Integrating Research and Education

with

University In-Reach

and

Community Out-Reach

Stephen Meder

December, 2011

TEAM

TEAM

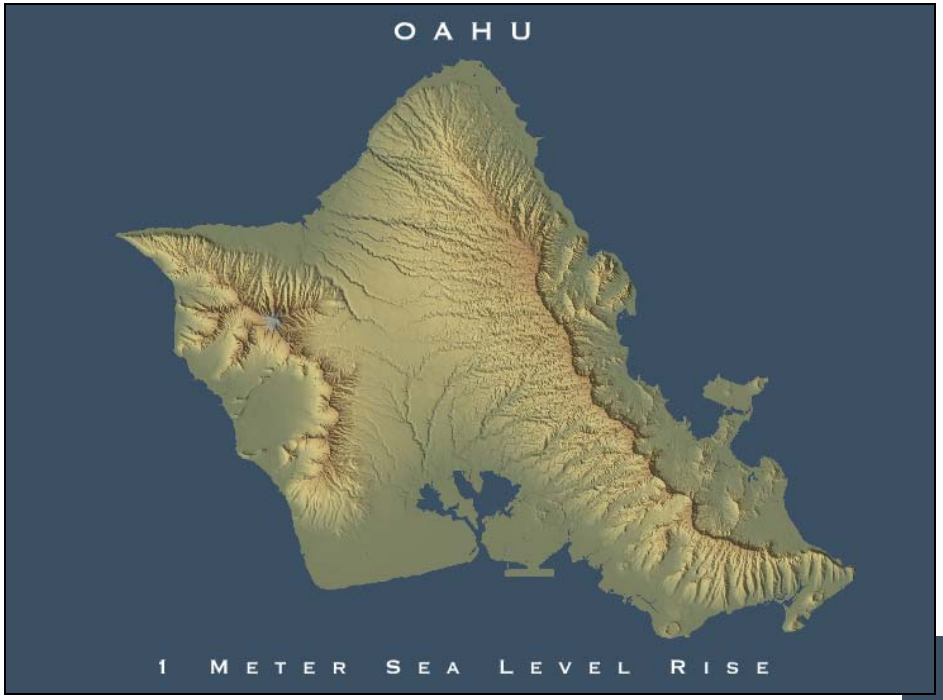
- 35 people working-students staff and professional consultants
- Students represent 6 different nationalities from various disciplines

Ocean Ecosystems – Coral Reefs

- About 30% of the world's coral reefs are seriously damaged
  - Close to 60% are likely to be lost in the next 30 years

CORKY'S HAWAII

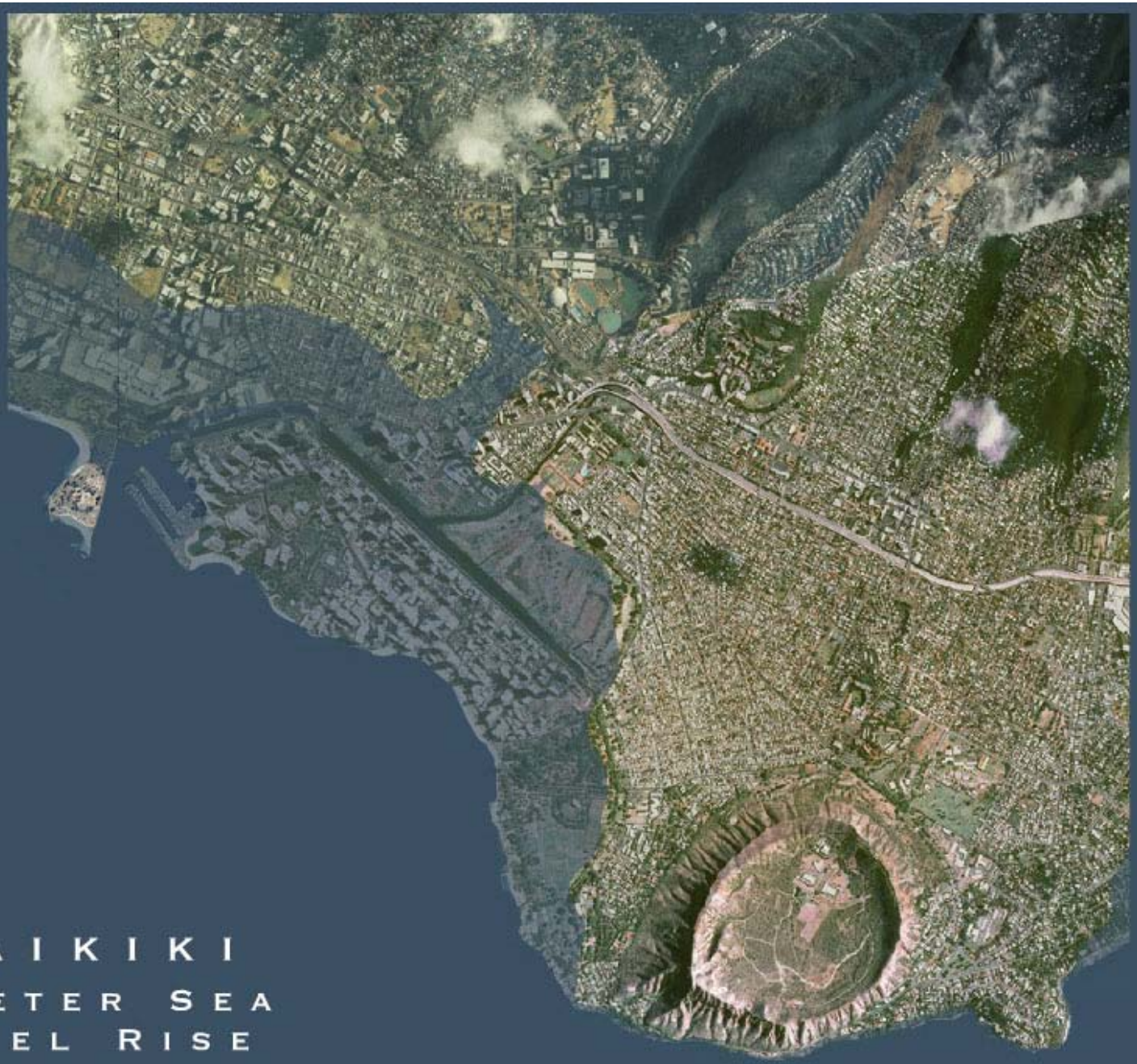
"I MUST SAY THE FAMED BEACH AT WAIKIKI IS DIFFERENT FROM WHAT I HAD IMAGINED..."



Climate Change and
Sea Level Increase on Oahu

1 meter sea level increase

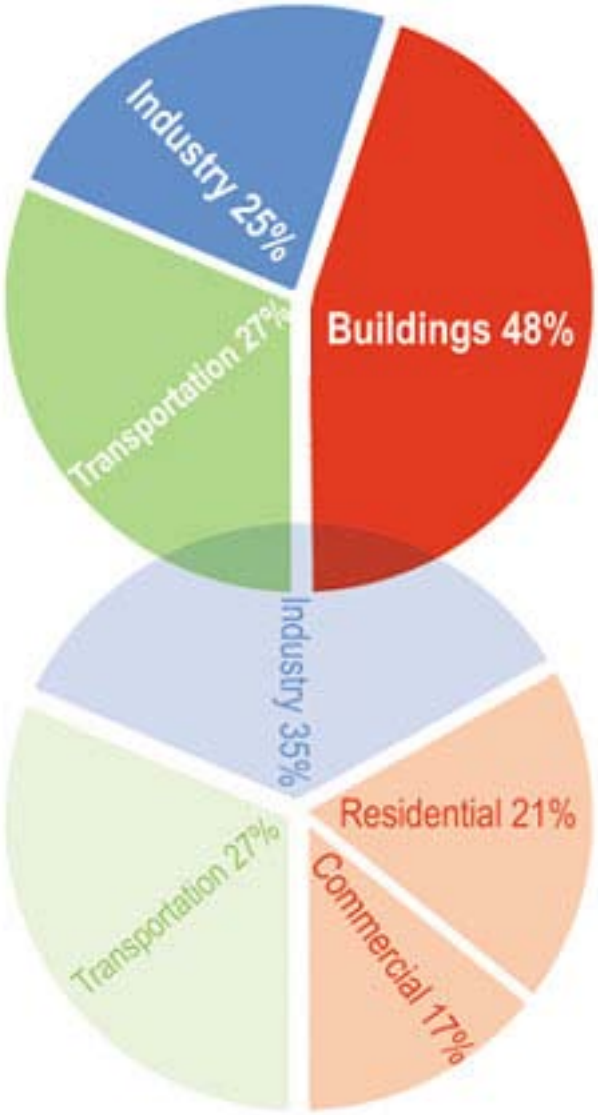
AIRPORT & DOWNTOWN
1 METER SEA LEVEL RISE



WAIKIKI

1 METER SEA LEVEL RISE

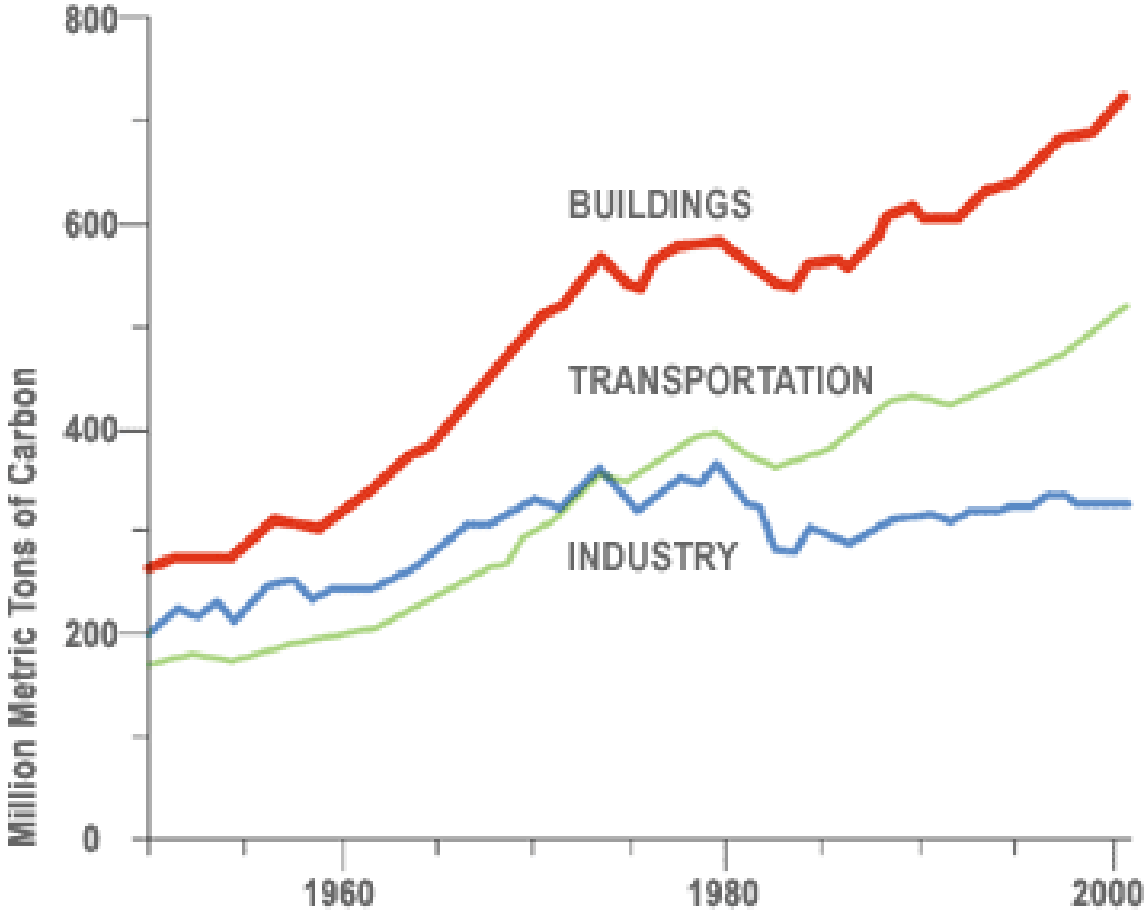
2030 CHALLENGE



ector

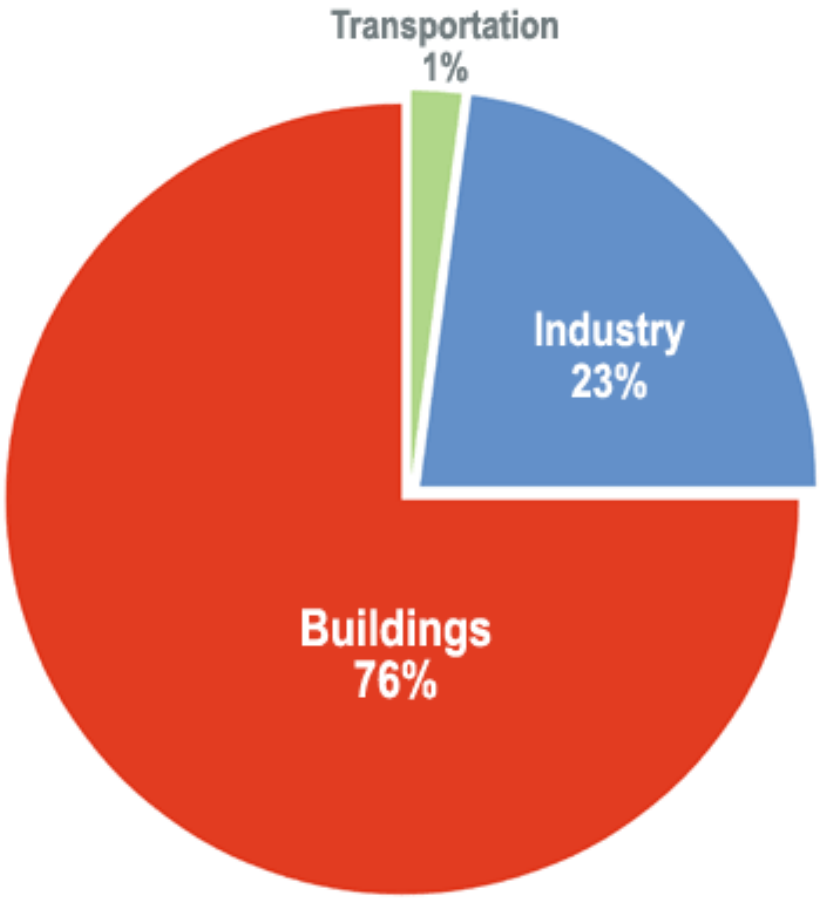
Taken from: Architecture2050.org, originally published in *Metropolis Magazine*, October 2003 Issue.

"Unknowingly, the architecture and building community is responsible for almost half of all U.S. greenhouse gas emissions annually. Globally the percentage is even greater."



Combining the annual energy required to operate residential, commercial, and industrial buildings along with the embodied energy of industry-produced building materials like carpet, tile, glass, and concrete exposes buildings as the largest energy consuming and greenhouse gas emitting sector.

Taken from: Architecture2050.org Source: U.S. Energy Information Administration statistics



U.S. Electrical Energy Consumption

Taken from: www.Architecture2030.org
Source: U.S. Energy Information Administration

The United States will also add 22 million fossil-fuel burning mini-power plants in new buildings over this period. The new buildings we construct each year not only consume electricity produced at a central power plant, but also directly burn oil, natural gas and/or propane in boilers, furnaces and hot water heaters. In fact, 58% of the site-use energy consumed in a building is burned at the site.

2030 ° Challenge

www.Archtecture2030.org

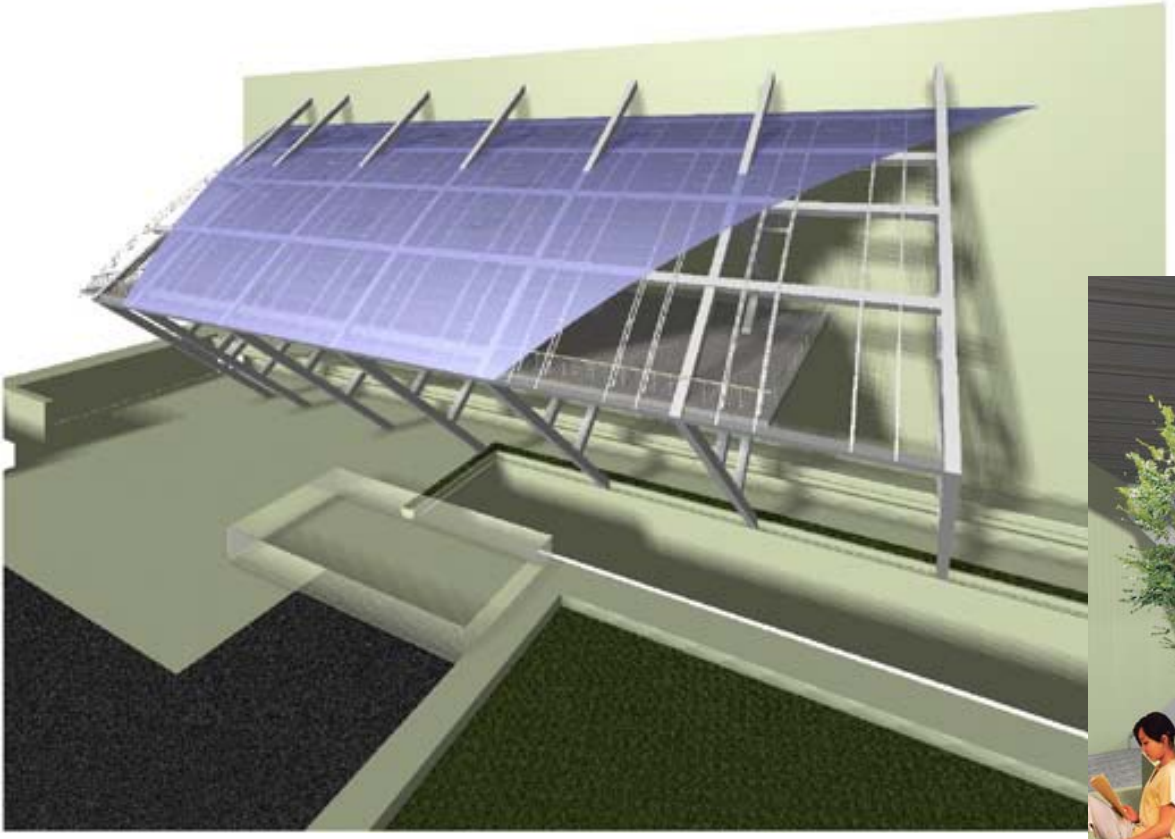
To accomplish this we are issuing the "2030 ° Challenge" asking the global architecture and building community to adopt the following targets:

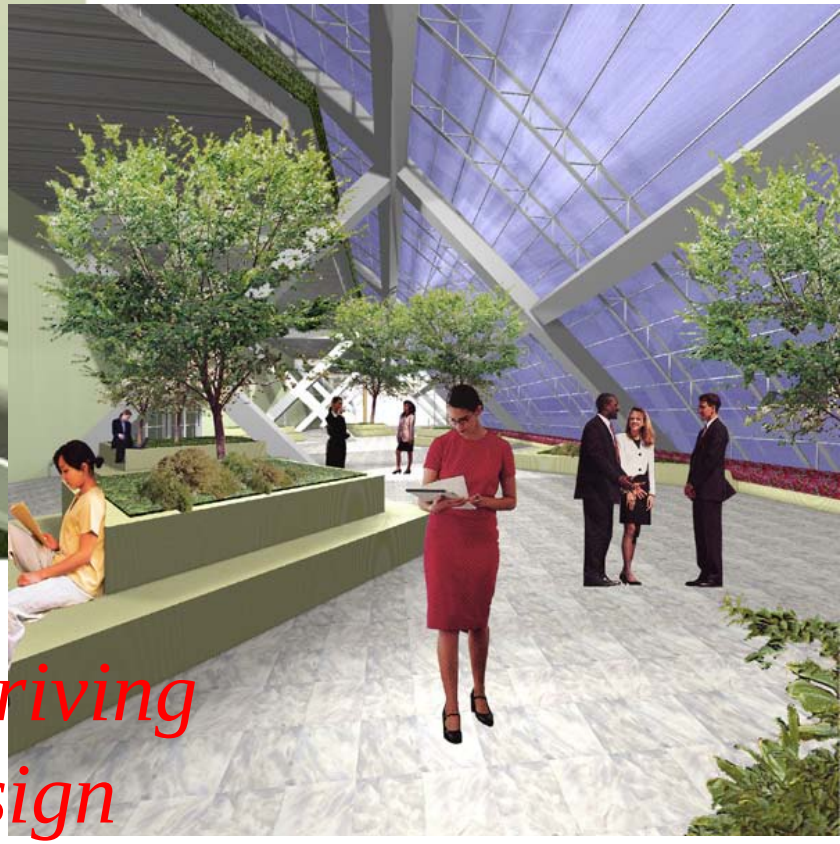
That all new buildings and developments be designed to use 1/2 the fossil fuel energy they would typically consume (1/2 the country average for that building type).

That at a minimum, an equal amount of existing building area* be **renovated annually to use 1/2 the amount of fossil fuel energy they are currently consuming** (through design, purchase of renewable energy and/or the application of renewable technologies).

That the fossil fuel reduction standard for all new buildings be increased to:

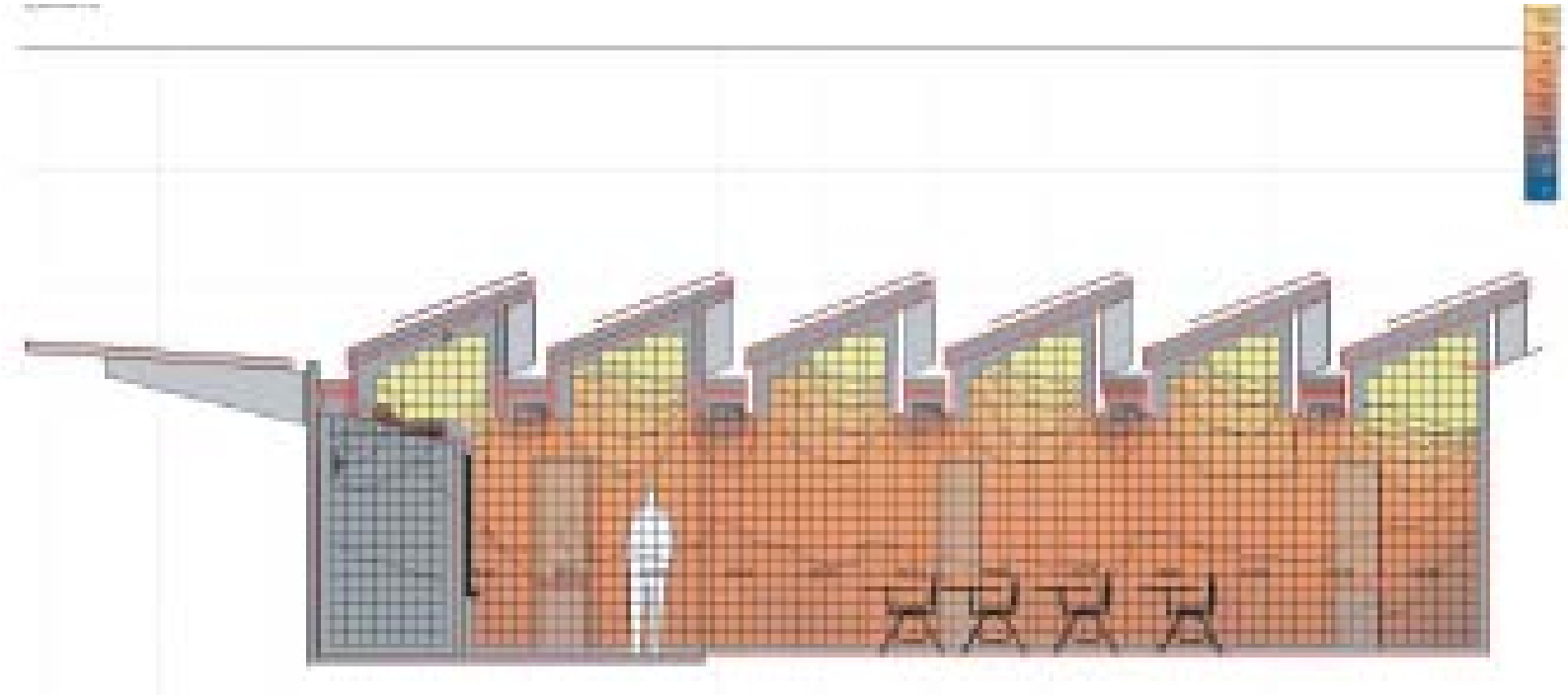
60% in 2010
70% in 2015
80% in 2020
90% in 2025
Carbon-neutral by 2030 (using no fossil fuel GHG emitting energy to operate).

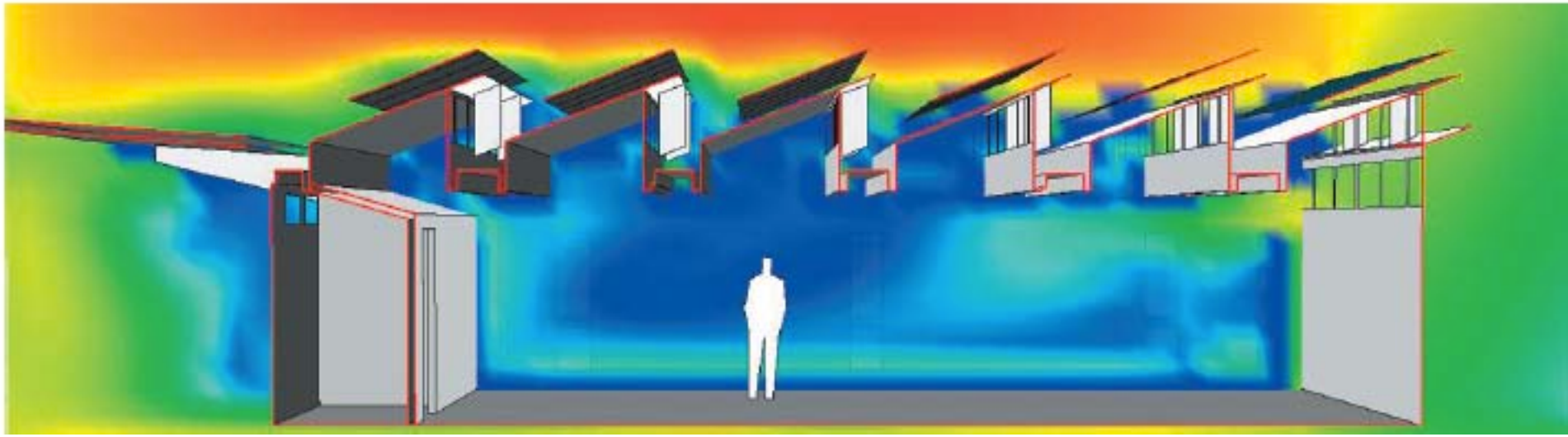


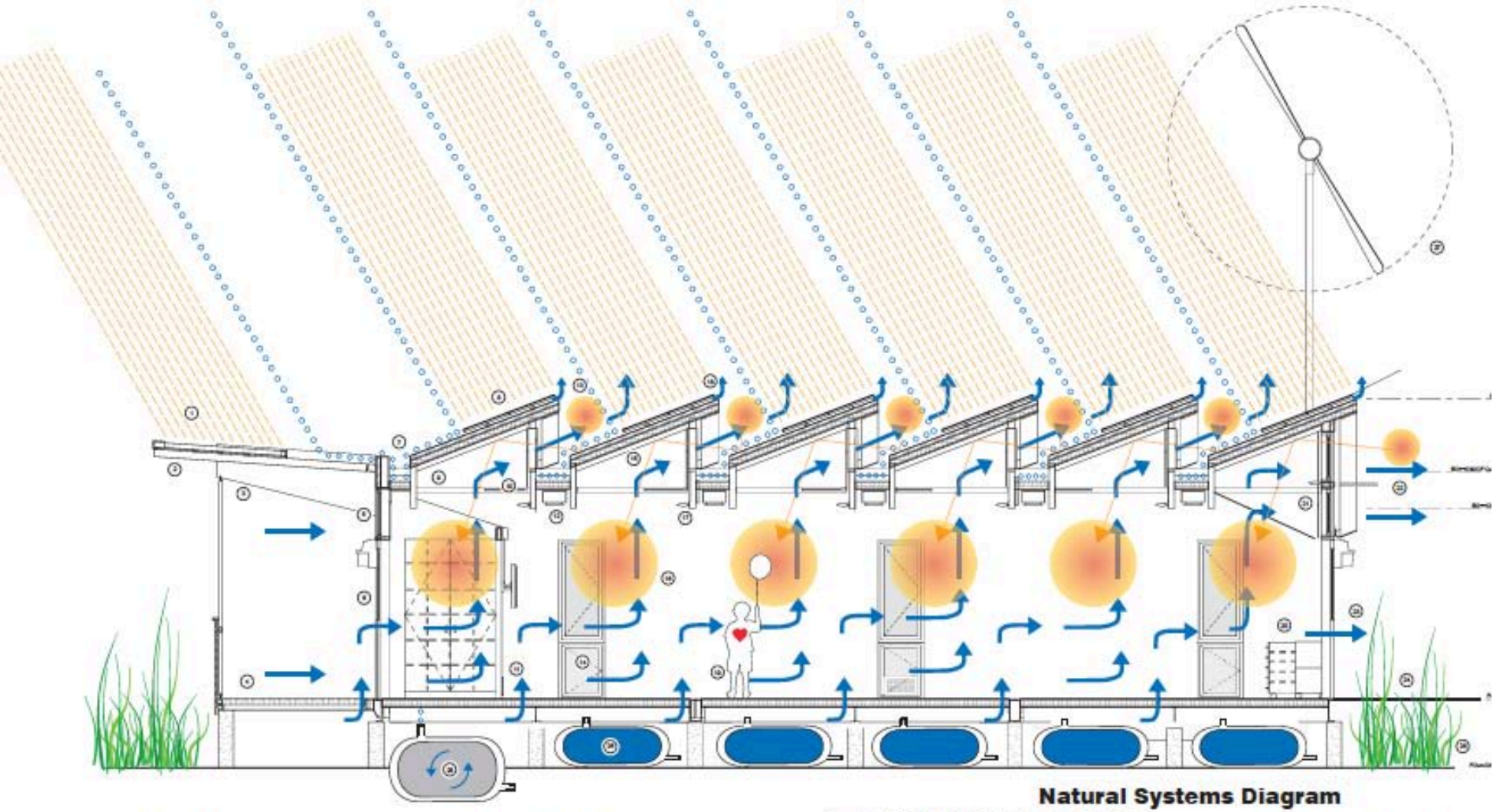


Solar Energy driving Building Design

Today, for the first time in our history we have the potential to design buildings that are not only ***energy users*** but ***energy generators***.







Natural Systems Diagram

1. Solar hot water heater option
2. Shade roof for entry deck option
3. Shade roof structure hinged for transport
4. Photovoltaic solar panels
5. Light reflective, sound absorbing ceiling tile
6. Clerestory windows for daylight and ventilation
7. Foam sandwich panel with metal skin, creating excellent heat reflection and insulation
8. Clerestory windows and indirect reflection create optimum daylighting
9. Windows optimized for cooling and daylighting
10. Optional exit door for safety and increased occupancy
11. Rear stairs can be specified as ramp

ENERGY POSITIVE PORTABLE CLASSROOM FOR HAWAI'I

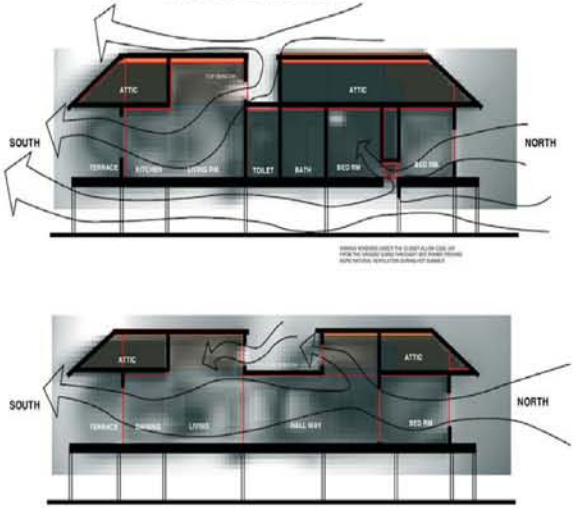
Anderson and Anderson Architects

New Life. New Experience.

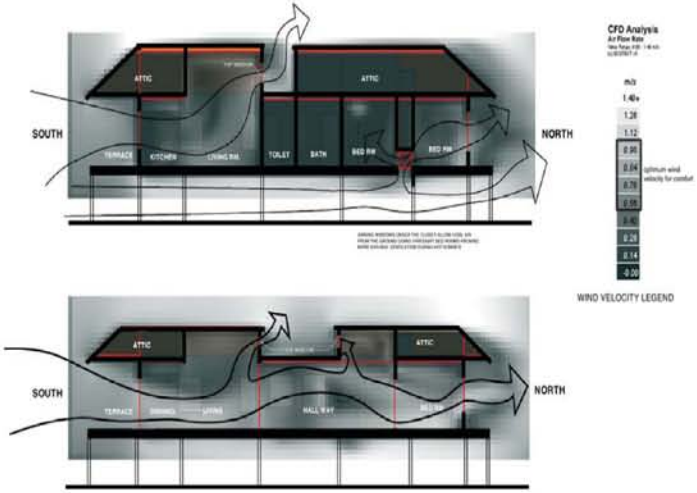
Passive Ventilation

SUMMER WIND ANALYSIS

AFTERNOON

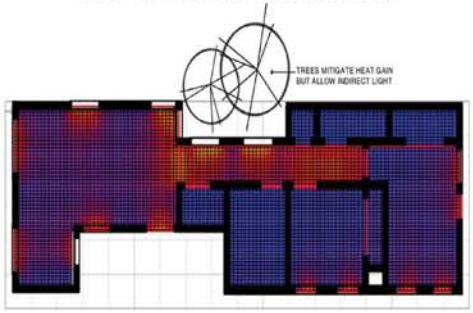


EVENING

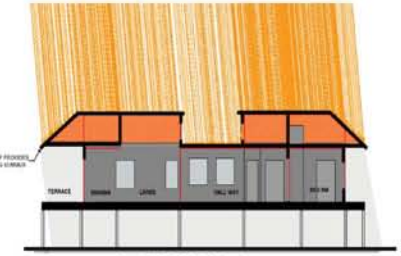


Daylight Analysis

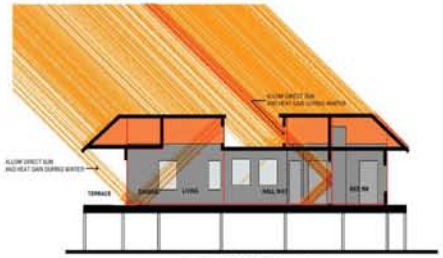
INDIRECT DAYLIGHT ANALYSIS



DIRECT DAYLIGHT ANALYSIS



SUMMER SOLSTICS at 12am



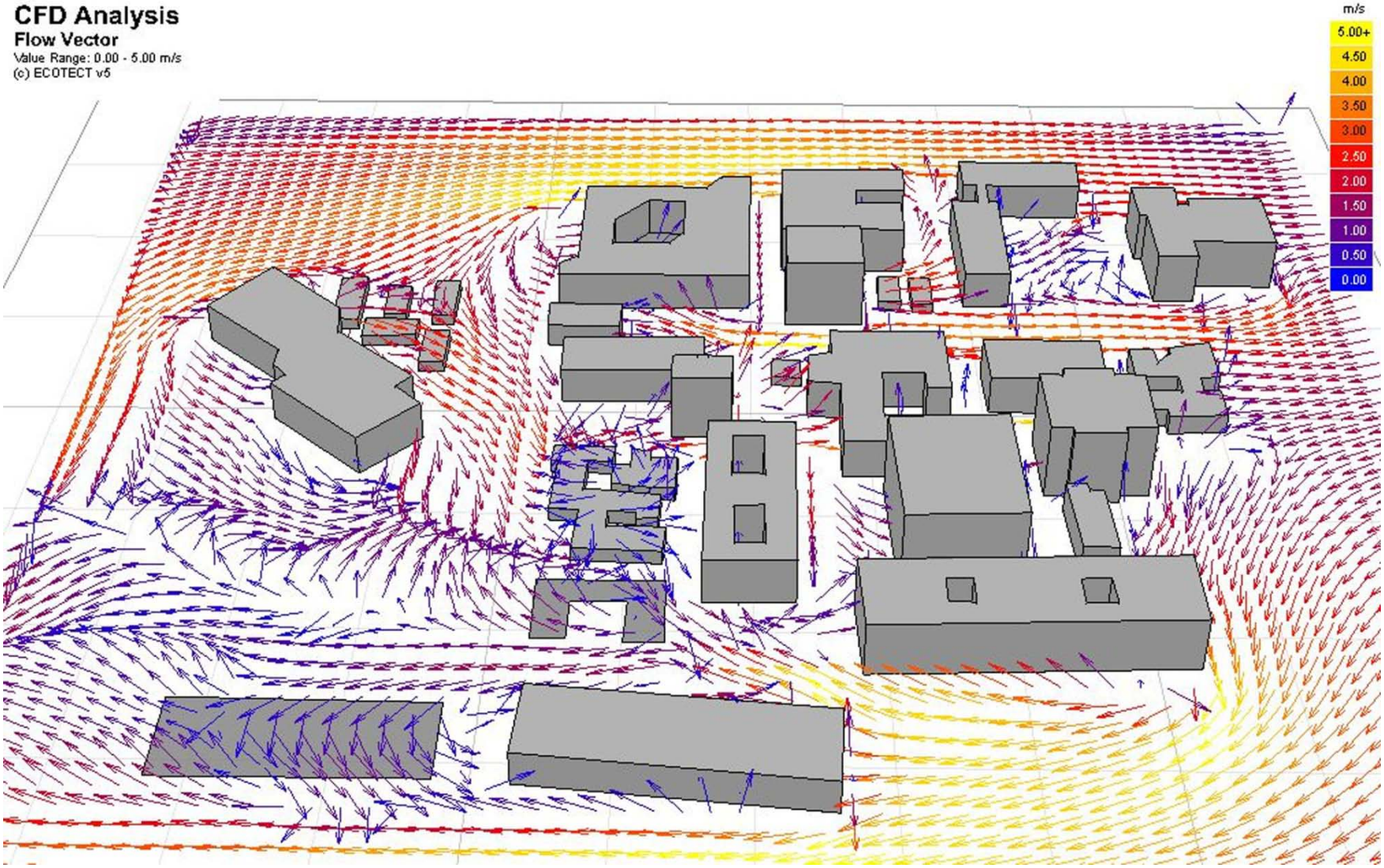
WINTER SOLSTICS at 12am

CFD Analysis

Flow Vector

Value Range: 0.00 - 5.00 m/s

(c) ECOTECT v5



University of Hawai ʻi
Building Information Modeling Project

Sponsors

Vice-Chancellor's Office for
Administration, Finance, & Operations

Assistant Vice-Chancellor's Office of
Financial & Physical Management

University of Hawai ʻi
School of Architecture

University of Hawai ʻi
Sea Grant College Program

Center for Smart Building
& Community Design

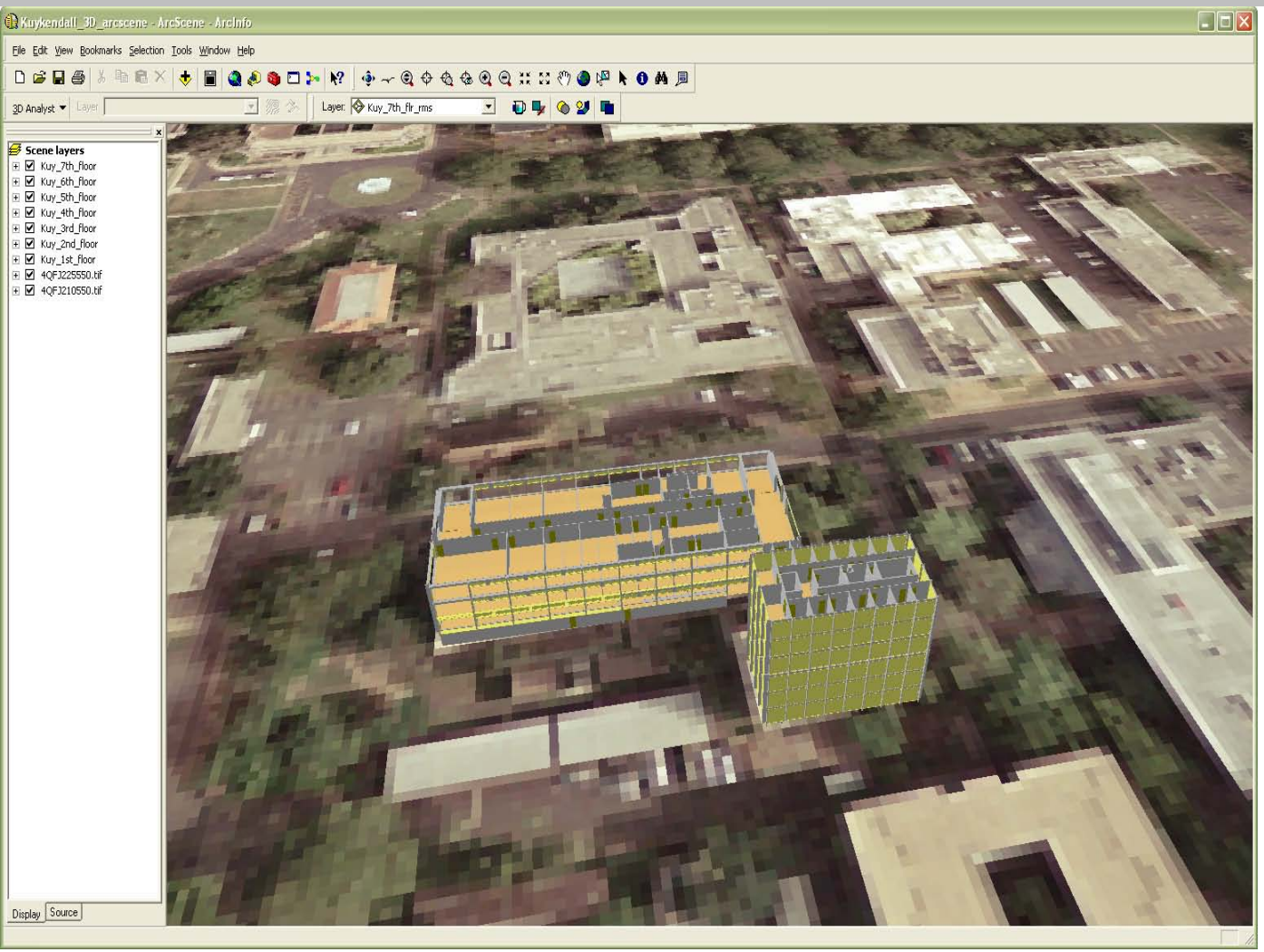
Developers

Environmental Research
& Design Lab (ERDL)

Advanced network
Computing Library (ANCL)

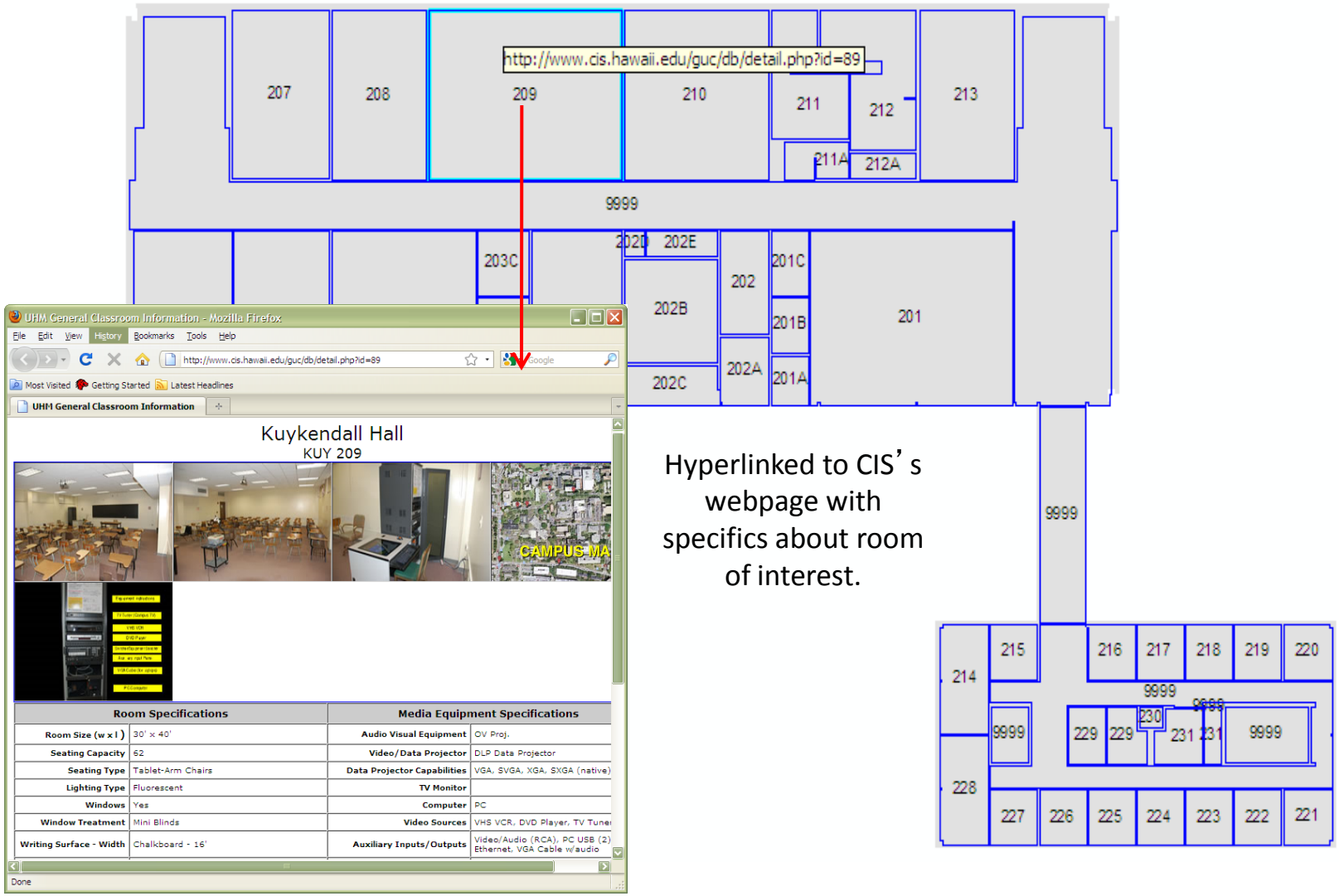
Geographic Information Systems
Research Lab | Botany Dept.

BIM Project | Campus Analysis



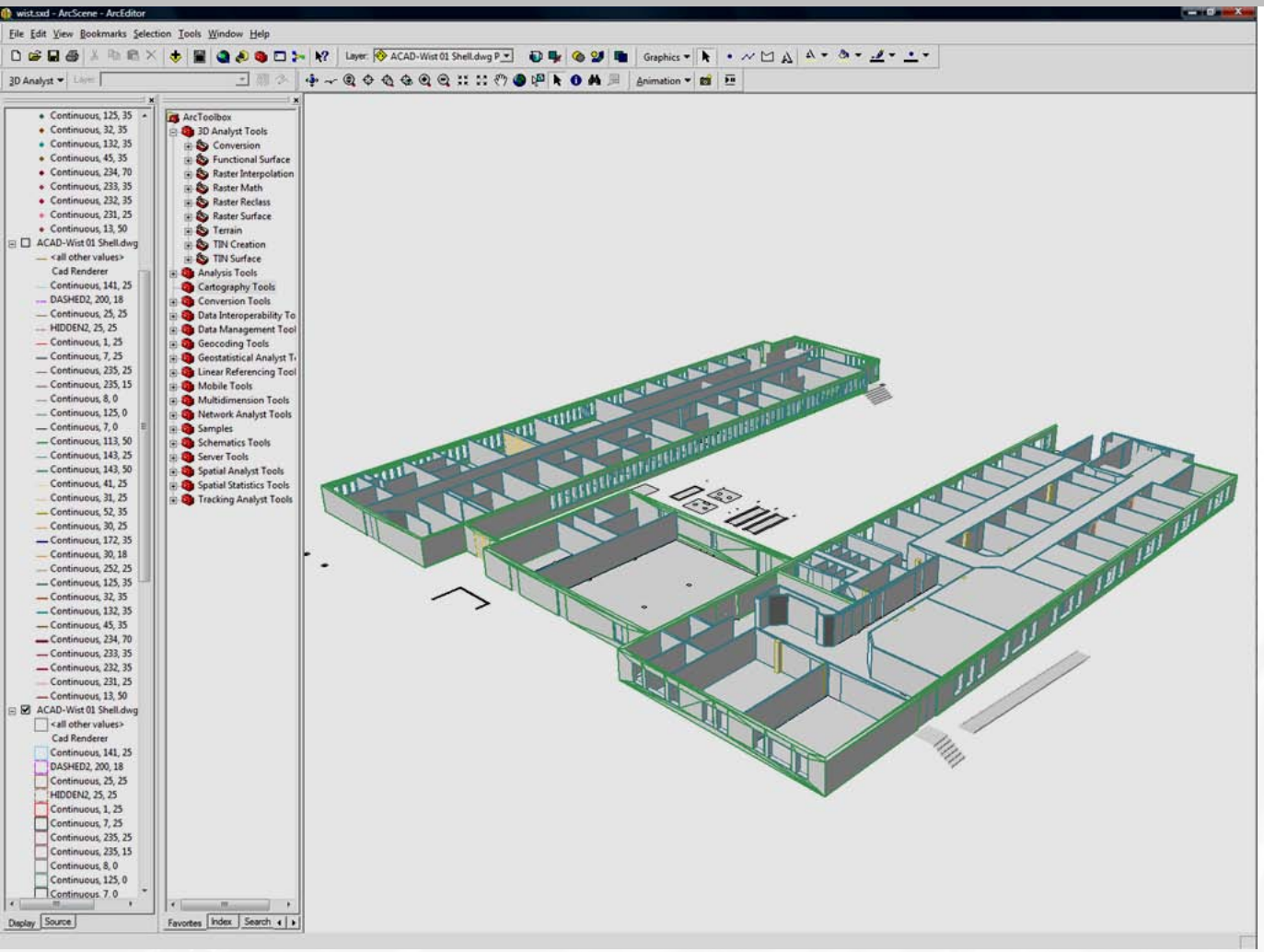
3D view of classrooms in ArcScene GIS

Campus 3D Model
with Building Information Management



Hyperlinked to CIS's webpage with specifics about room of interest.

Arch GIS | Desktop



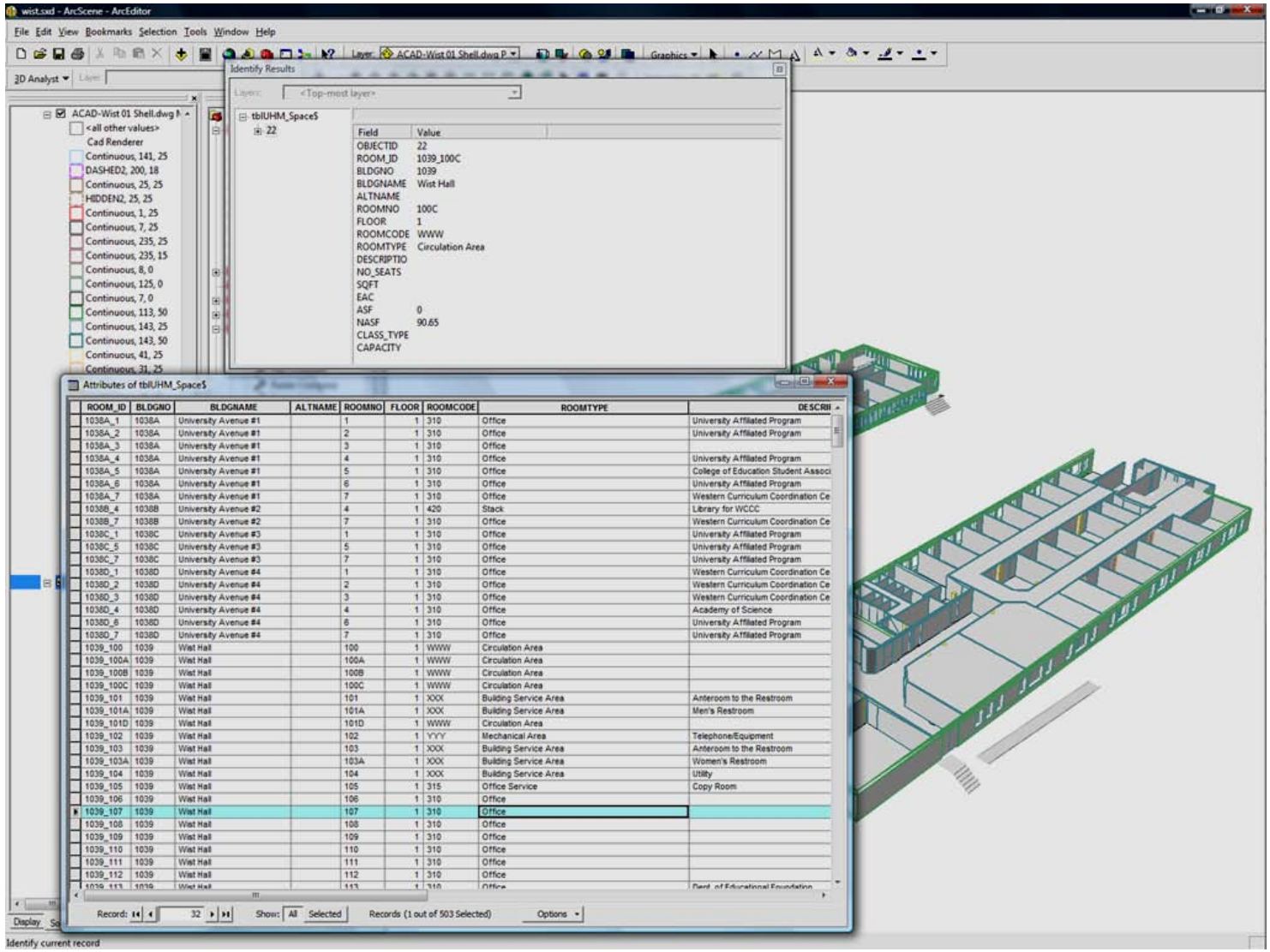
3D view of classrooms in Arc Scene GIS

Hyperlink operation applicable to several types of media.

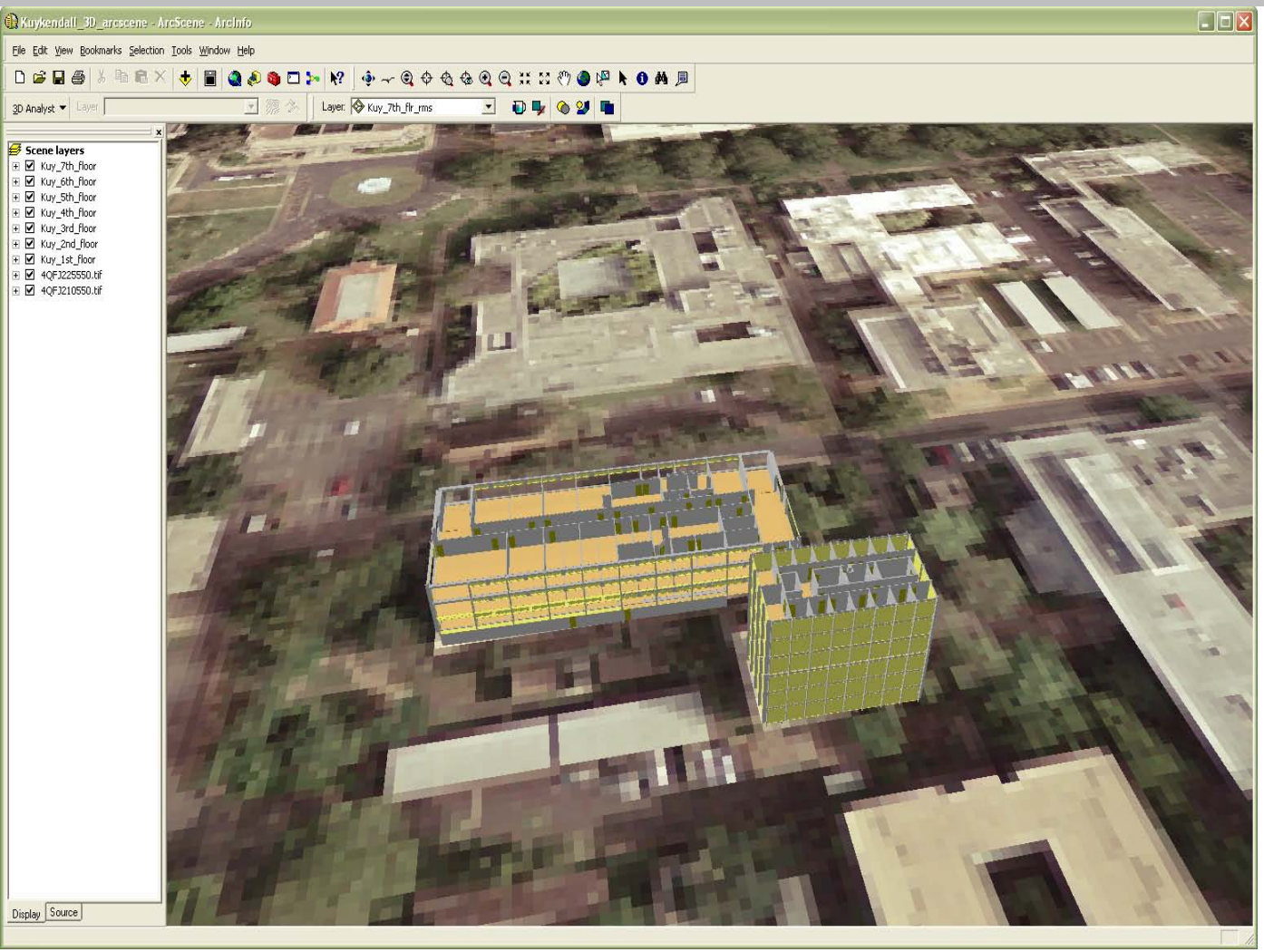
- Internet
- Intranets
- Databases
- Images

Campus 3D Model
with Building Information Management

Query spatial criteria in GIS



BIM Project | Campus Analysis



3D view of classrooms in ArcScene GIS

Kuykendall Hall Renovation

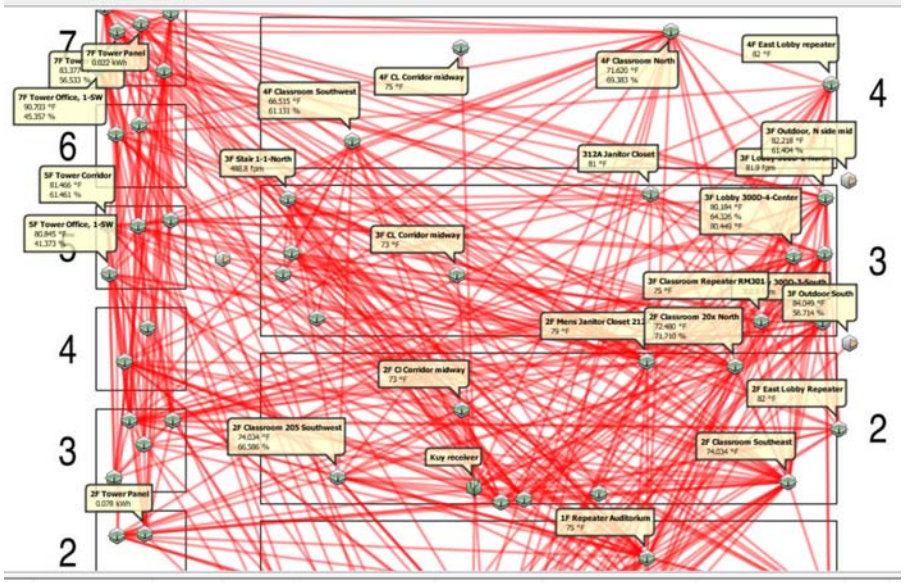
Setting up wireless sensors

Environmental sensors placed in key locations to measure temperature, humidity, air flow, and radiant heat.

Current transducers place on all circuits and data transmitted wirelessly

Kuykendall Hall Renovation

Data acquisition



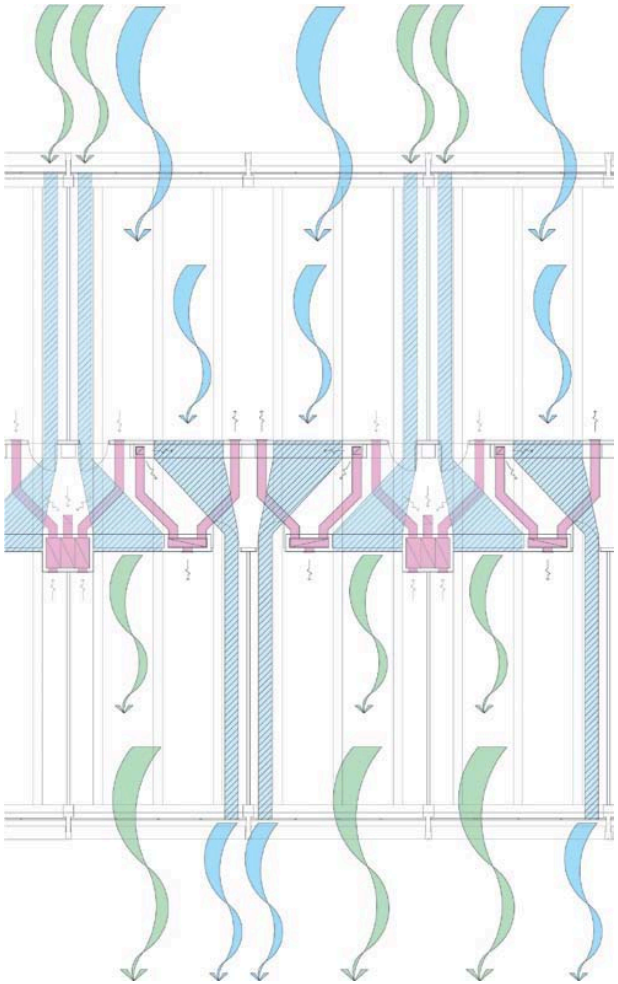
Wireless sensor network can be accessed remotely.

Occupancy sensors and plug load logger for window AC units are downloaded manually each month.

Kuykendall Hall Renovation

Weather Station

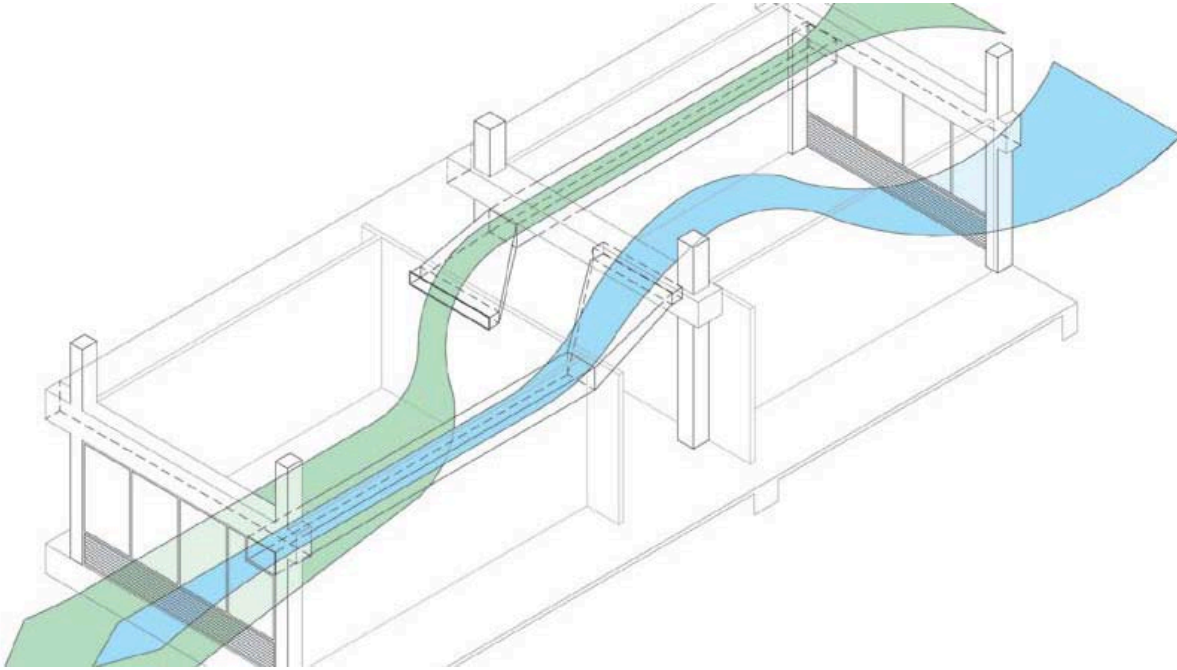
Onset HOBO U30 weather station with Ethernet connection automatically uploads data to a website.



MAUKA CLASSROOM AIRFLOW

MAKAI CLASSROOM AIRFLOW

MECHANICALLY ASSISTED AND DEHUMIDIFIED AIR



Pahoa Clubhouse

Normal Climate

Normal Temperatures

(PUU MANAWAHUA 725.6 Weather station, 6.35 miles from Waianae)

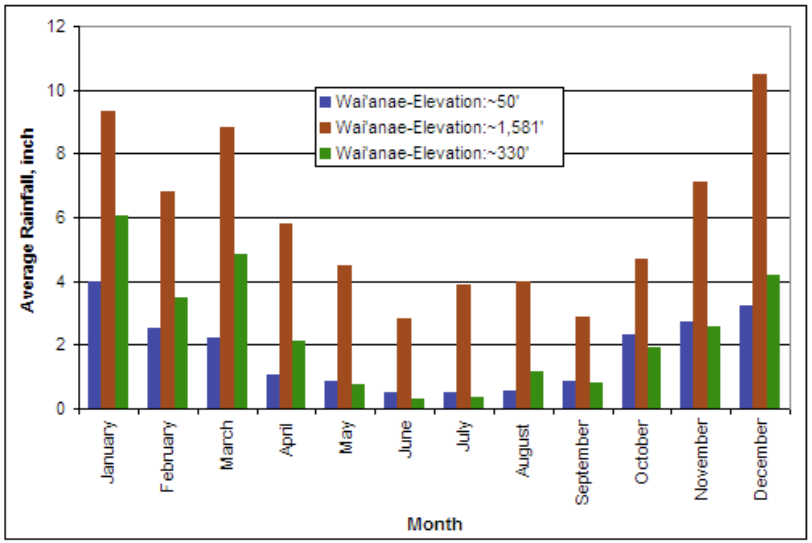
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max °F	74.9	75.1	75.5	76.7	78.2	80.5	81.8	83.1	83.1	81.4	78.6	75.7	78.7
Mean °F	66.1	66.0	66.5	67.7	69.0	71.0	72.5	73.5	73.6	72.2	69.9	67.3	69.6
Min °F	57.3	56.9	57.5	58.6	59.7	61.4	63.2	63.9	64.0	62.9	61.1	58.8	60.4

Normal Precipitation

(WAIANAE 798 Weather station, 1.20 miles from Waianae)

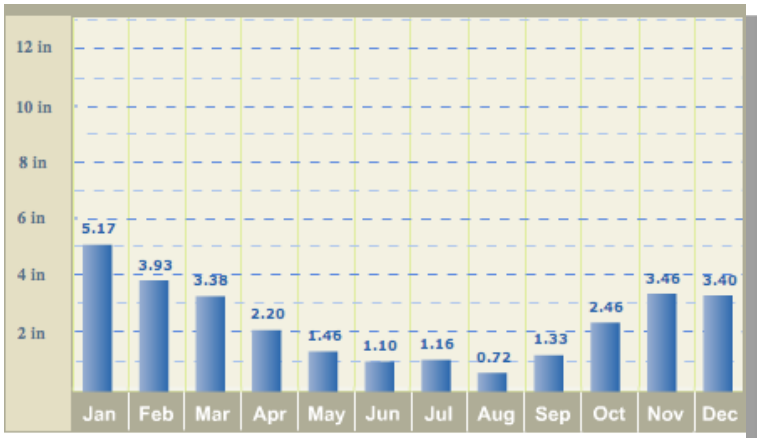
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Inch	3.54	2.66	1.59	0.85	0.81	0.63	0.63	0.56	0.94	2.96	2.57	3.19	20.93

Data sources:



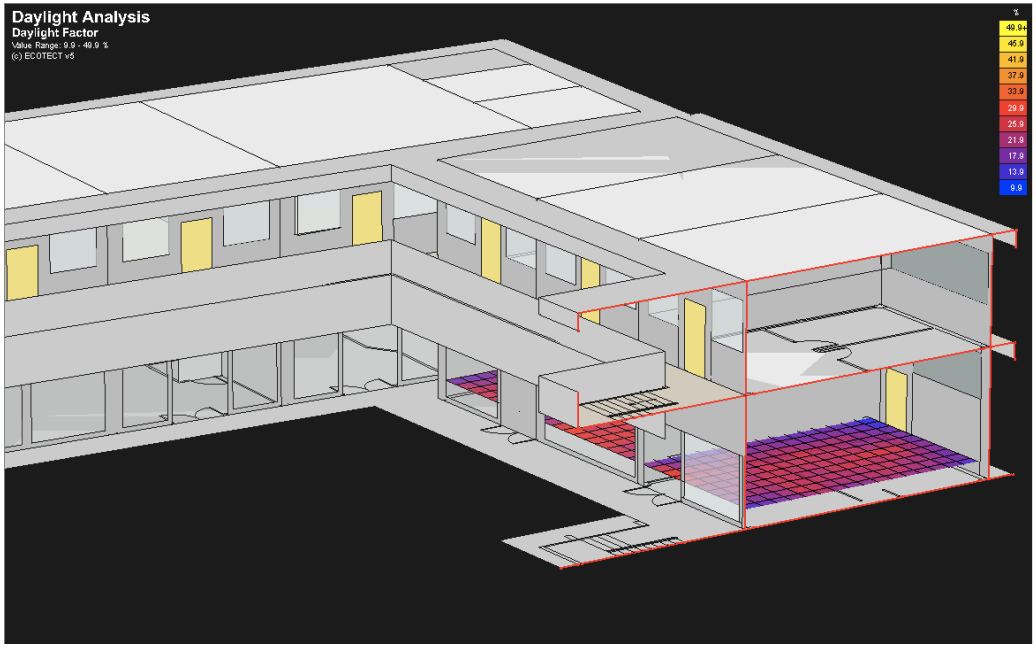
Average monthly rainfall totals for three Wai'anae gages at different elevations.

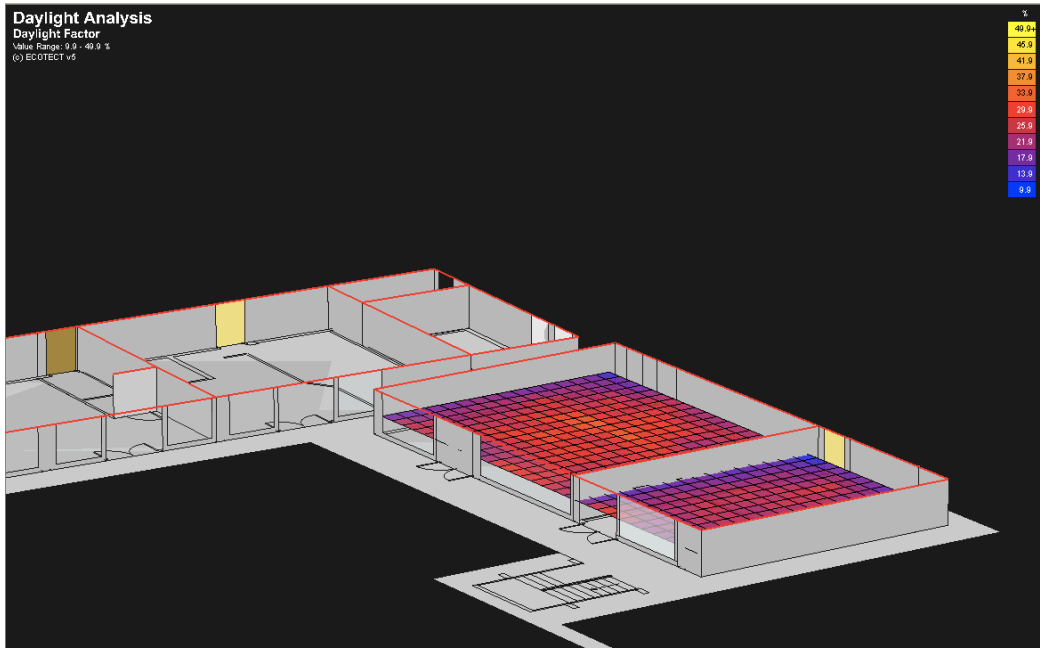
Source: Created from data provided by the Western Regional Climate Center (2004).



Waianae, HI (96792) Weather Facts

- The average warmest month is August.
- The highest recorded temperature was 96°F in 1986.
- The average coolest month is February.
- The lowest recorded temperature was 46°F in 1983.
- January is the average wettest month.


Daylight Analysis
Daylight Factor
Value Range: 9.9 - 49.9 %
(c) ECOTECT v5
%
49.9+
45.9
41.9
37.9
33.9
29.9
25.9
21.9
17.9
13.9
9.9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Value Range: 9.9 - 49.9 %
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%
49.9+
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37.9
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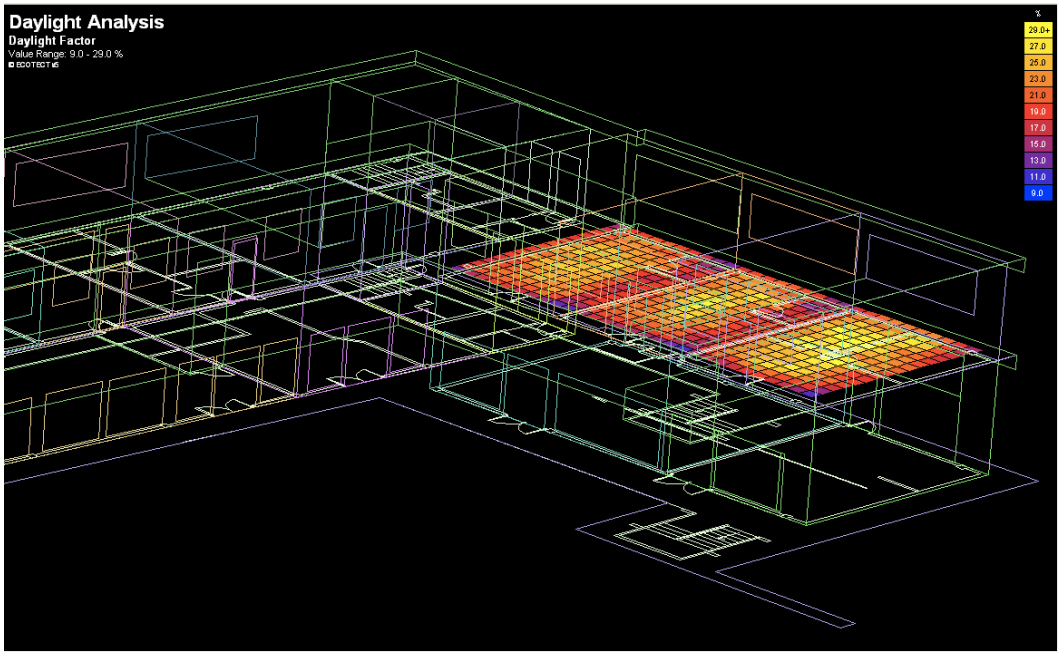
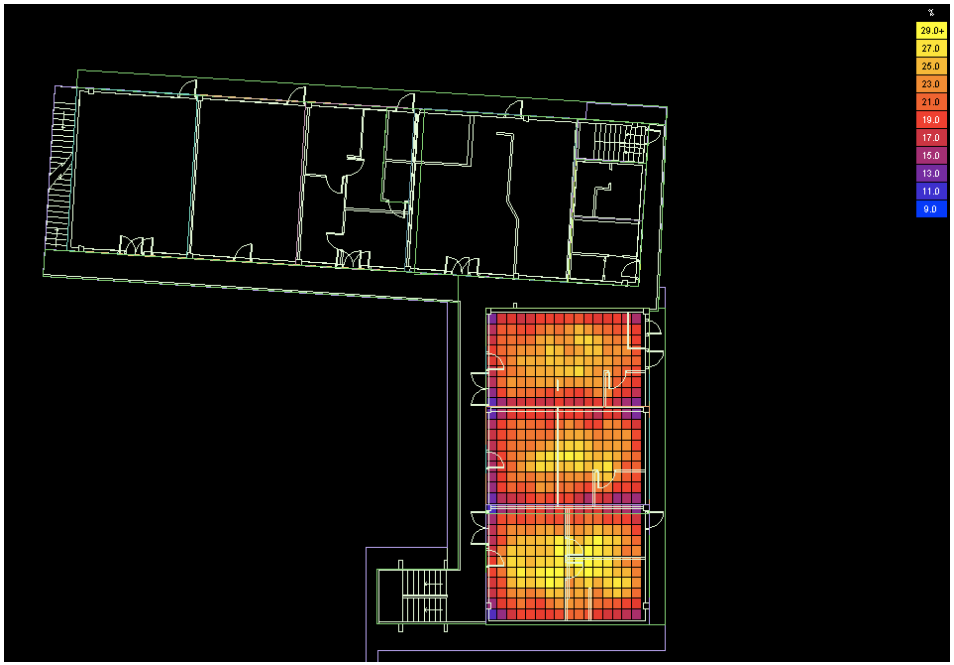
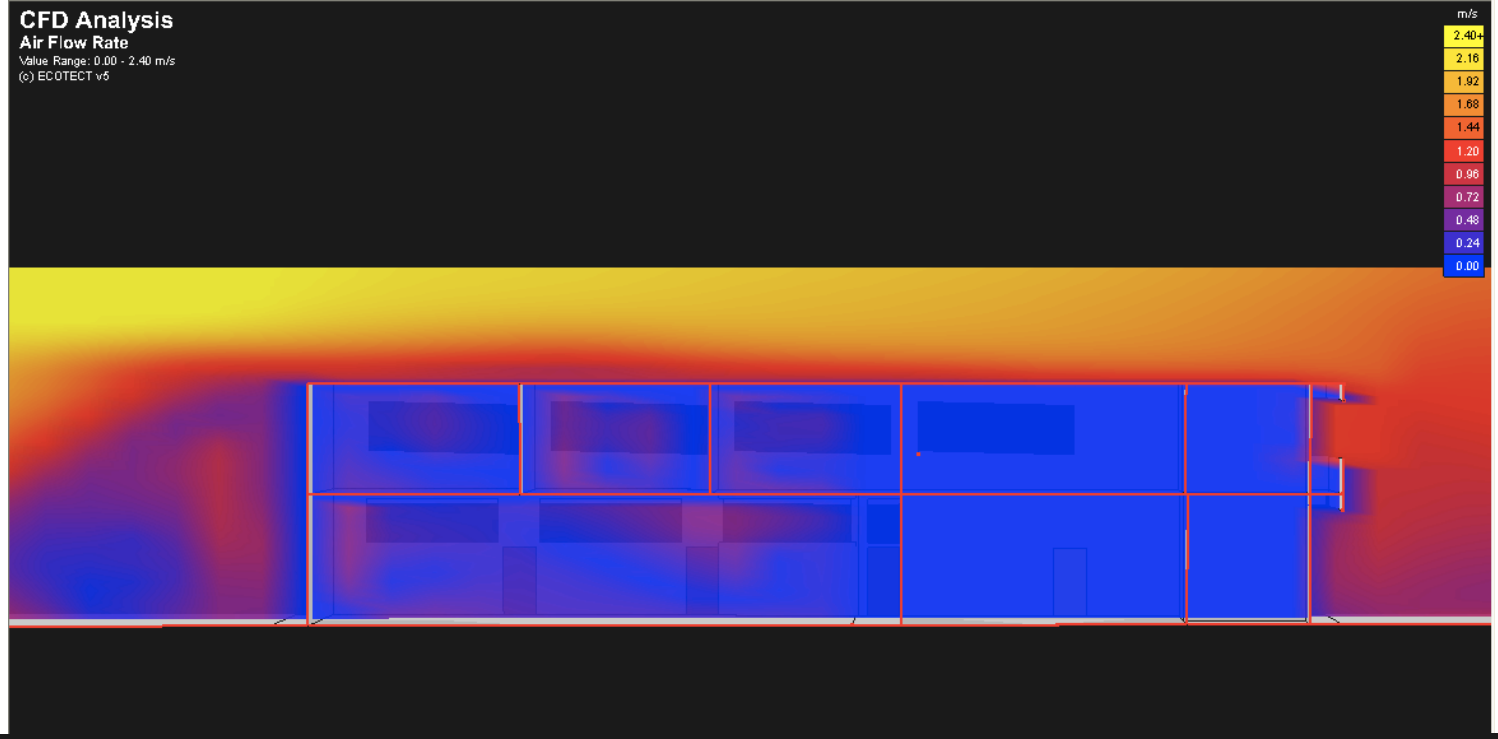
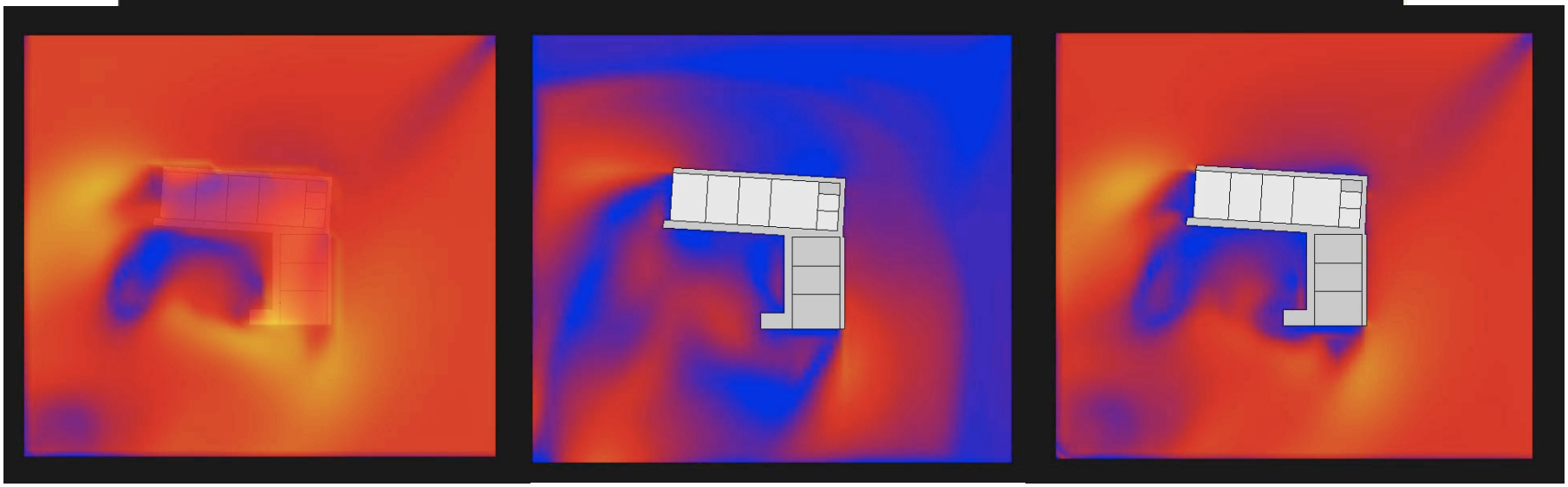
25.9
21.9
17.9
13.9
9.9

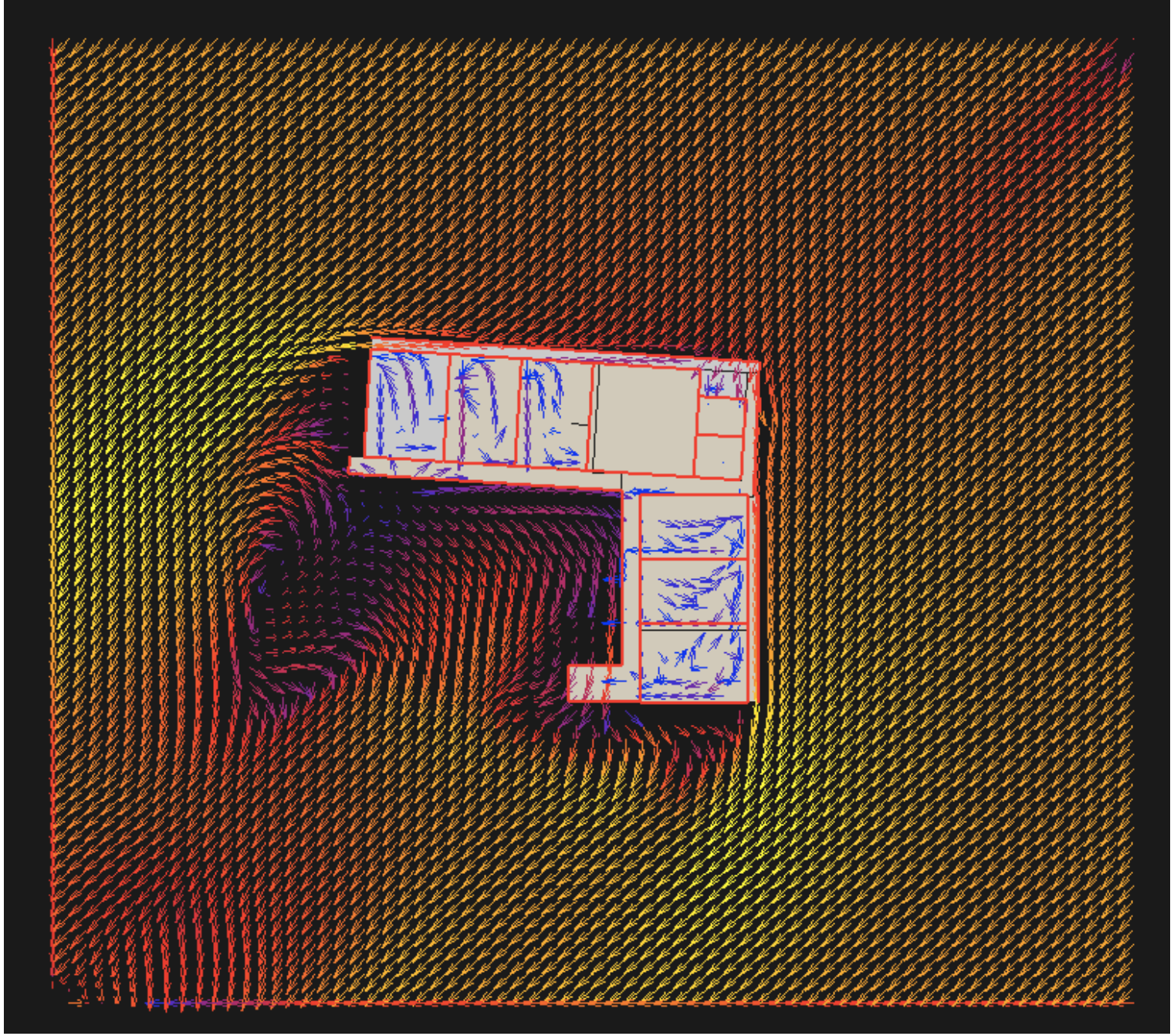




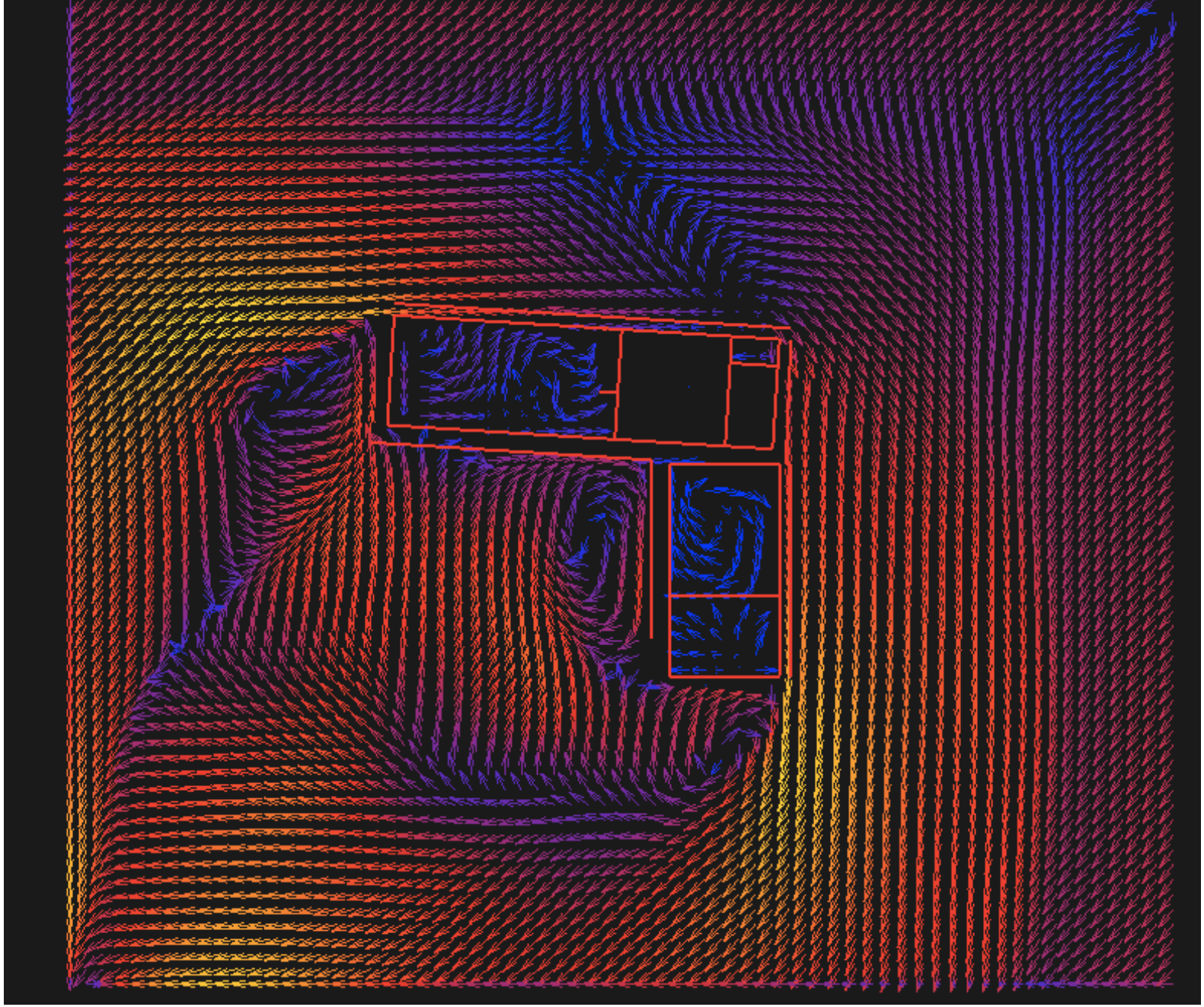
Daylighting Analysis of Second Floor


CFD Analysis
Air Flow Rate
Value Range: 0.00 - 2.40 m/s
(c) ECOTECT v5
m/s
2.40+
2.16
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00





CFD of Exterior Condition



CFD of Interior Condition

MODEL HOUSE

CONTROL HOUSE

Building Industry Association - Hawaii

"The New Hawaiian Home"

Features:

- High efficiency glazing
- Radiant barrier
- Whole house fan
- Ceiling fans
- Outdoor dining area
- Vegetable garden
- Hydroponic garden
- Photovoltaic system
- Solar water heating
- Rain water catchment

http://biahawaii.blogspot.com/

Energy Auditing of Military Homes

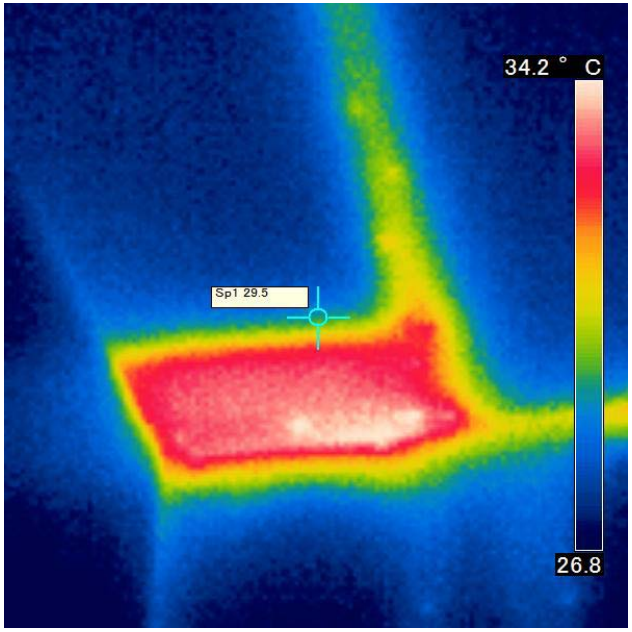
Military Communities

- ✓ **Basic audit**:
  - ✓ Appliance inventory and condition:
    - ✓ AC compressor, air handler
    - ✓ Solar water system and controls
    - ✓ Backup water heater
    - ✓ Refrigerator
  - ✓ Lighting audit
  - ✓ Plug load inventory
  - ✓ Sub-metering for 30 days

Energy Auditing of Military Homes

Forest City Military Communities

- ✓ **Advanced auditing**:
  - ✓ Blower door testing
  - ✓ Duct blasting
  - ✓ Infrared thermography



Infrared thermography reveals missing insulation in corner of ceiling.

Students practice pressurizing ducts

Energy Auditing of Military Homes

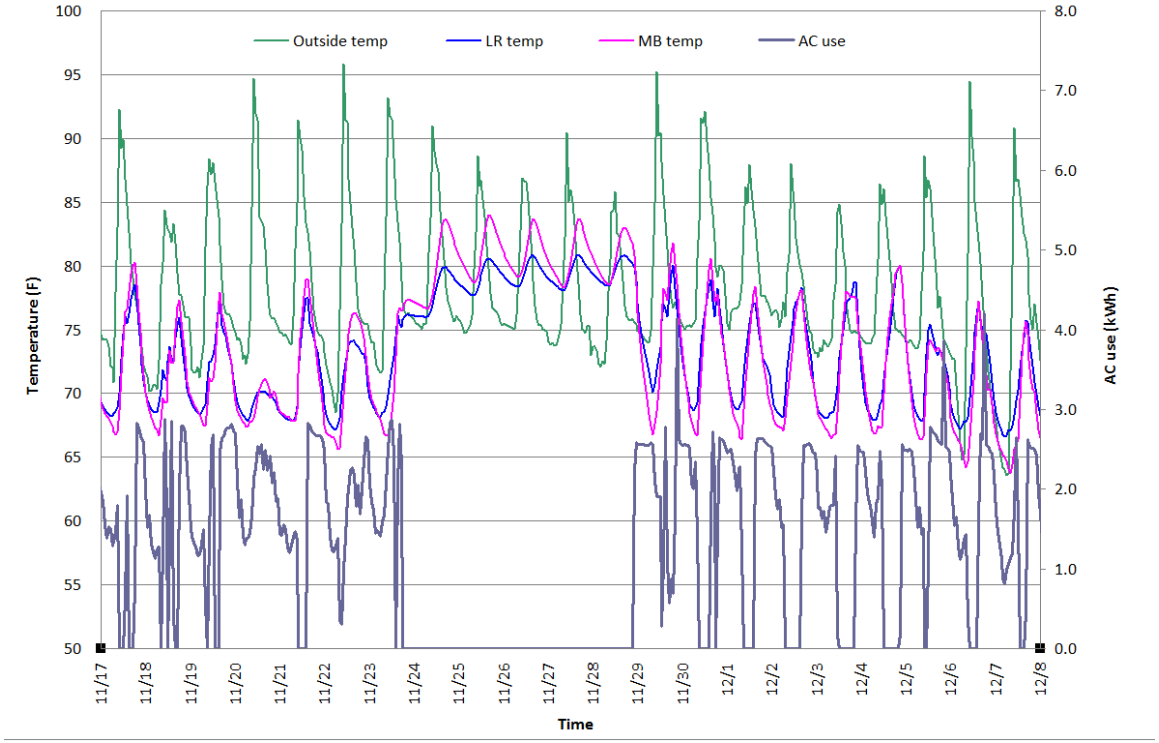
Forest City Military Communities

Students from the Environmental Research and Design Lab receive hands-on training in military homes.

Energy Auditing of Military Homes

Forest City Military Communities

- Sample data analysis:
  - AC energy consumption vs. living room and master bedroom temperatures.
  - This family went away for Thanksgiving and turned the AC off for 5 days.



Energy Auditing of Military Homes

The AC consumes a high% of the energy used in a home. Factors affecting this are:

- Thermostat set point
- Duct, register, grill designs
- Condition of ducts
- Infiltration of outdoor air
- Condition of compressor heat exchange fins and air handler coil
- Operating habits of the resident

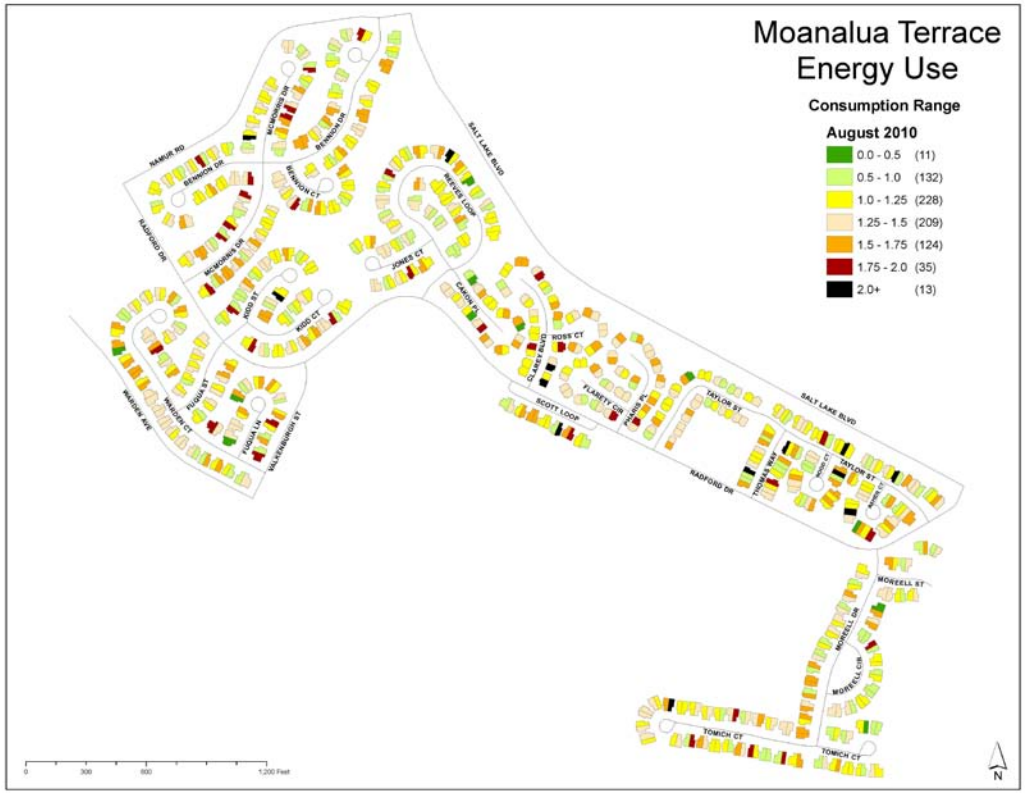
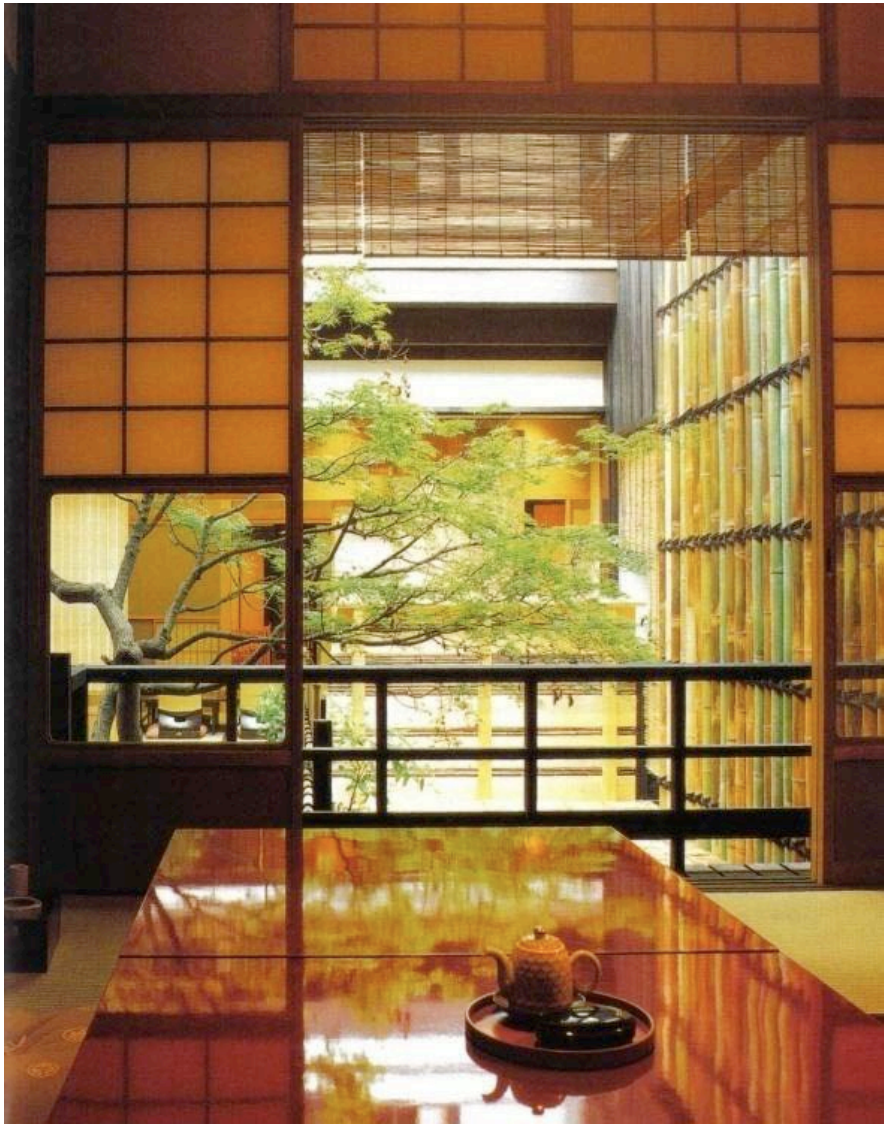
Table 1. Comparison of AC power consumption, percent time compressor was on, thermostat type, living room temperature range, and type of AC compressor for 11 homes.

Unit	AC ave. kWh/mo	% time AC on	Thermostat	Temperature Range (°F)	Air Conditioner
M1	1,138	80%	Manual	61-74	2T 1996 Carrier
M4	1,050	73%	Manual	67-82	2T 1996 Carrier
M3	840	71%	Program.	71-79	2T 1996 Carrier
M7	672	44%	Manual	72-82	2T 1997 Carrier
M2	609	82%	Program.	73-81	2T 1996 Carrier
M8	586	41%	Program.	72-76	2T 1996 Carrier
M6	567	57%	Program.	73-76	2T 2008 Trane
P6	1,125	74%	Manual	67-79	2.5 T 2001 Carrier
P4	781	55%	Program	72-76	2.5 T 2001 Carrier
P2	411	42%	Program	74-77	2.5 T 2009 Rheem
P3	342	25%	Program	74-76	2.5 T 2001 Carrier

Programmable thermostats cannot be set lower than 72°F, resulting in lower energy consumption than manual thermostats.

Energy Auditing of Military Homes

- Energy consumption can be mapped in GIS to look for effects of orientation, pavement, vegetation, etc.



Transparencies and layering of built and natural environment both vertically and horizontally