Challenges of assessing life cycle impacts of buildings

Life-Cycle Energy & Related Impacts of Buildings Webinar Series

October 29, 2020
Agenda

I. Opening Remarks
   Karma Sawyer, Program Manager, U.S. DOE Building Technologies Office

II. Introduction to Life Cycle Carbon Assessment (LCA)
   Lyla Fadali - AAAS Policy Fellow, U.S. DOE Building Technologies Office

III. Whole-Building Life Cycle Analysis
   Jennifer O’Connor, President, Athena Institute

IV. Building Life Cycle Analysis with GREET
   Hao Cai, Principal Environmental Analyst, Argonne National Labs

V. Metrics & Tools for Sustainable Buildings
   Joshua Kneifel, Research Economist, National Institute of Standards and Technology

VI. Q&A Session
   Cedar Blazek - Management & Program Analyst, U.S. DOE Building Technologies Office
# Building Life Cycle Impacts DOE Webinar Series

<table>
<thead>
<tr>
<th>Topic</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview of life cycle impacts of buildings</td>
<td>Oct. 16</td>
<td>12:00pm – 1:00pm ET</td>
</tr>
<tr>
<td>Challenges of assessing life cycle impacts of buildings</td>
<td>Oct. 29</td>
<td>12:00pm – 1:00pm ET</td>
</tr>
<tr>
<td>Innovative building materials</td>
<td>Nov. 12</td>
<td>12:00pm – 1:00pm ET</td>
</tr>
<tr>
<td>“Real Life” buildings striving to minimize life cycle impacts</td>
<td>Dec. 3</td>
<td>12:00pm – 1:00pm ET</td>
</tr>
<tr>
<td>Intersection of life cycle impacts &amp; circular economy potential for the building sector</td>
<td>Dec. 17</td>
<td>12:00pm – 1:00pm ET</td>
</tr>
</tbody>
</table>
Poll Questions

• What industry are you from?
• How familiar are you with life cycle analysis tools?
Efficiency is key to meeting U.S. energy goals

Our Homes and Buildings Use More Energy than Any Other Sector

- Residential & Commercial: 40%
- Industrial: 32%
- Transportation: 28%

Source: EIA Monthly Energy Review
Building Technologies Office

BTO invests in energy efficiency & related technologies that make homes and buildings more affordable and comfortable, and make the US more sustainable, secure and prosperous.

Budget ~US$285M/year; activities include:

- **R&D**
  Pre-competitive, early-stage investment in next-generation technologies

- **Integration**
  Technology validation, field & lab testing, metrics, market integration

- **Codes & Standards**
  Whole building & equipment standards technical analysis, test procedures, regulations
DOE research has saved energy and saved consumers money

FOR EXAMPLE:

Past

Units half the price, almost 20% bigger, and 75% less energy to operate – AND have more features!

Efficient

• $550 purchase
• $50/year to operate
• 22 cubic feet
Our impact on a national scale

Energy efficiency standards completed through 2016 are expected to save 142 quadrillion Btu through 2030 — more energy than the entire nation consumes in one year.
BTO’s work is making a difference, but we’re missing part of the picture.
Historically, BTO has focused on operating buildings.

- **Global energy use in buildings**
  - Commercial: 22%
  - Building construction: 17%
  - Residential: 61%

- **Global emissions from buildings**
  - Commercial: 28%
  - Building construction: 28%
  - Residential: 44%

Global building stock expected to more than double, making embodied carbon increasingly important.

Global building stock through 2060

Source data from GlobalABC Status Report in 2017
Let’s look at the whole picture:

**Lifecycle carbon** refers to carbon emissions associated with all stages of a building’s life.

- Resource extraction
- Manufacturing
- Transportation
- Construction/Installation
- Equipment Replacement/Maintenance
- Demolition/End of life
- Operations

**Embodied carbon** is the carbon associated with all stages of a building’s life cycle not including operating the building.

**Operational carbon** is the carbon associated with operating the building.
### Reality is complicated.

<table>
<thead>
<tr>
<th>Which mine?</th>
<th>Which manufacturer?</th>
<th>How much material is needed?</th>
<th>How is the product used?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource extraction</td>
<td>Manufacturing</td>
<td>Construction/Installation</td>
<td>Equipment Replacement/Maintenance</td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
<td></td>
<td>Demolition/End of life</td>
</tr>
</tbody>
</table>

**Industry average?**

**How far?**

**How long does a building last?**

**Landfill or?**
Whole-Building Life Cycle Assessment

Athena Impact Estimator for Buildings

Middlesex Centre Wellness and Recreation Complex

Reduced total environmental impacts by 20%

Cornerstone Architecture Incorporated
COMMON WHOLE-BUILDING LCA RESULTS:

- Global Warming Potential (carbon footprint)
- Acidification Potential
- Eutrophication Potential
- Smog Potential
- Ozone Depletion Potential
- Human Health Particulate
- Fossil Fuel consumption
Rideau Valley Conservation Centre

Reduced embodied carbon impact by 100 metric tons CO₂.
Life Cycle Stages for a Building

Life cycle stages per EN 15978:11 *Sustainability of construction works — Assessment of environmental performance of buildings — Calculation method.*
**Athena databases**
- LCI data on materials, products, energy, transportation
- Rolled up LCA data on some products
- Scenario data: transportation distances, construction energy and waste, repair and replacement schedules, end of life treatment
- TRACI characterization factors

**User inputs**
- Material quantities
- Location, etc.
- Operating energy

**Athena Impact Estimator for Buildings**

**LCA results:** global warming, acidification, smog, etc

**LCI results:** air emissions, water emissions, resource use, etc

**Lifecycle bill of materials**
Choose closest city for regionally-accurate results.
Create a project
Option 1: Early design

Use dialogue boxes to quickly create assemblies. The software will calculate a bill of materials.
Create a project

Option 2: Import a bill of materials

Load a file and map it. Save the map for future projects.
Make custom concrete mixes as needed
Get detailed LCA and LCI results by life cycle stage and by assembly

<table>
<thead>
<tr>
<th>LCA Measures</th>
<th>Unit</th>
<th>PRODUCT (A1 to A3)</th>
<th>CONSTRUCTION PROCESS (A4 &amp; A5)</th>
<th>USE (B2, B4 &amp; B6)</th>
<th>END OF LIFE (C1 to C4)</th>
<th>BEYOND BUILDING LIFE (D)</th>
<th>TOTAL EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Total</td>
<td>Replacement</td>
<td>Operational Energy Use</td>
<td>Total Total</td>
<td>Total A to C</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>kg CO2 eq</td>
<td>5.45E+05</td>
<td>6.31E+04</td>
<td>9.31E+03</td>
<td>0.00E+00</td>
<td>9.31E+03</td>
<td>4.01E+04</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>kg SO2 eq</td>
<td>2.40E+03</td>
<td>5.02E+02</td>
<td>7.58E+01</td>
<td>0.00E+00</td>
<td>7.58E+01</td>
<td>5.05E+02</td>
</tr>
<tr>
<td>HH Particulate</td>
<td>kg PM2.5 eq</td>
<td>7.06E+02</td>
<td>3.36E+01</td>
<td>5.40E+00</td>
<td>0.00E+00</td>
<td>5.40E+00</td>
<td>2.38E+01</td>
</tr>
<tr>
<td>Eutrophication Potential</td>
<td>kg N eq</td>
<td>2.04E+02</td>
<td>3.41E+01</td>
<td>2.61E+00</td>
<td>0.00E+00</td>
<td>2.61E+00</td>
<td>3.14E+01</td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>kg CPC-11 eq</td>
<td>5.00E-03</td>
<td>2.43E-04</td>
<td>2.98E-04</td>
<td>0.00E+00</td>
<td>2.98E-04</td>
<td>1.66E-06</td>
</tr>
<tr>
<td>Smog Potential</td>
<td>kg O3 eq</td>
<td>3.66E+04</td>
<td>1.44E+04</td>
<td>6.30E+02</td>
<td>0.00E+00</td>
<td>6.30E+02</td>
<td>1.65E+04</td>
</tr>
<tr>
<td>Total Primary Energy</td>
<td>MJ</td>
<td>5.73E+06</td>
<td>7.95E+05</td>
<td>1.01E+05</td>
<td>0.00E+00</td>
<td>1.01E+05</td>
<td>5.93E+05</td>
</tr>
<tr>
<td>Non-Renewable Energy</td>
<td>MJ</td>
<td>5.43E+06</td>
<td>7.80E+05</td>
<td>1.01E+05</td>
<td>0.00E+00</td>
<td>1.01E+05</td>
<td>5.92E+05</td>
</tr>
<tr>
<td>Fossil Fuel Consumption</td>
<td>MJ</td>
<td>4.37E+06</td>
<td>7.58E+05</td>
<td>9.95E+04</td>
<td>0.00E+00</td>
<td>9.95E+04</td>
<td>5.91E+05</td>
</tr>
</tbody>
</table>
Eutrophication Potential LCA Measure Chart By Assembly Groups (A to C)

Project: Case Study - Condo Reference

Multiple graph options, or export all results to Excel
Operational vs Embodied Global Warming Potential (A to C)

Project: Case Study - Condo Reference

- Operational GWP (15,948,413.01 kg CO2 eq)
- Embodied GWP (1,926,873.99 kg CO2 eq)

Compare operating and embodied energy and carbon
Comparison of Global Warming Potential By Life Cycle Stage (Embodied Effects)
[With Case Study - Condo Reference as Project Baseline]

Easy side-by-side comparisons
Live running totals (value or percent) of any measure, by assembly
Instantly generate project reports and LEED submittals

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**General Assessment Information**

The purpose of this report is to provide information required for on-line submittal for LEED v4 Materials and Resources credit "Building life cycle impact reduction" Option 4. Whole building life cycle assessment.

The results of this assessment have been generated by the Impact Estimator for Buildings software. Please refer to the [Lease Guide to whole-building GWP in Green Building Programs](#) for useful guidance on how to complete the credit.

Provide the following general information on the assessment:

<table>
<thead>
<tr>
<th>Information</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Name</strong></td>
<td>UMass Amherst Design Building</td>
</tr>
<tr>
<td><strong>Assessor</strong></td>
<td>Matt Brown, Senior Research Associate, Athena Sustainable Materials Institute</td>
</tr>
<tr>
<td><strong>Verifier (optional)</strong></td>
<td>Jamie Melt, Research Principal, Athena Sustainable Materials Institute</td>
</tr>
<tr>
<td><strong>Internal</strong></td>
<td>✔ Yes</td>
</tr>
<tr>
<td><strong>External</strong></td>
<td>✔ No</td>
</tr>
<tr>
<td><strong>Date of assessment</strong></td>
<td>December 2016</td>
</tr>
<tr>
<td><strong>Assessment timing</strong></td>
<td>✔ Schematic Design</td>
</tr>
<tr>
<td>****</td>
<td>✔ Construction</td>
</tr>
<tr>
<td>****</td>
<td>✔ Design Development</td>
</tr>
<tr>
<td>****</td>
<td>✔ Operations &amp; Maintenance</td>
</tr>
<tr>
<td>****</td>
<td>✔ Construction Documents</td>
</tr>
<tr>
<td>****</td>
<td>✔ End of Life</td>
</tr>
</tbody>
</table>

**Whole-building LCA Results**

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Baseline Building</th>
<th>Proposed Building</th>
<th>Units</th>
<th>Percent Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming potential</td>
<td>4,617,577</td>
<td>4,895,420</td>
<td>lb CO2 eq</td>
<td>-13.1%</td>
</tr>
<tr>
<td>Stratospheric ozone depletion</td>
<td>9,538-22</td>
<td>7,676-22</td>
<td>lb GFO-11 eq</td>
<td>-15.1%</td>
</tr>
<tr>
<td>Acidification of land and water</td>
<td>23,883</td>
<td>21,755</td>
<td>lb SO2 eq</td>
<td>-8.9%</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>1,376</td>
<td>1,376</td>
<td>lb N eq</td>
<td>0.0%</td>
</tr>
<tr>
<td>Tropospheric ozone formation</td>
<td>382,026</td>
<td>368,320</td>
<td>lb CO2 eq</td>
<td>-3.6%</td>
</tr>
<tr>
<td>Deposition of non-renewable energy resources</td>
<td>56,492,129</td>
<td>48,143,200</td>
<td>Mj</td>
<td>-14.8%</td>
</tr>
</tbody>
</table>

Number of measures with at least 10% reduction: 3
Factors Affecting Reliability of Results for Any Whole-Building LCA study

- **Bill of materials:** Accuracy and comprehensiveness
- **Background material and process data:** Accuracy, consistency, comprehensiveness
- **Life cycle stages:** Comprehensiveness
# The Whole-Building LCA technical infrastructure

<table>
<thead>
<tr>
<th>Component</th>
<th>Purpose</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standards</td>
<td>Guardrails</td>
<td>Good</td>
</tr>
<tr>
<td>Guidelines</td>
<td>Consistency</td>
<td>Inadequate</td>
</tr>
<tr>
<td>Data and methods</td>
<td>Accuracy</td>
<td>Lots of gaps</td>
</tr>
<tr>
<td>Software tools</td>
<td>Access</td>
<td>Needs improvement</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>Comparison</td>
<td>Missing</td>
</tr>
<tr>
<td>Training</td>
<td>Interpretation</td>
<td>Inadequate</td>
</tr>
</tbody>
</table>
• Free software download
• Case studies
• Research reports
• Learn more about LCA

www.athenasmi.org

• Join our mailing list!
HAO CAI
Principal Environmental Analyst
Systems Assessment Center
Argonne National Laboratory

10/29, BTO Building Life-cycle
LCA IS AN EFFECTIVE APPROACH TO ADDRESSING EMBODIED CARBON/ENERGY, WHICH BECOMES INCREASINGLY IMPORTANT FOR PROMOTING NEAR-ZERO ENERGY/EMISSIONS DESIGNS

- As the building sector continues to improve energy efficiency to reach net zero energy buildings, embodied energy/GHGs become the integral part of consideration for pursuing sustainable building components/technologies and whole buildings.

### Illustrative Tradeoffs Between Embodied Energy and Operational Energy: MJ/M²

<table>
<thead>
<tr>
<th>Built to local energy code (akin to 2001 IECC)</th>
<th>Built to local energy code (PHI Low Energy Building Standard)</th>
<th>Built to local energy code (akin to 2009 IECC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>Low Energy</td>
<td>Near Zero Energy</td>
</tr>
<tr>
<td>Operational Energy: 88%</td>
<td>Embodied Energy: 12%</td>
<td>Embodied Energy: 12% + Extra energy efficiency measures</td>
</tr>
<tr>
<td></td>
<td>Operational Energy: 38%</td>
<td>+ Extra energy efficiency measures + Some renewable energy generated onsite</td>
</tr>
<tr>
<td></td>
<td>Embodied Energy: 62%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operational Energy: 87%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Embodied Energy: 13%</td>
<td></td>
</tr>
</tbody>
</table>

(From Goetsch 2020; Chastas et al, 2016)
Building LCA: Cradle-to-grave consideration of a building product/technology to address its energy and environmental footprints

Making of Product: embodied energy/emissions
- Materials
- Energy
- Water
- Others
- Emissions
- Other discharges
- Material composition
- Manufacturing processes

Use of Product: operation energy/emissions
- Energy
- Water
- Others
- Emissions
- Other discharges
- Energy efficiency: how much used
- Type of energy used: natural gas, electricity, etc.

End of Life of Product: reuse/recycling/disposal
- Energy
- Water
- Others
- Emissions
- Other discharges
- Debris disposal
- Fate of product and its materials
- Circularity of products/materials

All inputs (materials, energy, and water) have their own life cycles and footprints!
With BTO support, Argonne is expanding its GREET LCA model for buildings and building technologies.
BUILDING LCA OFFERS INSIGHTS FOR PROMOTING SUSTAINABLE BUILDING TECHNOLOGIES AND DESIGNS

- LCA results can help answer numerous questions that arise during the design and construction of a green building. It can reinforce the decisions taken by architects, manufacturers, and engineering firms by providing a scientific justification (American Institute of Architects, 2020)

Example: holistic and comparable LCA results of insulation materials offer insight on material choices in architecture designs.
BUILDING LCA CHALLENGES: METHODOLOGIES

- *Thorough, consistent LCA methodologies need to be agreed upon to*
  - Clearly defined and consistent system boundary
  - Defining and using a performance-equivalent functional unit is key to comparable LCA among building technologies
BUILDING LCA CHALLENGES: DATA

- **Building LCA needs extensive, representative data**
  - Extensive and consistent background data
    - Energy supply systems:
      - Electricity, natural gas, etc.
      - Emissions of not only end use but also supply chain of energy systems (electricity generation, methane leakage of NG supply chain)
    - Material supply systems:
      - LCI data for raw materials to end-use materials
      - Commonality and uniqueness of materials specifications among different applications, e.g., automobile steel vs structural steel/rebar
  - Foreground data need to be developed for building components/technologies
    - Embodied energy/emissions as well as operational performance data are needed
    - Impacts of circular economy practices in the building sector as well as in other sectors need to be considered for dynamic evaluation
**EPS Production**

**Process-level foreground data**

**Common background data for process materials and energy types**

- **Functional Unit**
  1 m² of EPS insulation with a thermal resistance RSI=1 m²K/W and with a building service life of 60 years

Reference: Franklin Associates, 2017
## Building LCA challenges: LCA models for Transparent, detailed, and consistent modeling of building products and technologies

<table>
<thead>
<tr>
<th>KEY MODEL FEATURES &amp; ASPECTS</th>
<th>GREET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling capability to address NEW building materials and technologies</td>
<td>✅</td>
</tr>
<tr>
<td>Transparent life-cycle inventory (LCI) data for user access and modification</td>
<td>✅</td>
</tr>
<tr>
<td>Consistent LCA methodology</td>
<td>✅</td>
</tr>
<tr>
<td>Consistent LCA system boundary</td>
<td>✅</td>
</tr>
<tr>
<td>Main data source</td>
<td>GREET background data and technology-specific foreground data from technology developers and modeling</td>
</tr>
<tr>
<td>Consistent background data</td>
<td>✅</td>
</tr>
<tr>
<td>Main users and applications</td>
<td>Building stakeholders needing LCA results for decision-making</td>
</tr>
</tbody>
</table>
ARGONNE GREET BUILDING LCA MODULE FOR DETAILED BUILDING LCA

- GREET: *Greenhouse gases, Regulated Emissions, and Energy use in Technologies*
- Argonne has been developing GREET since 1995 with DOE support
- It is publicly available at [greet.es.anl.gov](https://greet.es.anl.gov)
- At present, there are >40,000 registered GREET users worldwide
- Users include governments, industries, R&D communities, universities, and NGOs

- Built in GREET2 platform to leverage existing data and analysis of materials
- Allow for detailed, transparent modeling of building components and whole buildings with consistent methodologies
- Beta Version is developed and ready for stakeholder inputs

For technical reports, user guide, and free tutorials, visit: [https://greet.es.anl.gov](https://greet.es.anl.gov)
The GREET building LCA module: Overall User Graphical Interface (GUI)

- The building LCA module architecture was designed with interactive features.
The GREET building LCA module: Addressing new building technologies
The GREET module provides an interactive Dashboard to quickly visualize, compare, and interpreting multiple metrics of LCA results of multiple modeled building materials/technologies.

**LIFE-CYCLE RESULTS DASHBOARD**

1) **Embodied Carbon Emissions**

<table>
<thead>
<tr>
<th>Building_Component</th>
<th>LC_Stage</th>
<th>Material_Energy...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon carbide</td>
<td>Finished Product Transport</td>
<td>Additives</td>
</tr>
<tr>
<td>Styrene</td>
<td>Manufacturing</td>
<td>Aluminosilicate slag (b)</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>Raw Material Sourcing</td>
<td>Binders, other binder</td>
</tr>
<tr>
<td>XPS_Time Weighted</td>
<td>Raw Material Transporta</td>
<td>Binders, phenolic resin</td>
</tr>
<tr>
<td></td>
<td>Use, Maintenance, Repa</td>
<td>Binders, urea</td>
</tr>
<tr>
<td></td>
<td>(blank)</td>
<td>Blast furnace slag (b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slagging agents (HFO)</td>
</tr>
</tbody>
</table>

**Embodied GHG Emissions**

- Raw Material Sourcing
- Manufacturing
- Use, Maintenance, Repar, Replacement

**Embodied GHG Emissions, Breakdown by Input**

2) **Embodied Energy Use**

**Embodied Energy**
WE START WITH YES,
WE END WITH THANK YOU.

www.anl.gov
Metrics & Tools for Sustainable Buildings

Joshua Kneifel, PhD
Economist
Applied Economics Office
Engineering Laboratory
Problem: Difficult to Measure and Evaluate Building Sustainability

Goal: Assist stakeholders in making more sustainable building-related decisions using life cycle analysis

Approach: Develop (standards-based) information, metrics, data, and tools that are accessible in a form and function that can be incorporated into their decision-making process.
Numerous Sustainability Criteria

**Economics**
*Life Cycle Cost (LCC)*

**Environmental & Human Health Impacts**
*Life Cycle Impact Assessment (LCIA)*

**Energy, IAQ, and Comfort**
*Whole Building Simulation*
Challenges Assessing Life Cycle Impacts

Hard to Quantify Environmental Impacts:
- Consistent, transparent scope, methodologies, and data?
- Comparable?
  - Building Product Selection (Interaction Effects?)
  - Whole Building Design (Comparable performance?)
  - Whole Building Life (Embodied and Operational?)

Hard to Communicate Environmental Impacts:
- How to present results in a useful way?
- How do you use results in decision-making?

Changing Demand and Technologies
- How to design tools to provide useful, up-to-date information to decisionmakers?
  - Relevant data, Flexibility to the user, Do not want to duplicate efforts
Building for Environmental and Economic Sustainability (BEES) Framework

- **Web Interface**
- **Individual Building Products**
- **Criteria**
  - LCIA Categories
  - Environmental Impact Score (EIS)
    - Weighted normalized average
  - Life Cycle Costs
- **Guidance and Default Values for Users**
  - Assumptions
  - Product selection
- **Visual Displays and CSV Access**

**Environmental Impact Score**
- Carcinogens
- GWP
- Acidification
- Respiratory Effects
- Non-Carcinogens
- Ozone Depletion
- Eutrophication
- Ecotoxicity
- IAQ
- Land Use
- Water Consumption

**Weighted Normalized Average**
- (ASTM AHP Std)

**Life Cycle Costs**
- (ASTM Bldg Econ Stds)

**Visual Displays and CSV Access**
Building Industry Reporting & Design for Sustainability (BIRDS) Framework

- Web Interface
- Whole Building Prototypes
- Building simulation results
  - Standards/Codes
  - Incremental Design
- Criteria
  - LCIA categories & EIS
  - Life Cycle Costs
  - Operational Energy
  - Thermal Comfort
  - IAQ
- Guidance and Defaults to assist Users
  - Assumptions
  - Building Designs
- Displays Key Results
- CSV Database available
Trends in Sustainability Analysis

- Shifts in Technology to estimate building performance
  - Data and Computing power
  - Massive simulation and computational capabilities
  - Software development
    - Capabilities are ever expanding and increasingly open source
- Shift in Demand for “Green” Buildings
  - Product & Building Certification Programs
- Shift in Focus of Sustainability in Buildings
  - Product -> assembly -> “whole building” LCA
  - Credits in green certification programs
Needs in Sustainability Analysis

• **Broader & Quantifiable Scope**
  - How can you make quick, accurate evaluations to make informed decisions without a need for expertise in sustainability measurement science?

• **Interoperable Software**
  - Disaggregated and modularized tools
  - Ability to connect software tools and analyses
  - Leverage/Collaborate with other organizations to accelerate development

• **Standards and Data**
  - Standardization in data format
  - Reliable, transparent data is costly and difficult to create and maintain
  - Leverage existing data when feasible
BIRDS Neutral Environment Software Tool (NEST)

- Life Cycle Impact Assessment (LCIA) API
  - Custom, real-time LCIA calculations for single-family dwellings
  - Generic building products
- Audience
  - Builders and Architects
  - (Green) Code Compliance Software
    - NASEO Harmonizing HERS and Home Energy Score
- Interoperable with DOE’s OpenStudio
  - 40,000+ users
  - Basis for building evaluation software
- BIRDS NEST API is Generic
  - Compatibility with other software tools
For further information...

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joshua.kneifel@nist.gov

NIST EL Applied Economics Office
http://www.nist.gov/el/economics/

BEES Online
http://ws680.nist.gov/Bees/

BIRDS
http://ws680.nist.gov/Birds

IE4B
http://www.athenasmi.org/our-software-data/impact-estimator/

OpenStudio
https://www.openstudio.net/
Highlighted Standardization and Data Efforts

• Detailed Documentation
  • Transparency on how the LCIA data was developed
  • BIRDS NEST code could be published on GitHub
  • Data will be published when feasible

• Standardized Component Dictionary and LCIA Results
  • LCIA Results using EN15978
  • Data Format using HPXML

• Operational Energy LCIA Data
  • Collaborating with NETL to develop publicly available on-site energy consumption LCIA data
  • Regionalized and published on a regular basis with most recent data
  • Electricity Baseline, Natural Gas Baseline, etc.

• Other Collaboration Efforts
  • Federal LCA Commons
    • Best Practices and consistent data across federal agencies
  • Building Transparency OpenLCI Project
    • North American LCI database
Easy to Use Software – LCA in Buildings

  - Individual Products
- **BIRDS (2014)**
  - Whole Building Prototypes
- **BIRDS NEST (2018)**
  - User-Defined Buildings
Poll Question

A variety of tools and resources exist now to assist organizations making lifecycle impact decisions. What additional resources would be most helpful?

Enter answers in the question box!
Q&A Session

- Use the Q&A feature to ask a question
- Panelists
  - Hao Cai, Principal Environmental Analyst, Argonne National Labs
  - Jennifer O’Connor, President, Athena Institute
  - Joshua Kneifel, Research Economist, National Institute of Standards and Technology
# Building Life Cycle Impacts DOE Webinar Series

<table>
<thead>
<tr>
<th>Topic</th>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>Overview of life cycle impacts of buildings</td>
<td>Oct. 16</td>
<td>12:00pm – 1:00pm ET</td>
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<tr>
<td>Challenges of assessing life cycle impacts of buildings</td>
<td>Oct. 29</td>
<td>12:00pm – 1:00pm ET</td>
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<tr>
<td>Innovative building materials</td>
<td>Nov. 12</td>
<td>12:00pm – 1:00pm ET</td>
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<td>“Real Life” buildings striving to minimize life cycle impacts</td>
<td>Dec. 3</td>
<td>12:00pm – 1:00pm ET</td>
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<tr>
<td>Intersection of life cycle impacts &amp; circular economy potential for the building sector</td>
<td>Dec. 17</td>
<td>12:00pm – 1:00pm ET</td>
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