

# APPENDIX C: RESOURCES

<b>Appendix C.1</b>	<b>Policy resource collection</b>
<b>Appendix C.2</b>	<b>Low Carbon Canada Initiative</b>
<b>Appendix C.3</b>	<b>North American Data Center Overview</b>
<b>Appendix C.4</b>	<b>Normalization method</b>

## **Appendix C.1**

### **Policy resource collection**

Note:

For a list of additional external resources (not specifically related to policy) compiled by the Carbon Leadership Forum, go to:

<http://www.carbonleadershipforum.org/resources/external-resources/>

For a sortable database of these resources, go to:

[CLF's Embodied Carbon Resources Database \(Google Sheet\)](#)

## Appendix C.1

### Policy Resource Collection

#### OVERVIEW

This Appendix is a collection of educational information, which the research team collated to provide high-level resources targeted to US-based policy professionals. Resources include official legislation and policy documentation, professional reports and whitepapers, research studies, recorded webinars, websites of programs and groups focused on embodied carbon and/or related policy, and more.

This document presents resources within four tables:

- C1 - Official documentation related to current US-based policies and programs
- C2 - High-level information on embodied carbon context and policy
- C3 - Tools and resources for general decision-making and technical support
- C4 - National and regional collaborations

#### RESOURCE TABLES

TABLE C1 – OFFICIAL DOCUMENTATION RELATED TO CURRENT US-BASED POLICIES AND PROGRAMS

1.1 Buy Clean California Act			
Title and link	Type	Source	Overview
<a href="#">AB 262: Buy Clean California Act</a>	Official legislation (2017)	CA State Legislature	Original bill signed into law on October 15, 2017
<a href="#">AB 1817: Amendment to Buy Clean California Act</a>	Official legislation (2018)	CA State Legislature	Signed into law June 27, 2018 - amends existing language and implementation dates
<a href="#">Proposed State Contracting Manual language</a>	Government document (2018)	CA Department of General Services (DGS)	Proposed language developed to provide policies, procedures and guidelines to CA state agencies when implementing law
<a href="#">Proposed Global Warming Potential (GWP) methodology</a>	Government document (2018)	CA DGS	Proposed methodology for calculating the GWP for the eligible materials
<a href="#">External Stakeholder Comments</a>	Government document (2018)	CA DGS	Comments submitted in response to the AB 262 External Stakeholder Outreach Event held by DGS on June 26, 2018
<a href="#">2016 California Green Building Standards Code (CALGreen)</a>	(2016)	CA Building Standards Commission	Includes two voluntary tier measures for LCA and WBLCA credits similar to LEED v4
1.2 Buy Clean Washington			
Title and link	Type	Source	Overview
<a href="#">HB 2412: Creating the buy clean Washington act</a>	Proposed legislation (2018)	WA State Legislature	Original bill introduced in the House Committee on Capital Budget in January
<a href="#">SHB 2412: Creating the buy clean Washington act</a>	Proposed legislation (2018)	WA State Legislature	Substitute bill introduced in February
<a href="#">House Capital Budget Committee - public hearing on HB 2412</a>	Video recording (2018)	WA State Legislature	Recorded public hearing held by House Capital Budget Committee. HB 2412 discussion/ testimonies begin at 44:45 of recording

<a href="#">Engrossed Substitute Senate Bill 6095</a>	Official legislation (2018)	WA State Legislature	Sec. 1030 and Sec. 5014 define scope and allocate funding for: (1) Buy Clean Washington Pilot (led by DGS) and (2) Buy Clean Washington Study (led by UW)
<a href="#">EO 1801: State efficiency and environmental performance</a>	Executive order (2018)	State of Washington Office of the Governor	Mandates state agencies to consider and account for GHS emissions
<b>1.3 Oregon</b>			
Title and link	Type	Source	Overview
<a href="#">HB 3161</a> and <a href="#">HB 3162</a>	Proposed legislation (2017)	Oregon State Legislature	Proposed requirements for Oregon Department of Transportation to establish pilot program to assess how procured products affect emissions of carbon dioxide
<a href="#">EO NO. 17-20: Accelerating efficiency in Oregon's built environment to reduce greenhouse gas emissions and address climate change</a>	Executive order (2017)	State of Oregon Office of the Governor	Outlines a number of energy efficiency measures for Oregon's building sector, including a directive for Oregon state agencies to analyze feasible options for lowering embodied carbon of building materials
<a href="#">Oregon Concrete EPD Program</a>	Official website	Oregon Concrete & Aggregate Producers Association	Supports concrete manufacturers to measure and report environmental impacts of concrete mixes through EPDs. Includes a web-based tool, a reimbursement incentive, and direct technical assistance to manufacturers
<b>1.4 US-based green building rating systems, codes and programs</b>			
Title and link	Type	Source	Overview
<a href="#">LEED v4.1</a>	Rating system/certification program	USGBC	Provides certifications at different levels based on number of points awarded for green building features
<a href="#">Living Product Challenge</a>	Certification program	International Living Futures Institute (ILFI)	Assesses products from cradle-to-grave, taking into account product's impact on energy consumption, water use and human health
<a href="#">Zero Carbon Certification</a>	Certification program	International Living Futures Institute (ILFI)	Requires projects to offset 100% operational carbon through renewable energy, and the total embodied carbon impact of construction
<a href="#">2030 Challenge for Products</a>	GWP reduction targets	Architecture 2030	Performance targets set for every decade leading to 2050 to realize zero product emissions
<a href="#">Green Globes</a>	Rating system/certification program	Green Building Initiative (GBI)	Uses an ANSI-approved consensus development process, in which energy performance is measured against regional performance data instead of baseline data from a typical building
<a href="#">B3 - Buildings, Benchmarks &amp; Beyond</a>	Government program	State of Minnesota	Includes an LCA component (Guideline M.1), requiring WBLCA for state-funded new building and major renovation projects
<a href="#">2012 International Green Construction Code (IgCC)</a>	Model code	International Code Council	A regulatory framework for new and existing buildings, establishing minimum green requirements for buildings and complementing voluntary rating systems

TABLE C2 – HIGH-LEVEL INFORMATION ON EMBODIED CARBON CONTEXT AND POLICY

2.1 Embodied Carbon Context			
Title and link	Type	Source	Overview
<a href="#">The Built Environment and Embodied Carbon Emissions</a>	Webinar (2017)	West Coast Climate & Materials Management Forum	Speakers explain the context of embodied carbon impacts, why they matter, and how they can be reduced (includes policies)
<a href="#">The Urgency of Embodied Carbon and What You Can Do about It</a>	Web article (2018)	Building Green	Describes the context of embodied carbon and issues around tracking, reporting and reducing its impact
<a href="#">USGBC LEED v4 Education Series: Materials and Resources</a>	Portal of educational resources (e.g. webinar courses)	USGBC	Educational courses presented in multiple formats. Relevant resources include “Demystifying EPDs” and “Whole Building Life-Cycle Assessment Basics”
<a href="#">Whole Life Carbon Assessment for the Built Environment, 1st edition</a>	Professional guidance report (2017)	Royal Institution of Chartered Surveyors	Guidance mandating a whole life approach to reducing carbon emissions within the built environment
2.2 Embodied Carbon Policy			
Title and link	Type	Source	Overview
<a href="#">The Embodied Carbon Review</a>	Report (2018)	OneClick	Reviews global certifications and regulations addressing embodied carbon emissions from construction materials
<a href="#">Embodied Carbon of Buildings and Infrastructure: International Policy Review</a>	Report (2017)	Forestry Innovation Investment	Reviews policy approaches by ‘leading’ countries addressing embodied carbon and best practices that could be considered in the development of a carbon framework
<a href="#">Embodied Carbon in the Built Environment: Change Through Policy</a>	Webinar (2018)	Embodied Carbon Network	Speakers presents knowledge, strategies and case studies related to policies addressing embodied carbon
<a href="#">The Carbon Loophole in Climate Policy: Quantifying the Embodied Carbon in Traded Products</a>	Report (2018)	KGM & Associates, Global Efficiency Intelligence	Provides updated analysis on the ‘carbon loophole’, a term to describe global imported consumption-based or embodied carbon levels
<a href="#">Buy Clean CA webinar</a>	Webinar (2018)	Thinkstep	Overviews law requirements and considerations/recommendations from an industry/LCA expert group perspective
<a href="#">IPCC Special Report – Summary for Policymakers</a>	Report summary (2018)	IPCC	Presents high-level findings of the IPCC Special Report (assessment of global warming research)
2.3 Case Studies			
Building Project	Key Details	Source	Overview
Helen Sommers Building	<a href="#">Measuring and Reducing Embodied Carbon in Concrete</a>	Sellen Construction	In-depth information on how the Sellen project team reduced the embodied carbon in concrete for the state-funded Helen Sommers Building
University of British Columbia Brock Commons Tallwood House	<a href="#">Brock Commons Time Lapse</a>	Naturally:wood	Overview of building project and estimated GHG emissions saved due to low carbon materials selection

TABLE C3 - TOOLS AND RESOURCES FOR DECISION-MAKING

3.1 RESOURCES TO SUPPORT DECISION-MAKING BY POLICY/GOVERNMENT PROFESSIONALS			
Title and link	Type	Source	Overview
<a href="#">Climate Friendly Purchasing Toolkit</a>	Toolkit	West Coast Climate & Materials Management Forum	Resources to help policymakers target the most significant GHG emissions in a public institution's supply chain, or the production of goods and services
<a href="#">Circularity in the Built Environment: Opportunities for Local Government Leadership</a>	Primer report (2018)	StopWaste, Arup	Presents government officials a high-level circular economy framework for the built environment at the community, neighborhood and building scales
3.2 TECHNICAL RESOURCES TO SUPPORT POLICY STANDARDS			
Title and link	Type	Source	Overview
<a href="#">Embodied Carbon in Construction Calculator (EC3)</a>	WA-based pilot program	Skanska USA, Carbon Leadership Forum, C-Change Labs	Collaborative project hosted at the University of Washington to develop an open-source EPD database sortable based on embodied carbon. Designed to align with and support building sector initiatives needing integrated data and tools to implement embodied carbon targets
<a href="#">Carbon Smart Building Materials Palette</a>	Interactive web-based tool	Architecture 2030	Provides designers with attribute-based guidelines for (1) designing buildings with low- or zero embodied emissions, and (2) specifying construction materials with low- or no-embodied carbon
<a href="#">Embodied Carbon: Developing a Client Brief</a>	Professional guidance report (2017)	UK Green Building Council	Provides industry professionals knowledge and resources to use when working with clients to request embodied carbon measurements
<a href="#">LCA Model Specifications V1</a>	Model specification templates (2017)	Carbon Leadership Forum	Provides editable model specification language for EPD/LCA data collection
<a href="#">LCA Practice Guide</a>	Professional guidance report (2018)	Carbon Leadership Forum	Introduces life cycle assessment concepts to building professionals and explains how to determine the environmental impacts of a building
<a href="#">LCA Technical Guidance</a>	Professional guidance report (2018)	Carbon Leadership Forum	Provides technical recommendations to support applying LCAs to buildings in North America. Supplements the <i>LCA Practice Guide</i> and intended for LCA experts

TABLE C4 - NATIONAL &amp; REGIONAL COLLABORATIONS

4.1 Sources	
Title and link	Overview
<a href="#">Embodied Carbon Network</a>	WA-based initiative convened by the UW Carbon Leadership Forum that brings together building sector professionals, researchers, and environmental advocates. Members focus on tracking/measuring/reducing embodied emissions. Network comprises ten topical groups focused on subjects related to embodied carbon, including a Policy Focus Group. Currently, there are over 360 members based throughout the world.
<a href="#">West Coast Climate and Materials Management Forum</a>	Collaboration of state, local, and tribal governments that develop ways to push sustainable materials management into standard practice. The forum identifies and shares effective greenhouse gas emission reduction strategies that also improve the way communities source, use, and recover materials throughout life cycle.
<a href="#">Bay Area Materials Working Group – Low-Carbon Concrete Codes Project</a>	Project consortium working to produce model code language for local governments to adopt low embodied-carbon concrete specifications for residential and non-residential applications. Project will provide technical assistance to four pilot projects to apply the specifications.
Structural Engineers (SE) 2050 Commitment Initiative. Supported by <a href="#">ASCE SEI Sustainability Committee</a>	Challenges structural engineers to meet embodied emissions 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 emissions baseline.

## **Appendix C.2**

### **Low Carbon Canada Initiative**





**NRC-CNRC**

**CONSTRUCTION**

**Developing a Low-Carbon Canada through Life Cycle Assessment in  
Infrastructure Projects – A National Low Carbon Infrastructure Initiative**

**A proposal for discussion**



National Research  
Council Canada

Conseil national de  
recherches Canada

**Canada** 

Authors: Geoffrey Guest, Ph.D., National Research Council of Canada  
Trevor Nightingale, Ph.D., National Research Council of Canada  
Jason Urquhart, P.Eng., National Research Council of Canada  
Jieying Zhang, Ph.D., National Research Council of Canada

Selected list of key supporting organizations:

- Athena Sustainable Materials Institute
- Atlantic Woodworks
- B.C. Climate Secretariat
- C-Change-Labs
- Canadian Cement Association
- Canada Green Building Council
- Canada Precast Pre-stressed Concrete Institute
- Canadian Standards Association Group
- Canadian Wood Council
- Clean Energy Canada
- Environment Climate Change Canada
- International Reference Centre for the Life Cycle of Products, Processes and Services (CIRAIG)
- National Research Council of Canada
- Natural Resources Canada
- Public Services and Procurement Canada
- The Forest Products Association of Canada
- Treasury Board Secretariat of Canada
- University of Calgary
- University of Sherbrooke
- University of Toronto
- Zizzo Strategy

Report Date: 5 November 2018

## Proposal Summary

**Motivation:** In the absence of climate action, climate change is estimated to cost Canada \$21-\$43 billion per year by 2050.<sup>1</sup> To address this pressing issue, the Federal, Provincial and Territorial governments have committed to reducing their greenhouse gas (GHG) emissions by 30% by 2030, and the Government of Canada (GoC) is also committed to 80% reductions of its operational GHG emissions by 2050. Current GoC pilot projects have focused on reducing the GHG operational emissions of GoC buildings as buildings account for 90% of its carbon footprint. Canadian industry experts have also joined the GoC in starting to develop procurement policy recommendations that will support the Pan-Canadian Framework objectives of GHG emissions reduction as well as spur innovation and build a robust economy based on clean growth.<sup>2</sup> These are all steps in the right direction; however, to realistically and efficiently achieve these ambitious goals will require a more holistic and coordinated approach, and perhaps more importantly, need sophisticated tools and quality databases to ensure robust results and facilitate quick adoption on a broader scale.

**Public and private sectors in support of the implementation of LCA:** The use of the relatively new practice of life cycle assessment (LCA) promises a greater and more integrated approach by going beyond operational GHG emissions reduction and addressing carbon emissions in all four stages of a built asset:

- emissions linked to the manufacture, transport and construction of building materials;
- emissions due to asset construction;
- emissions/sinks associated with asset operation; and,
- emissions during the de/re-commissioning of the asset.

For many years in Canada, focus has been on GHG emissions associated with asset operations. This has resulted in a robust green construction industry valued at \$23.5 billion in 2014 while also generating nearly 298,000 direct jobs that produced green materials and technologies, and contributed to designing and constructing low-carbon buildings.<sup>6</sup> This industry now recognises the importance of addressing carbon emissions in the other stages of a built asset and is showing growing interest in the Canada Green Building Council's Zero-Carbon Building Standard<sup>7</sup> which requires estimating the total carbon footprint using LCA.

### Several provincial and municipal initiatives requiring LCA

The Ministry of Infrastructure Ontario recognizes the importance of integrating environmental LCA into their infrastructure planning, procurement, business case development and decision-making processes and they plan to use LCA in the near future.<sup>3</sup> The province of Quebec developed an initiative to increase the use of wood in construction, requiring a comparative analysis (LCA-based) of life cycle GHG emissions for structural materials in provincially funded projects.<sup>4</sup> Both Alberta and Nova Scotia are presently establishing similar Wood Charters as Quebec which will also require life cycle emissions data at the funding application stage. Municipally, Vancouver is taking the lead, introducing a new low-carbon rezoning policy with a compliance path that requires the reporting of embodied emissions using a whole-building LCA perspective.<sup>5</sup> Beyond these examples it is evident that the LCA tool is playing an important role in GHG reporting and mitigation in various jurisdictions across Canada.

Integrating LCA into decision making will ensure that climate change mitigation is fully considered during the planning process, and thus support selection and use of lower-carbon materials and services during procurement and construction. When LCA is coupled with life cycle cost assessment (LCCA) it becomes

<sup>1</sup> Assumes no adaptive action taken: National Round Table on the Environment and the Economy (2011) Climate Prosperity: Paying the price: The Economic Impacts of Climate Change For Canada. Report 04. <http://nrt-trn.ca/wp-content/uploads/2011/09/paying-the-price.pdf>

<sup>2</sup> Clean Energy Canada (2018) The Power of Procurement: Cutting the federal government's carbon emissions. [http://cleanenergycanada.org/report/procurement-federal-emissions/](http://cleanenergycanada.org/report/procurement-federal-emissions/http://cleanenergycanada.org/report/procurement-federal-emissions/)

<sup>3</sup> Ministry of Infrastructure Ontario (2017) Building better lives: Ontario's long-term infrastructure plan 2017. <https://www.ontario.ca/document/building-better-lives-ontarios-long-term-infrastructure-plan-2017/chapter-2-planning-future#section-2>.

<sup>4</sup> Government of Quebec (2017) The Wood charter. <https://www.mffp.gouv.qc.ca/publications/forets/entreprises/charte-du-bois-anglais-Web.pdf>.

<sup>5</sup> City of Vancouver (2017) Green buildings policy for rezoning. <http://guidelines.vancouver.ca/G015.pdf>

<sup>6</sup> In 2014: DelphiGroup (2018) Green building in Canada – Assessing the market impacts & opportunities.

[https://www.cagbc.org/CAGBC/Advocacy/Green\\_Building\\_in\\_Canada\\_Assessing\\_the\\_Market\\_Impacts\\_Opportunities.aspx](https://www.cagbc.org/CAGBC/Advocacy/Green_Building_in_Canada_Assessing_the_Market_Impacts_Opportunities.aspx).

<sup>7</sup> CaGBC (2017) Zero carbon building standard. [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).

possible to assess the total cost of ownership (TCO) which now enables asset owners to make a fully informed financial decision when adjudicating construction bids for private and public sector projects.

**Enabling reliable assessment of emissions and ownership cost:** The NRC's *National Low-Carbon Infrastructure Initiative* will provide enhanced and integrated tools, guidelines and databases to empower Canadians to take carbon-based decision-making actions:

A first of its kind centralized and validated national Life-Cycle Inventory (LCI) database is required to unleash the full potential of LCA and allow for fair comparison of tendered projects both in terms of life-cycle GHG emissions and in the total cost of asset ownership over its lifespan. Robust, defensible, and meaningful evidence-based carbon decision-making requires high-quality LCI data. The core of this initiative therefore revolves around establishing a publicly accessible, transparent, scientifically robust, regionally relevant, and ever-growing national LCI database where the onus will initially be placed on construction materials and followed by transportation, fuel pathways and beyond.

Whole-infrastructure LCA guidelines and enhanced LCA tools (infrastructure-specific) will further assist in providing the step-by-step approach needed to measure, evaluate, and track the full life-cycle of carbon emissions of buildings and infrastructures. The tools and guidelines will leverage the LCI database, stimulate innovation in low-carbon materials, technologies and design, and contribute to aligning capital investment decisions with sustainability policies at all jurisdictional levels across Canada. This will be reinforced by changes to the National Master Construction Specifications.

The development of both will require close partnership with a consortium of stakeholders from across industry, government and academia to ensure equal opportunities and innovation is stimulated throughout the low-carbon supply chains and infrastructure design.

**Economic and Innovation Outcomes:** The global market for low-carbon goods and services is worth over \$5.8 trillion, and it is projected to grow 3% per year.<sup>2</sup> Canada's green building industry is worth \$23.5B in GDP and directly supports an estimated 298,000 jobs<sup>8</sup>. Embedding LCA in the infrastructure procurement decision making process will accelerate the growing trend of Canadian companies developing advanced green materials and energy efficient technologies, increase their competitive edge and access to both domestic and foreign markets like Europe, Asia and the United States.<sup>9</sup> Open and transparent requirements in the LCA guidelines and tools will enable all construction material segments to participate in the development of materials, systems, and designs selected for projects based on their performance. This non-prescriptive approach will stimulate innovation by being democratic and inclusive and will enable informed financial decisions that will lower the TCO of Canada's built assets.

Deferred maintenance (DM) is a large and growing problem in Canada because operating budgets do not accommodate the high back-end cost of low-up-front construction bids. Municipal governments have seen a 10-fold growth in their deferred maintenance since 1985, the university sector more than doubling since 2000 and estimates of accumulated DM costs for hospitals ranging between \$15B and \$20B.<sup>10</sup> This project will benefit Canada as a whole by developing the tools needed to curb this trend and to systematically address this DM in a methodical and most cost effective manner.

**Willing Consortium of Support:** The *National Low-Carbon Infrastructure Initiative* will require a total of four years to establish all elements to full operational readiness. The estimated \$7-9M of funding required will be delivered through a consortium of stakeholders each being a member of the Steering Committee that will set the overall direction and priorities, oversee and direct the Initiative projects, each designed to deliver one or more outputs defined by the Steering Committee. Projects will be delivered by Technical Teams working collaboratively, comprised of Canada's leading talent from industry, academia, and government labs, and making use of existing knowledge and data, where possible.

Critical mass has been achieved with commitments or expression of strong interest to join (by NRC, NRCan, TBS, PSPC, Canadian Wood Council, Cement Association of Canada, and others). The Initiative will launch in

---

<sup>8</sup> Canada Green Building Council, "NATIONAL GREEN BUILDING ECONOMIC IMPACT"

<sup>9</sup> See footnote 2.

<sup>10</sup> Deferred Hospital Maintenance in Canada. [http://www.healthcarecan.ca/wp-content/themes/camyno/assets/document/Reports/2015/HCC/EN/Deferred%20Maintenance\\_EN.pdf](http://www.healthcarecan.ca/wp-content/themes/camyno/assets/document/Reports/2015/HCC/EN/Deferred%20Maintenance_EN.pdf)

January 2019 with the first Steering Committee meeting. Meantime, consultation of over fifty other stakeholders from across Canada is underway.

Please contact Marcel Lavoie for more details: [Marcel.Lavoie@nrc-cnrc.gc.ca](mailto:Marcel.Lavoie@nrc-cnrc.gc.ca) .

## **Appendix C.3**

### **North American Data Center Overview**

# A North American life cycle inventory data center

Jeremy Gregory, Massachusetts Institute of Technology

Debbie Steckel, American Center for Life Cycle Assessment

April 2017

## Summary

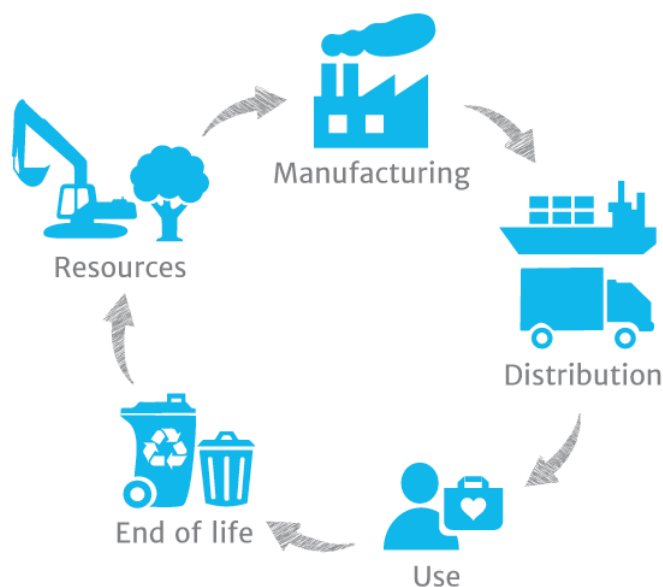
We are seeking \$3M in funding over a four-year period to seed the creation of a center to manage North American life cycle inventory data. Such data is critical for conducting life cycle assessments, which are increasingly used to support government and industry policy and design decisions that involve product environmental footprints. High-quality and transparent data will increase the confidence in and use of these important analyses, which are starting to be used in many economic sectors.

We have assembled a diverse set of stakeholders to support the development of the data center. These stakeholders come from a broad array of sectors including government, academia, industry, academia, and consulting. A primary objective of the group is to establish a business model that ensures the long-term viability of the center.

## Motivation

Quantitative assessments of products' life cycle environmental footprints are increasingly used to support decisions in policy and government arenas. For example, the [US EPA](#) requires an assessment of the environmental footprint of renewable fuels before they can be approved under the Renewable Fuel Standard. The [US Green Building Council](#) provides points in its LEED building standard for the use of building products that have a quantified environmental footprint.

Life cycle assessment (LCA) is the methodology used to quantify a product's environmental footprint throughout its entire life cycle from cradle to grave. Life cycle inventory (LCI) data is used in every LCA. It includes information on material and energy inputs for each process in the life cycle, along with emissions to air, land, and water. LCAs rely on databases that include LCI data for thousands of processes such as transportation, electricity generation, and material production.



<http://www.ecoenterprises.qc.ca/innovate-and-optimize/business/life-cycle-assessment>

High quality LCI data is a critical component of a reliable LCA. Most of the best LCI data comes from Europe. While there have been some efforts to create an LCI database for the US, efforts have stalled due to a lack of reliable funding sources. There are numerous gaps in existing US LCI data, the data are not updated, and there is no consistent format.

*There is broad consensus that there is a need for high-quality, transparent life cycle inventory data applicable to North American industry.*

## Vision

We are creating a center to cultivate and maintain transparent LCI data that support North American industry and policy decisions and that are interoperable with data from other regions. A top priority for the center is a business plan that ensures its long-term viability.

## Creation of the Center

A coalition of partners interested in creating the center will assemble and create a request for quotes (RFQ) targeting an organization that will operate the center. The coalition will establish the terms of the RFQ, evaluate the quotes submitted, and select an entity to run the data center. Key considerations in the RFQ would include scope of the center's activities (e.g., LCI data only, or consulting as well), tax status (e.g., profit or non-profit), and details expected in the proposed center's business model.

Coalition partners will contribute funds that will be used to seed the data center in its start-up phase before subscription fees could fully fund the center, similar to a start-up business with investors. Terms will be established for what partners would receive in exchange for seed funding (e.g., access to LCI data for a certain period of time without paying fees).

An advisory board will also be created that includes stakeholders who would like to contribute to the process of creating the center, but are not able contribute financially to be a member of the coalition. Advisory board members will not have voting status for decisions related to the creation of the center.

The American Center for Life Cycle Assessment will act as the legal entity that manages the creation of the center, including writing contracts for each coalition partner, receiving fees from the partners, managing selection of the entity chosen to run the center, creating a contract for the entity, and distributing fees to the entity. However, it is important to note that this would purely be an administrative role. This effort will be truly collaborative and it is in our interest to ensure that a broad range of stakeholders are engaged in the creation of the center.

## Stakeholders engaged in the process

A stakeholder group has begun to shape the vision for the center and define the terms of coalition and advisory group members. The group has had numerous web and in-person meetings over the course of several months and includes representatives from a wide variety of entities listed here.

- **Government:** FHWA, National Energy Technology Laboratory, NIST, National Renewable Energy Laboratory, Natural Resources Canada, USDA, USEPA, USFS, US Green Building Council
- **Industry:** American Chemistry Council, Apple, Chevron, Dow, Dupont, Eastman, GE, Interface, International Copper Association, National Asphalt Paving Association, National Ready Mixed Concrete Association, P&G, Portland Cement Association, Sabic, SETAC, Siemens, Steel Recycling Institute, The Aluminum Association, The Sustainability Consortium, US Green Building Council
- **Academia:** Arizona State, Carnegie Mellon, Harvard, MIT, Michigan Tech, Northeastern, Polytechnique Montréal, UC Santa Barbara, UC Berkeley, UC Davis, U of Illinois-UC, U of Pittsburgh, U of Washington, Yale
- **LCA Consulting:** CADIS, EarthShift Global, ERG, Pre, Quantis, thinkstep, WSP



## Seed Funding

We are seeking \$3M in seed funding to support the initial creation of the center over a four-year period. \$2M will be used to support the first two years of the center while it is creating its database. At the beginning of year three support will decrease to \$750k as the center starts to receive revenue from other sources (e.g., subscription fees for the database, or additional longer-term investment). Support will decrease further in year four to \$250k as the center receives increased revenue. No further seed funds will be provided after year four.

Funds from coalition partners will be used as seed funds. A maximum of \$250k is expected from coalition partners. We are seeking the remaining \$2.75M from other partners.

## Timeline

Activities to-date:

- May 2, 2016: Kick-off web meeting with stakeholders
- Summer 2016: stakeholder survey
- September 30, 2016: stakeholder meeting at LCA XVI
- Fall 2016: two web meetings about value proposition and coalition membership

Next steps:

- Develop contract for coalition members
- Recruit coalition and advisory group members
- RFP development
- Obtain seed funding
- Once seed funding is obtained:
  - Distribute RFP
  - Select entity
  - Open NA LCI Data Center

## Appendix C.4

### Normalization method

As described in Chapter 3 and Chapter 5, in order to permit design and construction flexibility, could permit use of weighted average calculations to enable ‘outlier’ high carbon options for select applications provided that other low carbon options can offset impacts above a performance threshold.

In order to compare performance results, project teams could normalize their embodied carbon values in each material category by dividing the total embodied carbon (in kg CO<sub>2</sub>e) by the total material weight in each category. An example of this calculation is shown as follows:

*Assume that a project has:*

- 1000 kg of Type 1 steel with an embodied carbon impact of 1.0 kg CO<sub>2</sub>e/kg steel
- 2000 kg of Type 2 steel with an embodied carbon impact of 2.0 kg CO<sub>2</sub>e/kg steel

*The total weighted embodied carbon impact is calculated as*

$$\begin{aligned}
 &= (\text{Embodied carbon of Type 1 steel}) + (\text{embodied carbon of Type 2 steel}) \\
 &= (1000 \text{ kg} \times 1.0 \text{ kg CO}_2\text{e/kg}) + (2000 \text{ kg} \times 2.0 \text{ kg CO}_2\text{e/kg}) \\
 &= (1000 \text{ kg CO}_2\text{e}) + (4000 \text{ kg CO}_2\text{e}) \\
 &= 5000 \text{ kg CO}_2\text{e total}
 \end{aligned}$$

*Dividing by the total weight of steel:*

$$\begin{aligned}
 &= (5000 \text{ kg CO}_2\text{e}) / (1000 \text{ kg Type 1 steel} + 2000 \text{ kg Type 2 steel}) \\
 &= 1.67 \text{ kg CO}_2\text{e/kg steel}
 \end{aligned}$$

*Thus, the normalized embodied carbon result for steel is 1.67 kg CO<sub>2</sub>e/kg steel.*

Using a normalized embodied carbon measure for each material, the resulting values should be equal to or less than the suggested benchmark value for that material category in order to meet Buy Clean requirements. In the example, if the benchmark value for steel is 2.0 kg CO<sub>2</sub>e/kg steel, then the result from the result from the example (1.67 kg CO<sub>2</sub>e/kg steel), being lower than the benchmark value, satisfies the benchmark requirements for steel.

If the results do not meet the benchmark requirements, then projects should select different material choices and re-perform the calculation. If projects are unable to meet the Buy Clean requirements, then the research team should seek special consultation with the Buy Clean program operators to explore alternative pathways to compliance.