INTEGRATED
DESIGN
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INC

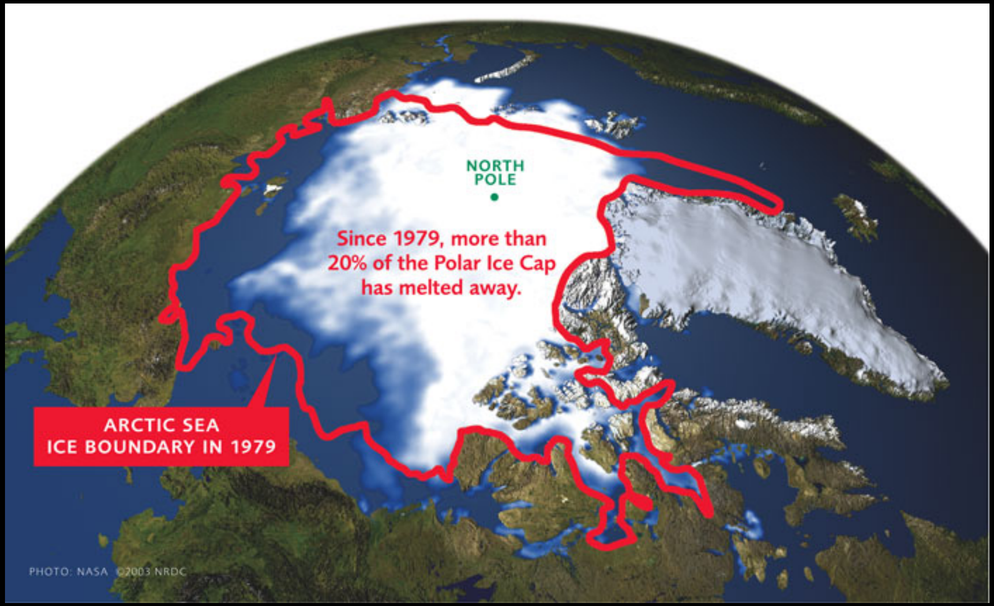
Practical Guide to Energy Efficient Design

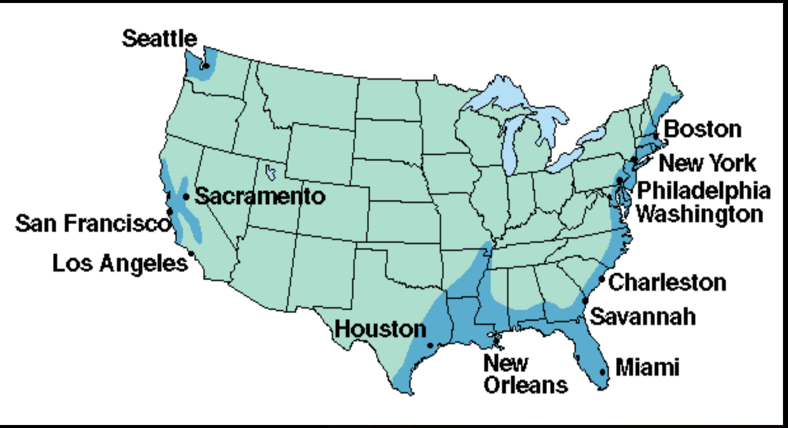
IEEE IAS San Francisco
May 15, 2009

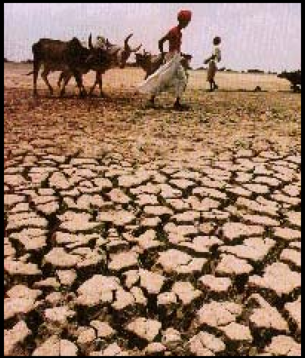
Presentation Overview

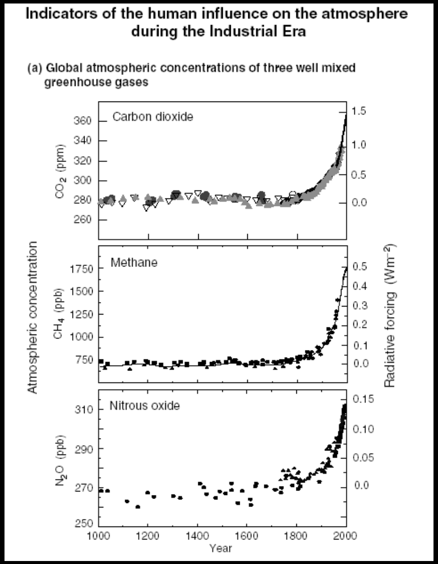
- Sustainability
- Sustainability Features
- Case Study – Tahoe Center for Environmental Studies
- Case Study – 1084 Foxworthy
- Conclusions

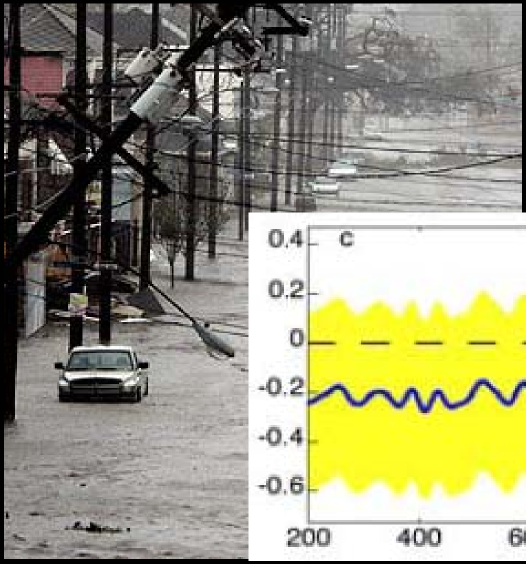
Why Sustainable Design

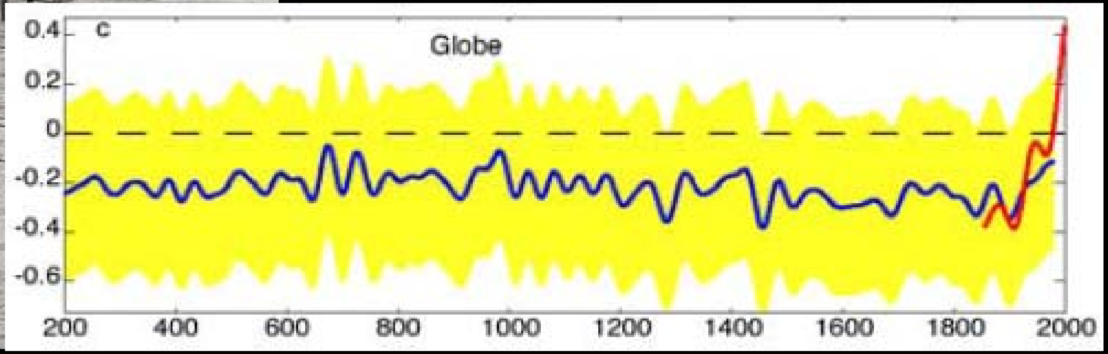












Green Building

Integrated Design:

When designing a Swiss watch or a green building, you don't design each piece in isolation from the others.

Sustainable Design

Sustainability = No Waste

Sustainable Design

The Engineering Paradox: Is it our education?

How Engineers are Taught….and design

Accept Givens

Perform Calculations

Create Details

Integrate with Project

- Linear Solutions
- Solves Engineer's Problems
- Textbook Approach
- Safe for Engineer

A Collaborative Approach

Respond to Project Goals

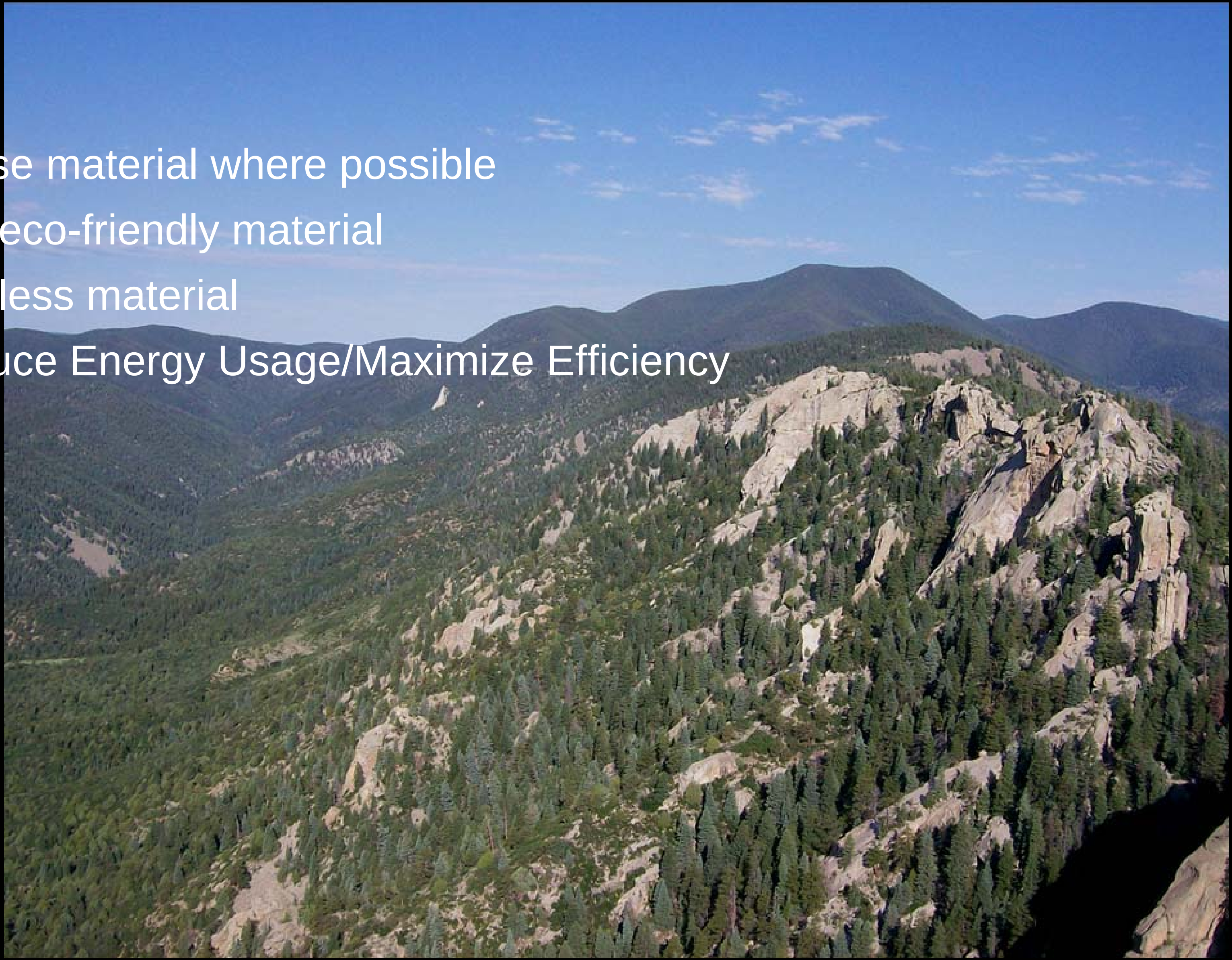
Integrate Design with Project

Create Details

Perform Calculations

- Solves Project's Problems
- Adds Value
- Leads to Innovation
- Riskier for Engineer
- Requires Technical Expertise

Sustainable Features



- Reuse material where possible
- Use eco-friendly material
- Use less material
- Reduce Energy Usage/Maximize Efficiency

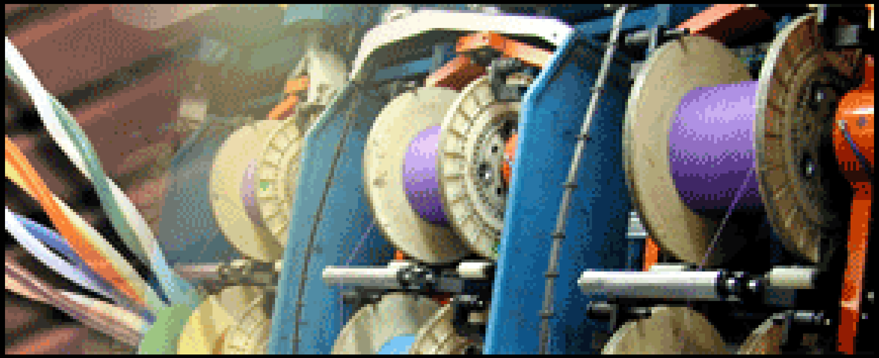
Reuse Materials

- Building Reuse
- Reuse electrical systems that have remaining life

Eco-Friendly Materials

- Avoid PVC
- Avoid Mercury
- Materials with lots of embedded energy

Courtesy Sylvania/Osram

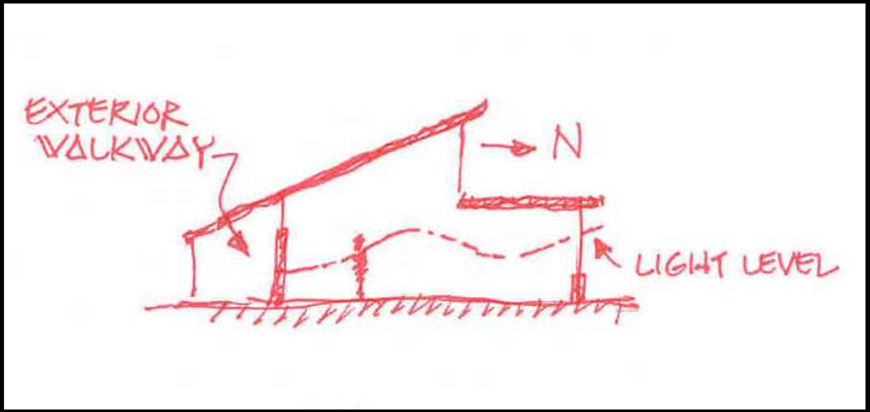


Use Less Material

- Use 480/277 volt where possible to limit wire size
- Think “wireless”
- Double usage - VOIP

Reduce Energy/Maximize Efficiency

- Use Energy Efficient Equipment
- Controls to Minimize Usage
- Building Orientation
- Thermal Envelope



Courtesy Wattstopper

Case Study – Tahoe Center for Environmental Science

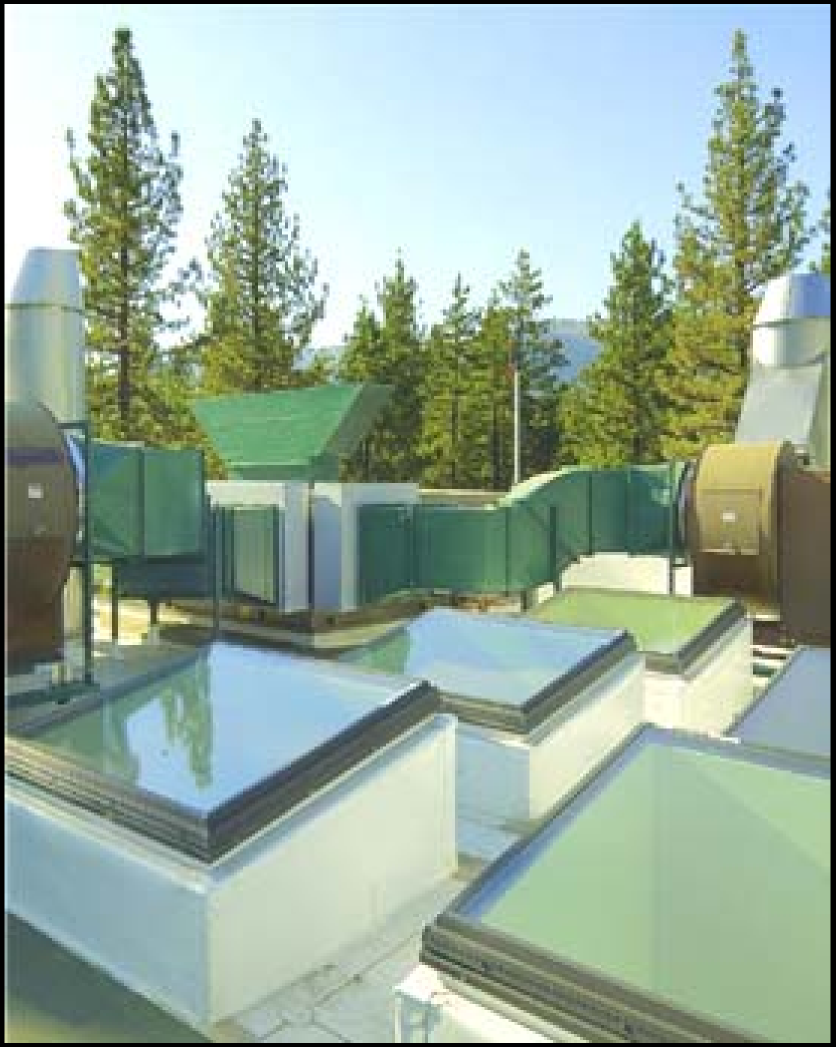
- High efficiency light sources
- Astronomic time clocks
- Task/ambient lighting
- Light pollution reduction
- Daylight switching photosensors
- Daylight dimming photosensors
- Photovoltaic systems
- Natural Gas Microturbine
- Upsized wiring
- High efficiency transformers
- Energy star equipment
- Plug load controls
- Wireless data
- VOIP

Case Study – Tahoe Center for Environmental Science

- High efficiency light sources

Case Study – Tahoe Center for Environmental Science

- Daylight switching photosensors
- Daylight dimming photosensors



Case Study – Tahoe Center for Environmental Science

- Upsized wiring

Courtesy: Copper.org

1. Larger wires = less resistance

2. Less resistance = less energy loss

3. Less energy loss = lower wire temperature

4. Lower wire temperature = less resistance (see #2)

Payback can be as low as 2 years!!

conductor size	length	resist/lf	resist (ohms)	amps	loss (va)		conductor size	length	resist/lf	resist (ohms)	amps	loss (va)
Row 1												
#12	80	0.00170	0.2720	12.0	39.17		#10	80	0.00105	0.1680	12.0	24.19
#12	8	0.00170	0.0272	3.2	0.28		#10	8	0.00105	0.0168	3.2	0.17
#12	8	0.00170	0.0272	2.4	0.16		#10	8	0.00105	0.0168	2.4	0.10
#12	8	0.00170	0.0272	1.6	0.07		#10	8	0.00105	0.0168	1.6	0.04
#12	8	0.00170	0.0272	0.8	0.02		#10	8	0.00105	0.0168	0.8	0.01
Row 2												
#12	10	0.00170	0.0340	8.0	2.18		#10	10	0.00105	0.0210	8.0	1.34
#12	8	0.00170	0.0272	3.2	0.28		#10	8	0.00105	0.0168	3.2	0.17
#12	8	0.00170	0.0272	2.4	0.16		#10	8	0.00105	0.0168	2.4	0.10
#12	8	0.00170	0.0272	1.6	0.07		#10	8	0.00105	0.0168	1.6	0.04
#12	8	0.00170	0.0272	0.8	0.02		#10	8	0.00105	0.0168	0.8	0.01
Row 3												
#12	10	0.00170	0.0340	4.0	0.54		#10	10	0.00105	0.0210	4.0	0.34
#12	8	0.00170	0.0272	3.2	0.28		#10	8	0.00105	0.0168	3.2	0.17
#12	8	0.00170	0.0272	2.4	0.16		#10	8	0.00105	0.0168	2.4	0.10
#12	8	0.00170	0.0272	1.6	0.07		#10	8	0.00105	0.0168	1.6	0.04
#12	8	0.00170	0.0272	0.8	0.02		#10	8	0.00105	0.0168	0.8	0.01
Total:					43.45							26.84

use: 12 hrs/day, 5 days/week
cost of electricity: $0.12/kwh
light fixture: 3 lamp, 32w/lamp

Annual Loss 136 kwh
Annual Cost $16.31

Annual Loss 84 kwh
Annual Cost $10.08

Difference $6.24
Payback 27 months

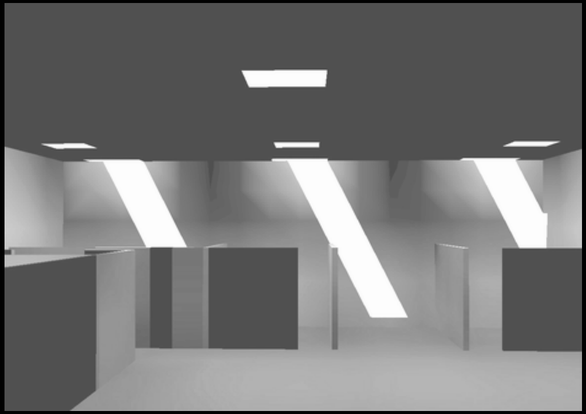
Case Study – Tahoe Center for Environmental Science

- Biodeisel/Natural Gas Microturbine
- Grid Tied – Electricity
- Waste Heat – Hot Water
- Biodeisel avoids releasing new carbon into atmosphere

Courtesy: Capstone

Case Study - 1084 Foxworthy

- High efficiency light sources
- Astronomic time clocks
- Task/ambient lighting
- Individual occupancy sensor task lighting controls
- Occupant sensor ambient lighting controls
- Mesopic lighting
- Light pollution reduction
- Daylight switching photosensors
- Daylight dimming photosensors
- Photovoltaic systems
- Upsized wiring
- Electro chromic glass
- High efficiency transformers
- Energy star equipment
- Plug load controls
- Wireless data
- VOIP



Case Study - 1084 Foxworthy

- Reuse an existing building

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- High Efficiency Light Sources

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- Control Solar Heat Gain

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- Task Ambient Lighting
  - 17 fc ambient light level
  - 90% reflective paint
  - 83% reflectance ceiling tiles

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- Automatic Lighting Controls

Case Study - 1084 Foxworthy

- Combination Lighting Controls

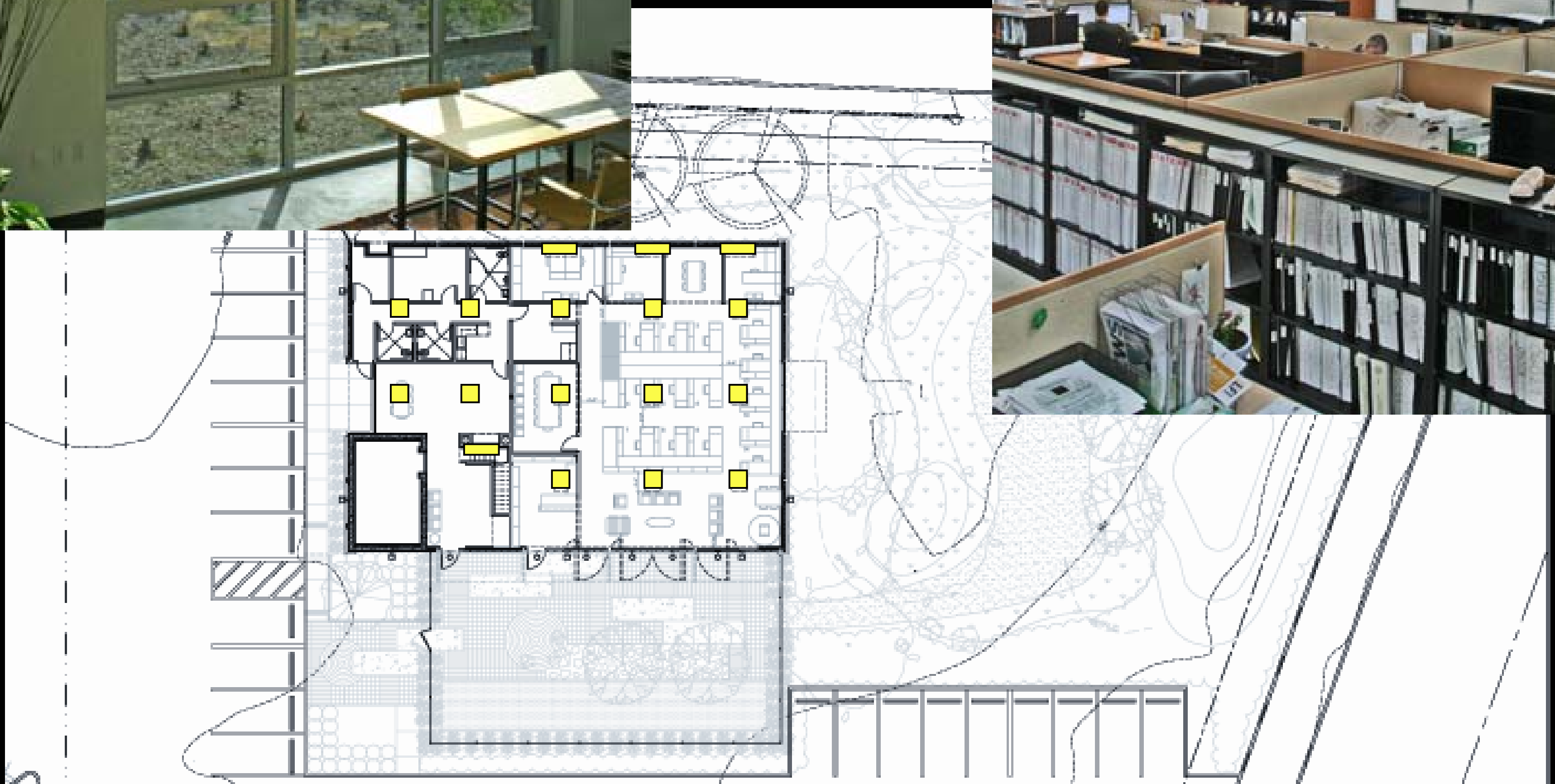






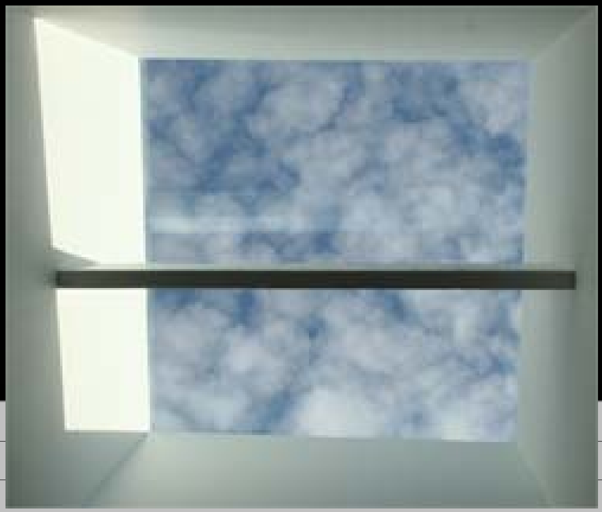
Case Study - 1084 Foxworthy

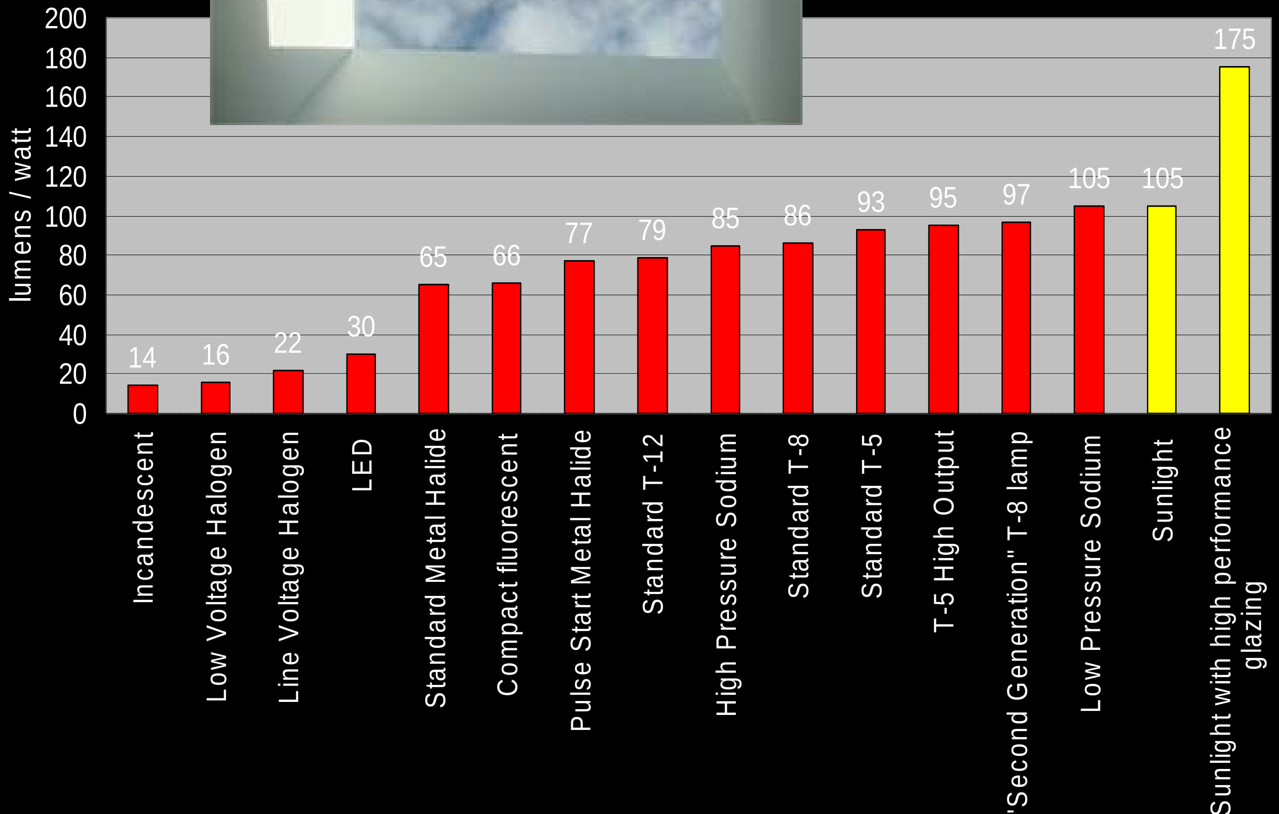
- Maximize Daylight and Views

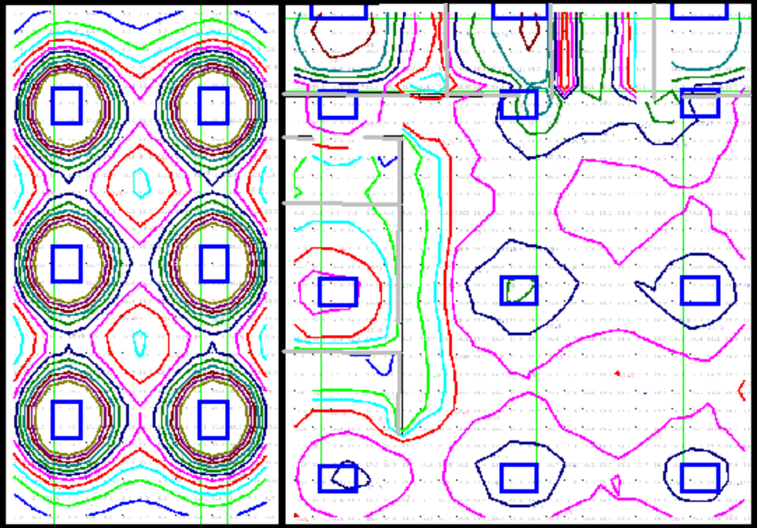


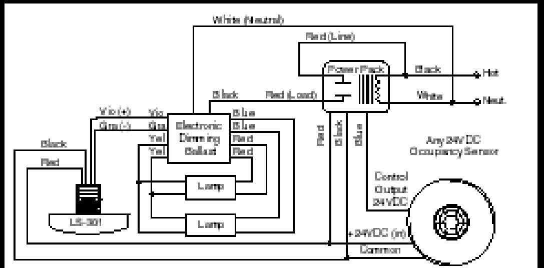
Case Study - 1084 Foxworthy

- Daylight Harvesting









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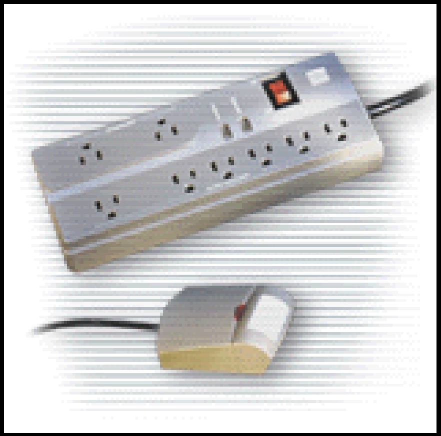
- Minimize Plug Loads
  - High efficiency equipment
  - Software based shut off
  - Occupancy based controls

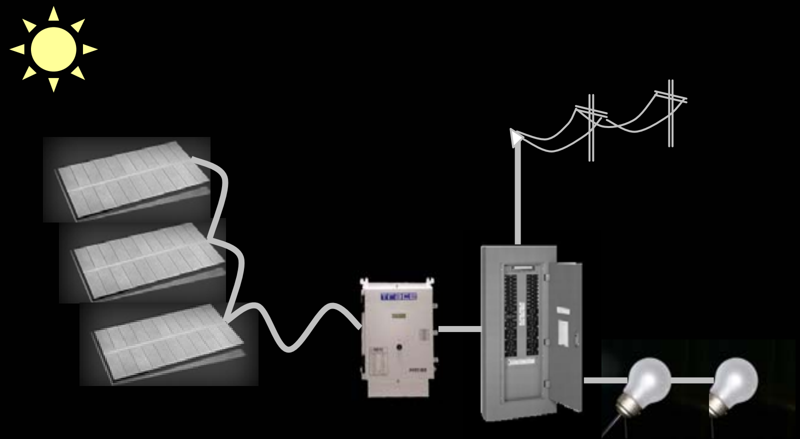


Case Study - 1084 Foxworthy

- Night Time Plug Load Shutoff
  - Security system circuit controls

Case Study - 1084 Foxworthy

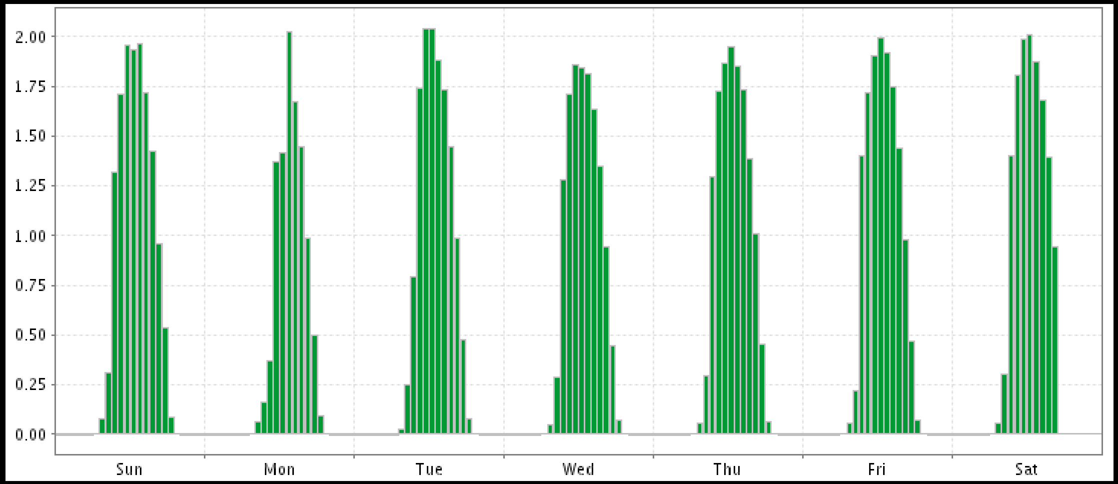
- Building Integrated Photovoltaics (BIPV)



- All electric building
- Net zero energy
- Zero carbon emissions

Case Study - 1084 Foxworthy

- Analysis: Energy Use
  - Building is all electric - no CO_2 is generated from burning natural gas.
  - Estimated annual energy consumption (DOE 2.1):
    - 54,000 kWh per year
    - 60% below ASHRAE 90.1 1999 Standards
  - PV Capacity: 30 kW, 54,756 kWh / year
  - PV's sized to generate 100% of the net electrical load.



Case Study - 1084 Foxworthy

- Analysis: PV System Incentives
  - PV Capacity 30 kW, 54,756 kWh / year
  - Estimated PV Cost:

$255,000	installed cost ($8.50/watt)
-78,000	CEC rebate ($2.60/watt)
34,206	tax on CEC rebate (35% fed tax, 8.854% state tax)
-76,500	30% federal tax credit
-89,250	accelerated depreciation* (35% federal corp tax)
$45,456	cost of system after 5 years

* calculation does not include the time cost of capital

  - the cost after rebates, tax credits and depreciation is about 20% of the installed cost.
  - Energy savings at $ 0.16 / kWh = $8,760/year
  - Payback is about 5.2 years

Case Study - 1084 Foxworthy

- Analysis: Estimated Additional Cost

Key differences from a conventional building:

$20,000	cost of upgraded glass
97,500	cost of radiant mechanical system over traditional system.
38,000	cost of concrete for radiant floor
45,500	cost of PV systems (after rebates and ta incentives)
$201,000	total
241,000	total with soft costs
$4,100,000	total cost of building
6.2%	premium to build a net zero energy building

Case Study - 1084 Foxworthy

- Analysis: Estimated CO_2 previous (lbs)

5,644	Previous gas use - 460 therms @ 12.27 lbs CO_2 / therm (1)*
35,053	Previous electricity use - 36,424 kWh @ 0.88 lbs CO_2 / kWh (2)*
37,228	Automobile travel - 43,775 miles / 23 mpg (4) = 1903 gals @ 19.56 lbs CO_2 / gal (3)*
15,613	Air travel - 35,484 miles @ 0.44 lbs CO_2 / mile (5)*
93,538	**Total** (lbs)

(1) Carbon Trust, http://www.carbontrust.co.uk/KnowledgeCentre/conversion_factors/default.htm

(2) EPA's eGrid database for calendar year 2000, emissions include adjustment for 9 percent line loss.

(3) Energy Information Administration, http://www.eia.doe.gov/oiaf/1605/coefficients.html

(4) Weighted average of reported employee vehicle mileage.

(5) Carbon Fund, http://carbonfund.org/site/pages/calculator/category/Assumptions/

*based on 2005 statistics

Case Study - 1084 Foxworthy

- Analysis: Estimated Final CO_2 (lbs)

0	Gas use - 0 therms @ 12.27 lbs CO_2 / therm (1)*
0	Electricity use - 0 kWh @ 0.88 lbs CO_2 / kWh (2)*
0	sub total building CO_2 (lbs)
37,228	Automobile travel - 43,775 miles / 23 mpg (4) = 1903 gals @ 19.56 lbs CO_2 / gal (3)*
15,613	Air travel - 35,484 miles @ 0.44 lbs CO_2 / mile (5)*
52,841	sub total travel CO_2 (lbs)
(52,841)	Carbon offsets
0	**Total**

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Lessons learned

- Use simple user interfaces
- Complex controls have complex commissioning
- City planning staffs are behind on the green building curve
- Using things for two purposes saves money
- Using things for two purposes can have unintended results (heat pump as water heater)

drawn by Giselle, age 5.

Conclusions

Successful Green Projects

- Have a client who is committed to sustainability and willing to take risks.
- Hire a team who is experienced in sustainable design.
- Bring together the entire team during conceptual design.
- Minimize energy consumption first, size PV's second.
- Look for LEED points after the design is completed. *(The building will probably be Gold or Silver.)*

One final thought:

The scientific community has come to a consensus that *Global Warming* is a real phenomenon...

Buildings contribute nearly 50% of the CO_2 generated in the US…

America is one of the leaders in development of efficient building standards and technologies...

Imagine the impact we would have if all of our buildings were

Z Squared.

Think about it.