Lighting: Advances in Technology and Design

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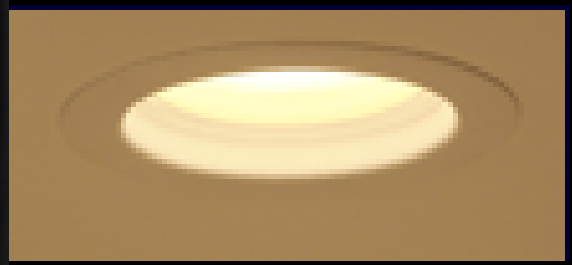
Light Source Developments

1. Ceramic Metal Halide
   - 20 watt
   - 400 watt
2. Fluorescent
   - T5 family
3. Compact fluorescent
   - GU24 base
4. LED
   - Finally……something we can use

Is the LED Downlight any good?

12 watt LED 6” downlight versus

a. Incandescent 65R30
b. Halogen 45PAR/IR/FL40
c. True CF 13 watt good downlight
d. Screw in CF 17 watt R40



Ratings

Lumen Output

1. True CF (900 L)
2. Halogen (800 L)
3. Incandescent (755 L)
4. Screw in CF (725 L)
5. LED (600 L)

Apparent Light

1. LED
2. Screw in CF (after warm-up)
3. Incandescent
4. True CF
5. Halogen

Ratings

Power

1. LED 12w
2. Screw in CF 15w
3. True CF 16w
4. Halogen 45w
5. Incandescent 65w

Dimming

1. Halogen
2. Incandescent
3. LED
4. True CF*
5. Screw in CF*

* Dimming ballast

Ratings

Glare Control

1. Halogen
2. True CF
3. Incandescent
4. Screw in CF
5. LED

Life (hours)

1. LED** (>20K)
2. True CF (10K)
3. Screw in CF (8K)
4. Halogen (4K)
5. Incandescent (2K)

**unproven

Ratings

Color

1. Halogen
2. Incandescent
3. LED
4. True CF
5. Screw in CF

Cost (downlight)

1. Incandescent $20
2. Halogen $25
3. Dimmable Screw in CF $35
4. Dimmable LED $75-100?
5. Dimmable True CF $100

A promising future 4” product

- Adds glare control
- Improves appearance
- 600 lumens 12 watts 2700K 92 CRI
- The “real” breakthrough?

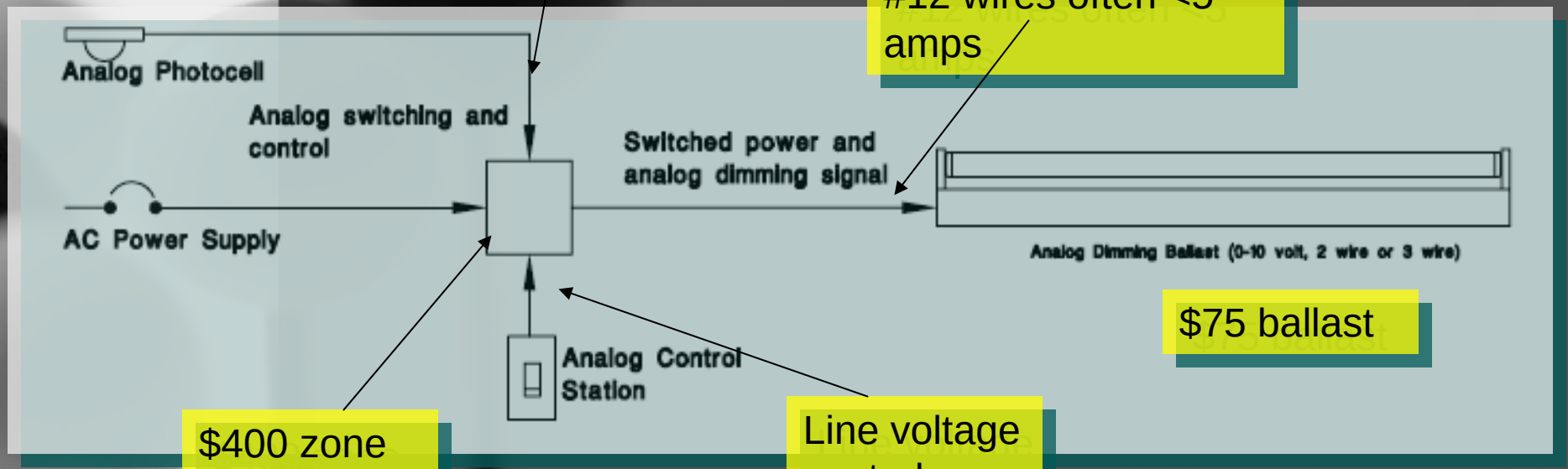
Controls and Ballasts

- Forget everything else. Digital is ready for prime time.
- Barriers
  - Lack of contractor familiarity
  - Perceived high cost of products

Traditional Wiring

Point to point low voltage wiring

One zone circuit with #12 wires often <5 amps



$75 ballast

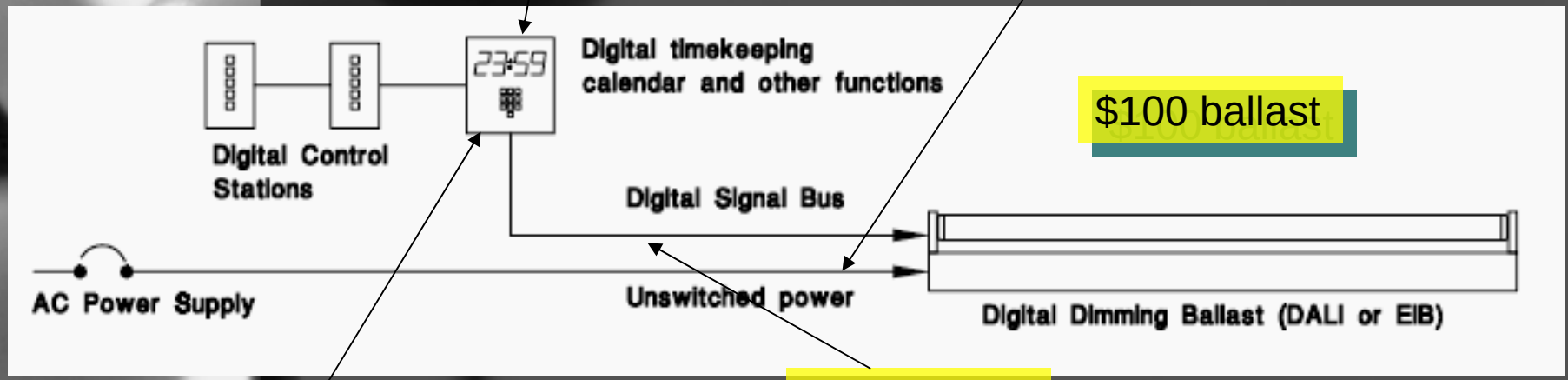
$400 zone controller

Line voltage controls includes #12 wires and conduit in wall and ceiling

Digital Wiring

Plug in low voltage wiring and stations – no conduit needed

Load any circuit up to 16 amps



$100 ballast

One master controller per building

Low voltage controls 18-22 ga.wire plenum rated

Digital has a break even point

Analog

- Minimum code complying $1.50/sf
- Full features, $2.50 to 3.00/sf

Digital

- Full features $2.25/sf

Real Benefits of Digital

- Over 70% less copper
- Over 50% less steel
- Up tp 50% less labor
- More energy saving capabilities
  - Demand response
  - Single sensor daylighting
  - Tuning

Codes and Standards

- Energy Code advancements
  - 90.1 and IECC
  - Title 24
  - Regional and Local
- LEED
- Epact 2005
- Incentives

Take the Triple Dip

- Achieve 5 LEED energy points (>25% better than 90.1-2004)
- Get a Federal Deduction (>40% better than 90.1-2001)
- Get a local rebate


Design – Net
Zero NOW

Defining “Net Zero”

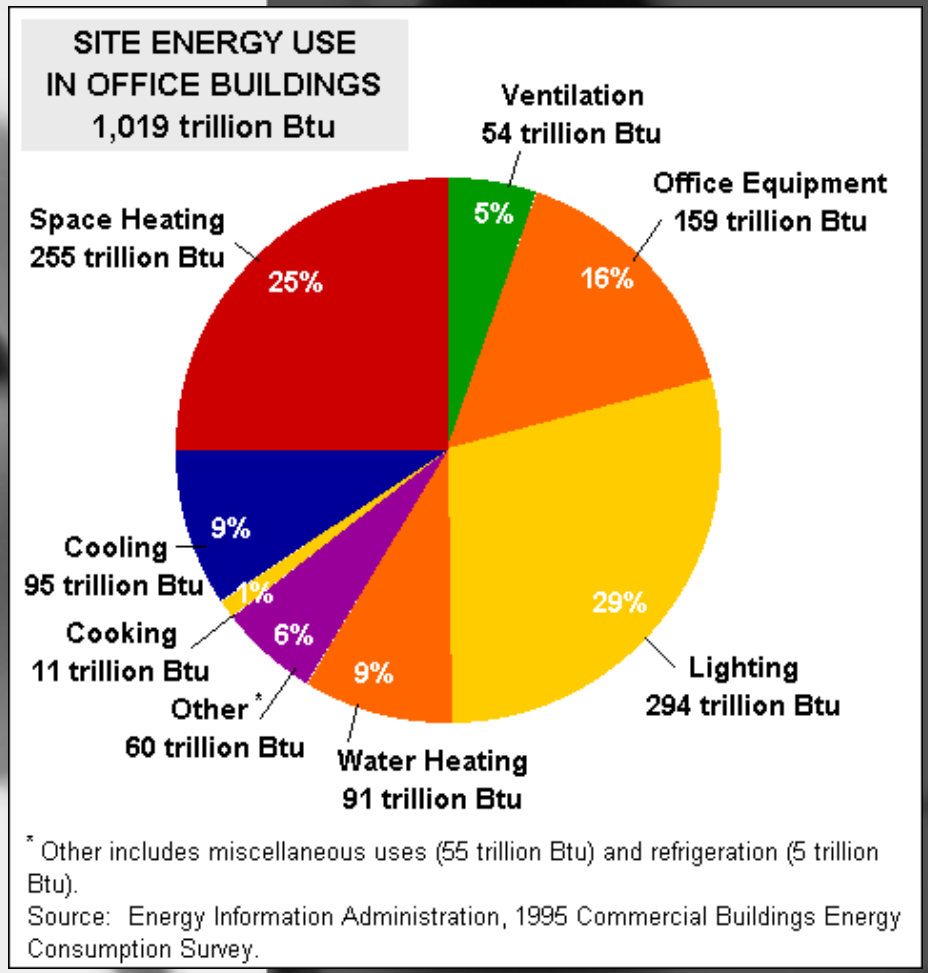
- Net Zero Electricity
- Net Zero Energy
- Net Zero Carbon Footprint
- Off Grid

Net Zero Electricity

The Chartwell School, Seaside CA

- LEED Platinum
- Practical Costs

Office Building Energy Use



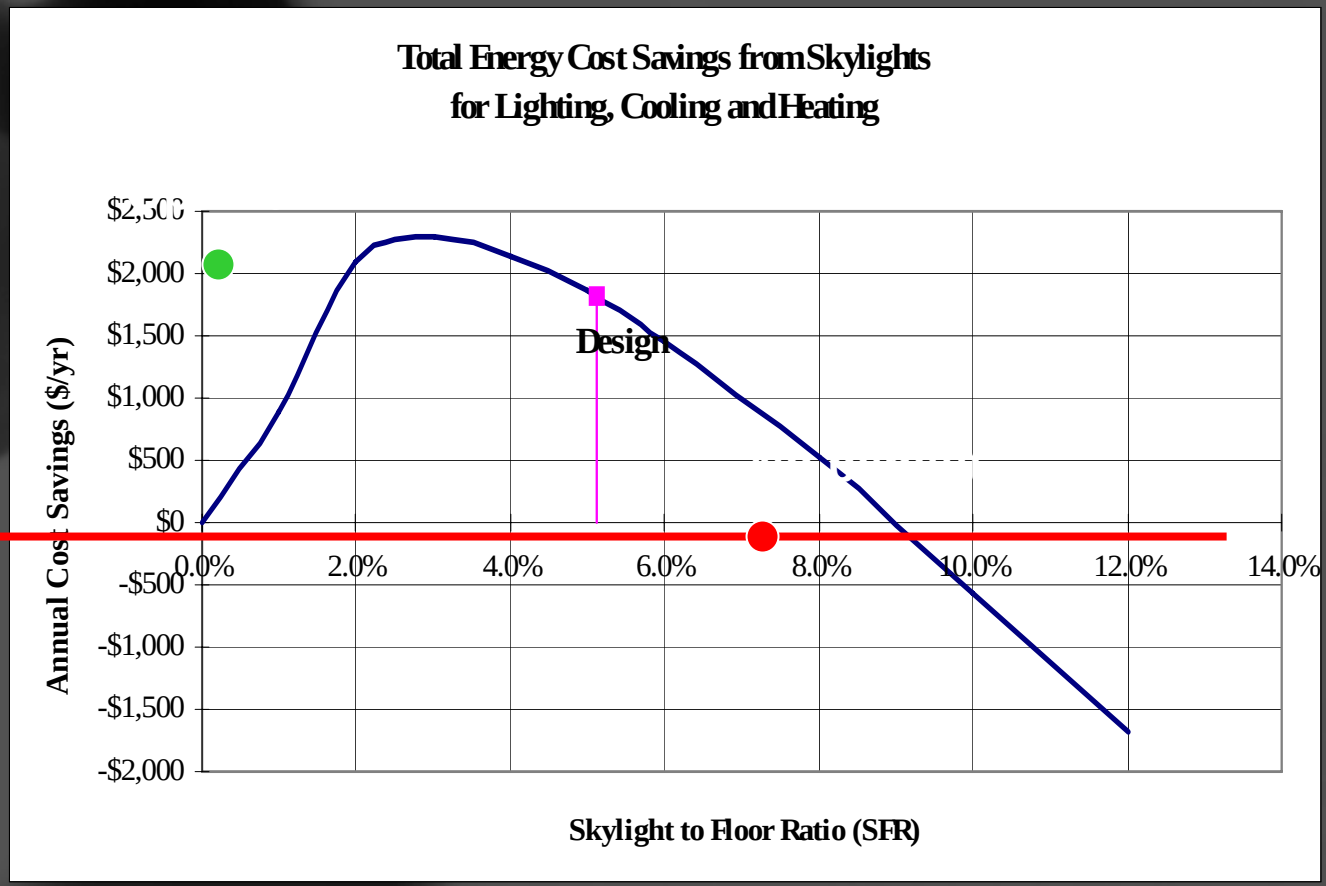
Prime Targets for Net Zero Electricity

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

Old Energy Proverb

Negawatts **cost less than Megawatts**

Step 1: Significantly Better 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

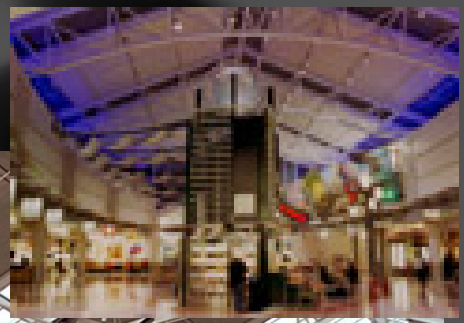
Critical to Good Daylighting

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

Step 2: Better 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

New Technique: Natural Ambient

Top Technologies

- Super T8
- T5
- Compact fluorescent
- LED

Step 3: Drop IT 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 Varies, at least 0.2 w/sf

Simple IT 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 Plug Loads

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

Same Old Building

- Lights 1.1 w/sf
- Computers 1.1 w/sf
- HVAC (cooling) 1.0 w/sf
- Plug load other .5 w/sf
- Non-process .5 w/sf

DEMAND 4.2 w/sf

Super Efficient Building

- Lights 0.2 w/sf
- Computers 0.5 w/sf
- HVAC (cooling) .5 w/sf
- Plug load other .25 w/sf
- Non-process .25 w/sf

DEMAND 1.7 w/sf

A Net Zero Building*

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*

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

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

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