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We the people

THE LEAP TO ZERO CARBON:

Incorporating Advanced Zero Energy Strategies into High Performance Design

FR65

THE LEAP TO ZERO CARBON:

Acknowledgements/Credits

[Optional]

THE LEAP TO ZERO CARBON:

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Overview:

Designing to Zero Carbon standards as defined by the Architecture2030 Challenge, requires a modified approach to current sustainable and high performance design methods. This session will answer the question “What is Zero Carbon?” and through a series of key case studies differentiate the means by which sustainable/high performance and low carbon buildings are designed. Case studies will be used to demonstrate how new low-carbon strategies and systems are incorporated to reduce GHG emissions.

Learning Objectives

- Participants will be able to **differentiate between sustainable design and carbon neutral** (zero carbon) design.
- Participants will be able to **identify key strategies** that must be included in architectural design in order to design buildings to carbon neutral, zero energy standards.
- Participants will be able to **assess the architectural implications and potential** of including Zero Carbon/Zero Energy strategies, materials and methods in a project.

Differentiating *Sustainable* vs. *Zero Carbon/Carbon Neutral:*

Sustainable design is a *holistic* way of designing buildings to minimize their environmental impact through:

- **Reduced dependency on non-renewable resources**
- **A more bio-regional response to climate and site**
- **Increased efficiency in the design of the building envelope and energy systems**
- **A environmentally sensitive use of materials**
- **Focus on healthy interior environments**
- **Characterized by buildings that aim to *"live lightly on the earth"* and**
- ***"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."***

United Nations World Commission on Environment and Development

Global Warming and Sustainable Design:

- A priority has been placed, above and beyond current trends in Sustainable Design, on the reduction of GHG emissions
- Buildings account for more than 40% of the GHG
- Green, Sustainable and High Performance Buildings are not going far enough, quickly enough in reducing their negative impact on the environment, and certainly not far enough to offset the balance of building that marches on in ignorance
- Carbon Neutrality focuses on the relationship between all aspects of “building/s” and CO_2 emissions
- Carbon Neutral Design strives to reverse trends in Global Warming

The LEAP to Zero Carbon…

- Energy Efficient (mid 1970s "Oil Crisis" reaction)
  - Green (environmentally responsive)
    - Sustainable (holistic and accountable)
      - High Performance (accountable)
        - Carbon Neutral

…a steady increase in the nature and expectations of performance criteria

Comparing Carbon Neutral to LEED™

- LEED™ is a *holistic assessment tool* that looks at the overall sustainable nature of buildings within a prescribed rating system *to provide a basis for comparison* – with the hopes of changing the market

- Projects are ranked from Certified to Platinum on the basis of credits achieved in the areas of Sustainable Sites, Energy Efficiency, Materials and Resources, Water Efficiency, Indoor Environmental Quality and Innovation in Design Process

- LEED™ *does not assess the Carbon value of a building, its materials, use of energy or operation*

Why Assess Carbon Neutrality?

- Sustainable design does not go far enough
- Assessing carbon is complex, but necessary
- The next important goal to reverse the effects of global warming and reduce CO^2 emissions it to make our buildings **“carbon neutral”**
- **“architecture2030”** is focused on raising the stakes in sustainable design to challenge designers to reduce their carbon emissions by 50% by the year 2030

www.architecture2030.org

Three Key Steps:

#1 - **Reduce loads/demand first** (passive design, daylighting, shading, orientation, etc.)

#2 - **Meet loads efficiently** (energy efficient lighting, high-efficiency MEP equipment, controls, etc.)

#3 - **Use on-site generation/renewables to meet energy needs** (doing the above steps *before* will result in the need for much smaller renewable energy systems, making carbon neutrality achievable.)

Reduce, Renew, Offset

Or, a paradigm shift from the recycling 3Rs…

Reduce - build less, protect natural ecosystems, build smarter, build efficiently

Renew - use renewable energy, restore native ecosystems, replenish natural building materials, use recycled and recyclable materials

Offset - compensate for the carbon you can't eliminate, focus on local offset projects

Net impact reduction of the project!

source: www.buildcarbonneutral.org

The Importance of Impact Reduction:

If the **impact** of the building is NOT reduced, it may be *impossible* to reduce the CO_2 to zero. Because:

Site and location matter.

- **Design for bio-regional site and climate**
- **Orientation for passive heating, cooling and daylighting**
- Brownfield or conserved ecosystem?
- Urban, suburban or rural?
- Ability to restore or regenerate ecosystems
- All determine *potential* for carbon sequestration on site

The buildings at IslandWood are located with a "solar meadow" to their south to take advantage of solar heating and daylighting.

7 Impacts source: www.buildcarbonneutral.org

Disturbance is impact.

- Protect existing soil and vegetation
- Design foundations to minimize impact
- Minimize moving of soil
- Disturbance changes existing ecosystems, natural habitats and changes water flow and absorption
- Disturbed soil releases carbon
- Disturbance can kill trees, lowering site potential for carbon reduction
- Look at the potential for reusing materials on site

Difficult foundations for a treed, sloped site for the Grand House Student Cooperative in Cambridge, Ontario, Canada

Natural ecosystems sequester carbon.

- Carbon is naturally stored below ground and is released when soil is disturbed

- Proper treatment of the landscape can keep this carbon in place *(sequestration)*

- Proper treatment of the landscape can be designed to store/accumulate/sequester more carbon over time

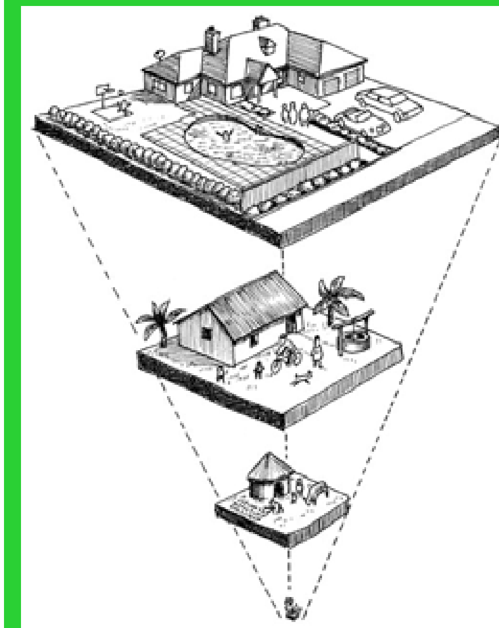
- Verify landscape design type with your *eco-region* – use of indigenous plant material requires less maintenance/water – healthy plants absorb more CO_2

- Possible to use the natural ecosystems on your site to assist in lowering the carbon footprint of your project

The natural site is preserved at IslandWood, Bainbridge Island.

Smaller is better.

- ***Simple!***…**less** building results in **less** embodied carbon; i.e. **less** carbon from materials used in the project, **less** requirements for heating, cooling and electricity….
- Re-examine the building program to see what is *really* required
- How is the space to be used?
- Can the program benefit from more inventive double uses of spaces?
- Can you take advantage of outdoor or more seasonally used spaces?
- **How much building do you *really* need?**
- **Inference of LIFESTYLE changes**



Calculating your "ecological footprint"

… can naturally extend to an understanding of your "carbon footprint"

Source: http://www.cycleoflife.ca/kids/education.htm

Buildings can help to sequester carbon.

- The materials that you choose can help to reduce your carbon footprint.

- Wood from certified renewable sources, wood harvested from your property, or wood salvaged from demolition and saved from the landfill can often be considered net carbon sinks.

- Planting new trees can help to compensate for the carbon released during essential material transport

- Incorporating *green roofs* and *living walls* can assist in carbon sequestration

Green roof at White Rock Operations Center, White Rock, B.C.

Green roof at Vancouver Public Library

Material choice matters.

- Material choice can reduce your building's *embodied* carbon footprint.
- Where did the material come from?
- Is it local?
- Did it require a lot of energy to extract it or to get it to your building?
- Can it be replaced at the source?
- Was it recycled or have significant post consumer recycled content?
- Can it be recycled or reused *easily;* i.e. with minimal additional energy?
- Is the material durable or will it need to be replaced *(lifecycle analysis)?*

Note: many of these concerns are similar to what you might already be looking at in LEED™

Foster's GLA – may claim to be high performance, but it uses many high energy materials.

Green on the Grand, Canada's first C-2000 building chose to import special windows from a distance rather than employ shading devices to control solar gain and glare.

Reuse to reduce impact.

- Reuse of a building, part of a building or elements reduces the carbon impact by avoidance of using new materials.
- Make the changes necessary to improve the operational carbon footprint of an old building, before building new.
- Is there an existing building or Brownfield site that suits your needs?
- Can you adapt a building or site with minimal change?
- Design for disassembly (Dfd) and eventual reuse to offset future carbon use

The School of Architecture at Waterloo is a reused factory on a remediated Brownfield site.

All of the wood cladding at the YMCA Environmental Learning Center, Paradise Lake, Ontario was salvaged from the demolition of an existing building.

How much Carbon – numeric validation?

Zero Carbon requires designers to numerically validate the effectiveness of their approaches.

- **Carbon Footprint** calculators are available online to look at your *personal carbon emissions*
- **Carbon Estimators** are available online to begin to assess the *impact of buildings*
- **Carbon Calculators** are available for purchase that will work with BIM systems and provide a fairly *accurate feedback mechanism*
- Carbon can be calculated by other methods, more project specific

carbon footprint™

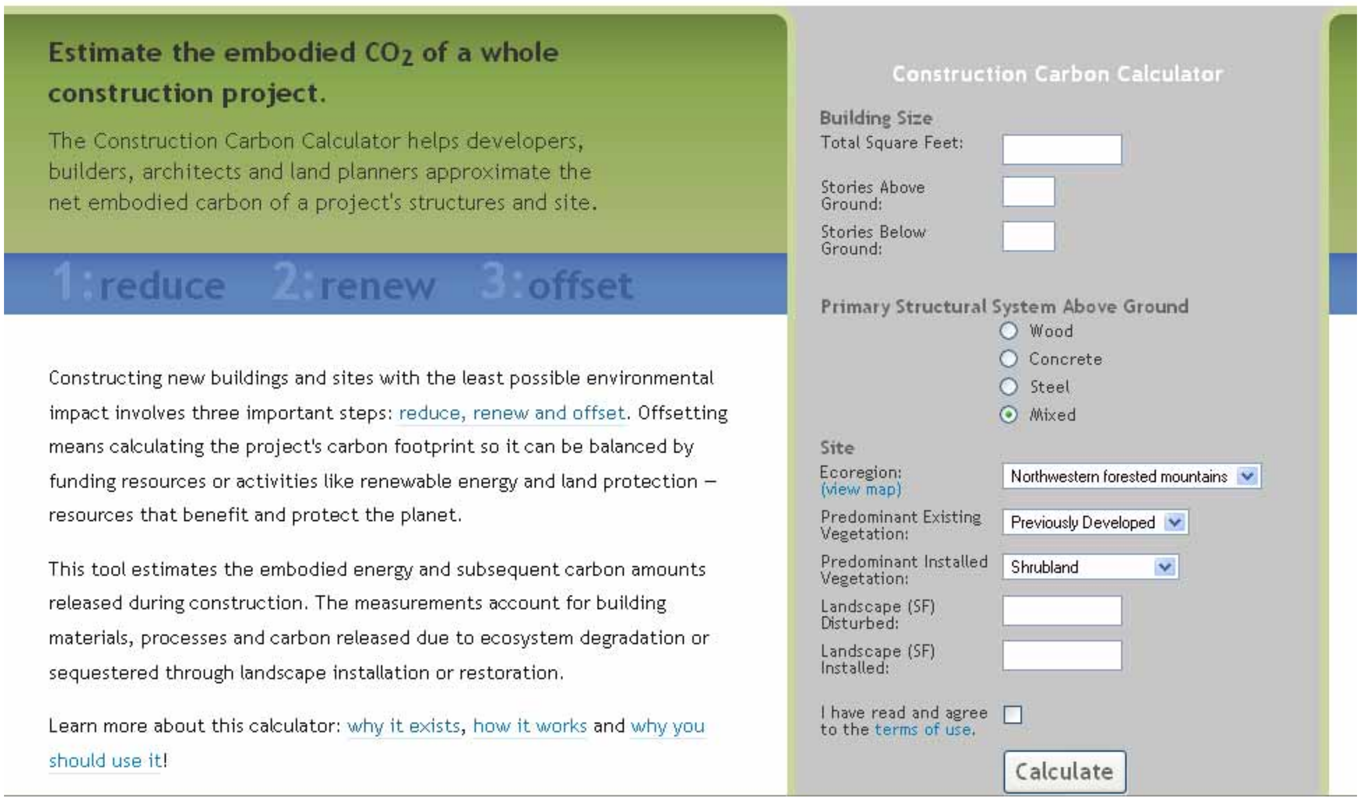
Source: www.carbonfootprint.com/

Estimating Carbon:

Software is available to assist:

- BuildCarbonNeutral: focuses on reducing *impact*

buildcarbonneutral beta

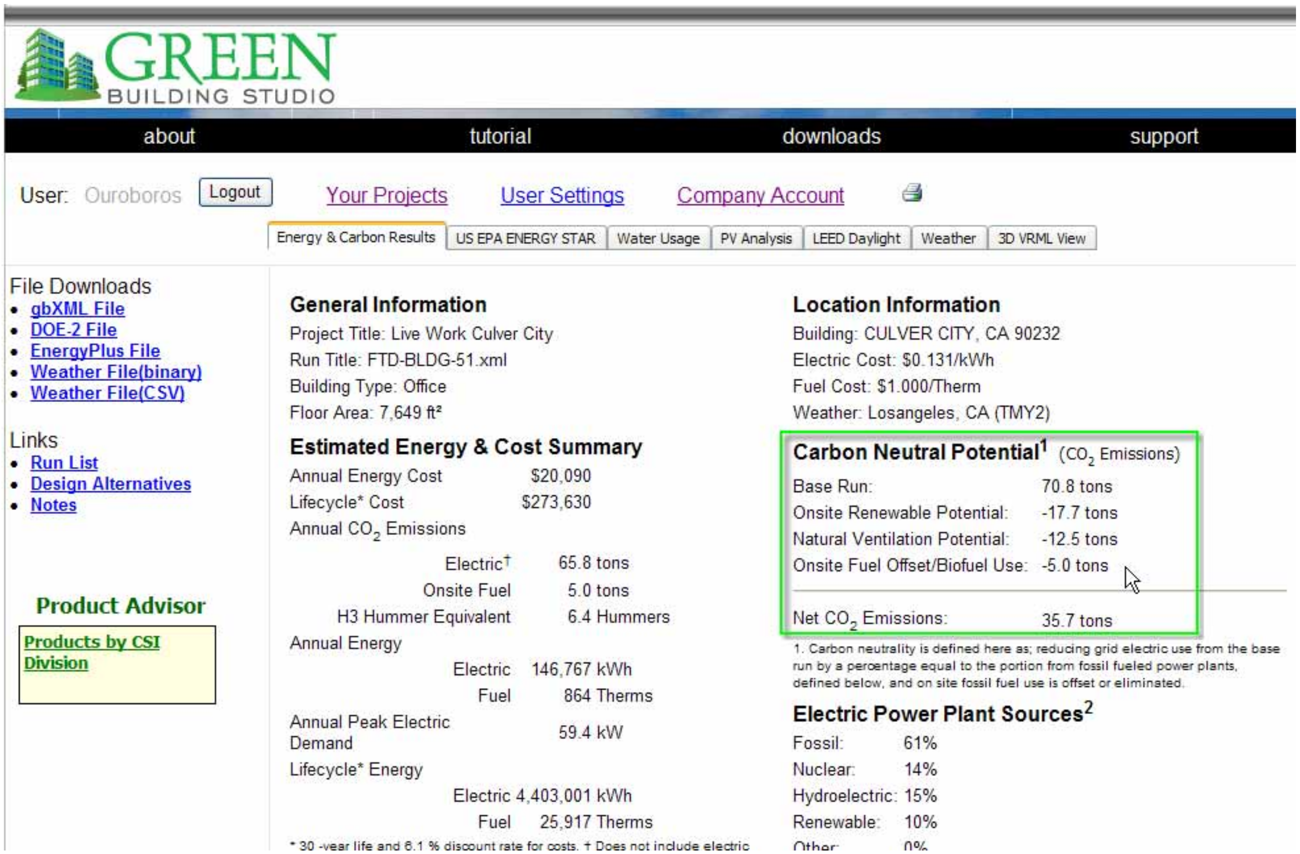


Source: www.buildcarbonneutral.org

Calculating Carbon:

Software is available to assist:

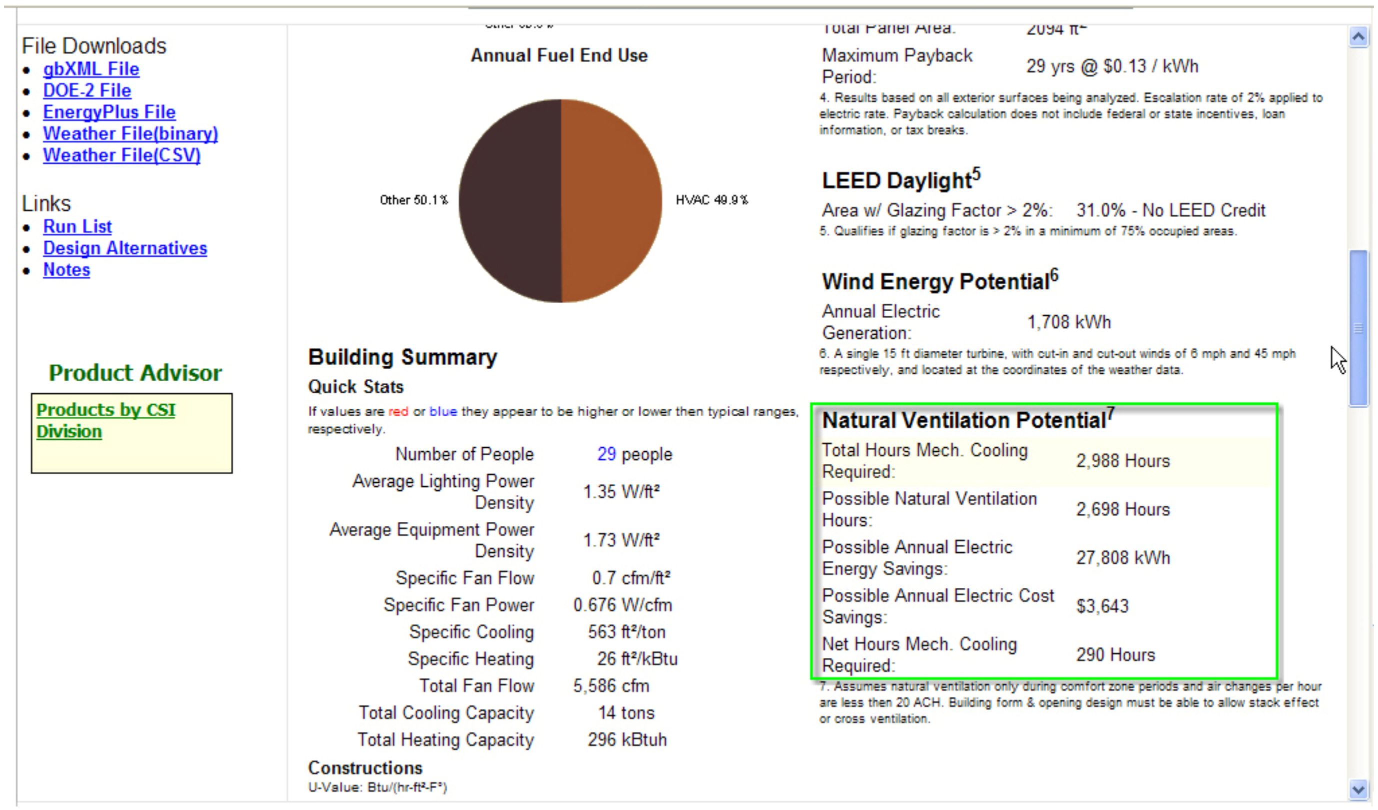
Green Building Studio: works with BIM



Source: www.greenbuildingstudio.com

Green Building Studio:

Runs a DOE model of the existing building to provide the basis for reworking the design to reduce carbon via daylighting, PV, natural ventilation, envelope/window redesign, electricity, water – all based on climate and location statistics



Source: www.greenbuildingstudio.com

The LEAP to Zero Carbon:

case studies

Next Generation Design Strategies: Toward Zero-Energy/Zero-Emission Design

Lessons from Five AIA COTE Award Winning Projects

▪***PREMISE: Architects need to re-engage the forces of sun and wind to inform design and foster an ecologically-based future***

▪EXEMPLARS: Next generation of ecological thinking can be found in the emerging body of zero-energy and zero-emission architecture

▪ZERO-ENERGY/ZERO-EMISSION VISION:

- At one end of a continuum, zero-energy design is merely a set of technical performance standards that elevate buildings to a new threshold of energy efficiency.
- At the other end, the essence of zero-energy and zero-emission design is a radical proposition; radical in the root sense of the word from the Latin *rādix*, which means arising from the root or source, fundamental.

Next Generation Design Strategies: Toward Zero-Energy/Zero-Emission Design

Lessons from Five AIA COTE Award Winning Projects

ZED ASPIRATIONS:

Lessons from low and zero-energy award winning projects

- Zero-energy design takes us back to very fundamental questions, such as how much energy and resources are appropriate to consume?
- Zero-energy design challenges us to frame a vision of architecture for the 21st century that asks how we might live differently in the future.
- Zero-energy design asks us to reconsider our daily lives. It requires change; the status quo will not move us to a zero-energy, zero-emission, and carbon-negative future.

A new architecture of the sun and wind can provide direction for the profession to gain a new way of thinking and greater performance standards, while at the same time developing an ecological ethic and an aesthetic of design capable of shaping a new social consciousness.

Next Generation Design Strategies:

Lessons from Five AIA COTE Award Winning Projects

Architect	Project	Location
Randall Stout Architects	Steinhude Sea Recreation Facility	Steinhude, Germany
Lake|Flato Architects	Government Canyon Visitor Center	Helotes, TX
Pugh + Scarpa	Solar Umbrella House	Venice, CA
Pugh Scarpa Kodama	Colorado Court Affordable Housing	Santa Monica, CA
Ray Kappe Architects	Z6 House	Santa Monica, CA

Next Generation Design Strategies: Toward Zero-Energy/Zero-Emission Design

Lessons from Five AIA COTE Award Winning Projects

Architect	Energy Level			Climate				Strategies: Solar Design										Natural Ventilation				Renewable Energy							Envelope		
	Zero	Low	Better Than Average	Cold	Temperate	Hot Humid	Hot Arid	Solar Orientation	Daylighting	Garden Sky Courts	Passive Solar Umbrella	Wind Orientation	Borrowed Light	Heliostats	Atrium Lightwell	Trombe Wall	Light Shelves	Cross Ventilation	Stack Ventalation	Solar Chimney	Wind Chimney	Ground Source	Photovoltaics	Passive Solar Water Heating	Geothermal Water Heating	Hydronic Thermal Storage	On-site Biomass	Wind Turbine	Responsive Façade	Green Roof	Double Façade
Randall Stout (Steinhude)		+		+					+									+					+	+							
Lake|Flato Architects (Gov Canyon)		+					+		+																						
Pugh + Scarpa (Solar Umbrella)		+					+				+							+					+								
Pugh Scarpa Kodama (Colorado Court)		+				+			+			+						+					+								
Ray Kappe Architects (Z6 House)	+					+			+									+		+			+	+						+	

Next Generation Design Strategies: Toward Zero-Energy/Zero-Emission Design

Lessons from Five AIA COTE Award Winning Projects

Architect	Shading							Systems																Materials					Process			
	Horizontal	Vertical	Parrones (pergolas)	Brise-Soleil	Sunshading	Overhangs	Shade Wall	Rainwater Retention	Grey Water Treatment	Automated Control System	Manually Operable	Heat Exchangers	Cooling	Heating	Thermal Mass	On-Site Cogeneration	Hydronic Heating	Porous Paving	VAV Energy-recovery Units	Valence Convectors	Katabatic Cooling Tower	Night Sky System	Thermal Flywheel	Locally Sourced Material	Recycled Materials	Low VOC	Cellulose Insulation	Certified Wood	Community Involvement	Embodied Energy Calculated	Lobbied for Improved Energy Cod	Life-cycle Cost Analysis
Randall Stout (Steinhude)								+	+	+					+	+									+			+				
Lake|Flato Architects (Gov Canyon)						+		+		+	+													+	+	+		+				
Pugh + Scarpa (Solar Umbrella)				+				+																								
Pugh Scarpa Kodama (Colorado Court)		+		+				+		+				+		+	+	+							+	+	+				+	
Ray Kappe Architects (Z6 House)								+	+	+							+							+	+	+		+				

Z6 House

Santa Monica, CA; Ray Kappe (Architects)

Z6 House

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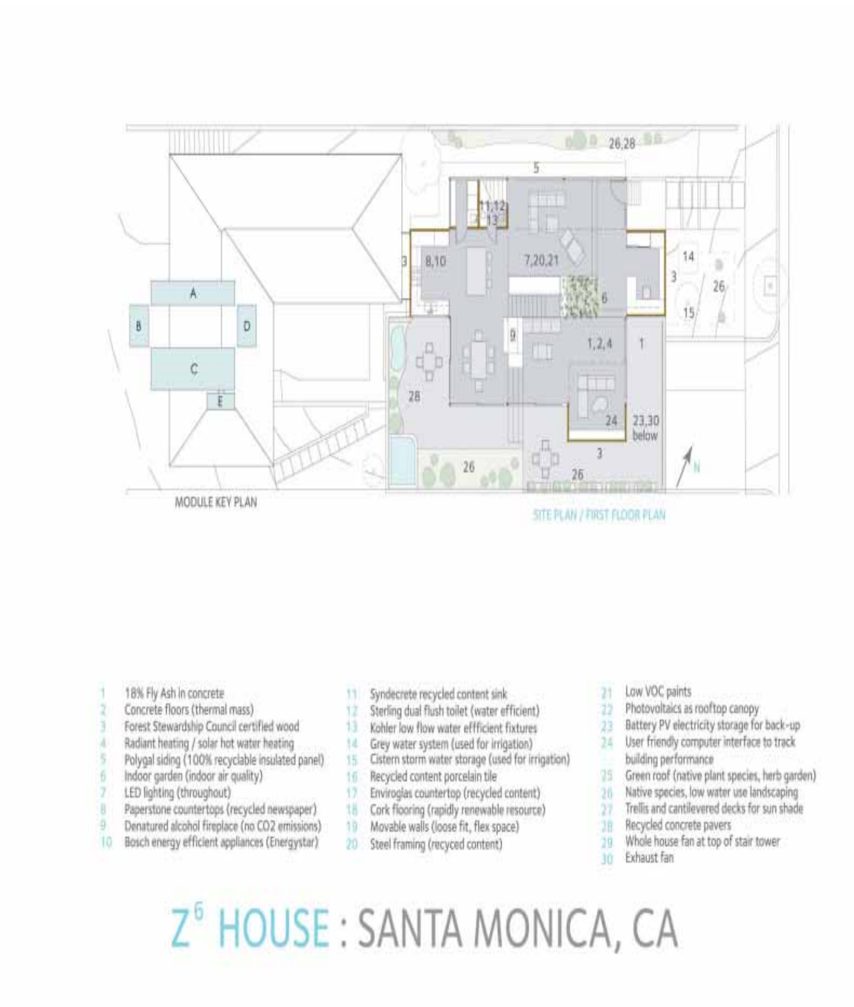
Z6 House

Santa Monica, CA; Ray Kappe (Architects)

Z6 House

Santa Monica, CA; Ray Kappe (Architects)



Z6 House

Santa Monica, CA; Ray Kappe (Architects)

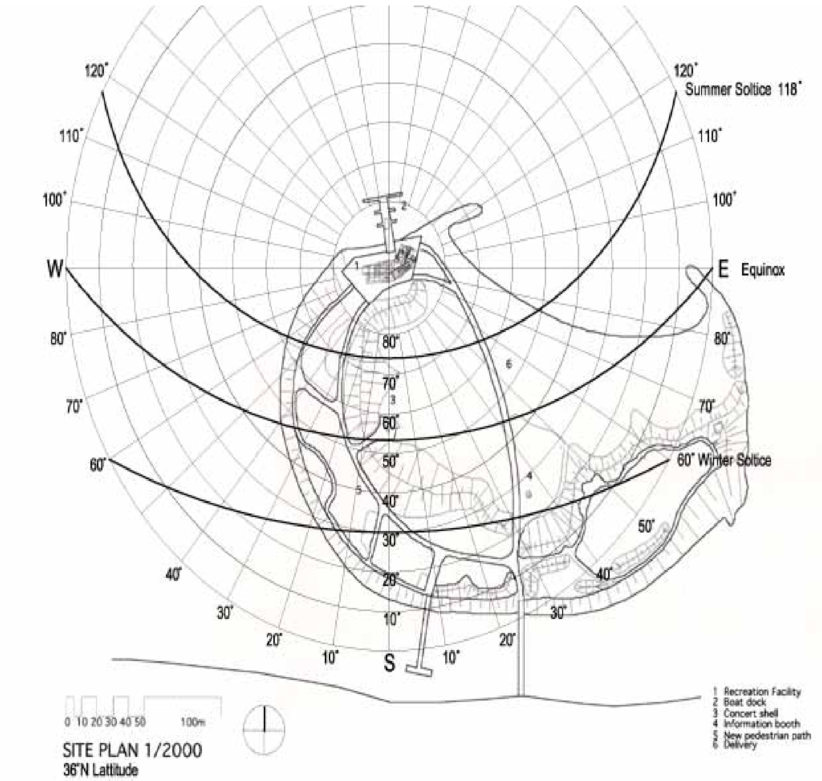
Next Generation Design Strategies: Z6 House

Santa Monica, CA; Ray Kappe (Architects)

- go beyond the current limits of “best practice”
- reframe the fundamental questions that inform design thinking
- establish robust ecological intentions and project goals
- “six zeros” as the performance target: zero waste, zero energy, zero water, zero carbon, zero emissions, and zero ignorance.
- go beyond incremental change challenge fundamental paradigms

Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)



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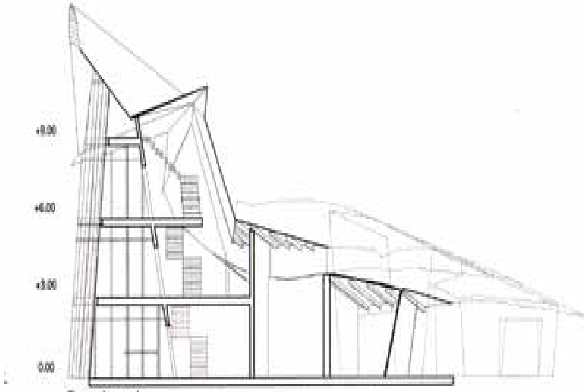
Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)



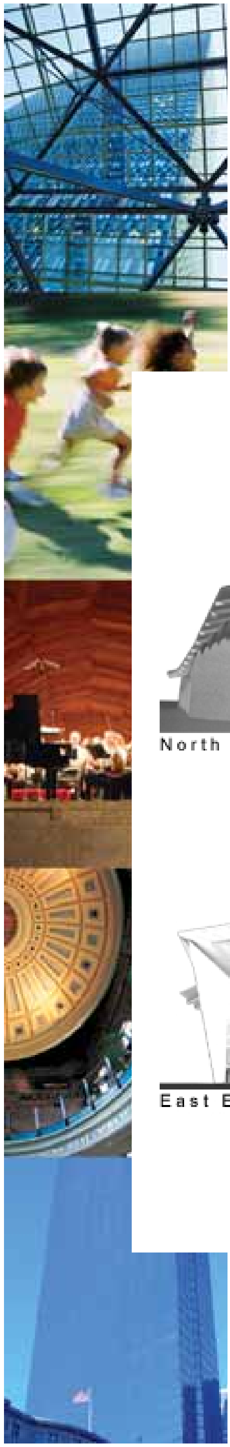
Section A

Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)

Photo by Peter Hubbe

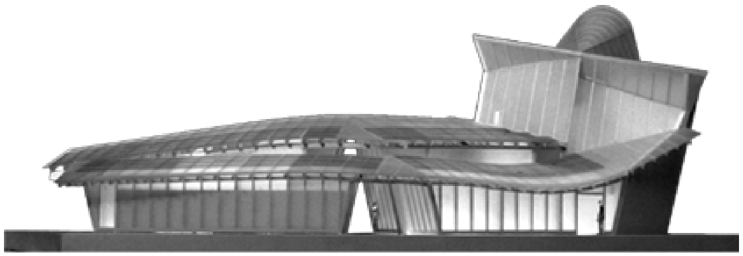
Photo by Peter Hubbe



Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)

North Elevation



South Elevation

East Elevation

West Elevation

Image By Architect

Photo by Peter Hubbe

Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)

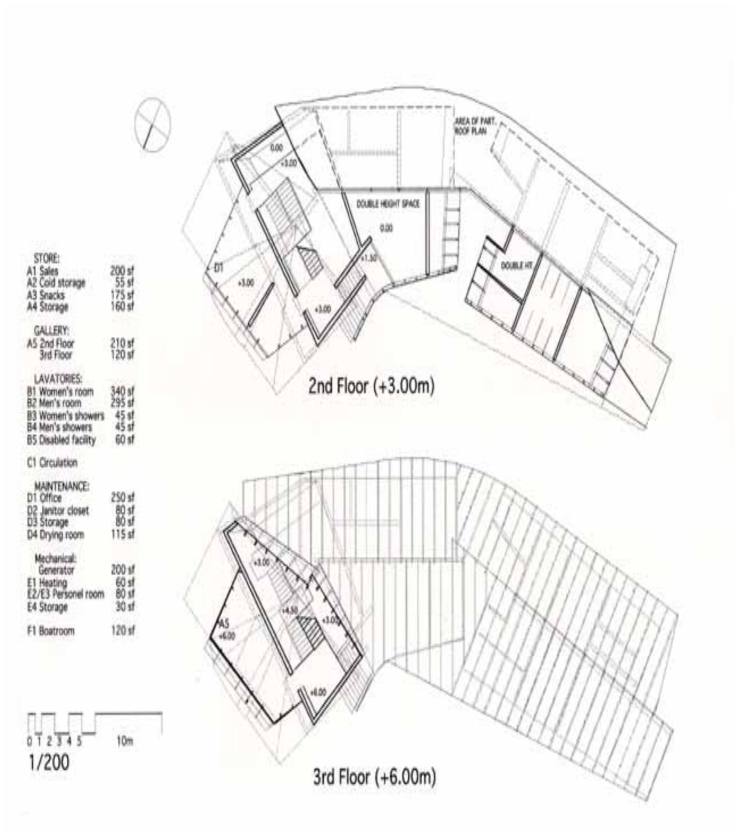


Image By Architect

Photo by Peter Hubbe

Next Generation Design Strategies: Steinhude Sea Recreation Facility; Randall Stout (Architects**)**

- optimize passive strategies and harvest free site energy for lighting, ventilation, and heating, integrate renewable energy
- energy self-reliant, with 100% of the needs met on-site
- passive systems are used for natural ventilation and daylighting
- active systems provide domestic hot water, space heating, and electricity via solar hot water collectors, photovoltaic panels, a ground source geothermal heat pump, and a seed-oil fueled cogeneration micro-turbine
- expressive formal and experiential potential of architecture as net-energy producer

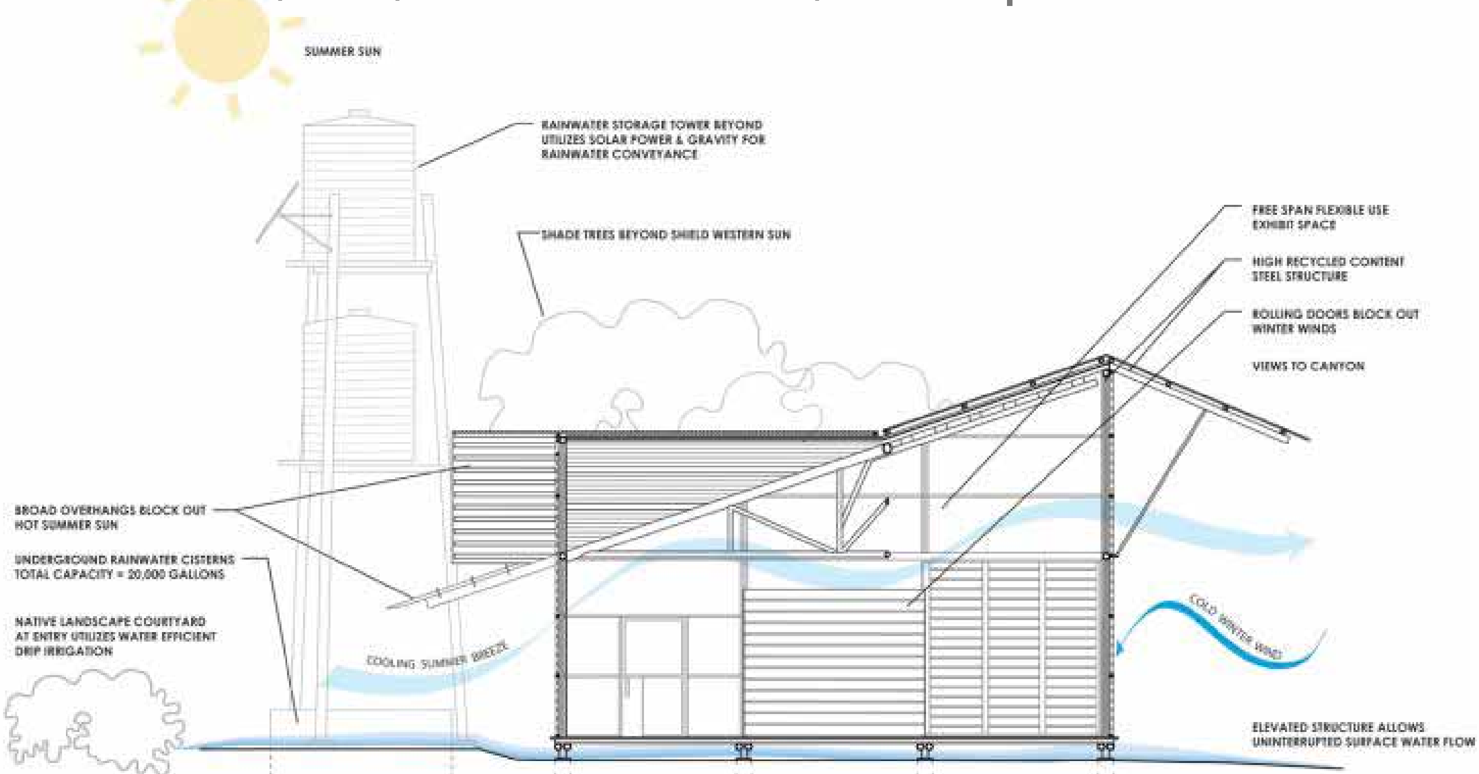
Government Canyon Visitor Center
Helotes, TX, United States; Lake|Flato Architects

Government Canyon Visitor Center

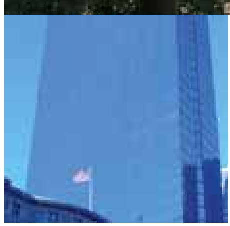
Helotes, TX, United States; Lake|Flato Architects

Government Canyon Visitor Center

Helotes, TX, United States; Lake|Flato Architects



Government Canyon Visitor Center
Helotes, TX, United States; Lake|Flato Architects



Next Generation Design Strategies: Government Canyon Visitor Center; Lake|Flato Architects

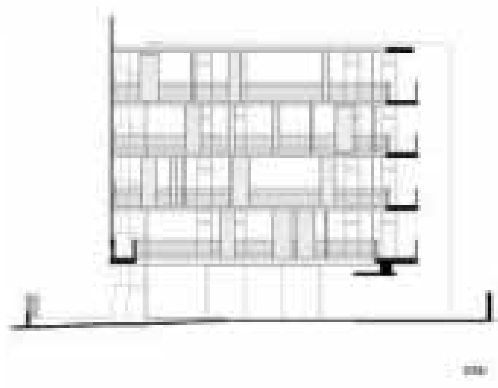
- reframe the project and program to reduce energy and resource consumption, costs, and maintenance
- reprogram activities, provide flexibility and adaptability, downsize, and create design and space innovations while also decreasing energy and resource consumption, reducing maintenance, and reallocating funds to improve the quality of space
- “reduced sizing” in lieu of “right sizing”
- air conditioning was eliminated and the size of the space to be cooled was reduced by 35%
- harvest daylighting and natural ventilation; integrate bioregional strategies

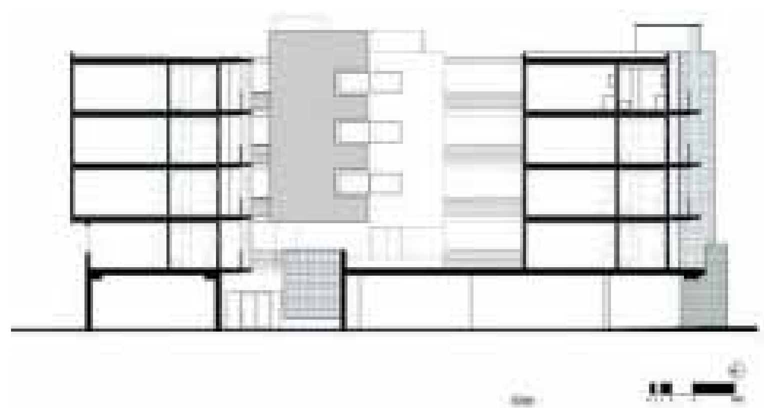
Colorado Court Affordable Housing

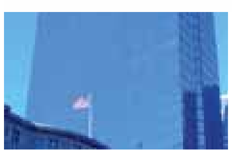
Santa Monica, CA, United States; Pugh Scarpa Kodama

Colorado Court Affordable Housing

Santa Monica, CA, United States; Pugh Scarpa Kodama







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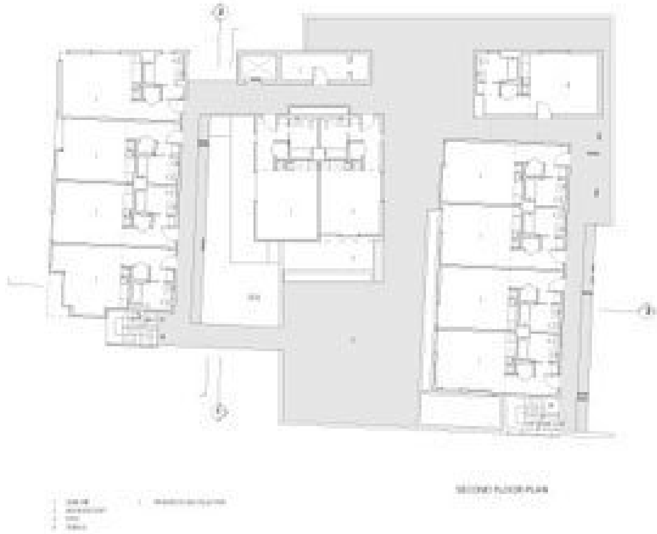
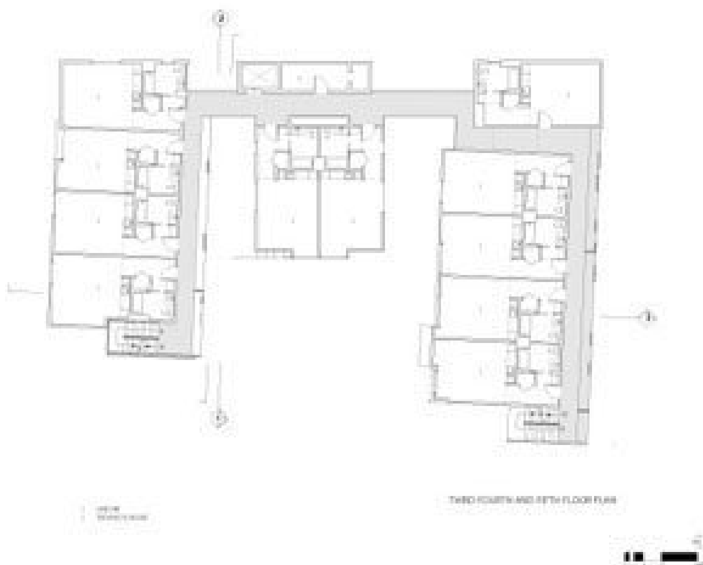




Colorado Court Affordable Housing

Santa Monica, CA, United States; Pugh Scarpa Kodama

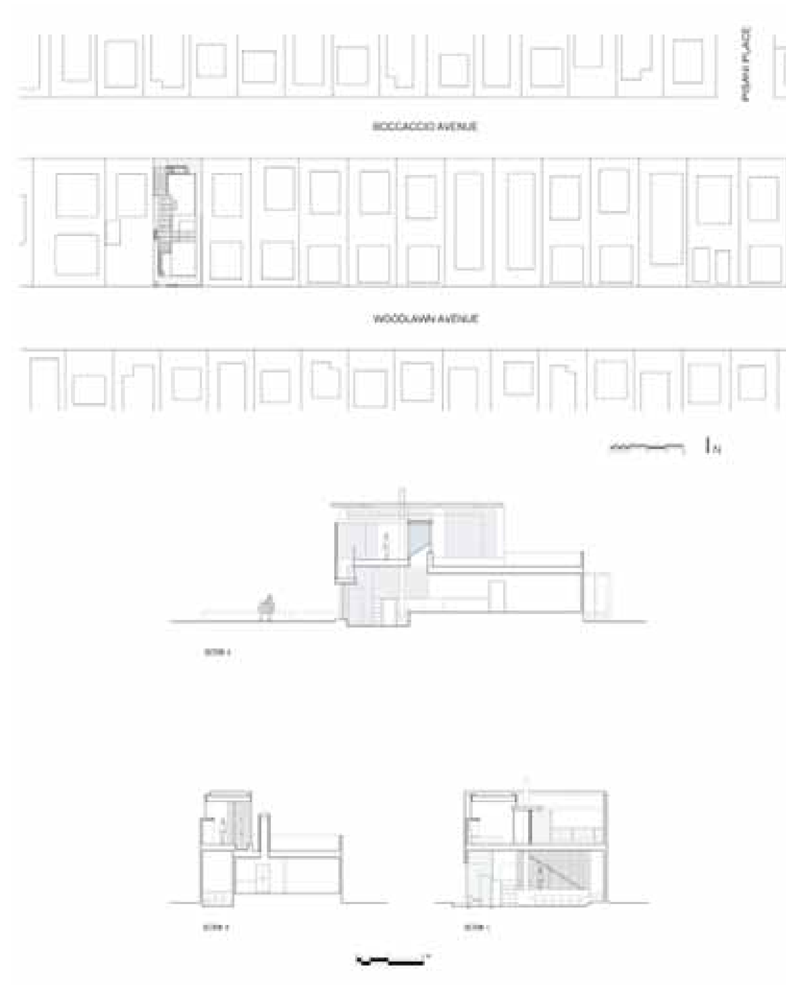
Next Generation Design Strategies: Colorado Court Affordable Housing; Pugh Scarpa Kodama

- address not only ecological effectiveness, but also a deeper understanding of green economics, equity, and social justice
- first energy-neutral affordable housing project in the U.S.
- optimize ecological benefits, building performance, social and human factors, and economic considerations
- passive strategies combined with a broad cross-section of renewable and low-carbon emitting technologies, including photovoltaic panels and a gas fired micro-turbine to produce 100% of the electricity on site
- foster connections to community and nature
- integrate ecological concerns with comfort and health

Solar Umbrella House
Venice, CA ; Pugh+ Scarpa (Architects)

Solar Umbrella House

Venice, CA ; Pugh+ Scarpa (Architects)



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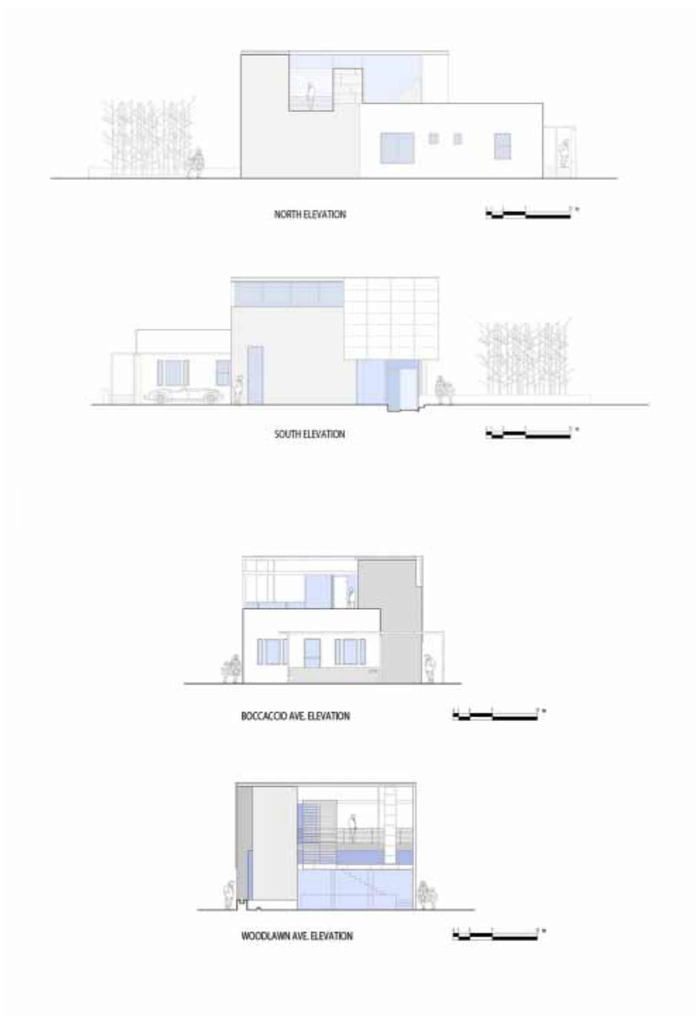

Next Generation Design Strategies: Toward Zero-Energy/Zero-Emission Design

Lessons from Five AIA COTE Award Winning Projects

Strategies

Architect	Energy Level			Climate				Solar Design										Natural Ventilation				Renewable Energy							Envelope		
	Zero	Low	Better Than Average	Cold	Temperate	Hot Humid	Hot Arid	Solar Orientation	Daylighting	Garden Sky Courts	Passive Solar Umbrella	Wind Orientation	Borrowed Light	Heliostats	Atrium Lightwell	Trombe Wall	Light Shelves	Cross Ventilation	Stack Ventilation	Solar Chimney	Wind Chimney	Ground Source	Photovoltaics	Passive Solar Water Heating	Geothermal Water Heating	Hydronic Thermal Storage	On-site Biomass	Wind Turbine	Responsive Façade	Green Roof	Double Façade
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Ray Kappe Architects (Z6 House)	+					+			+									+		+			+	+						+	

Next Generation Design Strategies: Toward Zero-Energy/Zero-Emission Design

Lessons from Five AIA COTE Award Winning Projects

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Randall Stout (Steinhude)								+	+	+					+	+									+			+				
Lake|Flato Architects (Gov Canyon)						+		+		+	+													+	+	+		+				
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Ray Kappe Architects (Z6 House)								+	+	+							+							+	+	+		+				

Next Generation Design Strategies: Solar Umbrella House; Pugh+ Scarpa (Architects)

- embody an ecological aesthetic and ethos
- precedent for the next generation of modernist architecture
- form is integral: essence of an architecture of the sun and wind
- building massing, section, and plan are designed to control the sun, provide shade, create indirect daylight, and optimize natural ventilation
- passive design is more than an energy reduction strategy; it fundamentally shapes and gives form to the design
- formal design implications in the forces of sun, wind, and site

Designing a New Future:
Next Generation Design
Toward Zero and Low-Energy Architecture

- next generation of design thinking has already emerged
- calls the profession to a more ambitious and inspired level of leadership to meet the urgent ecological issues of our time
- vision of a future that solves ecological problems with design integrity and beauty and provides solutions to living more respectfully within our local ecosystems
- architects are called to integrate both the art and science of an architecture of the sun and wind
- means to awaken the heart and enable our society to embody a new ecological ethos that is both hopeful and promising.

Aldo Leopold Legacy Center

Carbon Neutral Building Case Study

Michael Utzinger, University of Wisconsin-Milwaukee

Approach to Carbon Neutral Design

- **Design a Net Zero Building**
- **Apply Carbon Balance to Building Operation (Ignore Carbon Emissions due to Construction)**
- **Include Carbon Sequestration in Forests Managed by Aldo Leopold Foundation**

Net Zero Energy Design

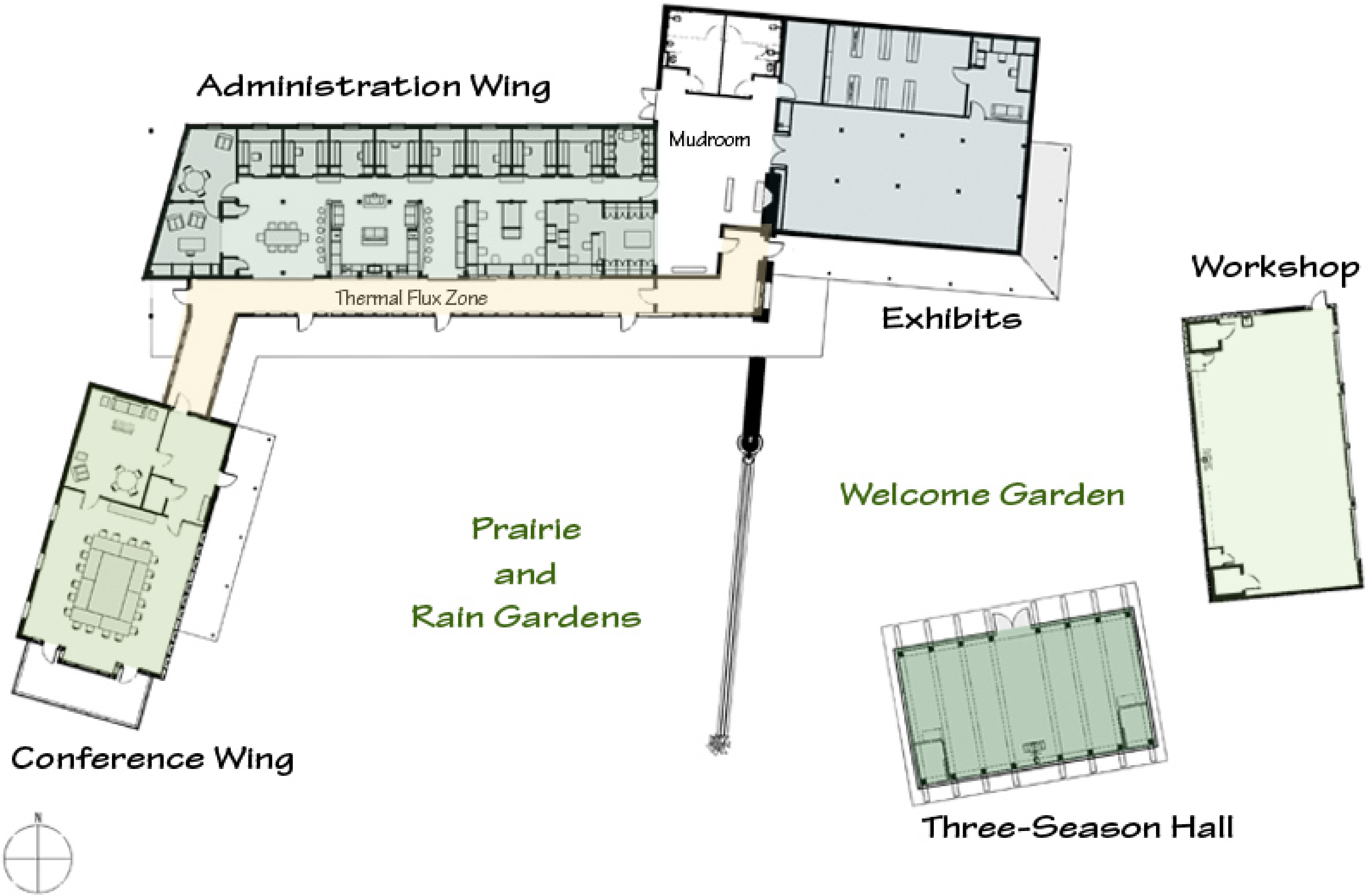
- Establish solar budget:
  3,000 photovoltaic array;
  50,000 kWh per year

- Set maximum building
  energy demand to fall
  within solar budget:
  8,600 Sq. Ft. building;
  5.7 kWh per SF per year

Architectural Design Strategies

- Program Thermal Zones
- All perimeter zones (no interior zones)
- Daylight all occupied zones
- Natural ventilation in all occupied zones
- Double code insulation levels
- Passive solar heating
- Shade windows during summer

Thermal Zones ~ Perimeter Zones



Three Season Hall

Daylight All Occupied Zones

Natural Ventilation

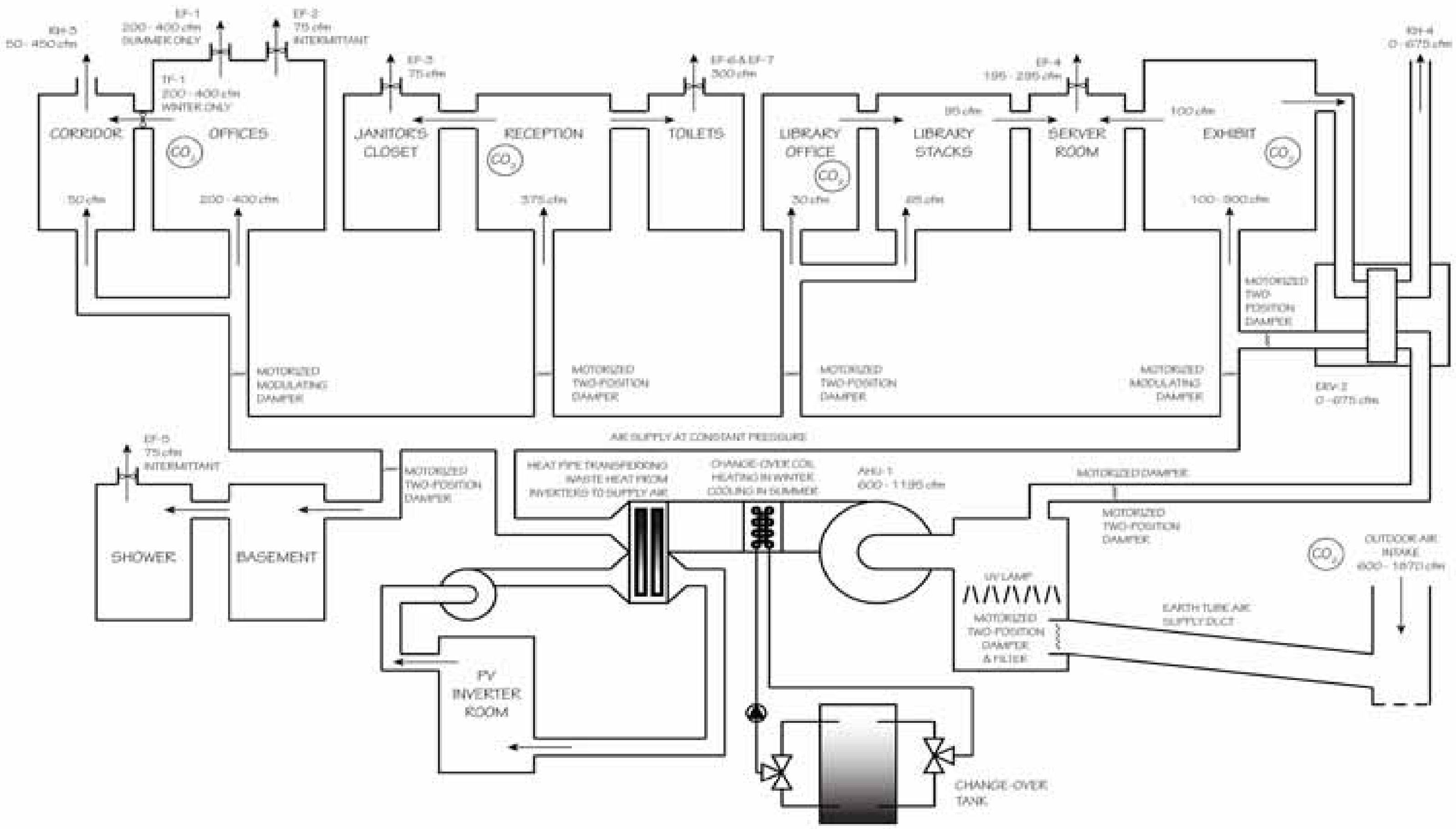
Passive Solar Heating

Shade Windows During Summer

HVAC Strategies

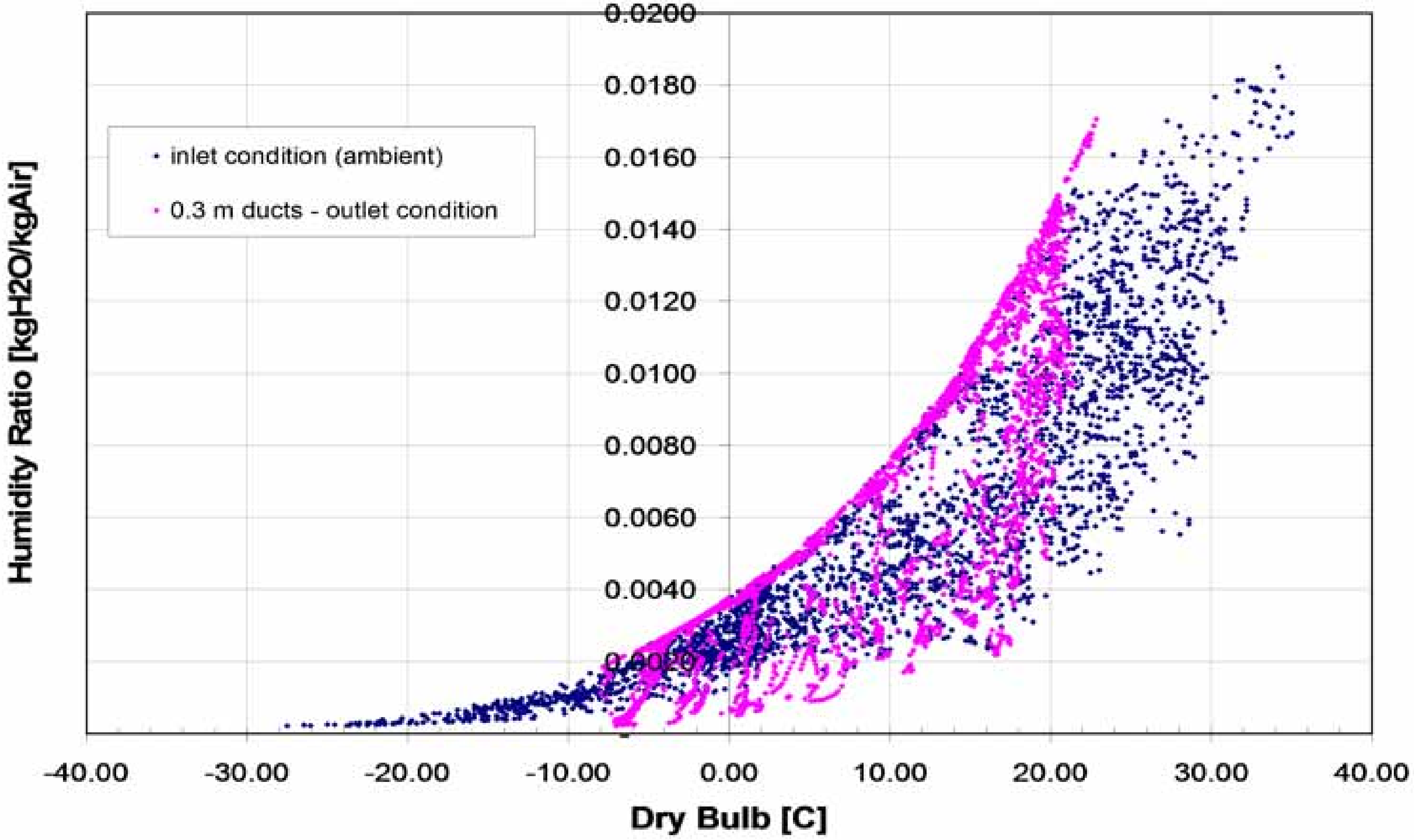
- Ventilate only to Occupant outdoor air requirements (2/3 ACH)
- 100% Outdoor air (no recirculation)
- Earth tube air pretreatment
- Demand Control Ventilation (600 to 2,500 cfm)
- Separate ventilation from heating and cooling
- Radiant floor slabs for heating and cooling
- Use ground as heat source & sink (ground source heat pumps)
- Storage tank as thermal capacitor between heat pumps & load
- Seasonal change-over system
- Solar heated service hot water

Ventilation System



Earth Duct for Air Pretreatment

Earth Duct Simulation Results



Radiant Heating and Cooling

Ground Source Heat Pumps

LEED Energy Modeling Results

	Regulated Loads (kWh)	Unregulated Loads (kWh)	Total Loads (kWh)
ECB	119,600	11,400	131,000
DEC	50,400	11,400	61,800
CNC	42,500	11,400	53,900

Solar electric generation: 61,200 kWh

Carbon Balance Analysis

Use the Greenhouse Gas Protocol
of the
World Resources Institute

Organizational Boundary:
Aldo Leopold Foundation

Project Boundary:
Aldo Leopold Legacy Center and woodlots certified for sustainable harvest

Carbon Emissions Accounting

- Scope 1: Direct Emissions
  - **Stationary Combustion (boilers, wood stoves)**
  - **Organizational Vehicles**
- Scope 2: Indirect Emissions
  (electricity generation)
- Scope 3: Indirect Emissions
  (organizational activities)
  - **Commuting to Work**
  - **Business Travel**

Scope 1:
Direct Greenhouse Gas Emissions

	Fuel	Amount	CO_2 Emissions (metric tons)
Direct combustion	Wood	2 cords	6.7
Vehicles	Gas	1,490 gallons	13.2
Total emissions			**19.9**

Scope 2: Indirect Greenhouse Gas Emissions (Electricity)

Electricity Source	Amount (kWh/year)	CO_2 Emissions (metric tons)
Green power contract	33,400	10.6 (offset)
Site solar generation	32,300	10.2 (offset)
Net carbon offset		**20.8 (offset)**

Scope 2: Indirect Greenhouse Gas Emissions (Organizational Activities)

Activity	**Amount**	**CO_2 Emissions (metric tons)**
Employee commuting	1,800 gallons of gas	16.0
Business travel	36,000 air miles	6.0
Solid waste removal	5,200 pounds	3.4
Total emissions		**25.4**

Forest Management & Sustainable Harvest

Before Harvest

After Harvest

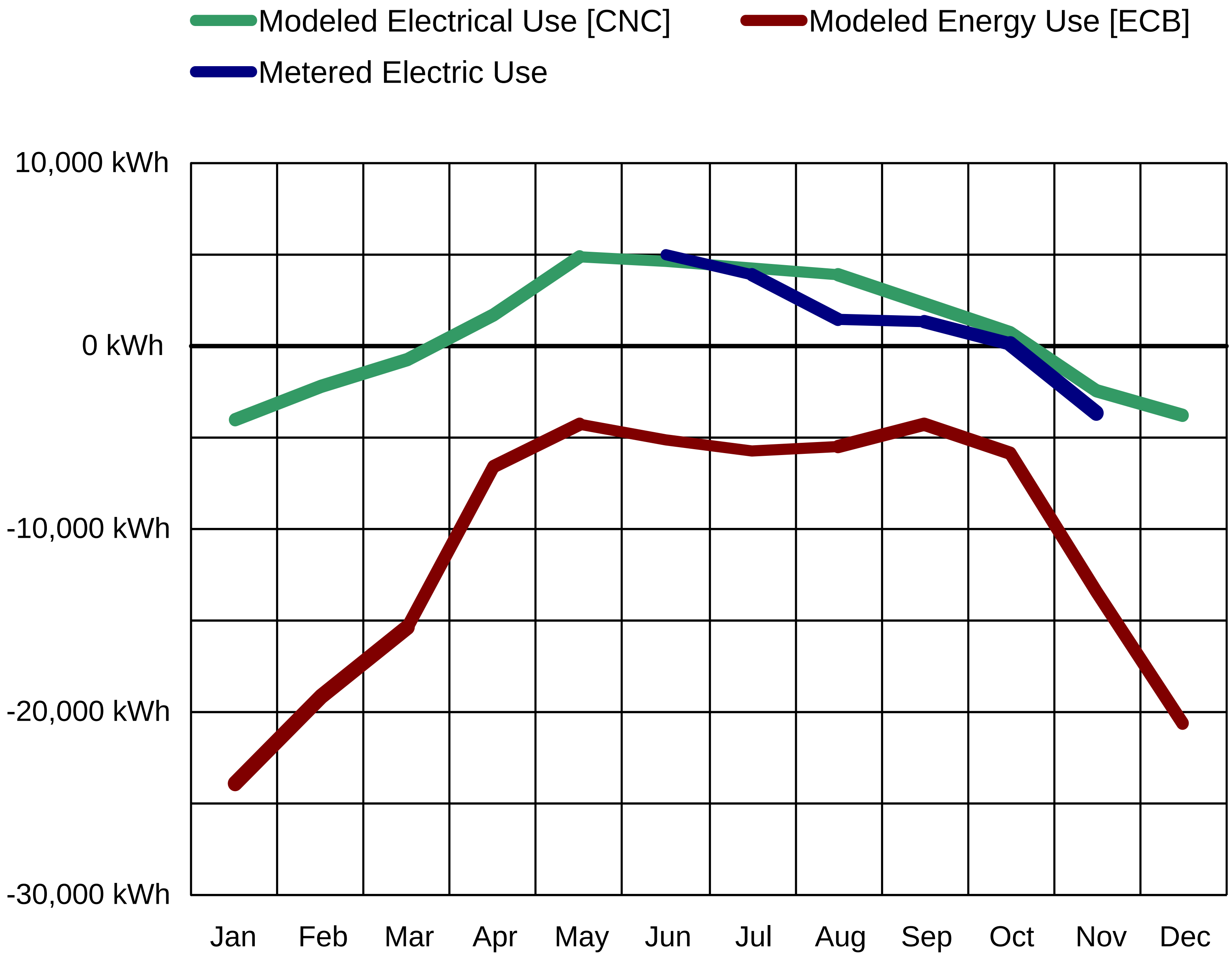
Carbon Sequestration
Carbon Absorbed by Managed Forest

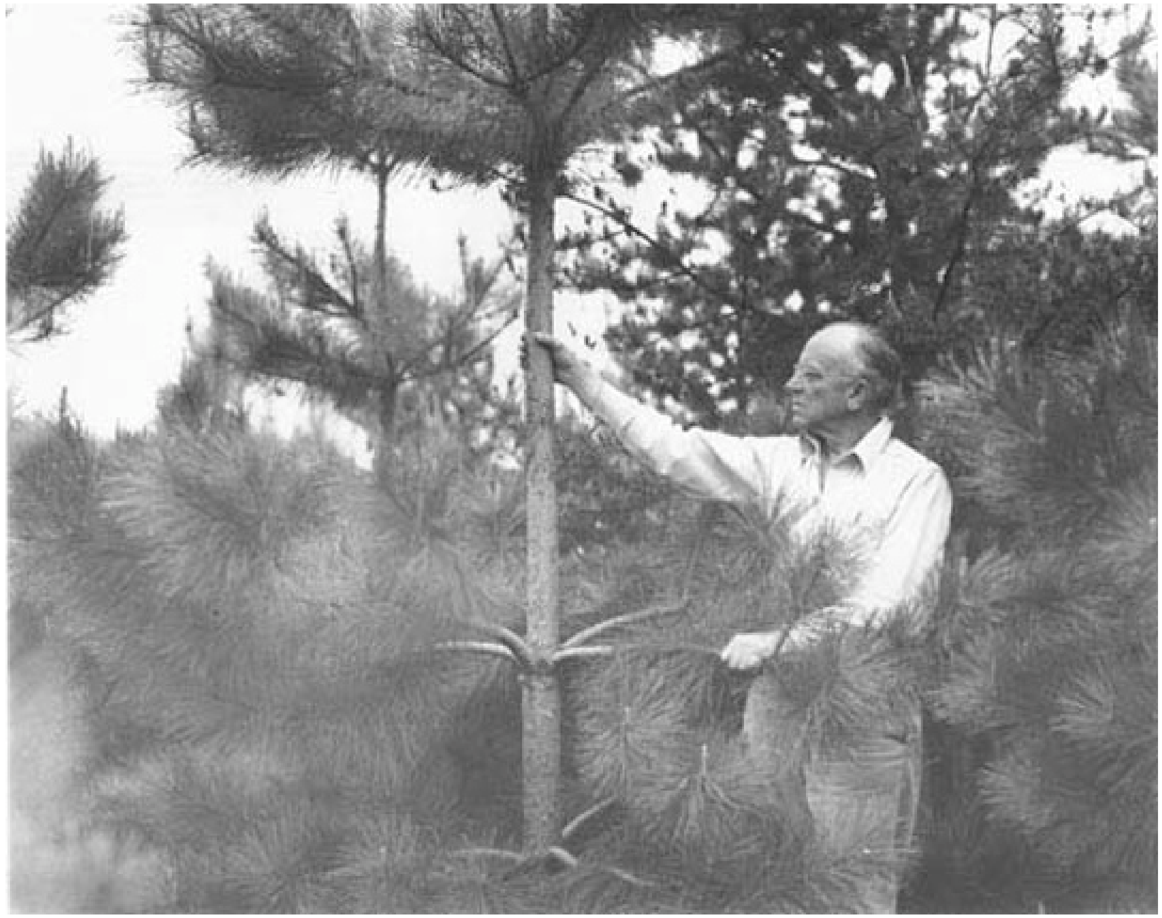
Managed Forest Area	Carbon Sequestration Rate	CO_2 Emissions
35 acres	0.25 IP tons of carbon per acre	29.1 metric tons (offset)

Carbon Balance Summary

	Source	CO_2 Emissions (metric tons)
Scope 1	Direct emissions	19.9
Scope 2	Indirect emissions: electricity	20.8 (offset)
Scope 3	Indirect emissions: organizational activities	25.4
Carbon sequestered	Managed forest	29.1 (offset)
Net carbon offset		**4.6 (offset)**

Aldo Leopold Legacy Cente
Net Electricity Sold to Utilit





We end, I think, at what might be called the standard paradox of the 20th century: our tools are better than we are, and grow better faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in human history: to live on a piece of land without spoiling it.

Aldo Leopold, 1938

Summary:

What IS the difference between a Sustainable Building and a Carbon Neutral Building?

- Point 1
- Point 2
- Point 3
- Point 4

Summary:

What ARE the KEY STRATEGIES needed to design to a state of CARBON NEUTRALITY?

- Strategy 1
- Strategy 2
- Strategy 3
- Strategy 4
- Strategy 5

-Strategy 6

- etc

Summary:

What are the ARCHITECTURAL IMPLICATIONS of designing to Zero Carbon?

- Point 1
- Point 2
- Point 3
- Point 4
- Point 5
- Point 6
- etc

Summary:

What is the POTENTIAL of designing a building to a state of Carbon Neutrality?

- Point 1
- Point 2
- Point 3
- Point 4
- Point 5
- Point 6
- etc

Evaluation

Speakers

(List alphabetically by last name regardless of speaking order)

- Boake, Terri Meyer
- Guzowski, Mary
- Utzinger, Michael

Contact Information

Terri Meyer Boake, BES, BArch, MArch, LEED AP
Associate Director, School of Architecture, University of Waterloo | President Society of Building Science Educators
tboake@uwaterloo.ca

Mary Guzowski, MArch
Associate Professor, College of Design, University of Minnesota
guzow001@umn.edu

Michael Utzinger, BArch, MS in Engineering
Department of Architecture, University of Wisconsin/Milwaukee
utzinger@umn.edu