Carbon Neutral Construction Basics

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Learning Objectives

Upon completing this program, the participant should know:

1. Potential Climate Change Influences
2. Confirmation on the confusion about what are green/climate neutral buildings & product
3. Understanding carbon strategies
4. Net Zero Energy concepts
5. LCA and carbon analysis
6. Carbon neutral strategies
New considerations impacting evaluation and specifying products

• Green Rating Systems
• Climate Change
  – GHG Reduction in the Building Sector
  – Energy Efficiency Goals above Code
  – IAQ
• Government Green Building & GHG Mandates
  – Federal, Regional, State, Local
• Climate Neutral Products
• Life Cycle Assessment
• Sustainability, Environmental & GHG Standards Development
• NGO Green Building ANSI Approved Standards

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Average impacts of a 150,000 sf commercial office building:

**Consumes Per Year:**
- 12,750,000,000 BTUs
- 54,750,000 gallons of H2O

**Generates Per Year:**
- 19,200,000 lbs of CO₂
- 375,000 lbs of waste

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“Energy efficiency is the world’s most valuable resource”

- Jim Rogers, CEO of Duke Energy stated at EE Global 2007 that energy efficiency is the world’s most valuable resource.

- He also echoed his message before congress where he called energy efficiency the 5th fuel

(See: www.google.com/search?hl=en&q=jim+rogers+duke+energy+testimony+congress)
Energy Efficiency to Drive GHG Reduction in the Building Sector

- According to DOE, modest increases in energy efficiency, including insulation, would eliminate the need for 600 new power plants.
- Power generation accounts for about one-quarter of total emissions of CO2, and is a significant factor in global warming. (ScienceDaily Mar. 21, 2007)

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Energy Efficiency to Drive GHG Reduction in the Building Sector

- Americans spend $1 million dollars on energy every minute. Based on information from the Energy Information Agency (EIA).
- It is also reported that over the next 20 years, U.S. natural gas consumption will rise by well over 50 percent.
- Demand for electricity will increase by 45 percent (US DOE National Energy Policy).
- To meet projected energy demand, the United States must have in place between 1,300 - 1,900 new electric plants by 2020.

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2030 Challenge Target Goals

Challenge to Reduce Fossil Fuel Energy of Construction and Operations

Targets based on Country Average for that Building Type in Commercial Building Energy Consumption Survey (CBECS).

All new Fuel Energy construction and an equal amount of existing building area to be remodeled.

Increasing Reduction in Fossil All new Fuel Energy

Carbon Neutral
Barack Obama’s Plan to Make America a Global Energy Leader

Set Building Efficiency Goals: Barack Obama will establish a goal of making all new buildings carbon neutral, or produce zero emissions, by 2030.

He’ll also establish a national goal of improving new building efficiency by 50 percent and existing building efficiency by 25 percent over the next decade to help us meet the 2030 goal.

Graphic from: Insulation, Life-Cycle and Climate Change: An International Mandate, Kirsten Ritchie, Gensler

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U.S. State Climate Action Plans

New England Region
Northeastern Governors Climate Action Plan:
Goals
- Reduce emissions to 1990 levels by 2010
- Reduce emissions 10% below 1990 by 2020
- Long term reduction of 75-85%

Regional Greenhouse Gas Initiative (RGGI)
- Develop Northeast regional GHG reduction policy
- Step toward a regional cap and trade system

Trading at approximately $80/ton
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21 US cities will measure and disclose their CO2 emissions

http://www.iclei-usa.org/programs/climate/ghg-protocol

- The cities will resort to a measuring system for CO2 and other greenhouse gases already in use by some 1,300 companies worldwide who voluntarily disclose their emissions.
- "Over 70 percent of total global emissions are generated from cities, and if you don't measure these emissions, you cannot manage them," Carbon Disclosure Project (CDP) CEO Paul Dickinson told AFP.
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Climate neutral construction

- While the solution to significant carbon dioxide emission reductions, energy efficiency, and energy independence are still years beyond our reach in terms of technology and government policy, certain measures to reduce the environmental impact of our buildings are currently available.
- From a structural engineering standpoint, a reduction in material demand, selection of methods geared toward shortening construction schedules, and reducing building volume without compromising architectural expression are all proven measures that contribute to happy clients and end users.

Close collaboration between all design team members is also key in creating green buildings. Both structural engineer and architect play a vital role in striking a balance between layout efficiency and aesthetics. As such, structural engineers will need to become much more involved in the early conceptualization of any proposed building to ensure that this balance is met.

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Green Rating Systems & Programs

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Climate Neutral Products and LEED

REC’s (Renewable Energy Credits) must be certified by Green-e, Environmental Resources Trust or proven equivalent. Carbon offset programs must be in the top 8

- AgCert/Drive Green (Ireland)
- AtmosFair (Germany)
- Carbon Neutral Company (UK)
- Climate Care (UK)
- Climate Trust (US)
- CO2 Balance (UK)
- Native Energy (US)
- Sustainable Travel/My Climate (US)

www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf

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- **Climate Neutral** - The process of offsetting carbon-producing activities with those that either reduce or capture carbon, thus credibly neutralizing the net amount of carbon released in the atmosphere from a particular activity.

- **Climate Neutral Products** - Products where CO2 emissions have been measured and reductions identified by a recognized 3rd party verification, and remaining emissions offset through established carbon trading in accordance with a verifier’s stated protocol.
What is a climate neutral product?

- Climate neutral refers to products, services and enterprises that have little or no effect on the Earth’s climate.
  - This is achieved by reducing and offsetting global warming gases associated with the production and delivery of products, services or total operations emissions for an enterprise to achieve a net zero impact on the Earth’s climate.

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Defining Carbon Neutral Buildings

- Generally understood to be those that require no GHG-emitting energy to operate.
- Accomplished by combining on and off-site renewable energy generation with ultra-efficient building materials and equipment.
The Vision: Zero Net Energy for Buildings – EEB

(Energy Efficiency in Buildings (EEB) project, World Business Council for Sustainable Development (WBCSD)

- Climate Neutral is defined as the process of offsetting carbon-producing activities with those that either reduce or capture carbon,
- Neutralizing the net amount of carbon released in the atmosphere from a particular activity.
- Implementation of Climate Neutral Buildings may include Carbon Trading strategies.

See: www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=MTA5NA

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Cap-and-trade program

• Key Elements of a Well-Designed Cap-and-Trade Program
  – Stringently capping emissions, with firm near-term goals
  – Including all major heat-trapping gas emissions. Those include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6).

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Defining Cap & trade

• Cap-and-trade systems, also known as allowance trading, can be best summed up as "pollution credits."

• What happens is that overall air quality goals are set for an area (such as the entire nation) and specific sources of air pollution (such as power plants, waste incineration facilities, etc.) are given a certain number of allowances, which represent the amount of various pollutants that the organization or facility is allowed to emit.

• Facilities that come in under that allowable limit because of air pollution control systems can then sell their leftover allowances to other facilities and organizations on the open market.

• This allows the facilities that buy up such allowances (pollution credits) to pollute more, because other facilities are polluting less.
What is a carbon offset?

• An emission reduction credit from another organization’s project that results in less carbon dioxide or other greenhouse gases in the atmosphere than would otherwise occur.

• Carbon offsets are typically measured in tons of CO2-equivalents (or 'CO2e') and are bought and sold through a number of international brokers, online retailers, and trading platforms.
Making Sense of the Voluntary Carbon Market - A Comparison of Carbon Offset Standards

Anja Kollmuss (SEI-US), Helge Zink (Tricorona), Clifford Polycarp (SEI-US)

- Clean Development Mechanism (CDM)
- Gold Standard (GS)
- Voluntary Carbon Standard 2007 (VCS 2007)
- VER+
- The Voluntary Offset Standard (VOS)
- Chicago Climate Exchange (CCX)
- The Climate, Community & Biodiversity Standards (CCBS)
- Plan Vivo System
- ISO 14064-2
- GHG Protocol for Project Accounting

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Standards for Carbon Offsets

• A number of standards exist for carbon offsets, including the VCS, Green-e, and The Gold Standard

• More standards are being announced regularly.
  – Each of these standards differs in key ways, with some being more rigorous than others.
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Emerging GHG Reporting requirements

ISO 14064 GHG Standards
for assessing and supporting greenhouse gas reduction and emissions trading


ISO is becoming less optional for US manufacturers because of international business opportunities requirements in many foreign markets.

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Shrinking the nation’s carbon footprint while allowing for population and economic growth requires a strategic focus on reducing the energy intensity of the U.S. economy and reducing the carbon intensity of the energy we consume.

Carbon dioxide is the most prevalent greenhouse gas (GHG) emitted in the United States and it primarily comes from the energy used in buildings and transportation.

**U.S. GHG Emissions (2005)**
- Carbon Dioxide: 84%
- Methane: 9%
- Nitrous Oxide: 5%
- Other GHGs: 2%

**U.S. CO2 Emissions by Sector (2005)**
- Buildings: 39%
- Transportation: 33%
- Industry: 28%

Source: Environmental Protection Agency

Source: Energy Information Administration
Carbon Neutral Design Technologies

Potential Carbon Reductions

- Energy Efficiency
  - Building envelope thermal efficiency
    - Air sealing
    - Low E Windows
  - Energy efficient lighting and automated controls
  - Right sizing HVAC systems

- Renewables
  - Solar
  - Wind Biofuels
  - Biomass
  - Geothermal
Climate Neutral Design Strategies

For New Buildings:
– Determine performance goals, use integrated design approach with state-of-the-art smart systems, construct and commission, operate to meet targets

For Existing Buildings:
– The “benchmark your energy use and set goals, actively monitor end use and indoor environmental quality, diagnose and fix problems as they arise -> take operational and/or investment actions to meet goals, and actively monitor feedback, re-evaluate benchmarks in light of costs…”

Program interaction
Build these programs around a single shared “life-cycle” Building Information Model (BIM)

Stephen Selkowitz Department Head, Building Technologies Department Lawrence Berkeley National Laboratory

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Carbon Abatement Strategies

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Example Results: Costs and Energy Savings of All Possible Combinations of Options

Source: NREL
Net Zero Energy READY Buildings

The next generation of residential and commercial building design concepts
- Progressive Energy Efficiency Goals
- **Ultimate Target** is Net Zero Energy
  or Net Zero Energy **PLUS**

30⇒50⇒NZER

(Ready)

An energy efficiency goal we can meet today!

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Buildings as the Integrator
Buildings represents a key market for many technologies being developed in EERE.

- **Building Technologies**
- **Solar**
  - PV and Solar Hot Water Technologies
- **Hydrogen & Fuel Cells**
  - Fuel Cell Technology & Hydrogen Infrastructure
- **Distributed Energy**
  - Combined Heat and Power Technologies
- **Zero Energy Buildings Goal**
  - Efficiency Technologies & Building Integration

NOW
Later
Later
Source: DOE Energy Efficiency and Renewable Energy
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- At the heart of the ZEB concept is the idea that buildings can meet all their energy requirements from low-cost, locally available, nonpolluting, renewable sources.
- At the strictest level, a ZEB generates enough renewable energy on site to equal or exceed its annual energy use.


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Net Zero Energy Definitions

- **Net Zero Site Energy**: A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site.
  - **Net Zero Source Energy**: A source ZEB produces at least as much energy as it uses in a year
    - when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site.
    - To calculate a building’s total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.
  - **Net Zero Energy Costs**: In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.
  - **Net Zero Energy Emissions**: A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources.


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Grid Connection Is Allowed and Necessary for ZEB Energy Balances

- A ZEB typically uses traditional energy sources such as the electric and natural gas utilities when on-site generation does not meet the loads.
- When the on-site generation is greater than the building’s loads, excess electricity is exported to the utility grid.
- By using the grid to account for the energy balance, excess production can offset later energy use.


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From Materials to ECO-MATERIALS

- Increasing use of “Bio” and “Eco” prefixes are used to market sustainable attributes, but typically are not supported with quantifying data within a sustainable life-cycle approach.
- Determining what a green building product has brought LCA (Life Cycle Assessment) into forefront as possible solution to reduce confusion.

![Graph showing Total energy vs CO2 Footprint for different insulation materials](image)

**Fig. 1** – Cambridge Engineering Selector: Total Energy vs CO2 Footprint for different insulation materials

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How far will GHG reporting go? Calculating Carbon Footprint of a Cheeseburger

6.3 to 6.8 pounds (2.85 to 3.1 kg) of carbon emissions per burger.

- Jamais Cascio, former managing editor over at Worldchanging and current proprietor of Open the Future, recently got to wondering: what do everyday, common items contribute to Global Warming
- The cheeseburger, 6.3 to 6.8 pounds (2.85 to 3.1 kg) of carbon emissions per burger.
  - This includes:
    - Growing the feed for the cattle for the beef and cheese,
    - Growing the produce, storing and transporting the components
    - Cooking them all
- The article says if all Americans eat the average amount of burgers, it will equal 7500-15000 SUV’s

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Companies Measure the Carbon Footprint of Consumer Products

Consumer products are beginning to display details about their environmental impacts. Source: http://www.timberland.com/shop/ad4.jsp

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**EcoCalculator**


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**ATHENA ASSEMBLY EVALUATION TOOL v2.3**

Southern USA low-rise building

**E. INTERIOR WALLS**

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<th>Assembly</th>
<th>Square Footage</th>
<th>Percentage of total</th>
<th>Primary Energy per SF (MMBtu)</th>
<th>GWP per SF (lbs)</th>
<th>Weighted Resource Use per SF (lbs)</th>
<th>Air Pollution Index per SF</th>
<th>H2O Pollution Index per SF</th>
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**TOTAL SQUARE FOOTAGE**: 1200.00

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**COLUMN AND BEAMS**

**INTERMEDIATE FLOORS**

**EXTERIOR WALLS**

**WINDOWS**

**ROOFS**
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Building Team Climate Neutral Design Requirements in Division 01 Sections

- Section 01 11 00 - Summary of Work
  ✓ Include Owner’s Goals For Climate Neutral
- Section 01 25 00 - Substitution Procedures
  ✓ Include Specific Requirements for Green Products
- Section 01 33 00 - Submittal Procedures
  ✓ Include Climate Neutral Requirements
- Section 01 33 29 - Sustainable Design Reporting
  ✓ New Section MasterFormat 2004
- Section 01 35 20 – Green Rating System Requirements
  ✓ Includes Specific Requirements for Green Rating System
- Section 01 44 50 - Testing for IAQ, Baseline IAQ, & Materials
- Section 01 57 30 - Indoor Environmental Control
  ✓ Coordinate with Green Rating System and Climate Neutral

This is an example in part…

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In Summary

• It is pretty much accepted that there are Climate Change impacts from carbon emissions in the building sector.
• Many energy efficiency/ carbon reduction programs are being initiated by global, Federal, State, local agencies and NGO’s.
• Most of the energy efficiency initiatives include carbon and/or GHG reduction targets tied to the Architecture 2030 goals of Net Zero by the year 2030.

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Challenges

• Establish carbon-neutral buildings by the year 2030

• Design buildings that use substantially less energy, reduce greenhouse gas emissions and create spaces that are healthy and comfortable

• Many high-performance buildings exist today that exceed minimum energy requirements by over 50 percent – yet aggressive research and development needed to achieve feasible, cost-effect net-zero-energy buildings
How Will We Do It?

- Standards
- Research
- Advanced Energy Design Guides
- Education Programs
- Modeling/BIM delivery
- Mandates and voluntary benchmarks
- Market incentives

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Specifying Climate Neutral / Carbon Neutral Products and Projects

Thank You!
This concludes the program.
Any Questions?

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