The Short Road to Net Zero Energy

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Learning Objectives

- Understand the roles of daylighting, efficient lighting, controls, and plug load management in net zero energy design & planning.
- Understand the relationship between load management and the effectiveness of on-site renewable generation.
- Know a definition of net zero energy buildings that is consistent with California's needs and State policies.

Defining "Net Zero"

Responsible Options

- Net Zero Electricity
- Net Zero Conventional Energy Use
- Net Zero Total Energy Use
- Net Zero Carbon Footprint
- Net Zero Electric TOU

Net Zero Options

	Measured Grid Energy Use	Measured Gas/fossil fuels Use	Net Energy of Building Materials and Construction	CO^2 generated by operations
Electricity	✓			
Energy Use	✓	✓		
Total Energy	✓	✓	✓	
Carbon Footprint	✓	✓	✓	✓
Electric TOU	✓*			

Arguments

Net Zero Electricity

- Very relevant
- Easy to measure
- Practical to accomplish
- Not fair when using other sources
- Could be a long way from “net zero”

Arguments

Net Zero Energy Use

- Very relevant
- Easy to measure
- Harder to accomplish
- Fair representation of energy use impact
- Not exactly “net zero”

Arguments

Net Zero Total Energy

- Extremely relevant
- Very hard to measure
- Very hard to accomplish
- Fair representation of energy impact
- Not exactly “net zero”

Arguments

Net Zero Carbon Footprint

- Profoundly relevant
- Nearly impossible to measure
- Probably impossible to accomplish
- Most honest representation of impact
- The real “net zero”

Arguments

Net Zero Electric TOU

* *Accounts for time of use*

- Short term significant relevance
- On peak excess energy counts more than off peak
- Easily measured
- Practical to accomplish
- Encourages off peak use
- A practical measure of current needs
- A net zero that makes a lot of sense

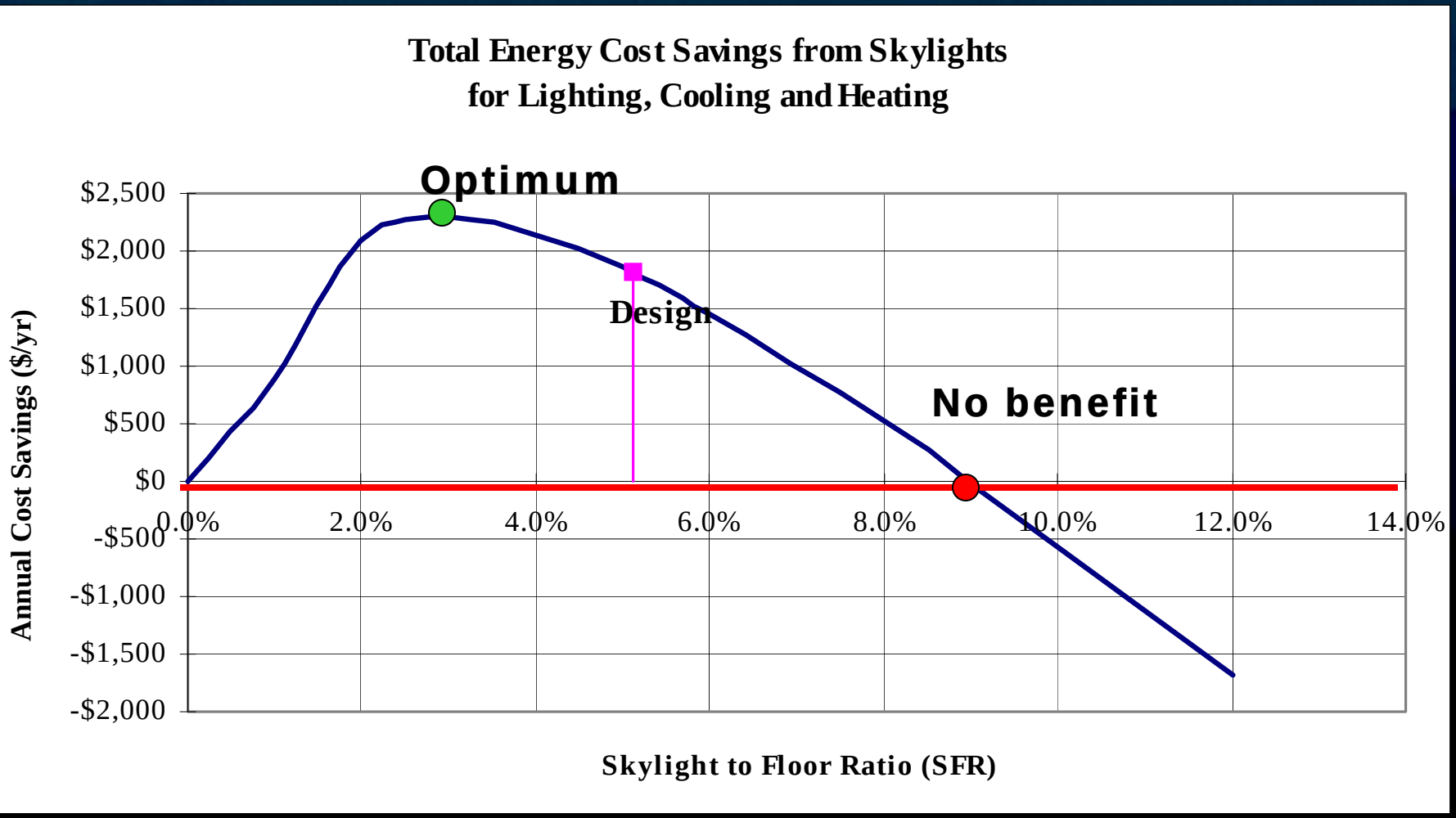
Concept Behind NZ Electric TOU

- Building energy demand profile does not match non-depletable source profile
- Excess thermal energy can be stored but excess electric energy is better off returned to the grid as a "bank"
- Bank "account" is depleted periodically
- Peak users pay a premium
- Peak generators are rewarded

Guiding Principles

1. Negawatts cost less than megawatts
2. Passive beats active any time
3. Start with the low hanging fruit on all trees

Step 1: Employ Daylighting



Savings from Good Daylighting

- Up to 100% of lighting demand
- The cooling associated with lighting demand
- Excessive cooling due to sub-optimal daylighting
- Cooling energy coincident with other peaks

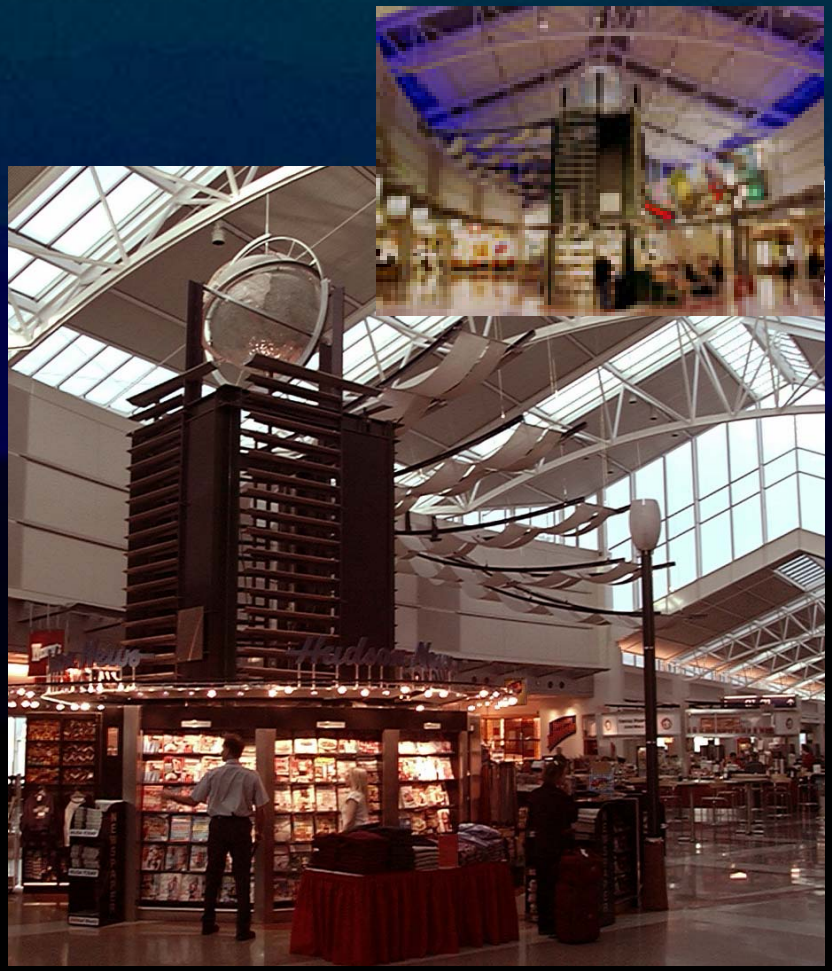
Critical to Good Daylighting

- Proper massing
- Proper orientation
- Proper shading
- Take advantage of topography, landscape and other natural elements

Step 2: Efficient Electric Lighting

- High efficiency lighting equipment
- Smart Lights – ability to control through digital lighting infrastructure
- Natural ambient design technique – in daylighted spaces, avoid trying to produce daytime light levels with electric light
- Low ambient design
- Integrated control that assures daylight harvesting

Technique: Natural Ambient



- Takes advantage of the day-night cycle
- High light levels by day (but not too high)
- Low light levels by night (but not too low)
- Lights OFF by day – let the levels follow nature

Technique: Natural Ambient

Top Technologies

Sources

- Super T8
- T5
- Compact fluorescent
- LED

Controls

- Electronic dimming ballasts
- Digital lighting control infrastructure

Step 3: I.T. Power

2007 oPod Survey of California Offices

• Lighting	1.1 w/sf
• Computers	0.7 w/sf
• Monitors	0.4 w/sf
• Printers and misc	> 0.2 w/sf
TOTAL I.T.	1.3+ w/sf

I. T. Power can be as high as 3-4 w/sf in regular spaces

Simple I.T. Changes

- Use laptops or thin clients
  - Standard office computer 60-120 watts
  - Laptop 15-50 watts
  - Thin client 10-20 watts
- Use LCD screens
- Minimize wall-warts
- Employ IT energy management software

Step 4: Control Other Plug Loads

oPod Survey Plug Loads Discovered

- Portable space heaters (10%) 1500w
- Hot/cold water dispenser 500 w
- Personal refrigerator (2%) 120 w
- Personal fan (5%) 25 w

Step 5: Mechanical and Envelope Solutions

Passive Systems such as

- Passive solar techniques
- White roof
- Better insulation
- Natural ventilation

Active Systems such as

- Hot water collectors
- Heat pumps (ground or water source)
- Dark sky systems
- Storage systems

Step 6: Load Shedding Controls

A system to shed loads to force a better demand profile or simply prevent use at bad times

A system to shed load in response to grid demand and/or time of use costs

Step 7: Add non-depletable source

Ordinary Efficient Building		Super Efficient Building	
• Lights	1.1 w/sf	• Lights	0.2 w/sf
• Computers	1.1 w/sf	• Computers	0.5 w/sf
• HVAC (cooling)	1.0 w/sf	• HVAC (cooling)	.5 w/sf
• Plug load other	.5 w/sf	• Plug load other	.25 w/sf
• Non-process	.5 w/sf	• Non-process	.25 w/sf
DEMAND	4.2 w/sf	DEMAND	1.7 w/sf

A Net Zero Building will have..

Envelope

- North facing triple glazed façade
- Central north facing clerestory skylight
- South facing windows with light shelf
- Skylights throughout

Mechanical

- Water source or ground source heat pump
- Natural ventilation
- Green roof with PV array
- Good insulation

A Net Zero Building will have..

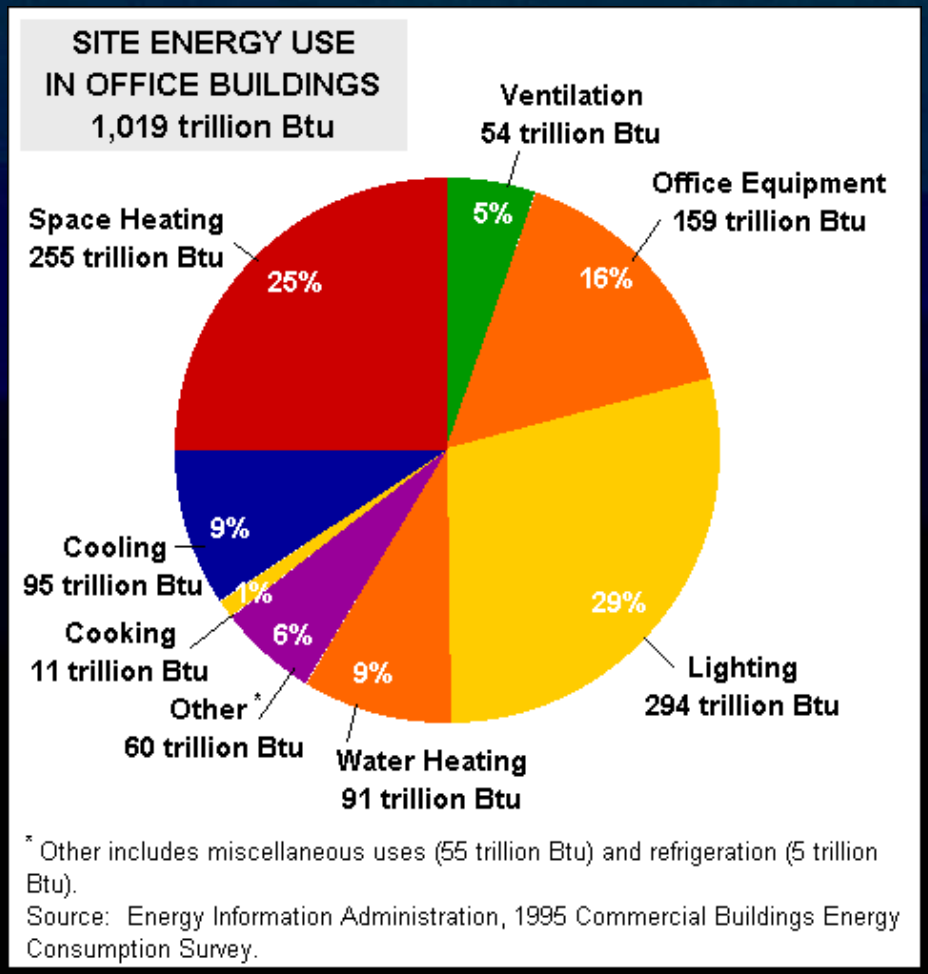
Lighting

- General lighting 0.3 w/sf
- Task lighting 0.45 w/sf
- Digital dimming and controls for all systems
- Daylighting designed for >90% effectiveness

Plug Loads

- Demand response and management controls
- Workstation sensors
- >95% conversion to laptops without desktop monitor
- All LCD monitors on other computers

Example: Office Building Energy Use



Prime Targets for Net Zero
Electricity or Electric TOU

- Lighting
- Lighting related cooling
- Cooling due to bad daylighting
- Office Equipment

Opportunity

- 50% less energy
- 70% less demand

Net Zero Electricity

The Chartwell School, Seaside CA

EHDD Architects, San Francisco

- LEED Platinum
- Practical Costs

Net Zero Electricity

Other Keys to Success

- Totally integrated design team
- Daylighting is part of schematic design
- Owner, architect, engineers and consultants are all part of schematic design
- Early definition of goals
- Early identification of incentives and rules
- Use LEED later not now

Net Zero Buildings - Why Wait for the Future?

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