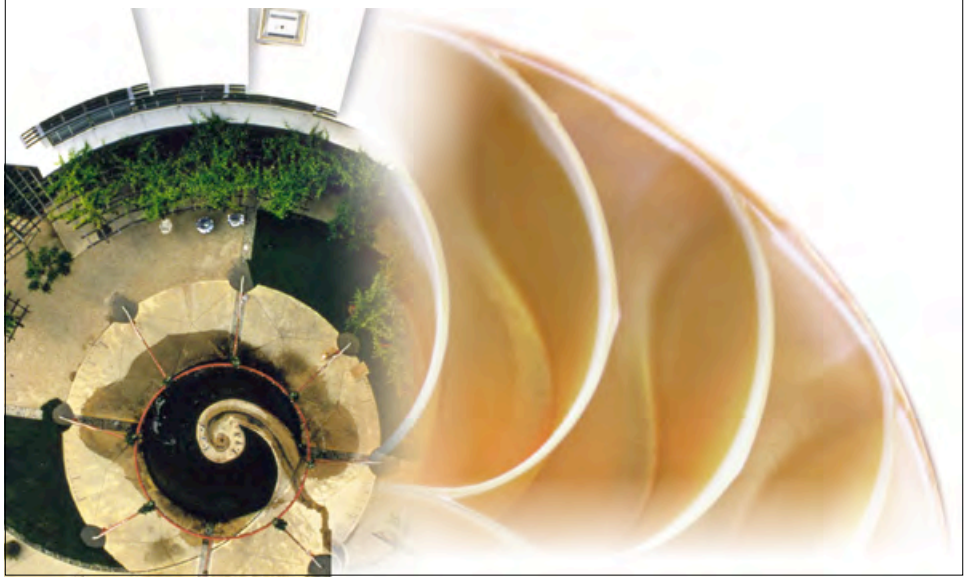
Design and Environmental Control Systems

ARCH 331/431 Spring 2008
Lecture 1

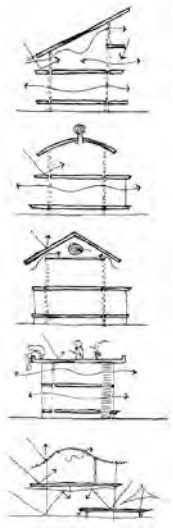


ARCH 331: *Environmental Control Systems*
ARCH 431: *Environmental Control Principles*

331 Discussion: **Rob Peña**
Tuesday, 5:30 - 6:20, 115 Smith Hall

431 Discussions: **Kevin van den Wymelenberg**
Tuesday, 5:30 - 6:20 and 6:30 - 7:20, Gould 440

431 Discussions: **Travis Anderson**
Thursday, 5:30 - 6:20 and 6:30 - 7:20, Arch 110



Exams (50%)
- **Weekly Quizzes** (25%)
- **Final Exam** (25%) Friday 6/13, 4:30 to 6:20 pm

Design Exercises + participation (50%)
Exercise Subjects*
1. Case Study of Climate Responsive Design
2. Climate Analysis
3. Envelope Heat Transfer
4. Shading Analysis and Design
5. Thermal Optimization
6. Daylight Model Studies

**Exercises may be revised to coordinate with your studio project(s)*

COURSE WEBSITE

http://courses.washington.edu/arch3431/index.shtml

FINAL EXAM

Friday, June 13

4:30 am - 6:20 pm

required text

recommended texts

First Reading Assignment for Thursday, 4/3:

Sun, Wind & Light (SWL):

Sections 38, 43, 46-47, 49

Reading Set 1(course website):

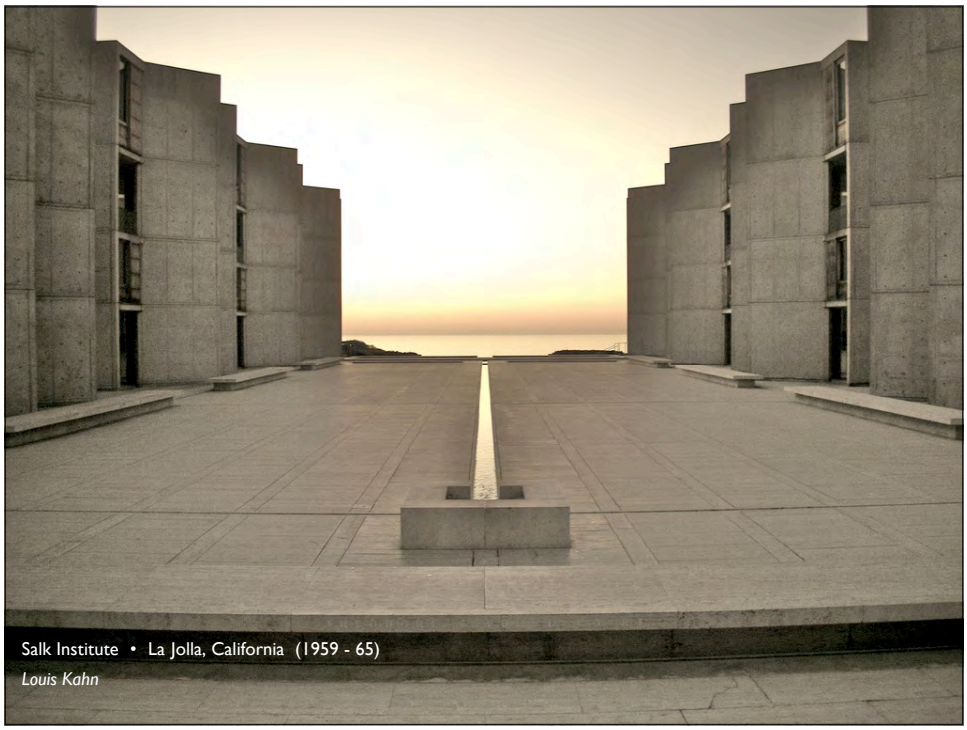
1.1 It's the Architecture Stupid, Ed Mazria

1.2 The New Red, White & Blue, Thomas Friedman

1.3 Blueprint for Disaster, Tom Folger

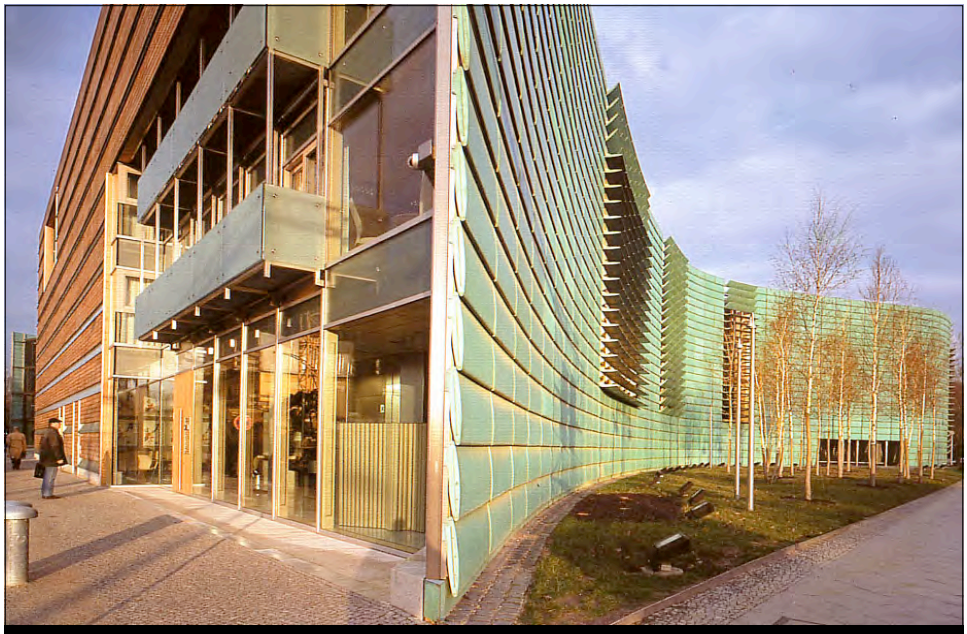
1.4 State of Energy, NY Times Editorial

1.5 Letter to the USGBC, Ed Mazria



Salk Institute • La Jolla, California (1959 - 65)

Louis Kahn



The Pan Nordic Building • Berlin, Germany
Berger + Parkkinen Architekten

Larkin Building • Buffalo, NY (1925)
Frank Lloyd Wright

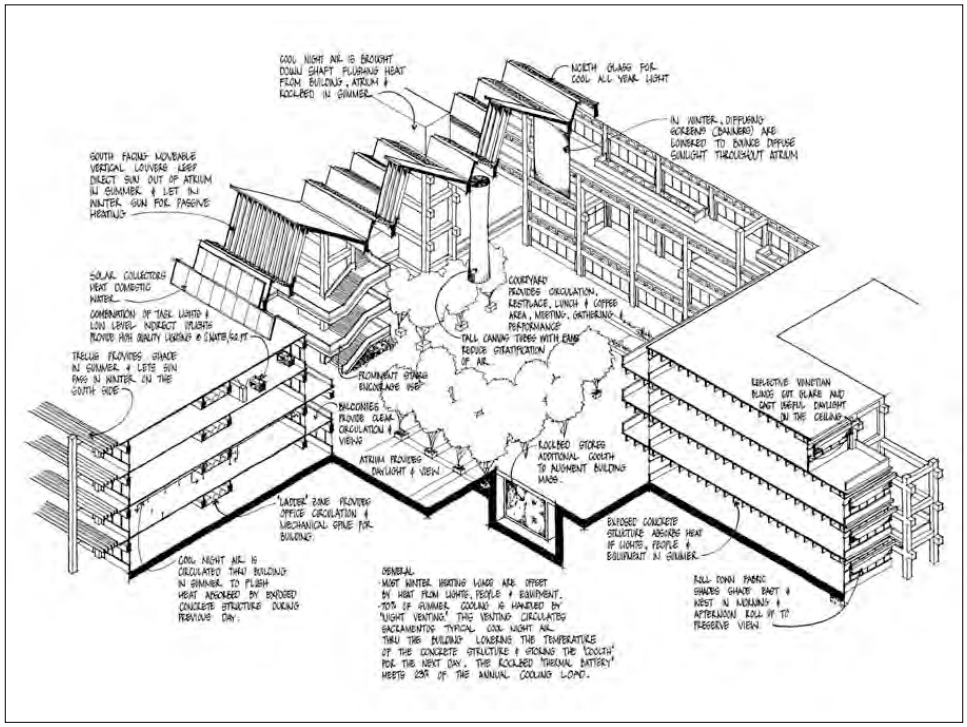
Phoenix Public Library • Phoenix, Arizona
Will Bruder

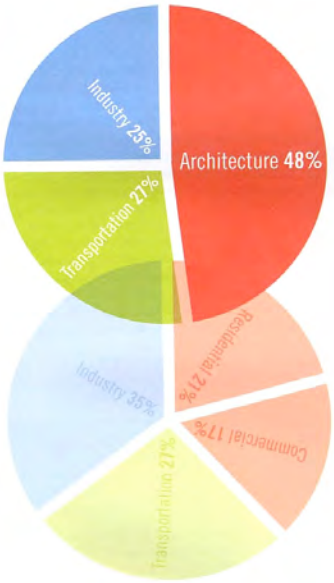
Adam Joseph Lewis Center for
Environmental Studies • Oberlin College
William McDonough

Warkenton Residence • West Marin, California
Van der Ryn Architects

Mt. Angel Abbey Library • St. Benedict, Oregon
Alvar Aalto

Gregory Bateson Building • Sacramento, CA
Sim Van der Ryn, State Architect



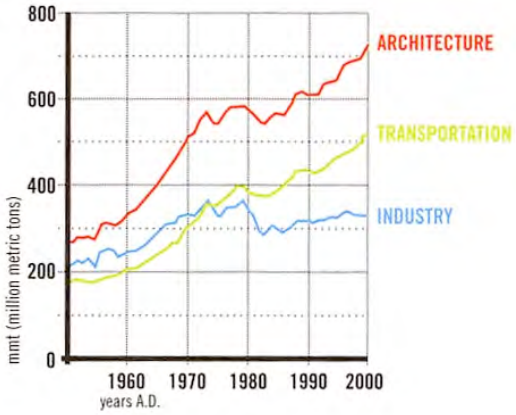


US Energy Use by Sector

"A reorganization of existing data - combining the energy required to run residential, commercial, and industrial buildings along with the embodied energy of industry-produced materials like carpet, tile, and hardware - exposes architecture as the hidden polluter."[1]

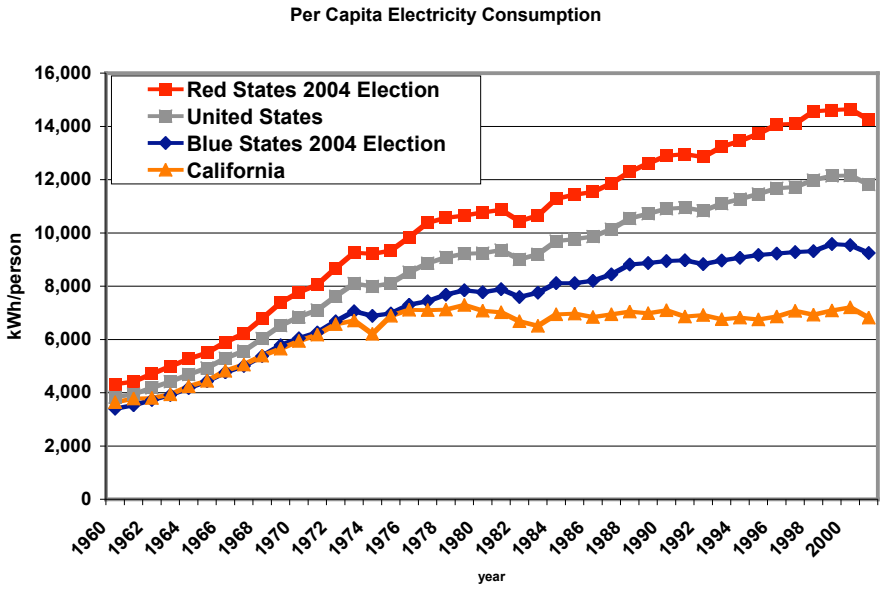
[1] *METROPOLIS October 2003*

US CO_2 Emissions by Sector

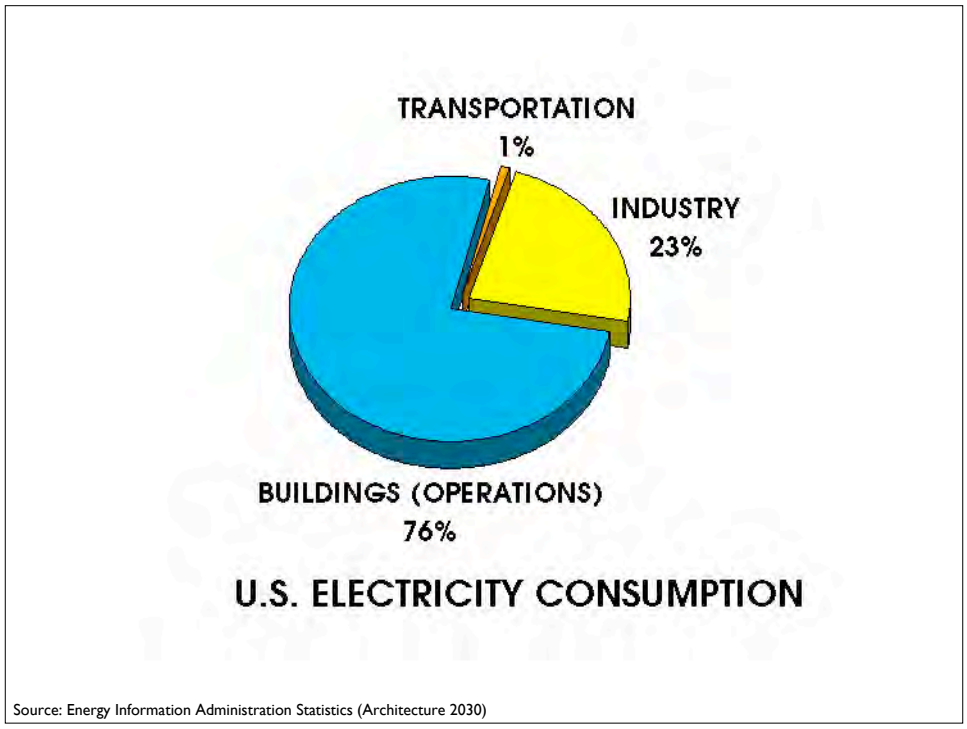


"While levels of carbon dioxide emissions produced by industry remain steady, those produced by architecture are soaring, signaling a pressing need for widespread change in the way architects design buildings."[1]

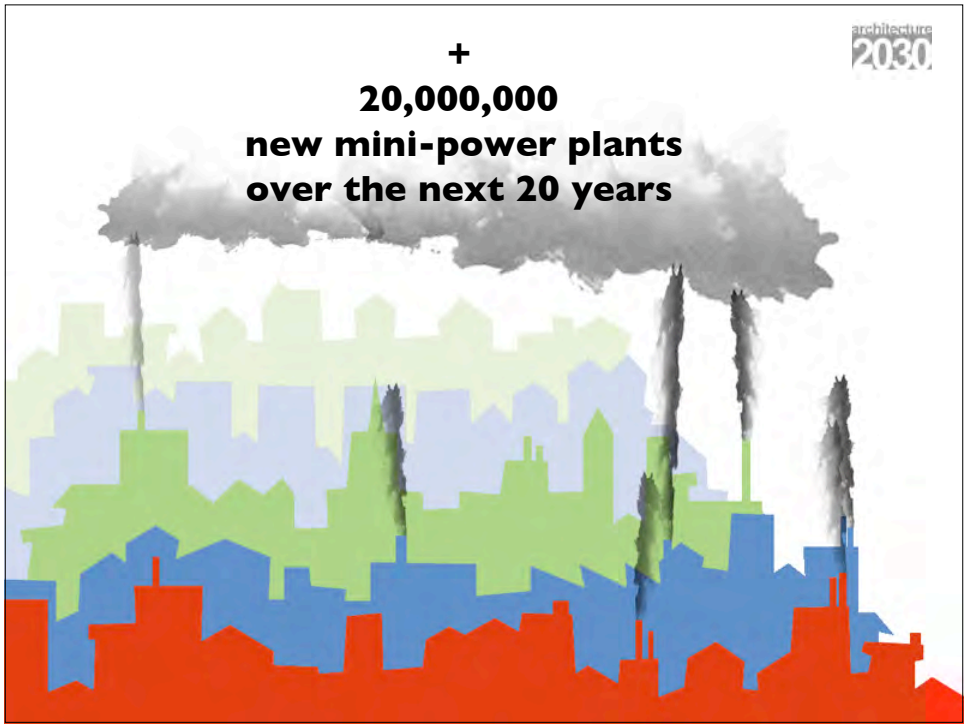
[1] *METROPOLIS October 2003*

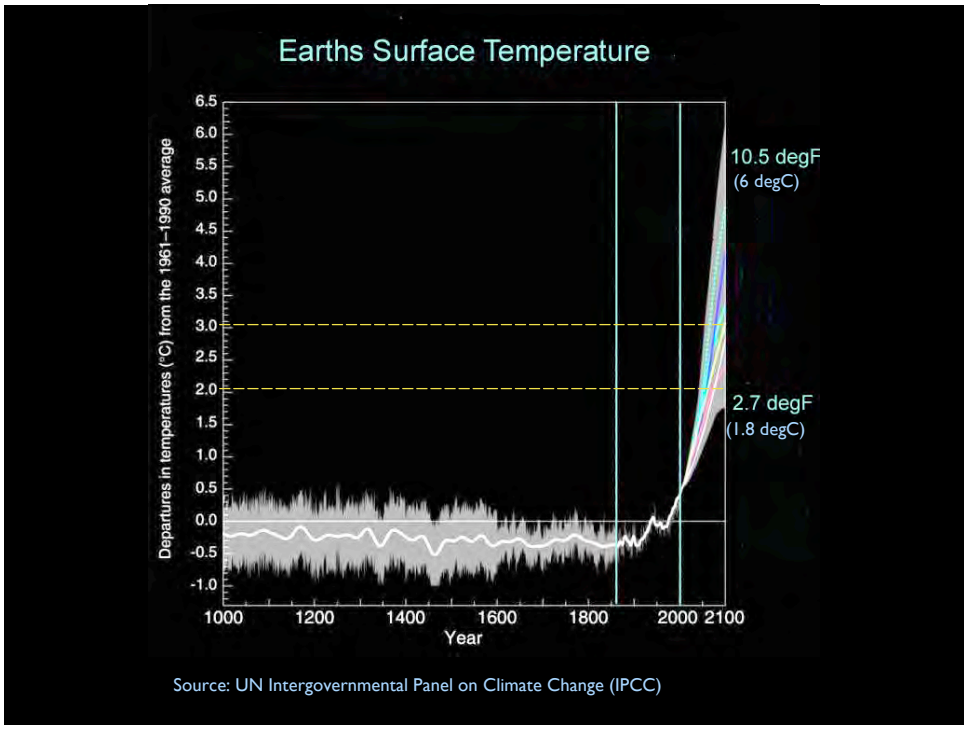


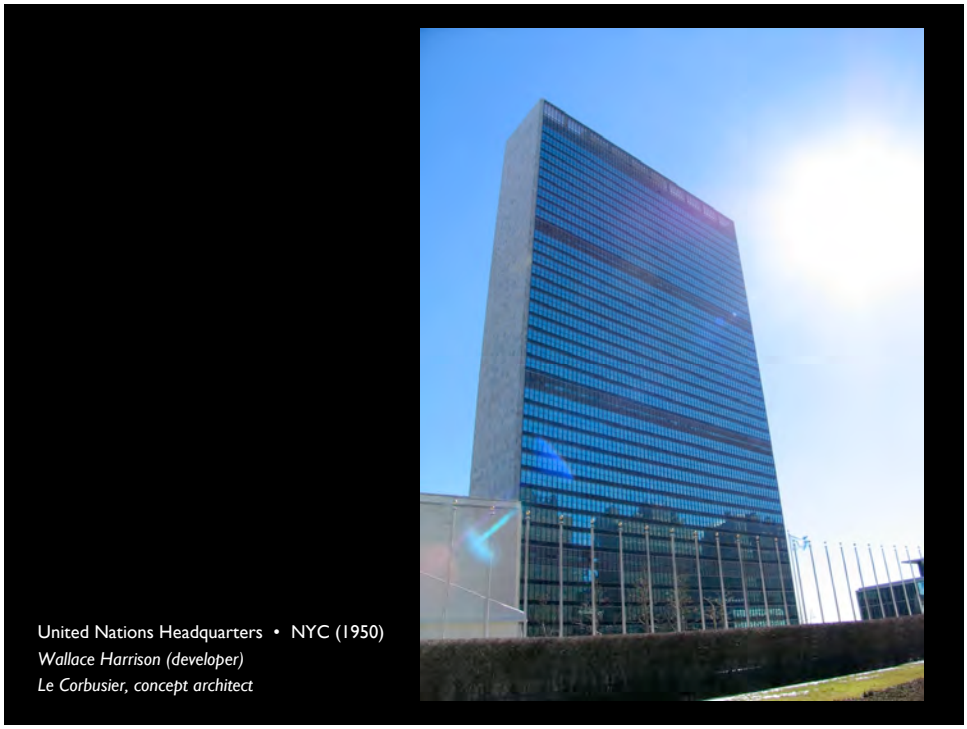
Source: California Energy Commissioner Arthur Rosenfeld



Source: Energy Information Administration Statistics (Architecture 2030)




Earths Surface Temperature
Departures in temperatures (°C) from the 1961–1990 average
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1000
1200
1400
1600
1800
2000
2100
Year
10.5 degF
(6 degC)
2.7 degF
(1.8 degC)
Source: UN Intergovernmental Panel on Climate Change (IPCC)



United Nations Headquarters • NYC (1950)
Wallace Harrison (developer)
Le Corbusier, concept architect

101 California • San Francisco (1982)
Eli Attia Architects (architect of record)
Johnson/Burgee (design architects)

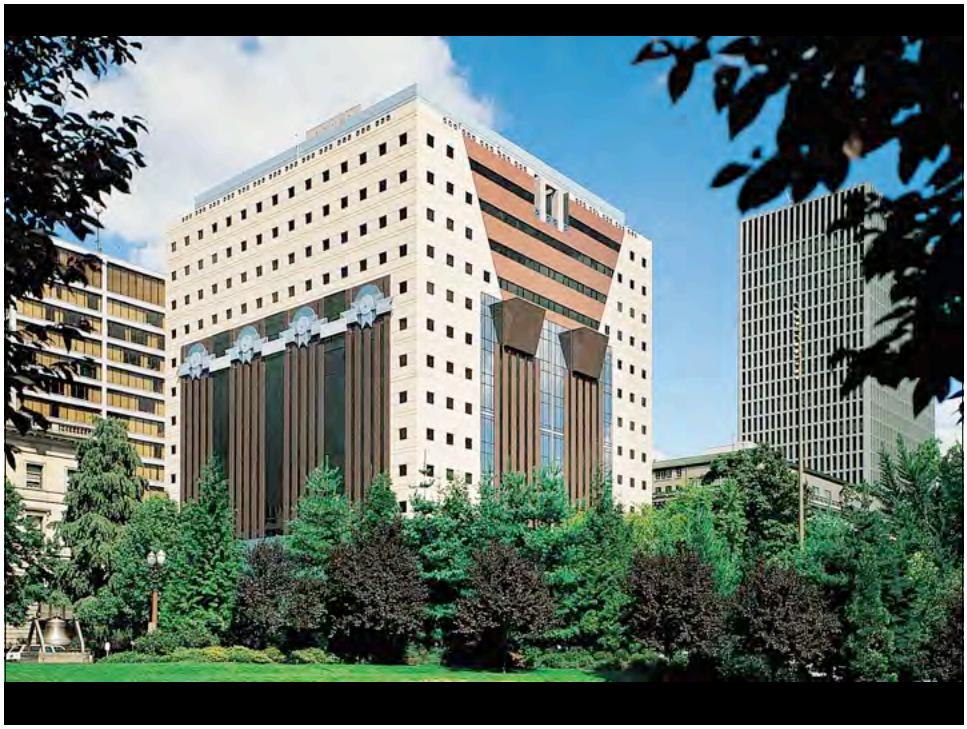


Image by Department of the Interior

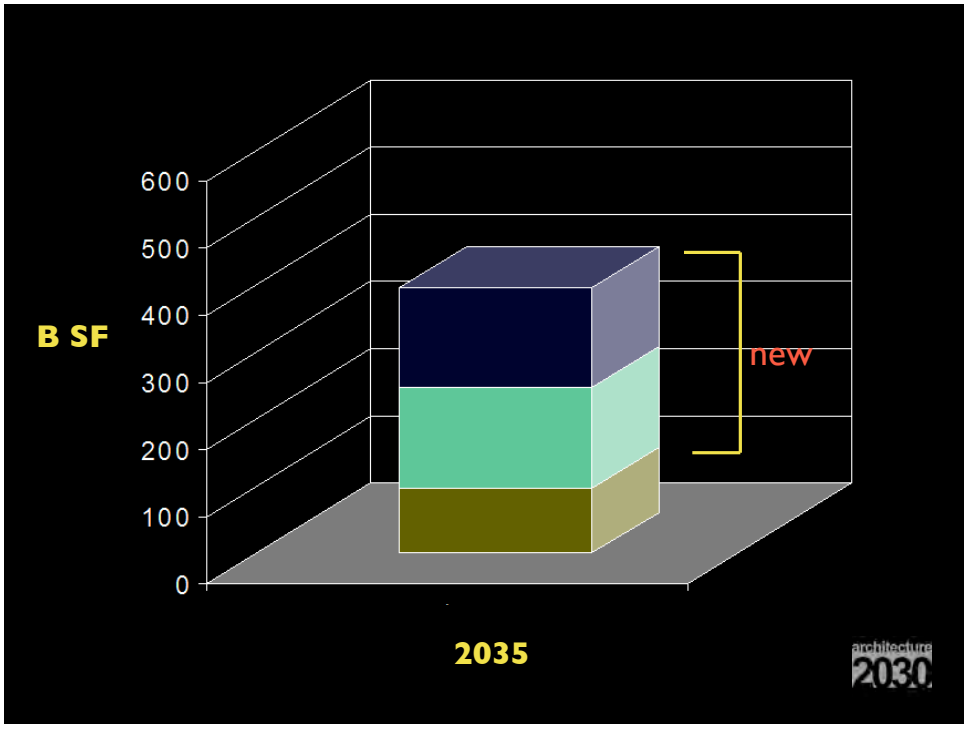
1.75 billion sq. ft.

5 billion sq. ft.

Image by NOAA

5 billion sq. ft.

architecture 2030


600
500
400
300
200
100
0
B SF
new
2035
architecture 2030


2030 0Challenge
http://www.architecture2030.org
architecture 2030

1. New building project, development and major renovation meet a fossil fuel energy-consumption performance standard of 50% of the regional (or country) average for that building type.

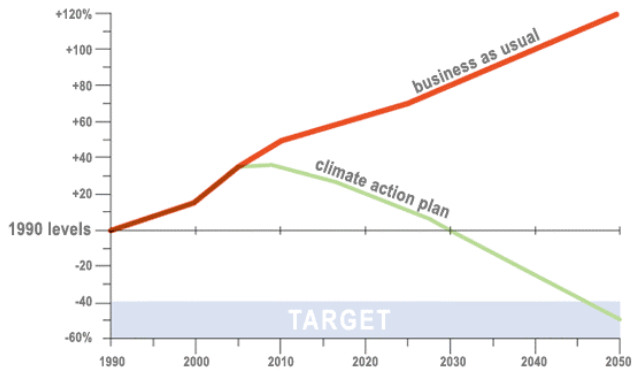
http://www.architecture2030.org

2. That at a minimum an equal amount of existing building area be renovated to use 50% of the fossil fuel energy they currently consume.

http://www.architecture2030.org

3. New Buildings - 50%
2010 – 60%
2015 – 70%
2020 – 80%
2025 – 90%
2030 - Carbon Neutral
(no fossil fuel energy to operate)

http://www.architecture2030.org



To stay under the 2°C threshold we must reduce greenhouse gas emissions by 40-60% below 1990 levels by 2050. By enacting the proposed Climate Action Plan, we can meet this target.

Mazria Inc.Odems Dzurec, 2005. (Generated from U.S. Energy Information Administration statistics)

How can we meet the
2030 ^{0}Challenge?

architecture 2030

1. design & innovation

architecture 2030

passive solar heating
passive cooling
daylighting
siting
building shape, color and orientation
fenestration location, size and shape
shading
natural ventilation
materials / properties
building type / density / smart growth
pedestrian and transit oriented development
landscaping / microclimate

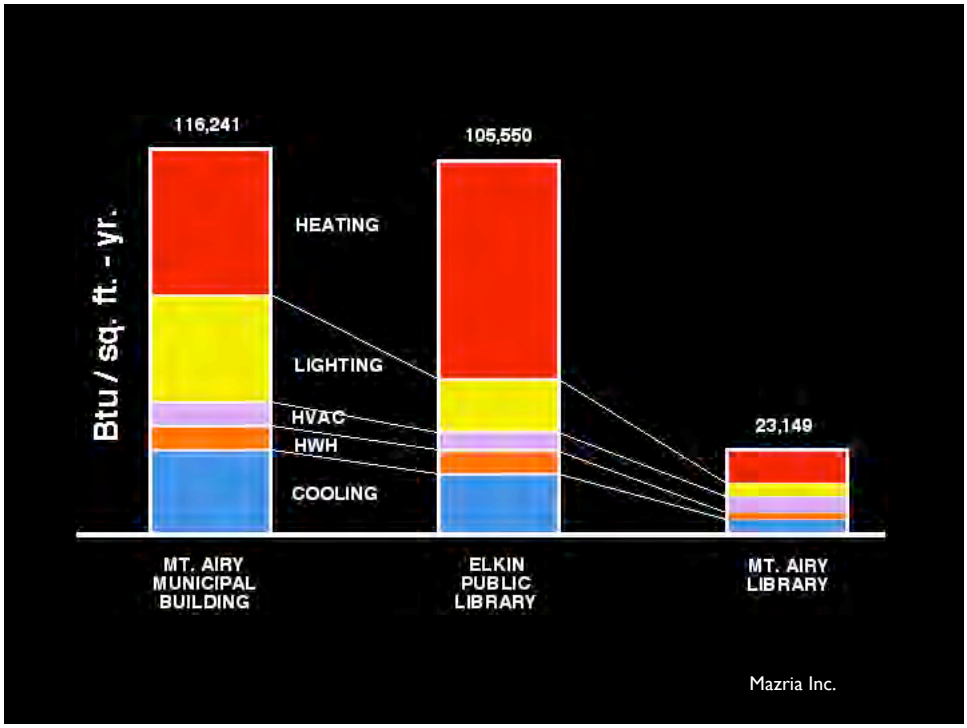
2. add technology

solar hot water
solar photovoltaics
wind microturbines
geothermal
biomass
moveable insulation
mechanized shading
high efficiency systems & appliances
energy management systems

3. Purchase green renewable energy or certified green renewable energy credits (1/5 max.)

wind
solar
geothermal
biomass


Mazria Inc.


116,241
105,550
23,149
Btu / sq. ft. - yr.
HEATING
LIGHTING
HVAC
HWH
COOLING
MT. AIRY MUNICIPAL BUILDING
ELKIN PUBLIC LIBRARY
MT. AIRY LIBRARY
Mazria Inc.

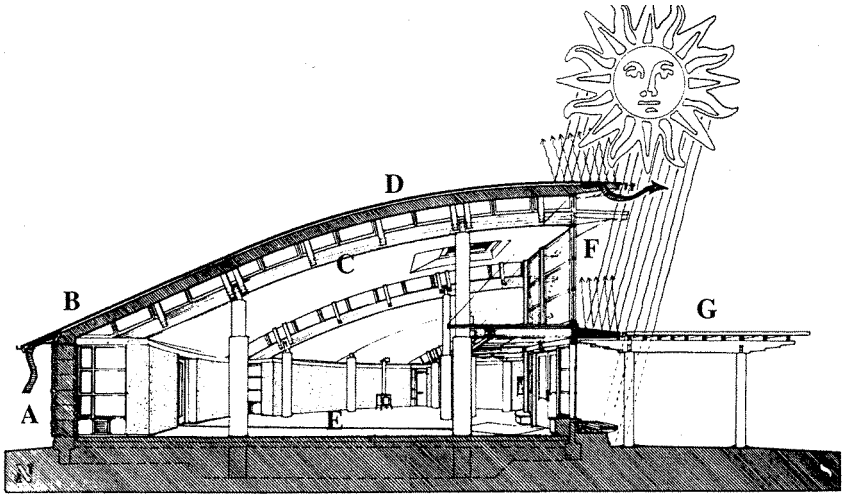

Mazria Inc.


Mazria Inc.

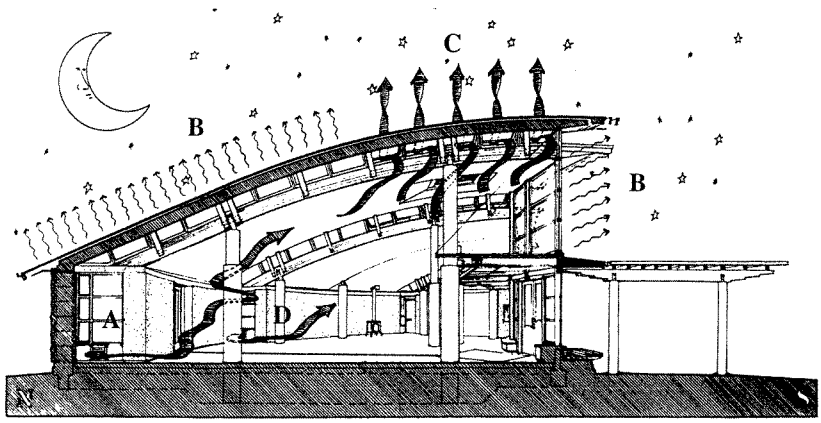
Zion National Park Visitor's Center
National Park Service

Real Goods Solar Living Center
Van der Ryn Architects

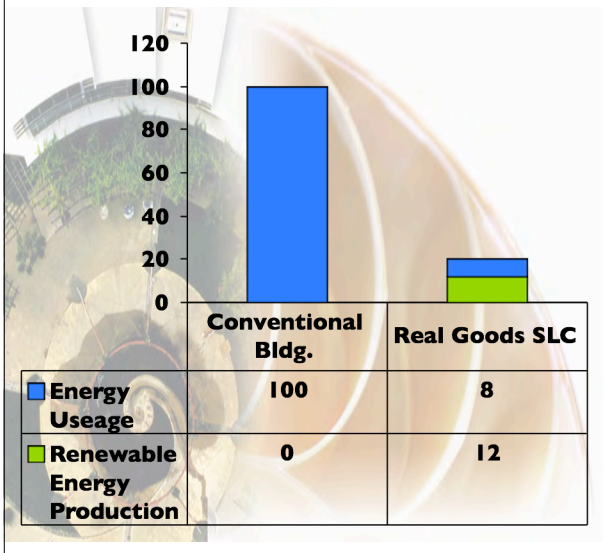
Summer Day Cooling Strategy



Summer Night Cooling Strategy



Energy

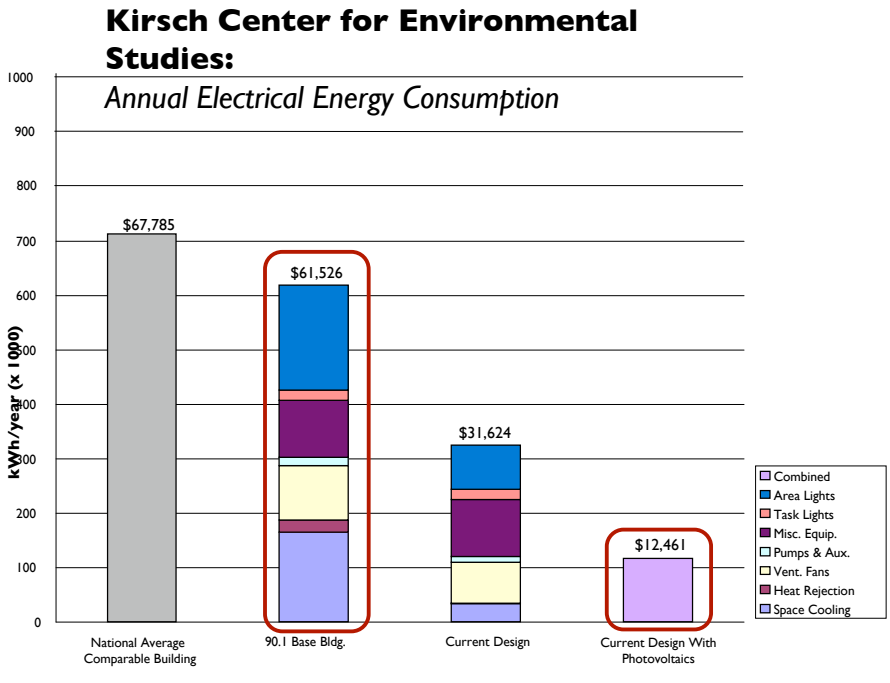


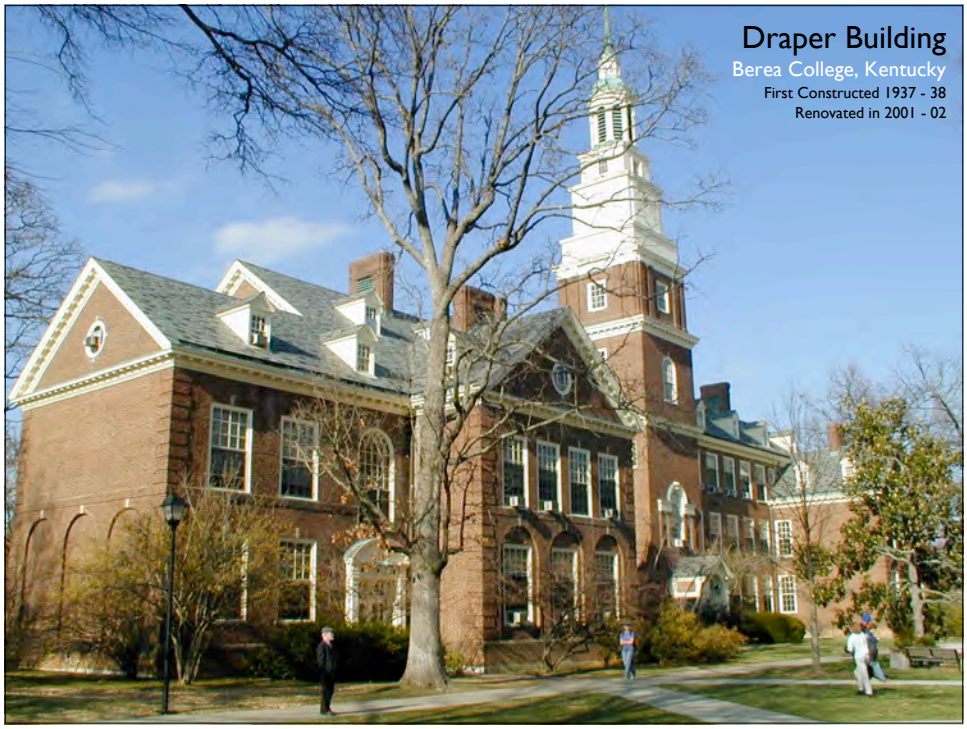
The Real Goods Solar Living Center uses **80% less energy** than a conventional building of similar size.

In addition, 60% of the electricity is produced from renewable sources (10KWH Photovoltaic System and a 3 KWH Wind System).

The Kirsch Center for Environmental Studies at De Anza College is the lead demonstration building for energy innovation and sustainability in the California Community College System.

View from the south-west



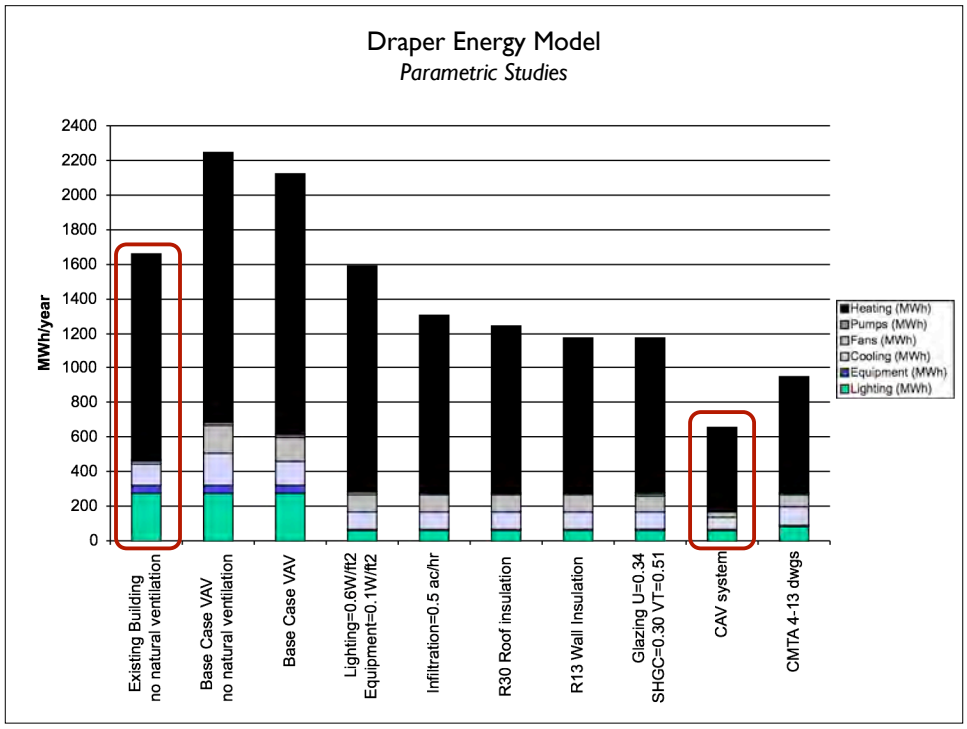

Draper Building
Berea College, Kentucky
First Constructed 1937 - 38
Renovated in 2001 - 02

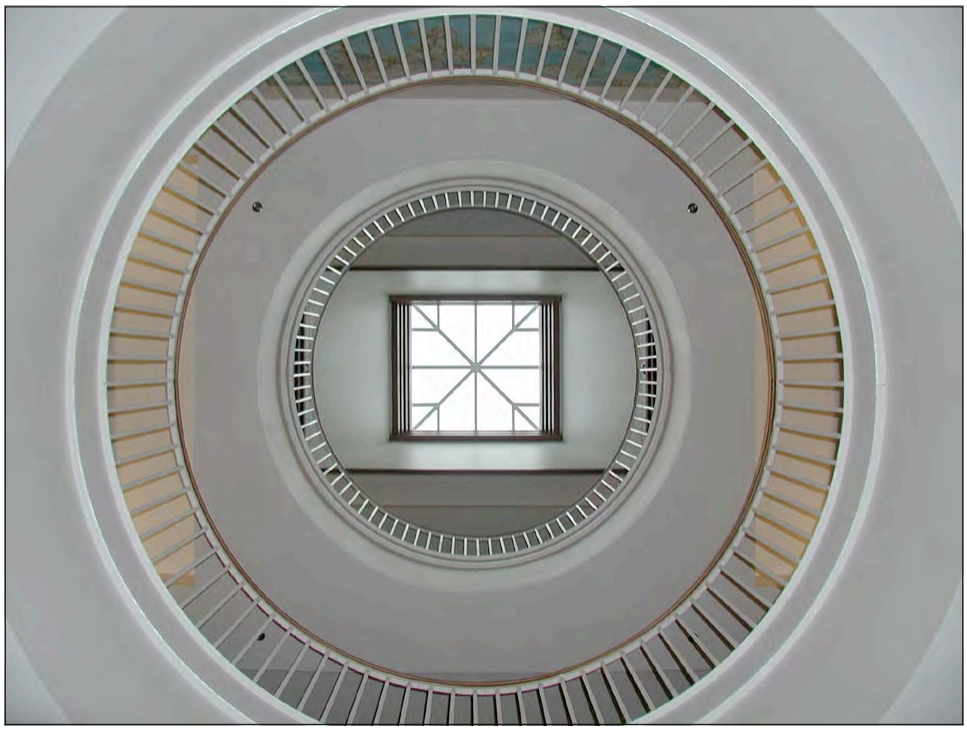

Before


After


Before


After


Draper Energy Model
Parametric Studies
MWh/year
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Heating (MWh)
Pumps (MWh)
Fans (MWh)
Cooling (MWh)
Equipment (MWh)
Lighting (MWh)
Existing Building no natural ventilation
Base Case VAV no natural ventilation
Base Case VAV
Lighting=0.6W/ft2 Equipment=0.1W/ft2
Infiltration=0.5 ac/hr
R30 Roof insulation
R13 Wall Insulation
Glazing U=0.34 SHGC=0.30 VT=0.51
CAV system
CMTA 4-13 dwgs

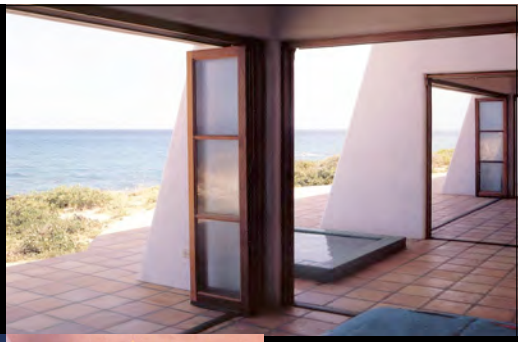


Sioux Tipi • Hailey, Idaho

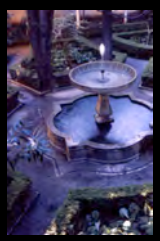
Airport Terminal at Riyadh, Saudi Arabia
SOM Architects

Palmetto House • Florida Keys
Jersey Devil

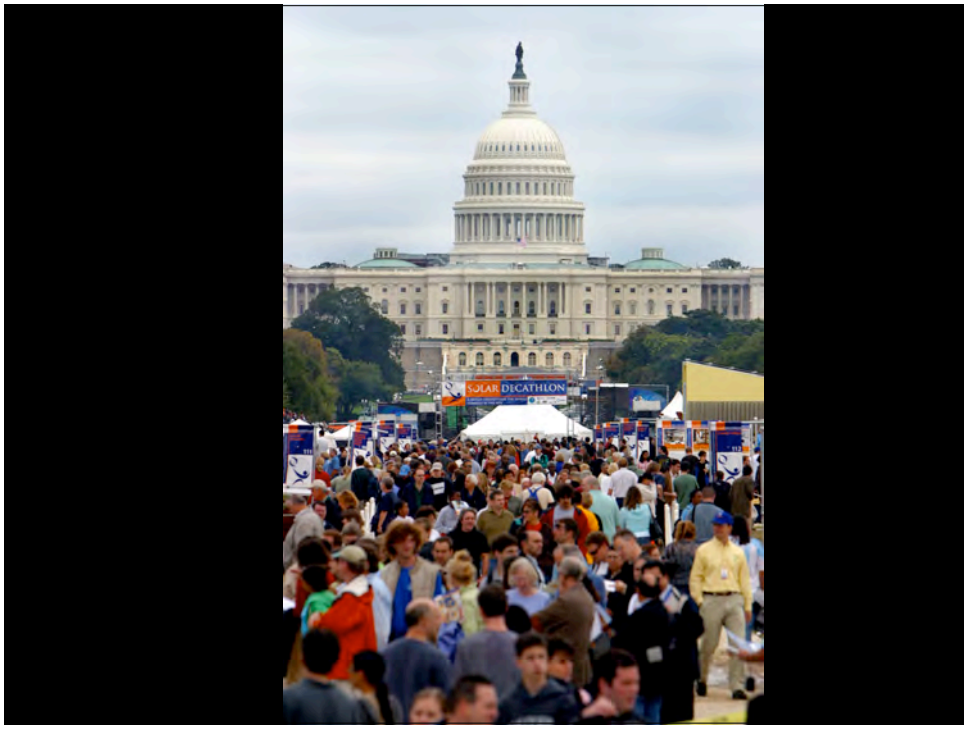
Casa Mariposa • Baja Mexico
Jersey Devil



The Alhambra • Spain




Falling Water
Frank Lloyd Wright
Fort Worth Water Gardens
Philip Johnson


SOLAR DECATHLON


PRIUS