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CONVENTION 2008

We the people

**THE LEAP TO ZERO CARBON:
*Incorporating Advanced Zero Energy
Strategies into High Performance Design***

FR65



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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 CO₂ 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 CO² emissions is 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 CO₂ 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

7 Impacts source: www.buildcarbonneutral.org



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



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 tree, 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 CO₂
- Possible to use the natural ecosystems on your site to assist in lowering the carbon footprint of your project

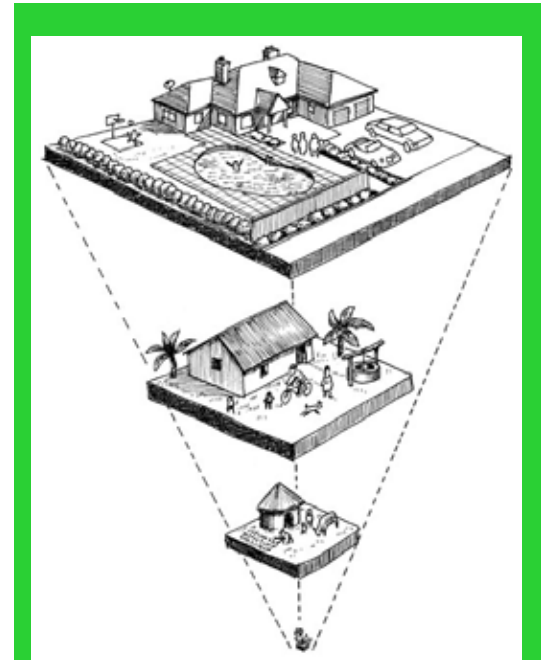


The natural site is preserved at IslandWood, Bainbridge Island.



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”



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





Estimating Carbon:

Software is available to assist:

- BuildCarbonNeutral: focuses on reducing *impact*

buildcarbonneutral beta

Estimate the embodied CO₂ of a whole construction project.

The Construction Carbon Calculator helps developers, builders, architects and land planners approximate the net embodied carbon of a project's structures and site.

1:reduce 2:renew 3:offset

Constructing new buildings and sites with the least possible environmental impact involves three important steps: *reduce*, *renew* and *offset*. Offsetting means calculating the project's carbon footprint so it can be balanced by funding resources or activities like renewable energy and land protection – resources that benefit and protect the planet.

This tool estimates the embodied energy and subsequent carbon amounts released during construction. The measurements account for building materials, processes and carbon released due to ecosystem degradation or sequestered through landscape installation or restoration.

Learn more about this calculator: [why it exists](#), [how it works](#) and [why you should use it!](#)

Construction Carbon Calculator

Building Size

Total Square Feet:

Stories Above Ground:

Stories Below Ground:

Primary Structural System Above Ground

- Wood
 Concrete
 Steel
 Mixed

Site

Ecoregion: [\(view map\)](#)

Predominant Existing Vegetation:

Predominant Installed Vegetation:

Landscape (SF) Disturbed:

Landscape (SF) Installed:

I have read and agree to the [terms of use](#).

Calculate

Source: www.buildcarbonneutral.org



Calculating Carbon:

Software is available to assist:

Green Building Studio: works with BIM

GREEN BUILDING STUDIO

about tutorial downloads support

User: Ouroboros Logout [Your Projects](#) [User Settings](#) [Company Account](#)

Energy & Carbon Results US EPA ENERGY STAR Water Usage PV Analysis LEED Daylight Weather 3D VRML View

File Downloads

- [gbXML File](#)
- [DOE-2 File](#)
- [EnergyPlus File](#)
- [Weather File\(binary\)](#)
- [Weather File\(CSV\)](#)

Links

- [Run List](#)
- [Design Alternatives](#)
- [Notes](#)

Product Advisor

[Products by CSI Division](#)

General Information

Project Title: Live Work Culver City
 Run Title: FTD-BLDG-51.xml
 Building Type: Office
 Floor Area: 7,649 ft²

Location Information

Building: CULVER CITY, CA 90232
 Electric Cost: \$0.131/kWh
 Fuel Cost: \$1.000/Therm
 Weather: Losangeles, CA (TMY2)

Estimated Energy & Cost Summary

Annual Energy Cost	\$20,090
Lifecycle* Cost	\$273,630
Annual CO ₂ Emissions	
Electric [†]	65.8 tons
Onsite Fuel	5.0 tons
H3 Hummer Equivalent	6.4 Hummers
Annual Energy	
Electric	146,767 kWh
Fuel	864 Therms
Annual Peak Electric Demand	59.4 kW
Lifecycle* Energy	
Electric	4,403,001 kWh
Fuel	25,917 Therms

Carbon Neutral Potential¹ (CO₂ Emissions)

Base Run:	70.8 tons
Onsite Renewable Potential:	-17.7 tons
Natural Ventilation Potential:	-12.5 tons
Onsite Fuel Offset/Biofuel Use:	-5.0 tons
Net CO₂ Emissions:	35.7 tons

Electric Power Plant Sources²

Fossil:	61%
Nuclear:	14%
Hydroelectric:	15%
Renewable:	10%
Other:	0%

* 30 -year life and 6.1 % discount rate for costs. † Does not include electric

1. Carbon neutrality is defined here as; reducing grid electric use from the base run by a percentage equal to the portion from fossil fueled power plants, defined below, and on site fossil fuel use is offset or eliminated.

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

File Downloads

- [gbXML File](#)
- [DOE-2 File](#)
- [EnergyPlus File](#)
- [Weather File\(binary\)](#)
- [Weather File\(CSV\)](#)

Links

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Annual Fuel End Use

Category	Percentage
HVAC	49.9%
Other	50.1%

Total Floor Area: 2094 ft²

Maximum Payback Period: 29 yrs @ \$0.13 / kWh

4. Results based on all exterior surfaces being analyzed. Escalation rate of 2% applied to electric rate. Payback calculation does not include federal or state incentives, loan information, or tax breaks.

LEED Daylight⁵

Area w/ Glazing Factor > 2%: 31.0% - No LEED Credit

5. Qualifies if glazing factor is > 2% in a minimum of 75% occupied areas.

Wind Energy Potential⁶

Annual Electric Generation: 1,708 kWh

6. A single 15 ft diameter turbine, with out-in and out-out winds of 6 mph and 45 mph respectively, and located at the coordinates of the weather data.

Building Summary

Quick Stats

If values are red or blue they appear to be higher or lower than typical ranges, respectively.

Number of People	29 people
Average Lighting Power Density	1.35 W/ft ²
Average Equipment Power Density	1.73 W/ft ²
Specific Fan Flow	0.7 cfm/ft ²
Specific Fan Power	0.676 W/cfm
Specific Cooling	563 ft ² /ton
Specific Heating	26 ft ² /kBtu
Total Fan Flow	5,586 cfm
Total Cooling Capacity	14 tons
Total Heating Capacity	296 kBtu/h

Constructions

U-Value: Btu/(hr-ft²-F°)

Natural Ventilation Potential⁷

Total Hours Mech. Cooling Required:	2,988 Hours
Possible Natural Ventilation Hours:	2,698 Hours
Possible Annual Electric Energy Savings:	27,808 kWh
Possible Annual Electric Cost Savings:	\$3,643
Net Hours Mech. Cooling Required:	290 Hours

7. Assumes natural ventilation only during comfort zone periods and air changes per hour are less than 20 ACH. Building form & opening design must be able to allow stack effect or cross ventilation.

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 *rādx*, 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	Strategies																															
	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	
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

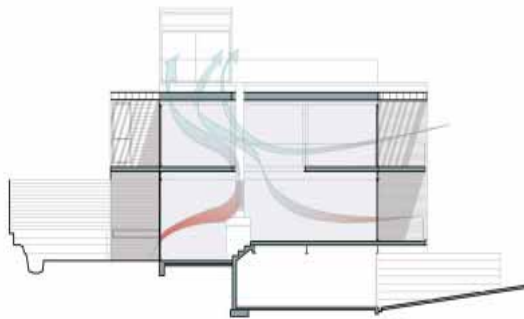
Lessons from Five AIA COTE Award Winning Projects

Architect	Shading		Systems														Materials			Process								
	Horizontal	Vertical	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)



SECTION : NATURAL VENTILATION AND SOLAR SHADING DIAGRAM

Z⁶ HOUSE : SANTA MONICA, CA





Z6 House

Santa Monica, CA; Ray Kappe (Architects)



Z⁶ HOUSE : SANTA MONICA, CA





Z6 House

Santa Monica, CA; Ray Kappe (Architects)



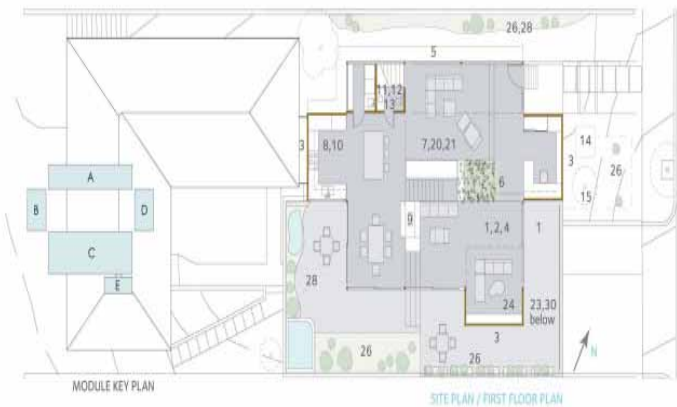
Z⁶ HOUSE : SANTA MONICA, CA





Z6 House

Santa Monica, CA; Ray Kappe (Architects)



- | | | |
|--|--|---|
| 1 18% Fly Ash in concrete | 11 Synconcrete recycled content sink | 21 Low VOC paints |
| 2 Concrete floors (thermal mass) | 12 Sterling dual flush toilet (water efficient) | 22 Photovoltaics as rooftop canopy |
| 3 Forest Stewardship Council certified wood | 13 Kohler low flow water efficient fixtures | 23 Battery PV electricity storage for back-up |
| 4 Radiant heating / solar hot water heating | 14 Grey water system (used for irrigation) | 24 User friendly computer interface to track building performance |
| 5 Polygal siding (100% recyclable insulated panel) | 15 Cistern storm water storage (used for irrigation) | 25 Green roof (native plant species, herb garden) |
| 6 Indoor garden (indoor air quality) | 16 Recycled content porcelain tile | 26 Native species, low water use landscaping |
| 7 LED lighting (throughout) | 17 Enviroglas countertop (recycled content) | 27 Trellis and cantilevered decks for sun shade |
| 8 Paperstone countertops (recycled newspaper) | 18 Cork flooring (rapidly renewable resource) | 28 Recycled concrete pavers |
| 9 Denatured alcohol fireplace (no CO2 emissions) | 19 Movable walls (loose fit, flex space) | 29 Whole house fan at top of stair tower |
| 10 Bosch energy efficient appliances (EnergyStar) | 20 Steel framing (recycled content) | 30 Exhaust fan |

Z⁶ HOUSE : SANTA MONICA, CA





Z6 House

Santa Monica, CA; Ray Kappe (Architects)



Z⁶ HOUSE : SANTA MONICA, CA





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)

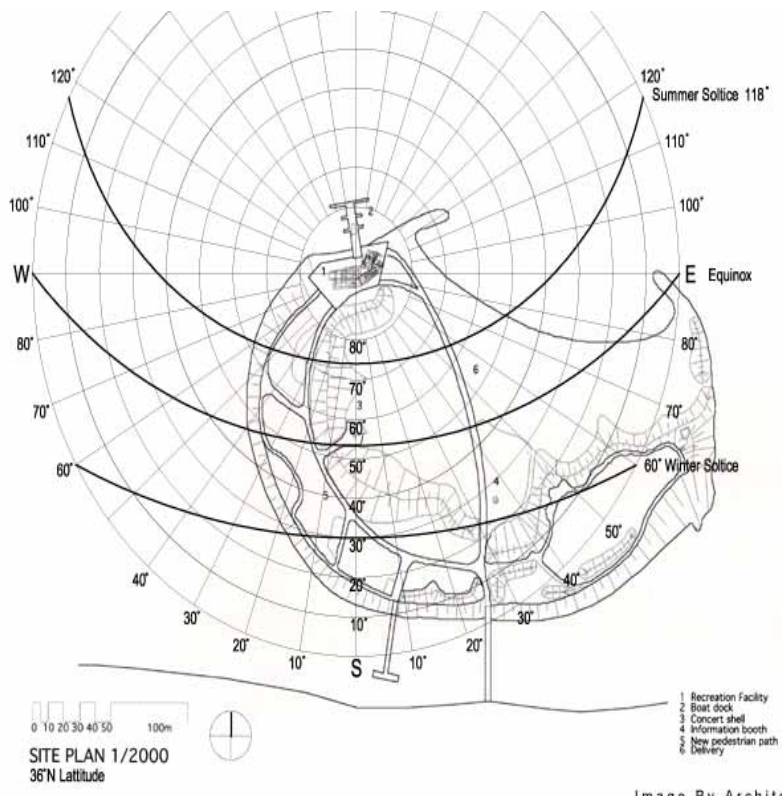


Image By Architect



Photo



Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)



Photo by Peter Hubbe

Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)



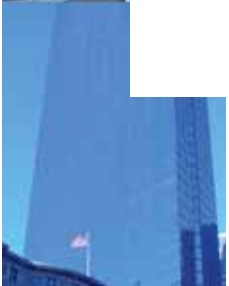
Photo by Peter Hubka



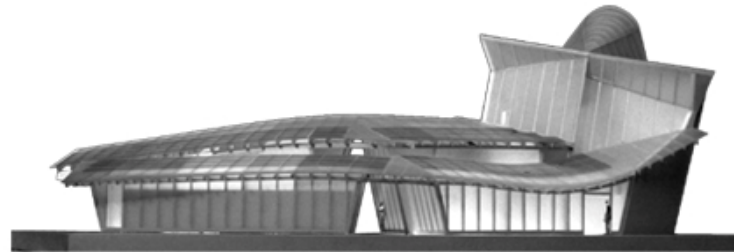
Photo by Peter Hubka

Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)



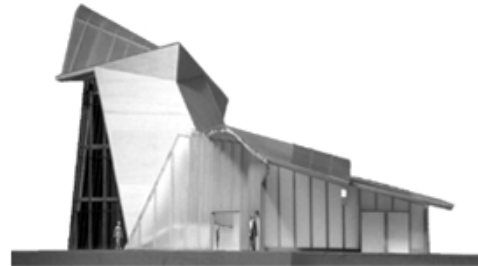
North Elevation



South Elevation



East Elevation



West Elevation

Image By Architect



Photo by Peter Hubbe

Steinhude Sea Recreation Facility

Steinhude, Germany ; Randall Stout (Architects)

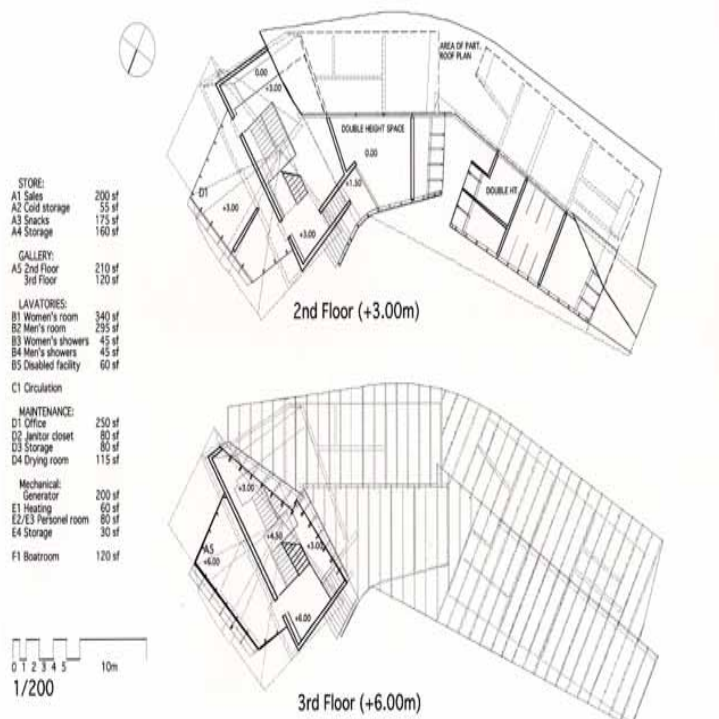


Image By Architect

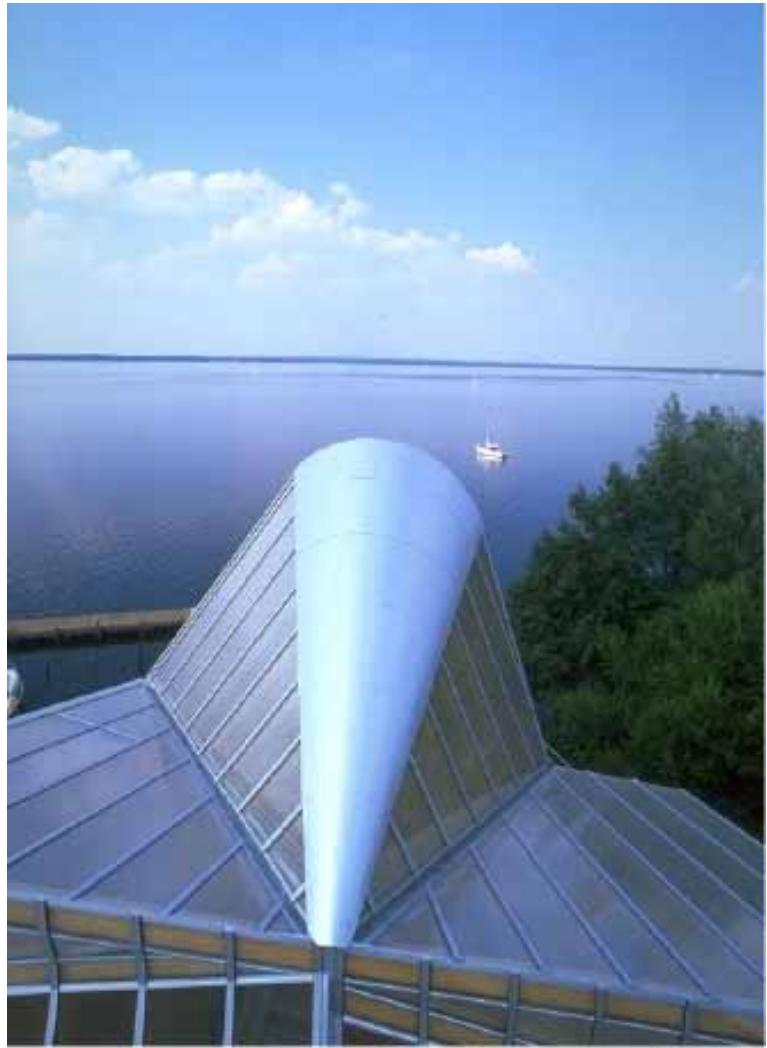


Photo by Peter Hubbe



Next Generation Design Strategies: Steinhide 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



LEGEND

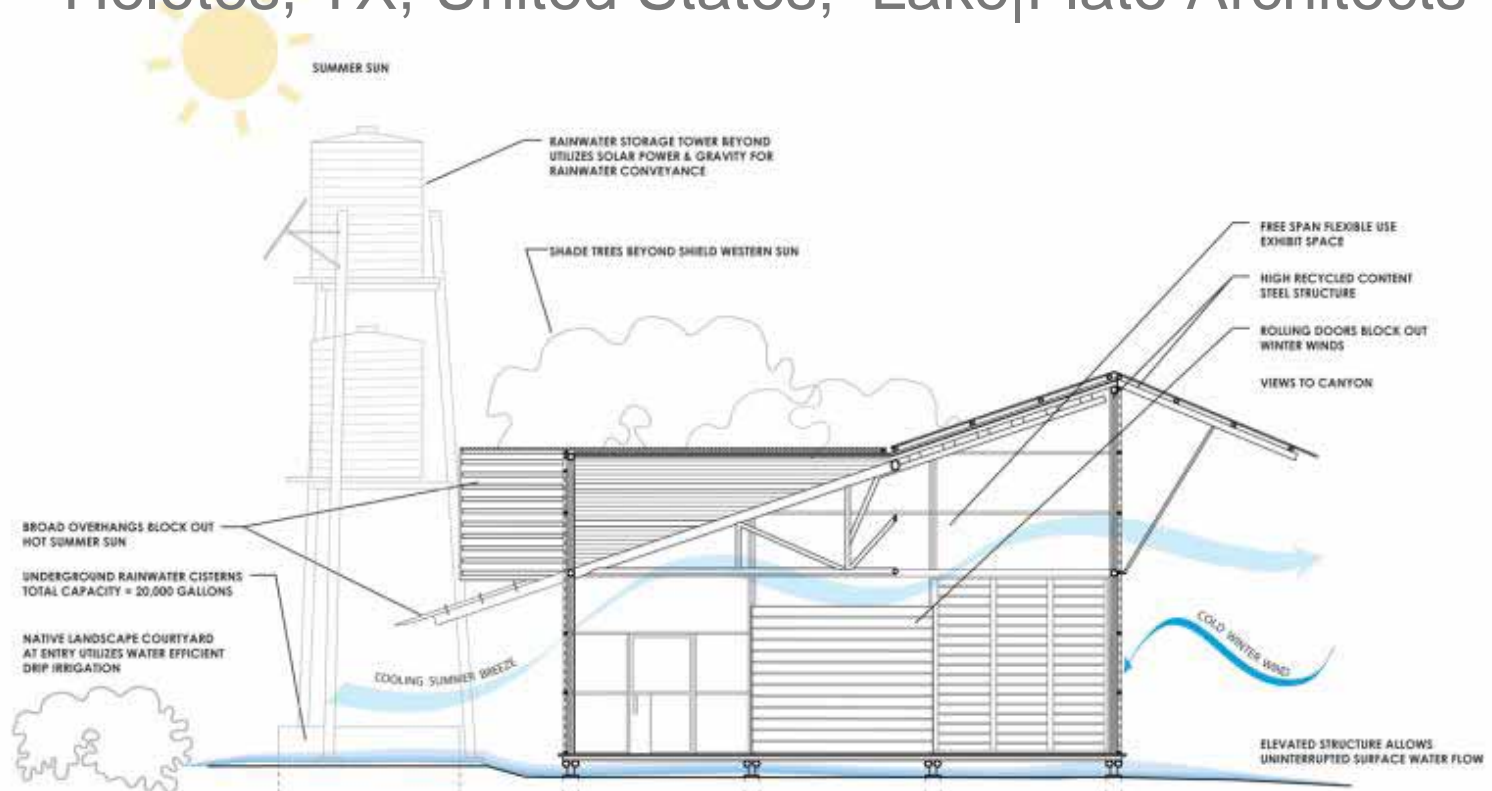
- | | | |
|---------------------|----------------------|----------------|
| 1. Exhibition | 5. Office | 9. Water Tower |
| 2. Gift Shop | 6. Washroom | 10. Cistern |
| 3. Exterior Terrace | 7. Storage | |
| 4. Classroom | 8. Outdoor Classroom | |

SITE PLAN / FLOOR PLAN



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

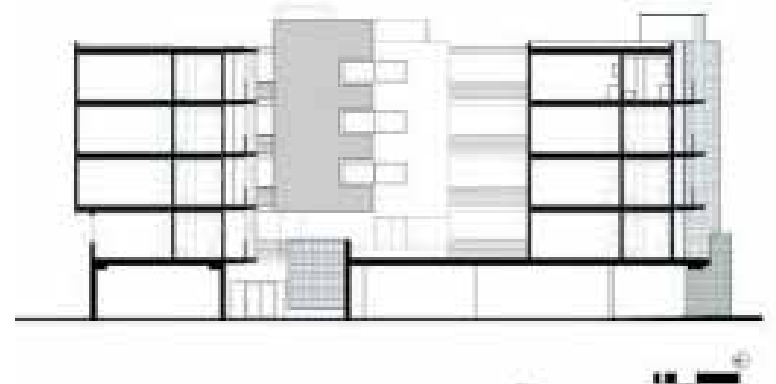
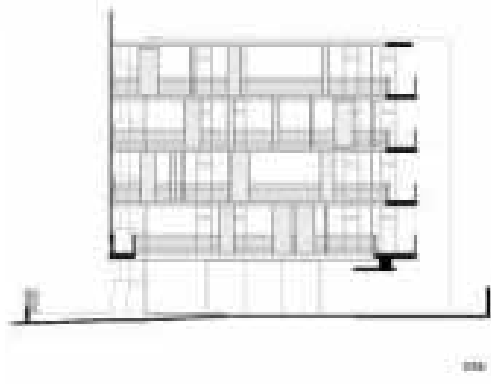
Santa Monica, CA, United States; Pugh Scarpa Kodama





Colorado Court Affordable Housing

Santa Monica, CA, United States; Pugh Scarpa Kodama

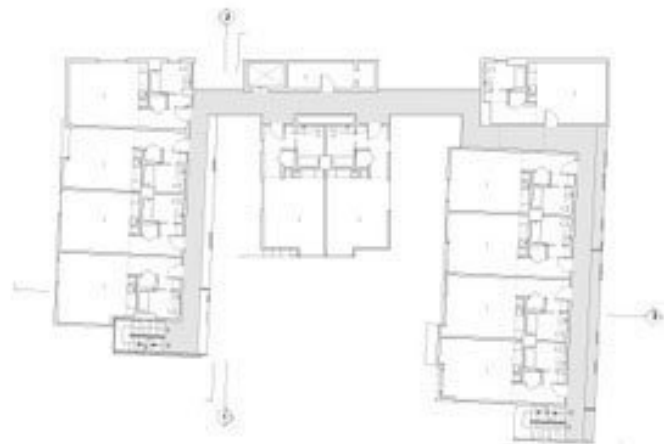


Colorado Court Affordable Housing

Santa Monica, CA, United States; Pugh Scarpa Kodama



SECOND FLOOR PLAN

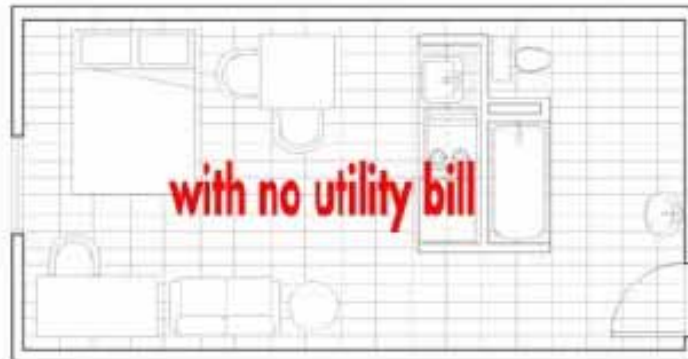


THIRD, FOURTH AND FIFTH FLOOR PLAN

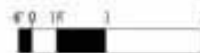


Colorado Court Affordable Housing

Santa Monica, CA, United States; Pugh Scarpa Kodama



Colorado Court Typical Unit Plan





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

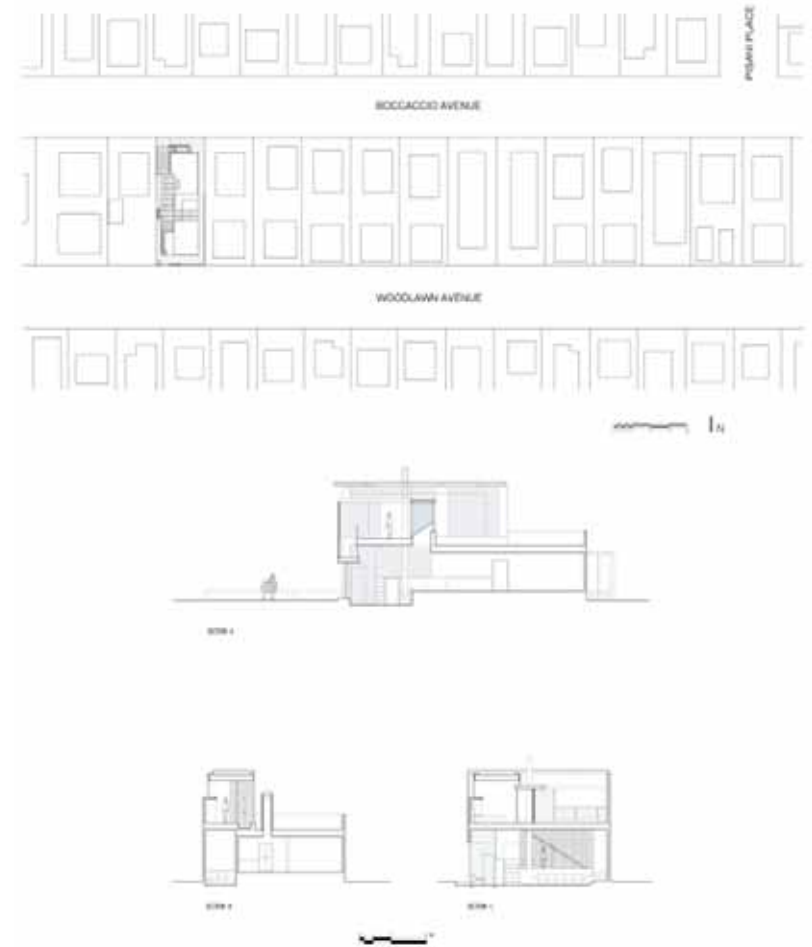
Venice, CA ; Pugh+ Scarpa (Architects)





Solar Umbrella House

Venice, CA ; Pugh+ Scarpa (Architects)





Solar Umbrella House

Venice, CA ; Pugh+ Scarpa (Architects)





Solar Umbrella House

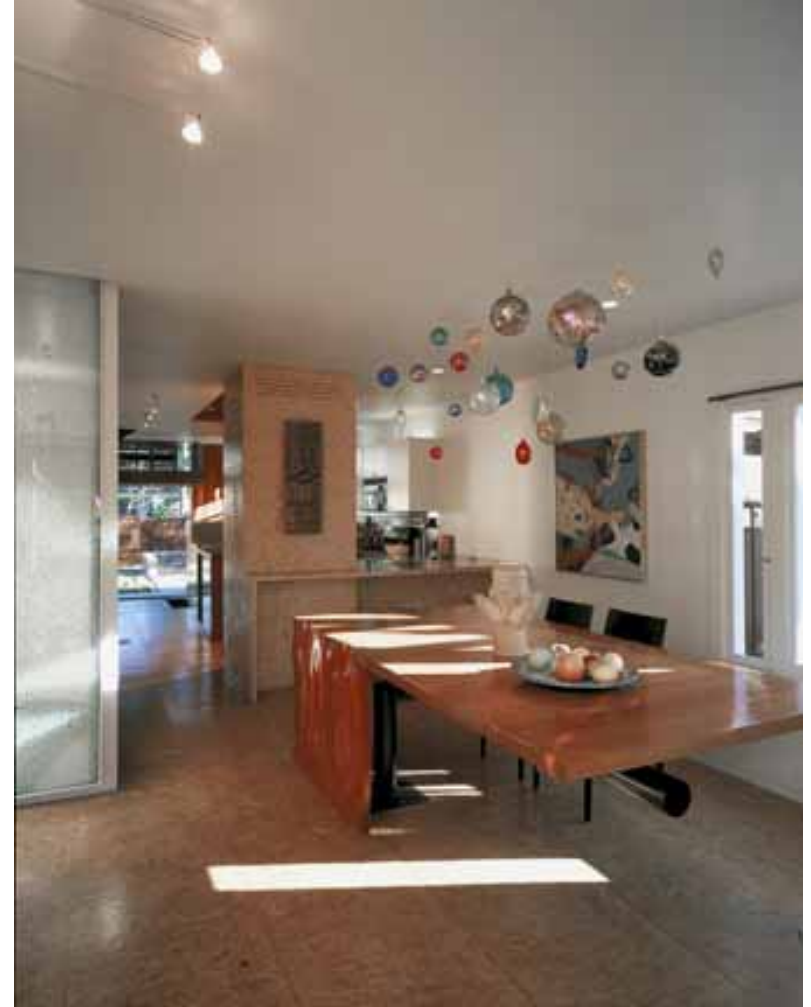
Venice, CA ; Pugh+ Scarpa (Architects)





Solar Umbrella House

Venice, CA ; Pugh+ Scarpa (Architects)





Solar Umbrella House

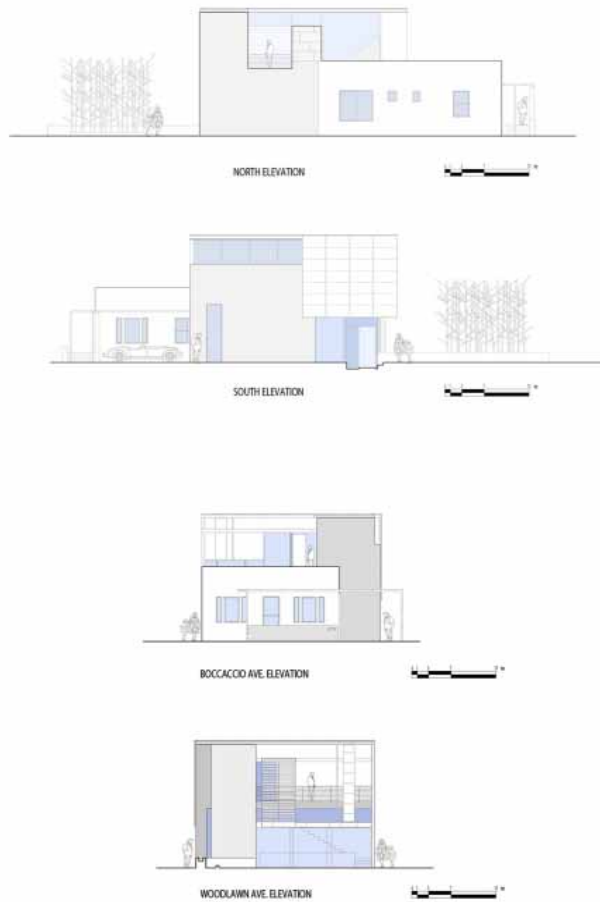
Venice, CA ; Pugh+ Scarpa (Architects)





Solar Umbrella House

Venice, CA ; Pugh+ Scarpa (Architects)





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

Lessons from Five AIA COTE Award Winning Projects

Architect	Strategies																															
	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	
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: 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

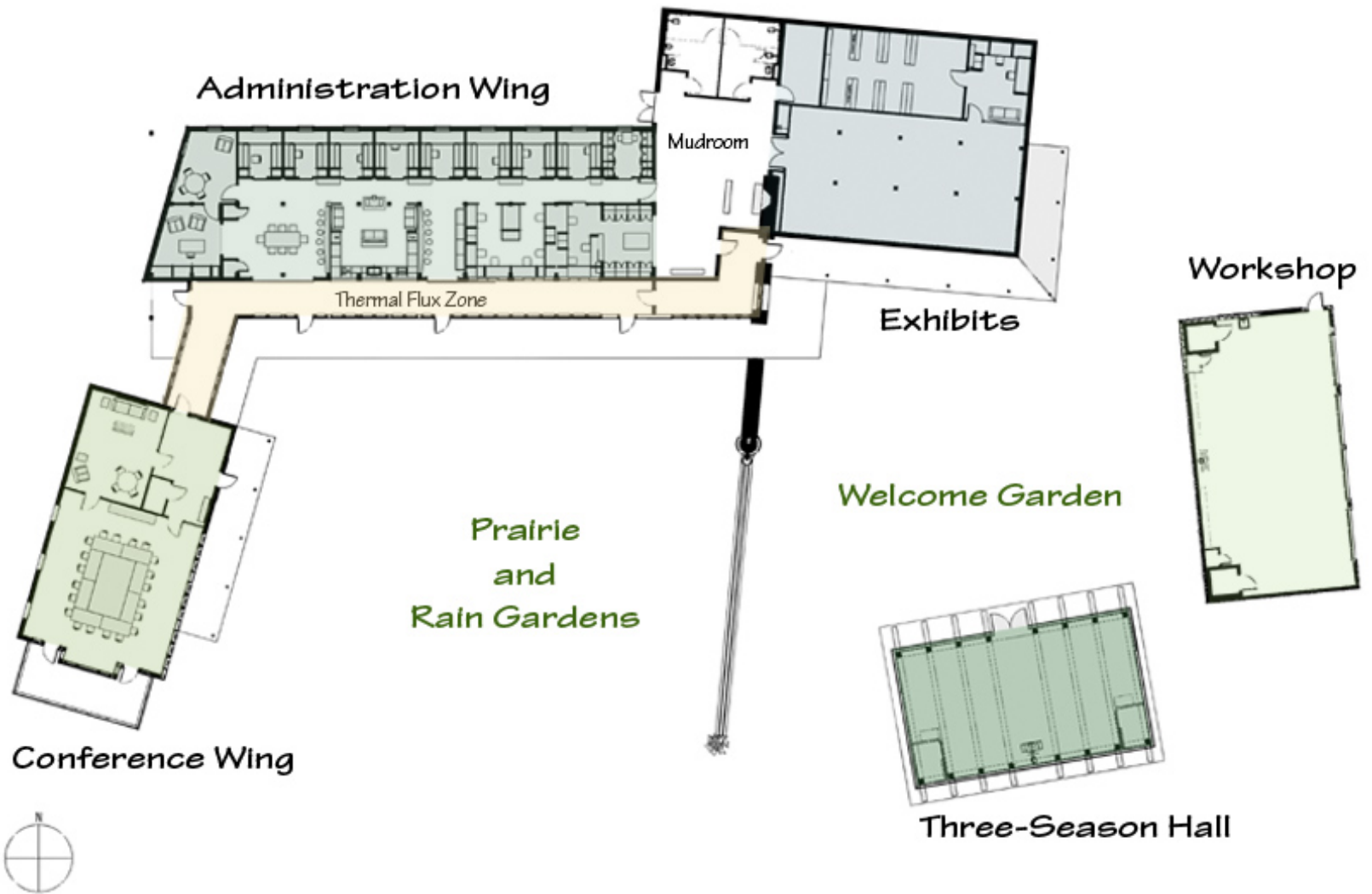




Architectural Design Strategies

- 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



May 9, 2007
3:45 pm CDT



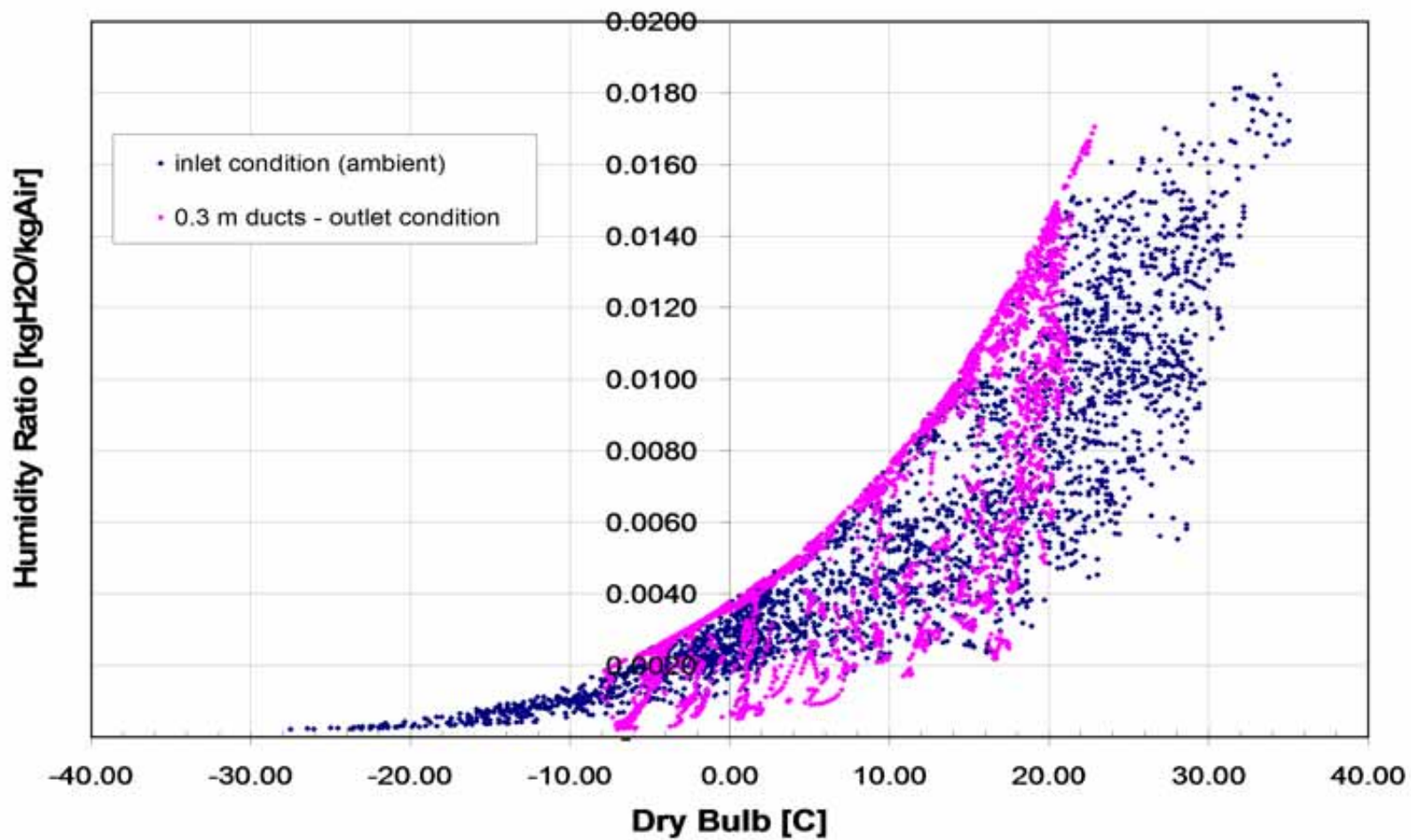
HVAC Strategies

- 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

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)



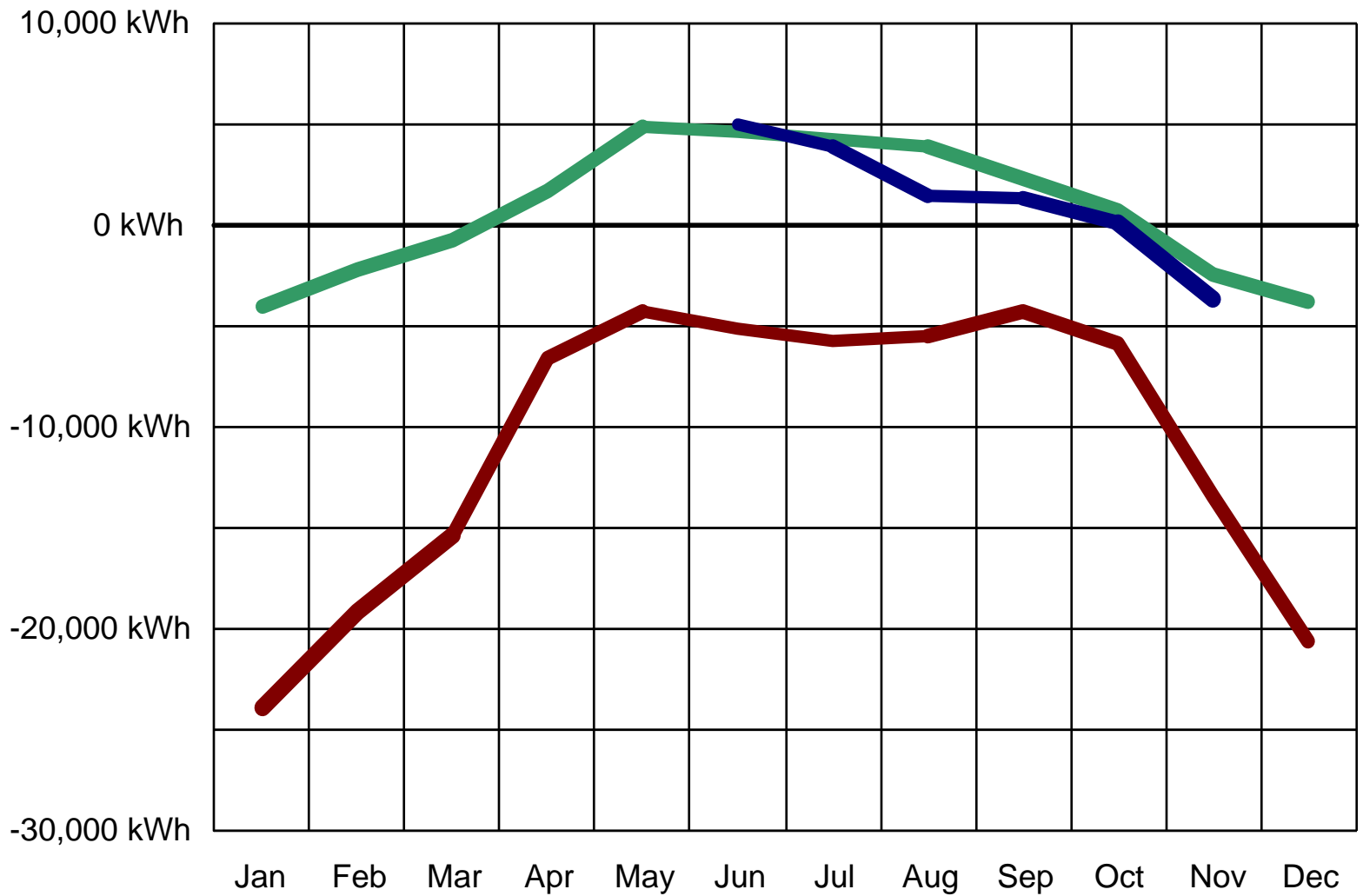
Carbon Balance Summary

	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 Center Net Electricity Sold to Utility

Modeled Electrical Use [CNC] Modeled Energy Use [ECB]
Metered Electric Use





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



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