Development of Wood Products LCA Data and Its Usage in Green Building Code Applications

Tools for Building Green with Wood

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There are three approaches referenced in the ICC 700 National Green Building Standard that allow for life cycle analysis (LCA) of products, built-up assemblies, or entire structures. AWC has completed sample LCAs for comparison of wood studs to steel studs using the National Institute of Standards and Technology’s (NIST) Building for Environmental and Economic Sustainability (BEES) program, as well as an LCA for an insulated wood stud wall assembly using Athena’s Impact Estimator. A whole building LCA will be conducted using REVIT software.
Upon completion of this course, participants will:

1. Learn what Life Cycle Assessment (LCA) is and how it is used to develop Environmental Product Declarations (EPD).
2. Learn about EPDs developed by the American Wood Council (AWC) and Canadian Wood Council (CWC) and how to use them in green building codes.
3. Learn how to apply LCA to earn credits in the National Green Building Standard (NGBS).
4. Discern differences in acceptable types of LCA in NGBS.
5. Learn about some of the software programs that are currently acceptable for LCA.

Polling Question #1

1. What is your profession?
   a) Architect
   b) Engineer
   c) Code Official
   d) Building Designer
   e) Other
Outline

• What is the ICC 700/ NGBS?
• What is LCA?
• Tools for LCA
• What is an EPD and how do you develop one?
• EPDs for the North American Wood Industry
• LCA in the NGBS
• Example
• Questions?

What is the ICC 700/NGBS?

• **ANSI/ NAHB/ ICC 700 – 2012 National Green Building Standard**
  • Residential green building rating system
  • Covers energy, water, IEQ, site, materials
  • Can be used for new construction or renovations
  • Can be used for single and multi-family homes
  • Contains provisions for land development of residential and mixed-use communities
What is the ICC 700/NGBS?

- **ANSI/NAHB/ICC 700 - 2012 National Green Building Standard**
  - Can be used by any designer or builder to certify a project
  - Can be used as a basis for a jurisdictional residential green code

What is the ICC 700/NGBS?

- **Changes from 2008 version**
  - IECC reference - 15% increase in energy performance
  - 2008 NGBS → 2006 IECC
  - 2012 NGBS → 2009 IECC
  - Two new chapters on renovations
  - Additional points for green community site selection
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What is LCA?

• LCA – Life Cycle Assessment
• Tool for the analysis of the environmental impacts of a product, material, or system
  • Includes resource extraction, manufacture, transportation, installation, use, maintenance, and disposal
• Yields results that are
  • Quantifiable
  • Standardized (ISO 14044)
  • Science-based
What is LCA?

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Tools for LCA

- How does the NGBS address LCA?
  - All tools used in LCA must be ISO 14044 compliant
    - SimaPro
    - GaBi
    - Revit plugin - "Tally"
    - Athena Impact Estimator
    - NIST BEES

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What is an EPD?

- **Types of Environmental Labels or “Ecolabels”**
  - Type I - ISO 14024 - awarded by 3rd party program to products that have good environmental attributes (usually single attribute)
    - Energy Star (appliances)
  - Type II - ISO 14021 - self-declared claims by manufacturer about some aspect of their product
    - Biodegradable product with manufacturer’s “green” label
  - Type III - ISO 14025 - Environmental Product Declaration (EPD)
    - Let’s talk about these more...

What is an EPD?

- **Environmental Product Declaration (EPD)**
  - “A concise, standardized, independently verified report on environmental performance”

- **ISO creates international standards for EPD development**
  - ISO 14025 - Type III EPDs
  - ISO 14040/ 14044 - LCAs
  - ISO 21930 - PCRs and EPDs for building products
How do you develop an EPD?

- **Program Operator**
  - Responsibilities set out in ISO 21930 standard, include:
    - Adopt, adapt, or develop PCR
    - Review and verify EPDs
    - Ensure standards are followed
  - UL Environment served as Program Operator for AWC/CWC EPDs
How do you develop an EPD?

- **Product Category Rules (PCR)**
  - PCR specify parameters to be considered for a given family of products
  - North American PCR developed by FPInnovations
    - Based on PCR from Norwegian EPD Foundation and German Institute for Construction and Environment
    - UL Environment adopted FPInnovations PCR for North American Wood Products

How do you develop an EPD?

- **Life Cycle Inventory/ Life Cycle Assessment**
  - LCI data collected by CORRIM (Consortium for Research on Renewable Industrial Materials)
  - CORRIM started collecting data on various stages of forest products harvest and manufacture in 2004
    - Data broken into modules that reflect environmental impacts of harvest and reforestation, transport of logs, and manufacture of wood products in various regions
    - CORRIM developed LCA reports to comply with PCR requirements
How do you develop an EPD?

- EPDs are based on LCA reports
  - EPDs produced under FPInnovations/ULE PCR report:
    - Global Warming Potential
    - Ozone Depletion Potential
    - Acidification Potential
    - Smog Potential
    - Eutrophication Potential
    - Additional LCI data per PCR

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EPDs for N. American Wood Industry

- AWC/CWC have published EPDs
  - Softwood Lumber
  - Softwood Plywood
  - OSB
  - Glued Laminated Timbers
  - LVL
  - Wood I-joists
  - Medium Density Fiberboard
  - Particleboard
  - Redwood Decking (AWC/ CRA)
- WRCA has EPD for Cedar Siding

EPDs for N. American Wood Industry

- EPD Third Party Verification form
EPDs for N. American Wood Industry

- EPDs are Business to Business (B2B) scope
  - Redwood decking and cedar siding are Business to Consumer (B2C)
- B2B scope also called “cradle-to-gate”
- B2C scope also called “cradle-to-grave”
- Multitude of potential uses for wood products makes cradle-to-grave EPD nearly impossible

EPDs for N. American Wood Industry

- LCA System Boundaries are shown in EPDs:
  - Shows what’s included, what’s not
- System boundaries are specified in PCR
EPDs for N. American Wood Industry

- How are EPDs used?
  - Green building certification programs
  - LEEDv4 MR credit – up to 2 points
  - Green Globes – up to 20 points
  - Make informed choices about building products
  - Allow manufacturers to analyze areas where products perform well vs. opportunities for reducing potential environmental impacts

Polling Question #2

2. All AWC EPDs are B2C (cradle-to-grave) in scope. True/False
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LCA in the NGBS

- How does the NGBS address LCA?
  - Three options provided for LCA:
    - Whole Building LCA - Section 610.1.1 (max 15 points)
    - Product LCA - Section 610.1.2.1 (max 10 points)
    - Assembly LCA - Section 610.1.2.2 (max 10 points)
LCA in the NGBS

• **Whole Building LCA (610.1.1) - 15 pts**
  
  “A whole-building LCA is performed using a life cycle assessment and data compliant with ISO 14044 or other recognized standards.”

• **LCA for product or assembly (610.1.2) - 10 pts**
  
  “An environmentally preferable product or assembly is selected for an application based upon the use of an LCA tool that incorporates data methods compliant with ISO 14044 or other recognized standards that compare the environmental impact of products or assemblies.”

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LCA in the NGBS

• **Product LCA (610.1.2.1)**
  
  **Compare two or more products for improved environmental impacts in:**
  - Fossil fuel consumption
  - Global warming potential
  - Acidification potential
  - Eutrophication potential
  - Ozone depletion potential

  **Points awarded for each comparison where the selected product improves upon the environmental impact measures by an average of 15%**
LCA in the NGBS

• **Product LCA (610.1.2.1)**
  - Points awarded based on number of impact measures showing improvement per product
  - Table 610.1.2.1

<table>
<thead>
<tr>
<th>Product LCA</th>
<th>4 Impact Measures</th>
<th>5 Impact Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>POINTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

• **Assembly LCA (610.1.2.2)**
  - Same environmental impact measures as Products
  - Can use assemblies for:
    - Exterior walls
    - Roof/ceiling
    - Interior walls or ceilings
    - Intermediate floors
  - Points awarded for each comparison where the selected assembly improves upon the environmental impact measures by an average of 15%
LCA in the NGBS

• **Assembly LCA (610.1.2.2)**
  - Points awarded based on number of assemblies and number of impact measure showing improvement
  - Table 610.1.2.2

<table>
<thead>
<tr>
<th>Building Assembly LCA</th>
<th>4 Impact Measures</th>
<th>5 Impact Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Types of Building Assemblies</td>
<td>POINTS</td>
<td>POINTS</td>
</tr>
<tr>
<td>2 types</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>3 types</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>4 types</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

Each impact measure need not improve by 15% - just the overall average!

Polling Question #3

• **Global Warming Potential is NOT** one of the impact categories that must be compared between LCA analyses in the NGBS.
• True/False
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Example

- So how do we do LCA?
  - Three Options
    - Product
    - Assembly
    - Whole Building
Example - Product

- **Starting small...**
  - Individual Product LCA
  - Many programs available
  - Compare Product A to Product B
- **BEES Example**
  - [http://www.nist.gov/el/economics/BEESSoftware.cfm](http://www.nist.gov/el/economics/BEESSoftware.cfm)

Example - Product

- **Two products serving same function compared**
  - Commentary states “comparisons should be made between rational physical and economic choices for a particular building in a given locale.”
  - Wouldn’t compare carpet and imported marble for low income housing project, etc.
Example - Product

• **BEES Major Group Elements**
  • Building Maintenance
  • Building Repair & Remodeling
  • Building Sitework
  • Equipment and furnishing
  • Interiors
  • Shells
  • Substructures

Example - Product

• **Compare Steel Stud to Untreated Wood Stud**

Select Weighting

Select Major Element
Select Group Element
Select Individual Element
Example - Product

• Compare steel stud to wood stud

Example - Product

• Results Available:
  • Summary Graphs (Economic vs. Environmental Impacts)
  • Life-Cycle Stage Graphs
  • Environmental Flow Graphs
  • Embodied Energy Graphs
Example - Assembly

• **Next level...**
  • **Assembly LCA**
    • Impact Estimator by ATHENA (http://www.athenasmi.org/)
    • Takes into account impacts from:
      • Material manufacturing (resource extraction and recycled content)
      • Related transportation
      • On-site construction
      • Regional variation in energy use, transportation, etc.
      • Building type and assumed lifespan
      • Maintenance and replacement effects
      • Demolition and disposal

Example - Assembly

• **Same requirements regarding physically and economically appropriate comparisons**
  • Assemblies should include all structural elements, insulation, and wall coverings in LCA
  • Assemblies should NOT include electrical and mechanical equipment and controls, plumbing products, fire detection and alarm systems, elevators, and conveying systems.
Example - Assembly

- Athena Impact Estimator for Buildings
- Simple user inputs for predefined systems
  - Walls
  - Floors
  - Roof
  - Foundation

Example - Assembly

- Compare a wood-framed wall to a steel-framed wall
Example - Assembly

- Provide results of comparison for following impact categories
  - Fossil fuel consumption
  - Global warming potential
  - Acidification potential
  - Eutrophication potential
  - Ozone depletion potential

Example - Whole Building LCA

- The most rigorous ... but also worth the most points!
  - No comparisons are necessary
    - Perform whole building LCA with ISO 14044 compliant tool
      - Revit with Tally plugin used for this example
Example – Whole Building LCA

Environmental Impacts per Full Building Life

Building Materials

Acidification Potential: 653.6 kg CO2 eq 
Eutrophication Potential: 98.47 kg N eq
Ozone Depletion Potential: 1.98 to 2.75 kg CFC 11 eq
Smog Formation Potential: 10.714 O3 eq
Primary Energy Demand: 1,606.59 MJ
Non-renewable Energy: 1,096.338 MJ
Renewable Energy: 510.255 MJ

Results per Life Cycle Stage, itemized by CSI Division

Legend

- Net value (inputs + credits)
- Manufacturing
- Energy
- Waste
- Water
- Air
- Noise
- Ozone
- Erosion
- Land use
- Water use
- Energy use
- Transportation
- Water pollution
- Soil pollution
- Air pollution
- Noise pollution

Global Warming Potential
Primary Energy Demand
Polling Question #4

4. Which of these LCA options does not require a comparative analysis between two or more options?

   a) Whole building
   b) Product
   c) Assembly
   d) Component

Questions?

• This concludes The American Institute of Architects Continuing Education Systems Course

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