrastructure, International Policy Review.”

<sup>99</sup> Zizzo et al.

<sup>100</sup> KBOB, “Koordinationskonferenz Der Bau- Und Liegenschaftsorgane Der Öffentlichen Bauherren KBOB,” accessed December 13, 2018, <https://www.kbob.admin.ch/kbob/de/home.html>.

<sup>101</sup> ecoinvent, “Mission & Vision – Ecoinvent,” accessed December 30, 2018, <https://www.ecoinvent.org/about/mission-and-vision/mission-and-vision.html>.

<sup>102</sup> Minergie, “Lesosai 2018 : Certification and Thermal Balance Calculation for Buildings,” accessed December 13, 2018, <http://www.lesosai.com/en/>.

<sup>103</sup> “Lesosai 2018 : Certification and Thermal Balance Calculation for Buildings,” n.d.

<sup>104</sup> United Nations University, “2,000 Watt Society,” 2009, <https://ourworld.unu.edu/en/2000-watt-society>.

<sup>105</sup> City of Zurich, “2000-Watt Society,” accessed December 13, 2018, [https://www.stadt-zuerich.ch/portal/en/index/portraet\\_der\\_stadt\\_zuerich/2000-watt\\_society.html](https://www.stadt-zuerich.ch/portal/en/index/portraet_der_stadt_zuerich/2000-watt_society.html).

- **Municipality LCA standards:** Several local governments including Zurich require all new government buildings to conduct whole-building LCA and meet an embodied carbon performance target for certain building types.<sup>106</sup>

## B.8 UNITED KINGDOM

The UK Climate Change Act 2008<sup>107</sup> established the world’s first legally binding target to cut 80% of emissions by 2050, outlining multi-sectoral policy to transition industries toward low carbon practices, including carbon capture and storage, and low carbon construction through increased use of renewable materials. The Act established five-year carbon budgets (until 2022) for all major UK Government departments, mandating agencies to develop and implement their own low carbon transition plans. The UK government attributes its progress toward emissions reduction to the Act – emissions decreased by 42% between 1990 and 2016, and in 2016 alone, emissions decreased by six percent.<sup>108</sup>

To support further progress towards targets outlined by the Act, the UK Government published the Clean Growth Strategy<sup>109</sup> in 2017, which included language on the UK’s commitment to stimulate innovation of “advanced materials” in order to support cost-effective low carbon products to replace materials with carbon-intensive manufacturing processes.

While the UK government has established a strong foundation of aligned policies and strategies targeting GHG emissions reduction, federal regulation specific to embodied carbon is limited. However, the nation’s longstanding voluntary assessment programs recognize the importance of tracking and reducing environmental impact of construction materials through LCA.

Further, UK industry groups play a leadership role to develop industry standards and capacity to account for embodied carbon. The UK Green Building Council (UKGBC) provides practical guidance documents and workshops to help industry professionals work with clients to measure embodied carbon, and in 2012, the UK Government established a joint industry-government board focused on green construction. The Green Construction Board<sup>110</sup> published *The Low Carbon Routemap for the Built Environment*,<sup>111</sup> a visual tool outlining policies, actions and strategies for the UK building industry to meet the UK Government’s target to cut GHG emissions by 80% by 2050. The roadmap addresses both operational and embodied carbon emissions.

<sup>106</sup> Zizzo et al., “Embodied Carbon of Buildings and Infrastructure, International Policy Review.”

<sup>107</sup> Legislation.gov.uk, “Climate Change Act 2008” (Statute Law Database), accessed December 13, 2018, <https://www.legislation.gov.uk/ukpga/2008/27/contents>.

<sup>108</sup> United Kingdom Department for Business, Energy, and Industrial Strategy, “The Clean Growth Strategy: Leading the Way to a Low Carbon Future,” 2017, [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/700496/clean-growth-strategy-correction-april-2018.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf).

<sup>109</sup> Department for Business, Energy, and Industrial Strategy.

<sup>110</sup> Designing Buildings Wiki, “Green Construction Board,” 2017, [https://www.designingbuildings.co.uk/wiki/Green\\_Construction\\_Board](https://www.designingbuildings.co.uk/wiki/Green_Construction_Board).

<sup>111</sup> The Green Construction Board, “The Low Carbon Routemap for the Built Environment,” 2013, [http://www.carbonaction2050.com/sites/carbonaction.ciobrebuild.io1dev.com/files/document-attachment/GCB\\_Carbon\\_ROUTEMAP\\_1.pdf](http://www.carbonaction2050.com/sites/carbonaction.ciobrebuild.io1dev.com/files/document-attachment/GCB_Carbon_ROUTEMAP_1.pdf).

Key features include:

- **Voluntary green building rating programs:** Two well-established programs - Building Research Establishment Environmental Assessment Method (BREEAM)<sup>112</sup> and Home Quality Mark<sup>113</sup> – include LCA and embodied carbon goals. Established in 1990, making it the oldest certification tool used (with LCA focus since 1996), BREEAM awards two types of points for 1) low-impact materials selection and 2) WBLCA application. Focused on residential buildings, Home Quality Mark includes a WBLCA incentive.
- **BREEAM certification tools and database:** BREEAM provides ‘BREEAM Projects’, an online platform providing pre-assessment tools and performance data from certified BREEAM projects.<sup>114</sup> The Building Research Establishment (BRE) Group (BREEAM’s operator) provides GreenBookLive, a free database that helps industry professionals select low impact products. This is complemented by the BRE Green Guide.
- **UKGBC Embodied Carbon – Practical Guidance:** The 2017 publication provides industry professionals with knowledge and resources to use when working with clients to request embodied carbon measurements.<sup>115</sup>
- **RICS Whole Life Carbon Assessment for the Built Environment:**<sup>116</sup> The UK Royal Institution of Chartered Surveyors (RICS) is a professional body that accredits professionals within the land, property, construction, and infrastructure sectors worldwide. In 2017, RICS published a guidance document that mandates its professional members adopt a whole life cycle approach to carbon emissions reduction in the building industry. The guidance document establishes specific mandatory principles and supporting guidance for interpreting and implementing EN 15978 (*Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method*) methodology.<sup>117</sup> Language included in the RICS document also aligns with BREEAM guidance and standards.

## C. OTHER INTERNATIONAL COUNTRIES: NEW/EMERGING POLICIES

This section presents new/emerging policies related to embodied carbon from other international countries – Canada, Japan, and Singapore.

<sup>112</sup> Building Research Establishment, “BREEAM: The World’s Leading Sustainability Assessment Method for Masterplanning Projects, Infrastructure and Buildings,” accessed December 13, 2018, <https://www.breeam.com/>.

<sup>113</sup> Building Research Establishment, “Home Quality Mark,” accessed December 13, 2018, <https://www.homequalitymark.com/>.

<sup>114</sup> Building Research Establishment, “BREEAM Projects,” accessed December 13, 2018, <https://tools.breeam.com/projects/index.jsp>.

<sup>115</sup> UK Green Building Council, “Embodied Carbon - Practical Guidance,” 2017, <https://www.ukgbc.org/ukgbc-work/embodied-carbon-practical-guidance/>.

<sup>116</sup> RICS, “Whole Life Carbon Assessment for the Built Environment, 1st Edition,” 2017, <https://www.rics.org/uk/upholding-professional-standards/sector-standards/building-surveying/whole-life-carbon-assessment-for-the-built-environment/>.

<sup>117</sup> European Committee for Standardization, “EN 15978:2011 Sustainability of Construction Works - Assessment of Environmental Performance of Buildings - Calculation Method,” *International Standard*, 2011.

## C.1 CANADA

To date, Canada has lacked a national approach to tracking and reducing embodied carbon. However, a wide range of initiatives are developing or underway:

- The National Research Council (NRC) is leading a unified approach to begin development in 2019 of a high-quality national life cycle inventory (LCI) database including regionally-specific (provincial-level) data. This database could be used to create high-quality LCA studies and EPDs for Canadian-based construction materials. This effort is considered a critical first step toward potentially requiring future construction projects – including government procurement – to meet specific low-carbon targets. See **Appendix C** for additional information on the developing LCI initiative.

Key features include:

- **City of Vancouver, Canada:** In 2016, the City of Vancouver passed the *Green Buildings Policy for Rezoning*,<sup>118</sup> which included a requirement for new construction projects to use WBLCAs to calculate embodied carbon impact. To receive a rezoning permit, design teams need to commit at the start of commercial building projects whether to pursue either the Passive House (or similar “near-zero” emissions) standard **OR** the City’s 10 Low Emission Building requirements, one of which includes reporting the building’s embodied carbon through a WBLCAs.<sup>119</sup>
- **Province of Quebec, Canada:** In 2013, the province adopted the Quebec Wood Charter to promote the use of wood in construction.<sup>120</sup> The policy updated the provincial building code to increase the maximum height for wood structures by two stories (six stories total), and requires developers of government-funded projects to consider wood as a material option, through requiring a comparative analysis of GHG emissions for structural materials. While buildings must submit emissions data at the funding application state, funding is not dependent on whether the project selects a low-carbon material.
- **CaGBC Zero Carbon Building Standard:** In May 2017, the Canada Green Building Council (CaGBC) published a Zero Carbon Building Standard – a voluntary program providing a pathway to Zero Carbon certification for new and existing buildings projects.<sup>121</sup> While operational carbon emissions are the core focus of the initiative, it requires applicants to use LCA software to report embodied carbon of a building’s structural and envelope materials. The reporting requirement is intended to help Canada’s building industry develop familiarity and capacity to conduct LCA.

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<sup>118</sup> City of Vancouver - Planning Urban Design and Sustainability Department, “Green Buildings Policy for Rezoning - Process and Requirements (Formerly: Green Rezoning Process),” 2017, [https://bylaws.vancouver.ca/Bulletin/G002\\_2017April28.pdf](https://bylaws.vancouver.ca/Bulletin/G002_2017April28.pdf).

<sup>119</sup> Light House Sustainable Building Centre, “We Are Ready for New City of Vancouver Rezoning Requirements – Are You? | Light House,” accessed December 13, 2018, <http://www.sustainablebuildingcentre.com/we-are-ready-for-new-city-of-vancouver-rezoning-requirements-are-you/>.

<sup>120</sup> Ministère des Forêts, de la Faune, et des Parcs, “The Wood Charter” (Québec), accessed December 13, 2018, <https://mffp.gouv.qc.ca/english/publications/forest/wood-charter.pdf>.

<sup>121</sup> Canada Green Building Council®, “Zero Carbon Building Standard,” 2017, [https://www.cagbc.org/cagbcdocs/zerocarbon/CaGBC\\_Zero\\_Carbon\\_Building\\_Standard\\_EN.pdf](https://www.cagbc.org/cagbcdocs/zerocarbon/CaGBC_Zero_Carbon_Building_Standard_EN.pdf).

- **Public Services and Procurement Canada’s (PSPC) Real Property Branch (RPB)** adopted an Integrated Design Process<sup>122</sup> (IDP) approach for new construction projects, incorporating whole-building performance assessment tools into its decision-making.<sup>123</sup>

## C.2 JAPAN

In 2000, the National Diet of Japan passed a law to promote a ‘recycling-oriented economy and society’, aiming to proliferate uptake of environmentally-friendly products and services. As a result, Japan’s Environmental Management Association for Industry (JEMAI) with support from the Japanese Ministry of Economy, Trade and Industry (METI) established EcoLeaf Environmental Label in 2001, a national EPD program.<sup>124</sup> EcoLeaf includes a national database of type III EPDs and an EcoLeaf label for manufacturers and suppliers meeting EcoLeaf guidelines.

## C.3 SINGAPORE

Singapore’s Building and Construction Authority (BCA)<sup>125</sup> establishes programs and standards for the city-state’s building sector. BCA operates the Green Mark Scheme, a building rating system established in 2005, which includes a voluntary LCA-based component.<sup>126</sup> Green Mark standards include guidance for materials selection and calculating embodied carbon; BCA provides a Carbon Calculator to assist quantification of embodied carbon impacts.

## 2.4 DISCUSSION

Embodied carbon policy is increasingly viewed as a critical component for phasing out global carbon emissions by 2050. In the short-term, new policies encourage the building sector to track, report and consider environmental impact data including embodied carbon – a pivotal first step to help motivate industries with limited self-led, scalable initiatives to promote emissions accounting as standard practice. In the mid- to long-term, embodied carbon policies underpinned by a robust technical framework, clear goals, and standards targeting carbon-intensive are valuable tools helping jurisdictions to meet emissions reduction targets.

The growing focus on embodied carbon arises from increasing recognition of a life cycle emissions gap not addressed by longstanding energy efficiency and renewable energy measures, or ‘operational carbon’ policies. While existing and emerging embodied carbon policies across the world are well-positioned to reduce the total carbon footprint of a building, recent research on the global ‘carbon

<sup>122</sup> Public Services and Procurement (Canada), “Integrated Design Process - Knowledge Areas - NPMS - Real Property - PSPC,” 2005, <https://www.tpsgc-pwgsc.gc.ca/biens-property/sngp-npms/bi-rp/conn-know/enviro/pci-idp-eng.html>.

<sup>123</sup> Public Works and Government Services (Canada), “Integrated Design Process - Knowledge Areas - NPMS - Real Property - PSPC,” November 2005, <https://www.tpsgc-pwgsc.gc.ca/biens-property/sngp-npms/bi-rp/conn-know/enviro/pci-idp-eng.html>.

<sup>124</sup> Japan Environmental Management Association for Industry, “EcoLeaf Overview | EcoLeaf Environmental Label,” accessed December 13, 2018, <http://www.ecoleaf-jemai.jp/eng/>; Japan Environmental Management Association for Industry, “JEMAI Environmental Label Program (EcoLeaf/Carbon Footprint Communication Program) Base Document,” 2013, <http://www.ecoleaf-jemai.jp/eng/data/JG-01-02.pdf>.

<sup>125</sup> Singapore Government, “Building & Construction Authority,” accessed December 13, 2018, [https://www.bca.gov.sg/AboutUs/about\\_bca.html](https://www.bca.gov.sg/AboutUs/about_bca.html).

<sup>126</sup> Singapore Government, “About BCA Green Mark Scheme,” accessed December 13, 2018, [https://www.bca.gov.sg/greenmark/green\\_mark\\_buildings.html](https://www.bca.gov.sg/greenmark/green_mark_buildings.html).

loophole’ highlights a significant gap in current policy that governments must address in order to make a true impact on global GHG emissions reduction.<sup>127</sup>

The ‘carbon loophole’ describes policies and national emission levels in an international context, considering the trajectory of embodied carbon attributed to goods and products through the global economy. The term considers emissions ‘offshoring’, a growing issue impeding international progress to meet global climate action targets. As developed countries phase out local production-based emissions and demonstrate progress toward meeting national emissions targets, they increasingly rely on developing countries to carry out carbon-intensive manufacturing practices no longer permitted or financially viable due to stringent local measures. This results in a redistribution of emissions that most policies are not considering, meaning that nations lack a holistic understanding of the carbon footprint of imported materials, and therefore do not have an accurate assessment of national progress toward meeting global GHG emissions targets.

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<sup>127</sup> Daniel Moran, Ali Hasanbeigi, and Cecilia Springer, “The Carbon Loophole in Climate Policy: Quantifying the Embodied Carbon in Traded Products,” 2018, <https://buyclean.org/media/2016/12/The-Carbon-Loophole-in-Climate-Policy-Final.pdf>; Renilde Becqué et al., “Europe’s Carbon Loophole - Draft Report for Consultation,” 2017, [https://www.climateworks.org/wp-content/uploads/2017/09/EU-carbon-loophole\\_final-draft-for-consultation.pdf](https://www.climateworks.org/wp-content/uploads/2017/09/EU-carbon-loophole_final-draft-for-consultation.pdf).