



# MOVING from A to Z(ero) NET

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# **ZERO NET ENERGY**

**Zero Net Energy (ZNE) buildings have a net energy consumption of zero over a typical year.**

# WHAT IS **ZERO NET** ENERGY?

## ***ZERO NET ENERGY (ZNE)***

*Building  
Energy  
Use*

*Distributed Renewable  
Energy Generation*



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**Btu**

**REDUCE**



**PRODUCE**

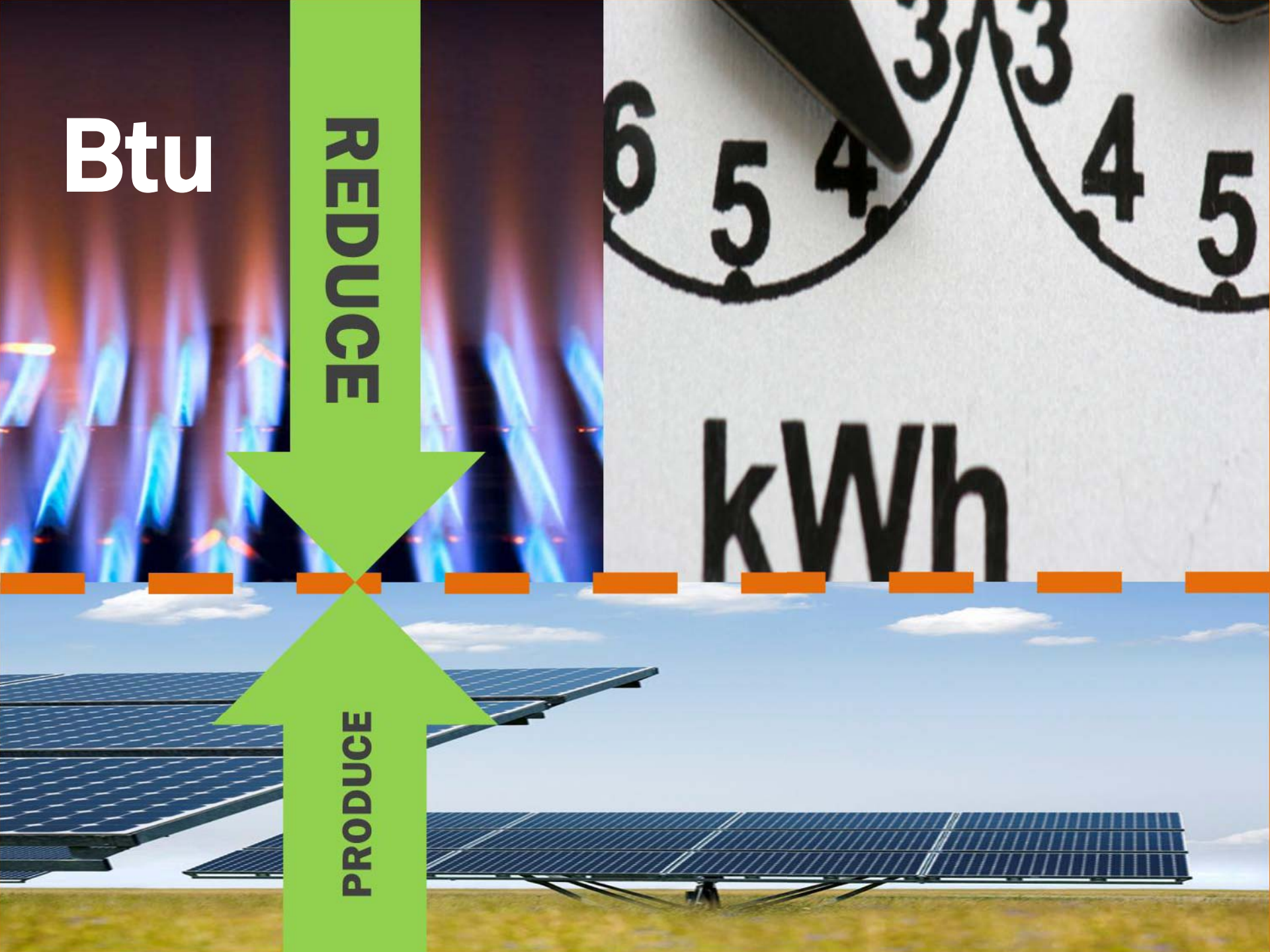


**Btu**

**REDUCE**

**kWh**

**PRODUCE**





**Btu**

**REDUCE**



**kWh**

**PRODUCE**



# STRATEGIC PLAN for ZNE BUILDING



## GOALS FOR COMMERCIAL BUILDINGS:

- 100% New Commercial Buildings are ZNE by 2030
- 50% of Existing Buildings are ZNE by 2030

## ED FACILITIES REPRESENT A LARGE % OF COMMERCIAL BLDGS:

- 1050 K-12 School Districts = 10,000 Campuses
- 72 Community College Districts = 112 Campuses



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# Btu

REDUCE

kWh

- Natural Day-Lighting
- High-Efficiency Lighting
- High Performance Envelopes with Increased Insulation
- Well Insulated Glazing

## **ENERGY EFFICIENT SYSTEMS:** REDUCE ENERGY

- Ground Source Heat Pump
- Solar Thermal



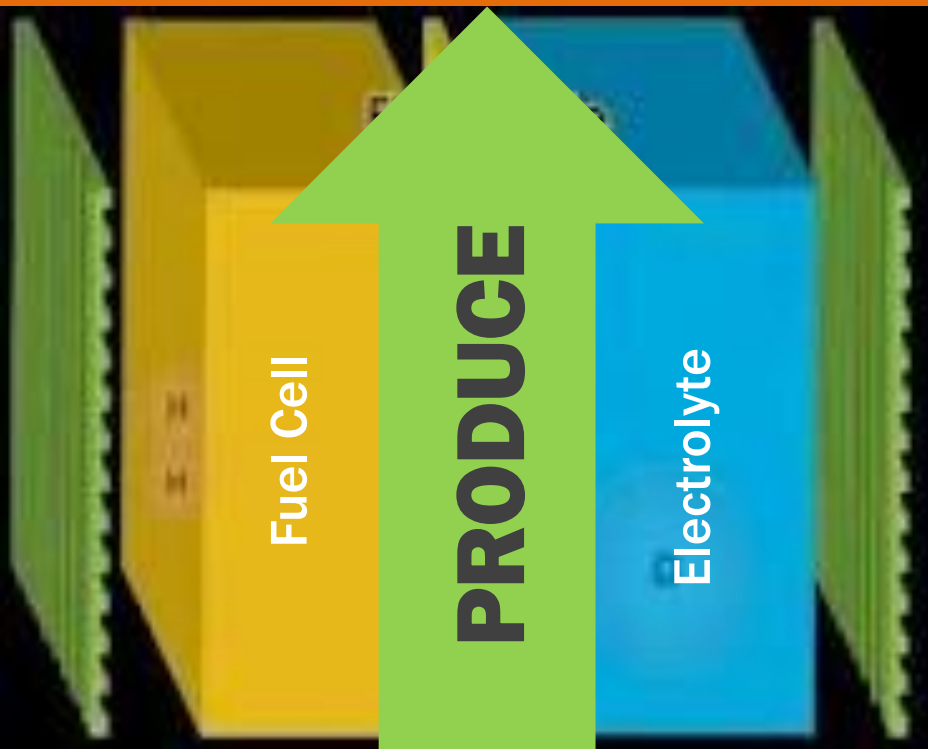
# RENEWABLES: PRODUCE ELECTRICITY

- Photovoltaics (DSA Interpretation of Regs: IR 16-8)
- Wind (DSA Interpretation of Regs: IR A-29)
- Micro-Hydro



# ALTERNATIVE METHODS

- Biomass (Conversion of Methane)
- Biogas (Cow Power)
- BioDigester (Conversion of Garbage)
- Fuel Cells (Water Vapor By-Product)
- Co-Generation Systems (Heat By-Product)





# **ZERO NET ENERGY**

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# ZNE DEFINITIONS

ZNE Definition	Includes	Description
Site Energy	Electricity + Natural Gas	Energy provided by on-site renewable energy sources is equal to the amount of energy used by the building.
Source Energy	Electricity + Natural Gas	Energy provided by on-site renewables equal to the energy used by the building including the fuel & energy used to generate the energy & transport on grid.
Societal Energy <i>Societal is the Time Dependent Value (TDV)</i>	Electricity + Natural Gas	Energy consumed by the building over the course of a typical year is less than or equal to the societal value of the renewable energy generated on-site.
Grid Neutral	Electric Only	A site that produces as much electricity as it uses in a year.





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## **GRID NEUTRAL:**

A site that produces  
as much electricity  
as it uses in a year.

# DSA GRID NEUTRAL GUIDEBOOK:

1. COMPREHENSIVE PLANNING
2. ENERGY MEASUREMENT
3. ENERGY EFFICIENT DESIGN
4. ENERGY GENERATING TECHNOLOGIES
5. MAINTENANCE & OPERATIONS
6. INNOVATIVE FUNDING

Find the guidebook online at:

[www.dsa.dgs.ca.gov/OtherProg/gridneutral.htm](http://www.dsa.dgs.ca.gov/OtherProg/gridneutral.htm)



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# COMPREHENSIVE PLANNING

- **ASSEMBLING THE TEAM**
  - Sponsors, Beneficiaries, Implementers and Other Plan Review Agencies
  - Use the Integrated Project Delivery (IPD) Method
- **DEVELOP ELECTRICAL POWER MASTER PLAN**
- **DEVELOP DISTRICT WIDE PROGRAM**



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# **ENERGY** MEASUREMENT

## **BENCHMARKING**

- Energy Star Portfolio Manager

## **UTILITY BILL ANALYSIS**

- Utility Companies |

## **MONITORING, MAINTENANCE REPORTING**

- Energy Management

## **PROGRAM PERSISTENCE**



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# ENERGY EFFICIENT DESIGN: TOP 5

## 1. PROGRAM & PLANNING

- Integrated Design Approach

## 2. SITE

- Building Orientation, Shade buildings

## 3. BUILDING

- Building Envelop, Day-Lighting, Cool Roofs

## 4. FURNISHINGS, FIXTURES, & EQUIPMENT

- Electrical & Plug Loads, Lighting Retrofits

## 5. SYSTEMS

- Automatic Controls, Commissioning





# ENERGY GENERATING TECHNOLOGIES

## PRODUCTION

- **Photovoltaic**
- **Wind**

## ENERGY EFFICIENCY

- **Solar Thermal: Heating Water**
  - Meets 50 - 75% of Water Heating Needs
- **Geoexchange Systems: Heating & Cooling**
  - Reduces Energy Costs by 20 - 60%
  - Reduces Maintenance Costs by 20 - 50%
  - Less Space Required for Equipment



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# **MAINTENANCE & OPERATIONS**

## **FACILITY EVALUATION**

- Site, Building & Equipment

## **ENERGY EVALUATION**

- How much and where is energy being used?
- Retrofitting Opportunities
- Commissioning & Recommissioning

## **INVESTMENT GRADE ENERGY AUDITS**

## **TRAINING**

- Students, Staff, Teachers & Facility Managers



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**Free Money | Borrow-to-Buy | Self Funding Options**

**INNOVATIVE FUNDING**



# **FOUR STEPS** to **GRID** NEUTRAL:

<b>1</b>	<b>NEW SCHOOL : Set Energy Performance Goal</b> <b>EXISTING SCHOOL : Measure Current Use, Set Goal</b>
<b>2</b>	<b>Implement &amp; Maintain Appropriate Energy Efficiency &amp; Conservation Measures to Lower Electricity Use</b>
<b>3</b>	<b>Install Solar or Wind Systems to Create Electricity to Meet Remaining Needs</b>
<b>4</b>	<b>Maintain Energy Systems</b> <b>Monitor Electricity Consumption &amp; Production</b>



$$\text{GRID NEUTRAL RATIO} = \frac{\text{PRODUCTION}}{\text{CONSUMPTION}}$$

## GRID NEUTRAL IN THE 2010 CALGreen CODE: VOLUNTARY MEASURE

- **NEW BUILDINGS:** Use proposed annual electrical energy budget (kwh) per California Energy Code adding estimated energy consumption of plug loads.
- **EXISTING BUILDINGS:** Need to have data for a year while producing on-site electricity.



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**THE MORE CONSUMPTION GOES DOWN WITH  
ENERGY CONSERVATION, THE LESS ELECTRICITY  
NEEDS TO BE PRODUCED TO ATTAIN GRID NEUTRAL.**



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# **PALO VERDE COMMUNITY COLLEGE**

## **DISTRICT: Grid Neutral Campus**



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- Blythe, California
- August 2009
- No Capital Outlay



# **GRID NEUTRAL CAMPUS: Palo Verde Community College**

- **Objective: Grid Neutral;  
Lower Energy Costs**
- **Installation: Ground  
Mounted System  
Shade Structure Mounted**
- **1.2 Mega Watt**



**Recent Energy Conservation Measures are  
Contributing to Grid Positive Results**



# **YUBA CITY UNIFIED SCHOOL DISTRICT: Star Campus**



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# **YUBA CITY USD: Riverbend Elementary School**

- 2010 Grid Neutral Award for Distinguished Campus
- 93 Energy Star Rating



- Objective: Model School Campus
- Installation: New Construction Roof Mounted PVs
- Currently 40% Grid Neutral



**YUBA CITY USD**



# **RIM OF THE WORLD UNIFIED SCHOOL DISTRICT: Energy Farm Project**



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# **SOLAR & WIND: Rim of the World High School**

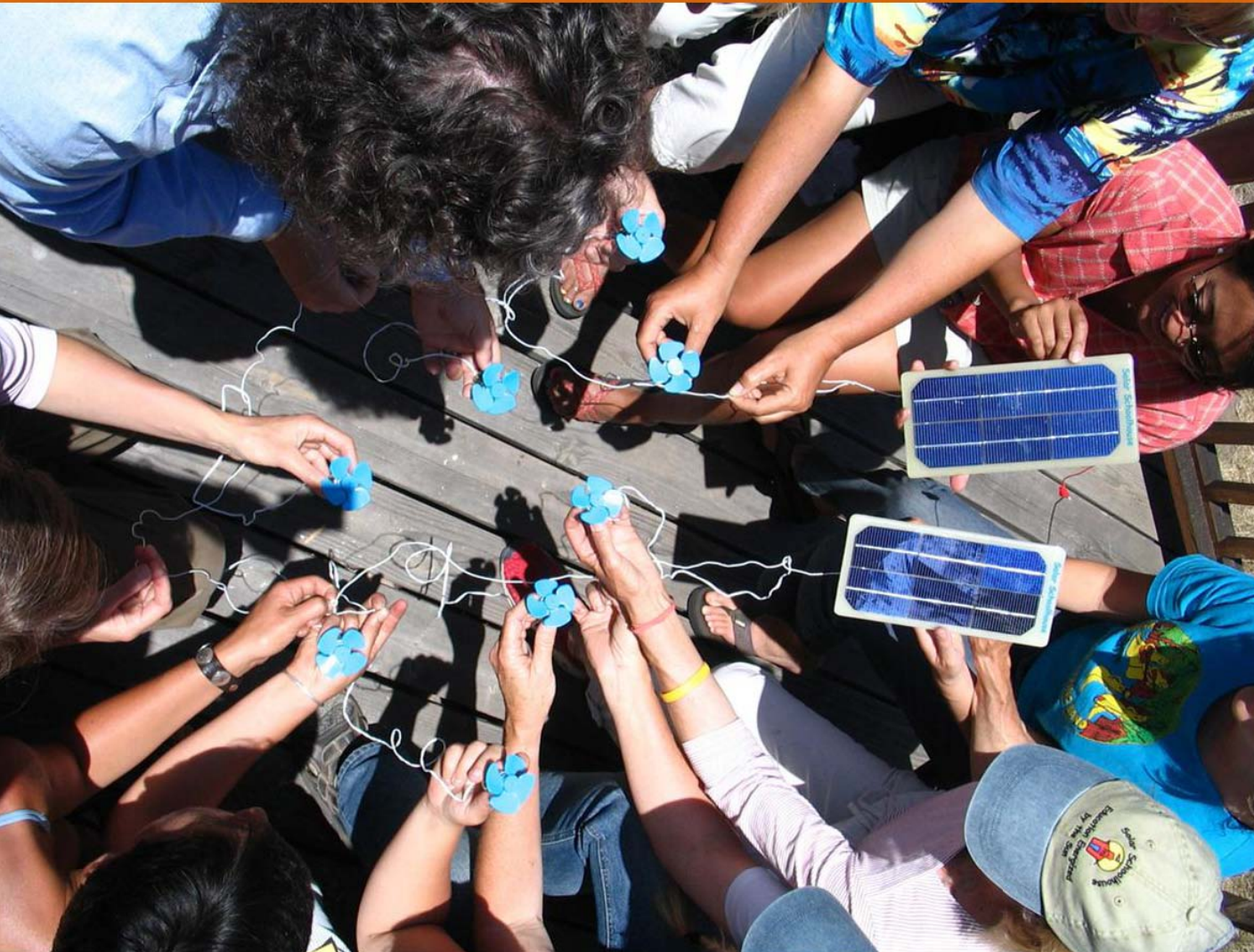


Photo Courtesy of  
Urban Green Energy



- **Objective: Energy Curriculum Science Courses**
- **Installation: 4 Wind Turbines - 100 Watts**  
**8 PV panels ground mounted – 220 Watts**  
**Fully Fenced, Accessible Teaching Station**
- **Averages 500 Kwh per month**

# SCIENCE CURRICULUM: Teaching Energy Concepts



- Measuring Energy Output & Wind Speed
- Career Paths to Green Energy Industry



# **BISHOP UNIFIED SCHOOL DISTRICT:**

## **Energy Conservation & Solar**



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# **SMALL SCHOOL DISTRICT:**

## **Two Elementary Schools**

- **Objective:** Generate Savings to Maintain Programs
- **Installation:** Roof Mounted
- **300 Kilowatts for 2 campuses**



# ENERGY EFFICIENCY PROGRAM:

## Creating Green Champions Out of Students & Staff

- Annual Energy Campaign Slogans

*“Let’s Not Be Power Hungry”*

*“We’ve Gone Green, So Let’s Get Lean & Mean”*

- Manual Thermostats Shut Down by Custodial Staff
- Custodial Staff Reporting on Energy Issues
- **RESULTS:** 17% Drop in Utility Bills in a Year!



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# **BUTTE-GLEN COMMUNITY COLLEGE DISTRICT : Grid Positive Campus**



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# BUTTE COMMUNITY COLLEGE

• 2009 National Campus Sustainability Leadership Award





# **GRID POSITIVE** by 2012

- **Objective: Grid Positive by 2012;  
Carbon Neutral by 2015**
- **Installation: Ground & Roof Mounted  
on Walkway Structures**
  - **6.5 Megawatts**



# **ZNE ACTIVITIES**

## **RESEARCH BY THE INVESTOR OWNED UTILITIES:**

- **ZNE Technical Potential Study**
- **Road to ZNE Study**

## **ZNE DEMONSTRATION BUILDINGS:**

- **SDG & E: ZNE Projects, SCE Sustainable Communities**
- **PG & E: ZNE Pilot Program**
- **DGS State Buildings per Executive Order B-18-12**
- **Five ZNE Buildings in CA; 18 in Nation**



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**THE MORE CONSUMPTION GOES DOWN WITH  
ENERGY CONSERVATION, THE LESS ELECTRICITY  
NEEDS TO BE PRODUCED TO ATTAIN GRID NEUTRAL**

... and **Zero NET** ENERGY.



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# SUSTAINABLE MODERNIZATION

Strategies for Building Systems and Envelope

Lisa Gelfand – Gelfand Partners Architects

**BEFORE**

© Lisa Gelfand, and Chris Duncan, Sustainable Renovation, Strategies for Commercial Building Systems and Envelope, 2012, this material is reproduced with permission of John Wiley & Sons, Inc.



# SUSTAINABLE MODERNIZATION

Strategies for Building Systems and Envelope

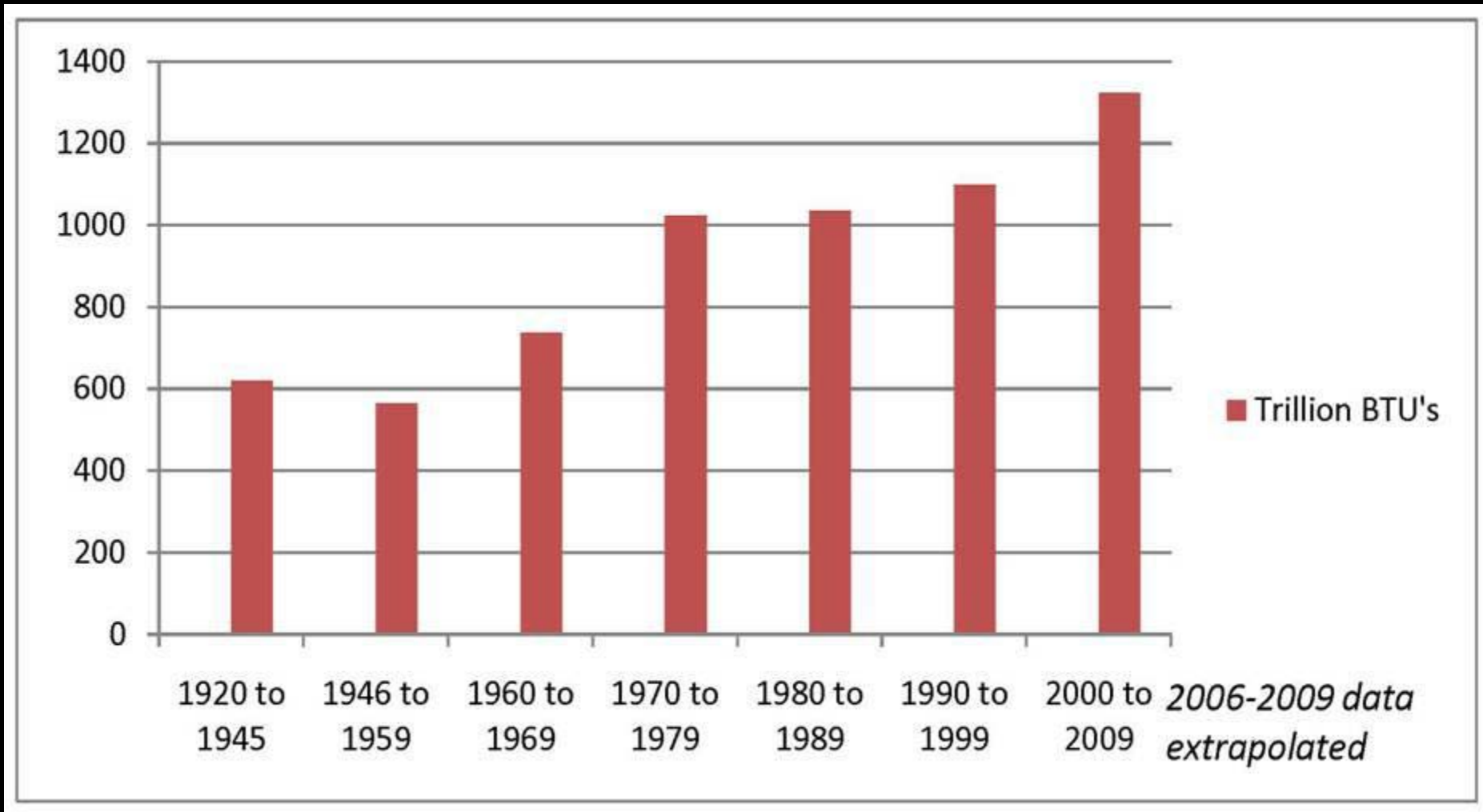
Lisa Gelfand – Gelfand Partners Architects





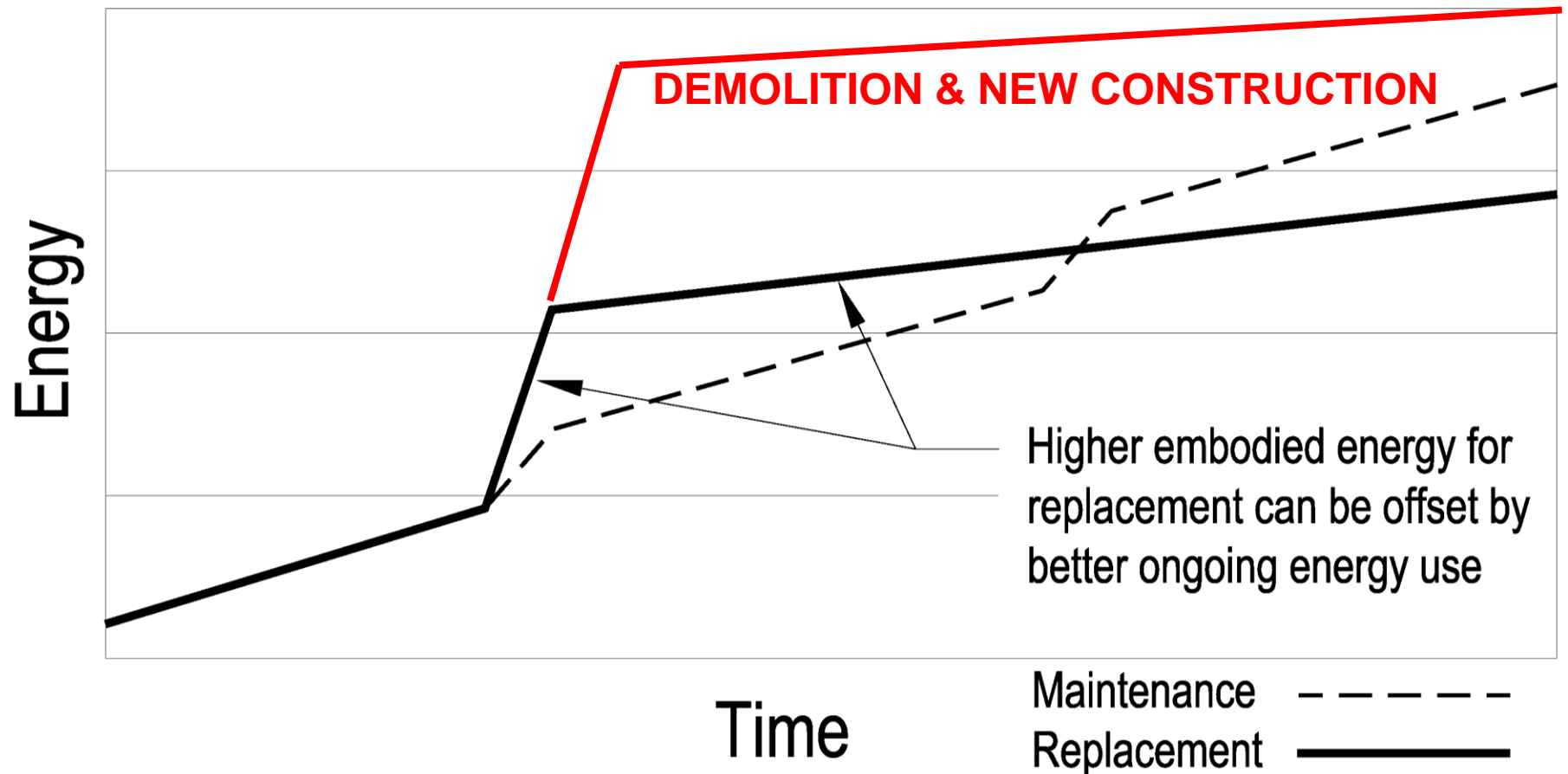
# ENERGY USE BY ERA

More recent buildings use more energy than older buildings.

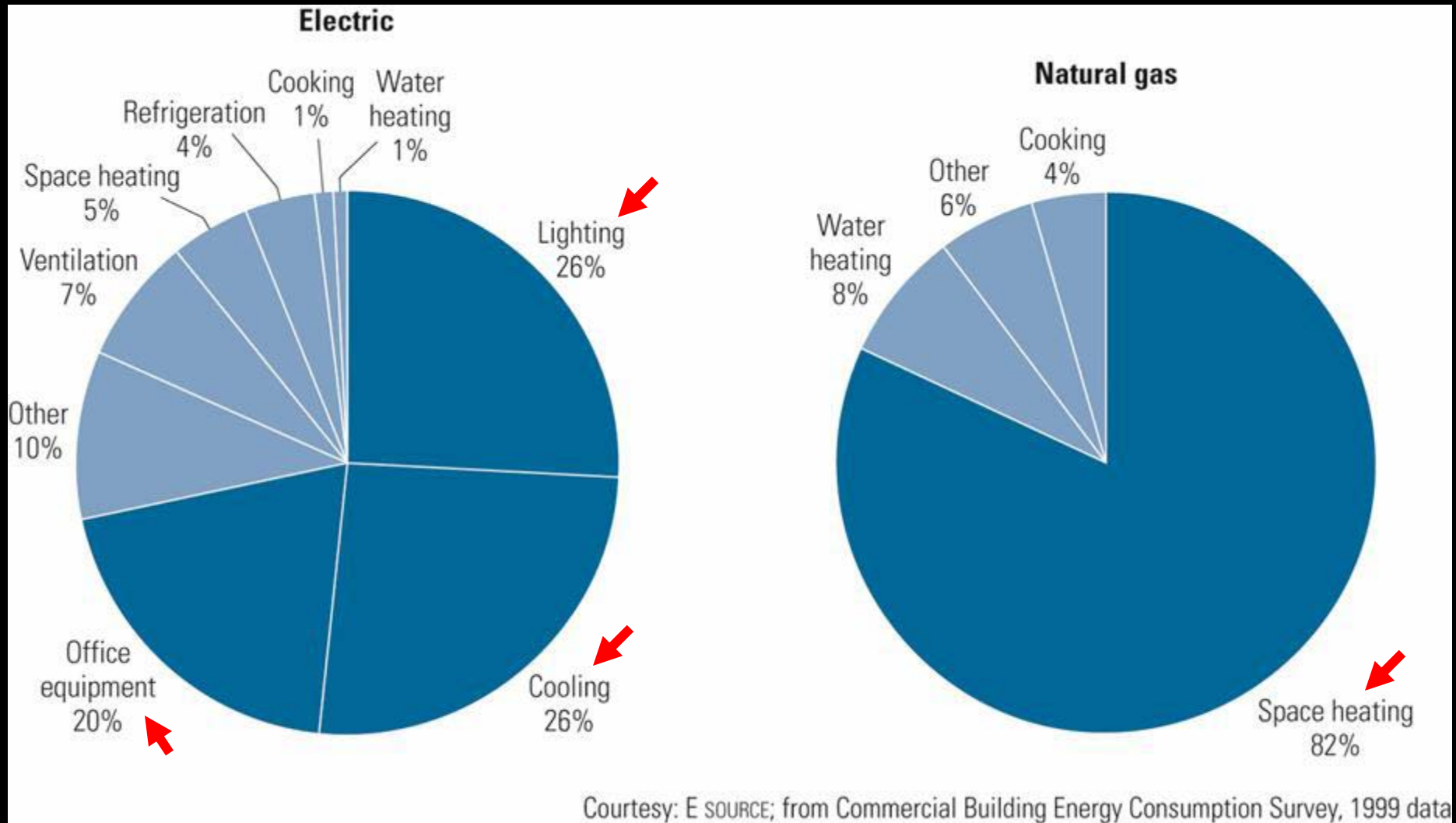


# EMBODIED ENERGY

## Maintenance vs Replacement



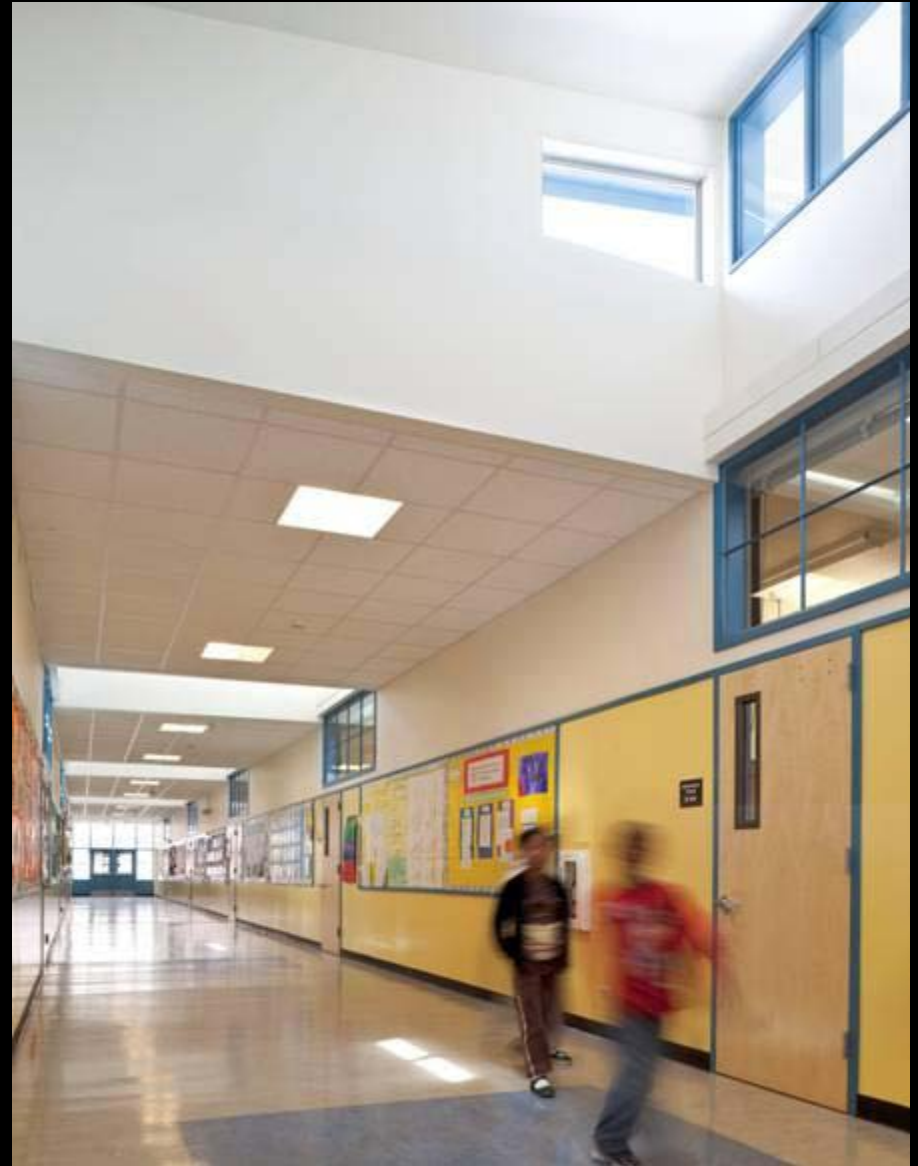
# ENERGY USE





# STRATEGIES

- Immediate Benefits
- Phased Benefits
- Transformation



# IMMEDIATE BENEFITS

## Low & No Cost Improvements

- Behavior Modification
- Retro-commissioning
- Weatherization
- Lighting Upgrades (lamps)
- Water Heating Upgrade (insulation, controls)
- Other Equipment Upgrades



# IMMEDIATE BENEFITS

## Low & No Cost Improvements

- Behavior Modification 4.3%
- Retro-commissioning 3.7%
- Weatherization 3.2%
- Lighting Upgrades 8.8%
- Water Heating 2.9%
- Other Equipment 3.6%

**27% TOTAL**





# BEHAVIOR MODIFICATIONS



# WEATHERIZATION



- Seal Around Windows & Doors
- Add Insulation
- Blower Door Test

# LIGHTING UPGRADES



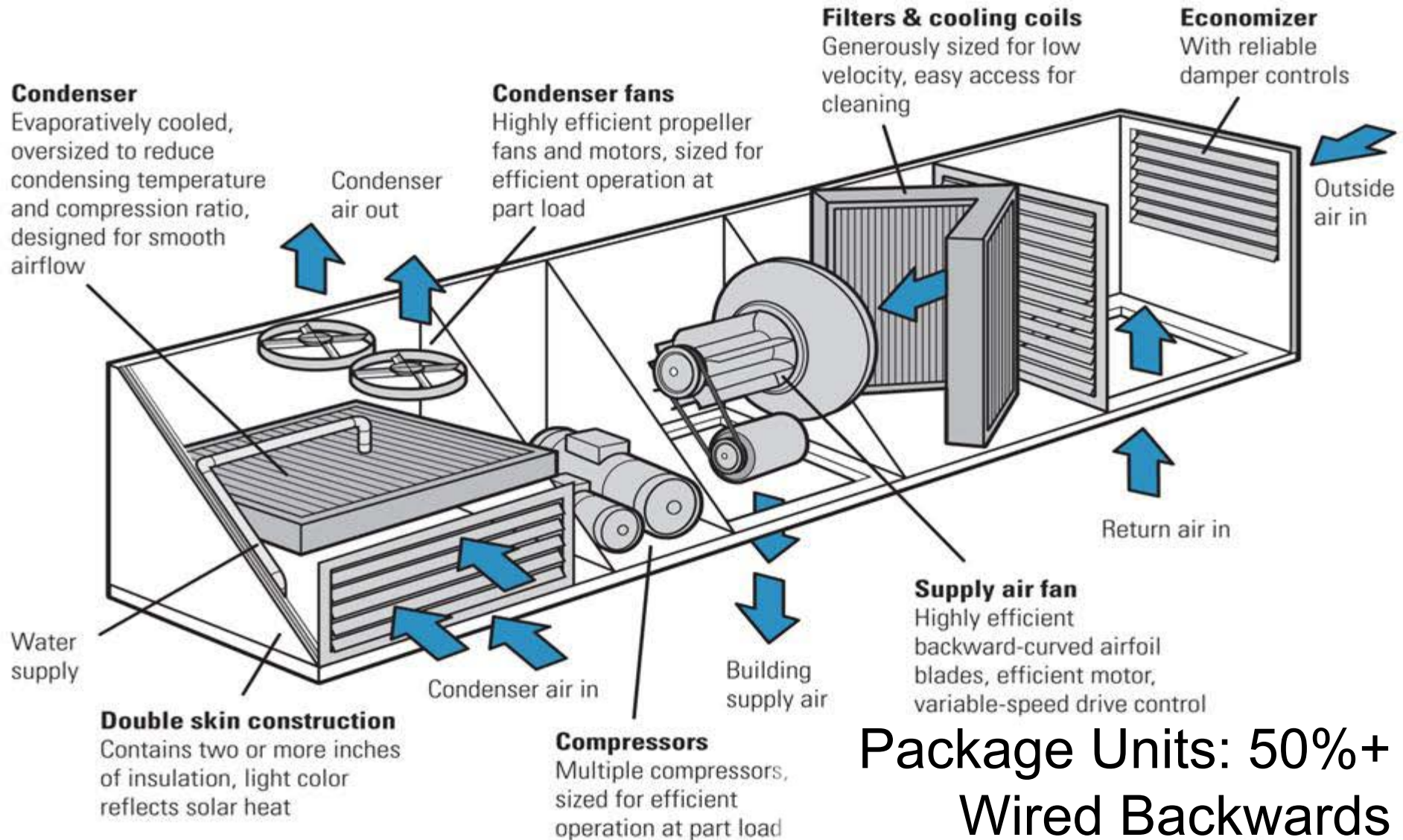
Relamping & Ballasts  
Fixture Replacement



# WATER HEATING UPGRADES



# OTHER EQUIPMENT UPGRADES



Package Units: 50%+  
Wired Backwards

Courtesy: E SOURCE

# PHASED IMPROVEMENTS

## Moderate Cost Improvements

- Upgrade Envelope
- Upgrade Equipment
- Reduce Plug Loads
- Utilize Direct Solar





# PHASED IMPROVEMENTS

## Moderate Cost Improvements

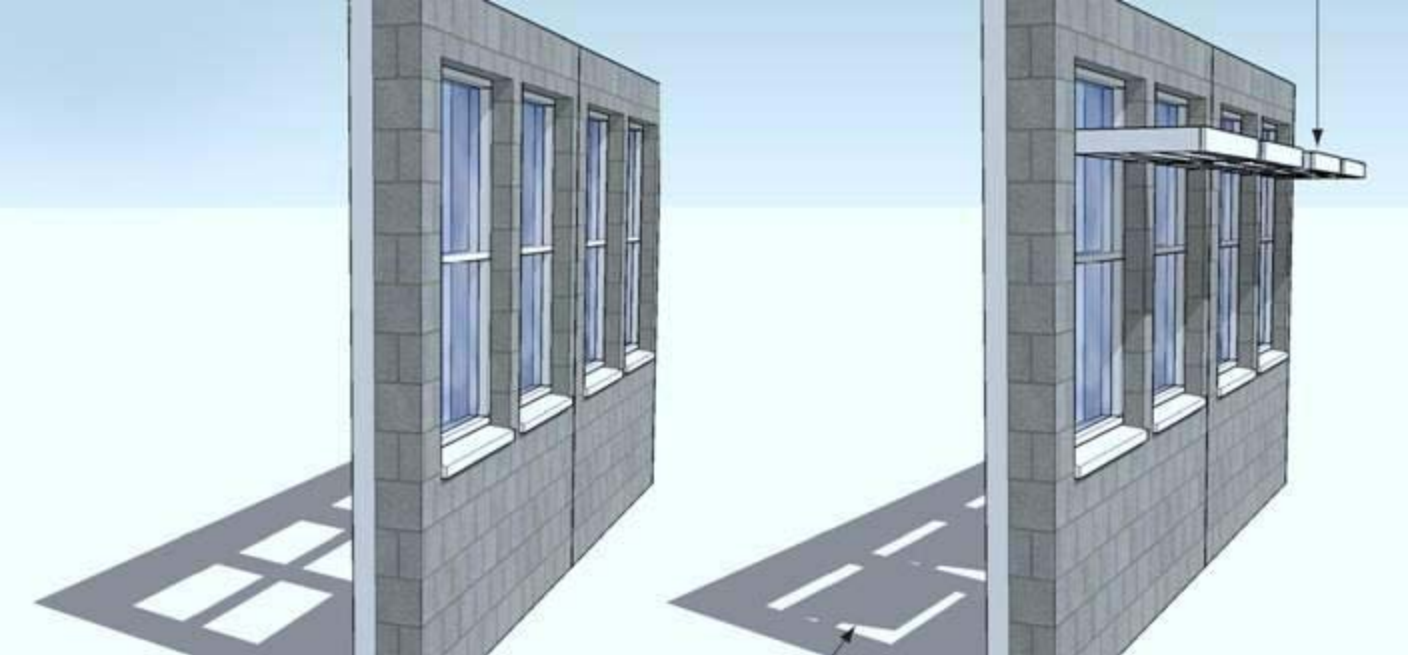
- Upgrade Envelope **7.7%** (ENVELOPE)
- Upgrade Equipment **4.1%** (ALL SYSTEMS)
- Reduce Plug Loads **2.4%** (ELECTRONICS)
- Direct Solar **2.7%** (HEATING)



# ENVELOPE UPGRADES

Replace Glazing Shade Windows





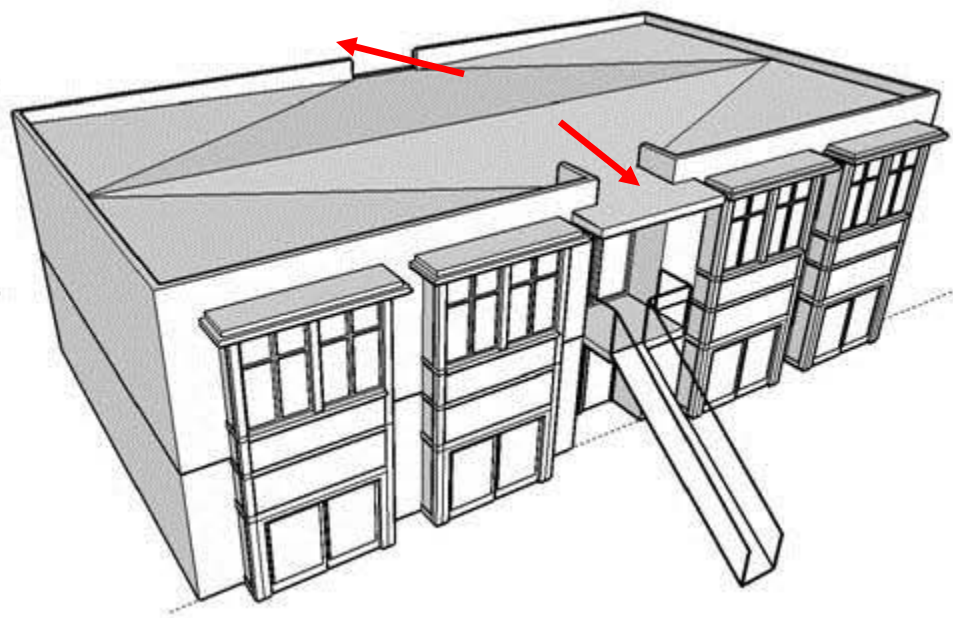
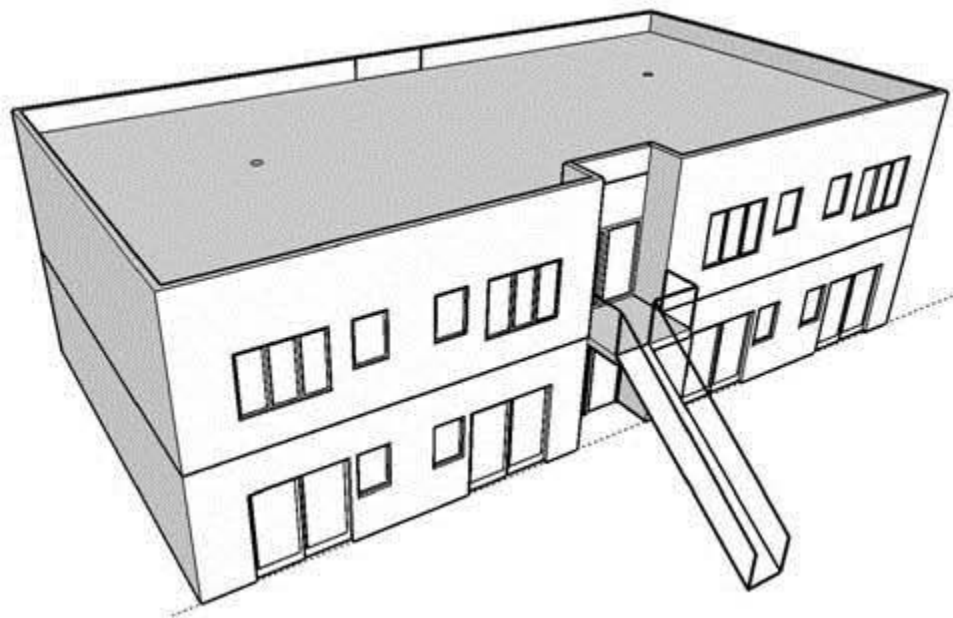
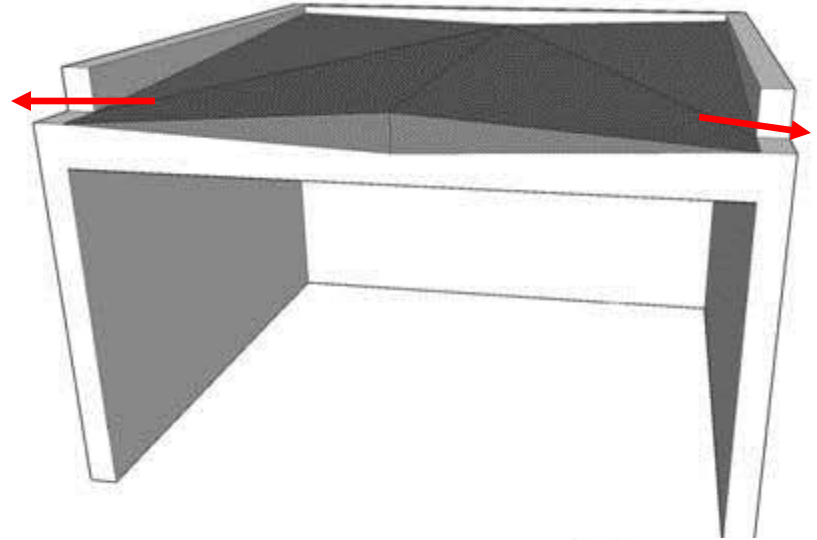
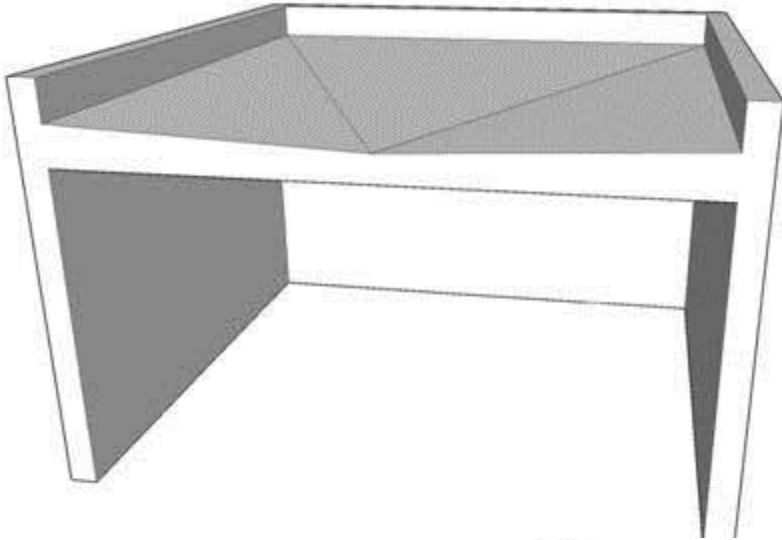
**Replace  
Glazing  
Shade  
Windows**





# ENVELOPE UPGRADES

Flat Roofs: Add insulation Provide Slope for Drainage



# EQUIPMENT UPGRADES

## Steam to Hydronics





# **DIRECT SOLAR**

## **Clerestories with Daylight Sensors**





# TRANSFORMATION

## Comprehensive Improvements

- Major Renovation
- Upgrade Equipment
- Plug Loads
- Solar Thermal & Photovoltaic



# TRANSFORMATION

## Comprehensive Improvements

- Major Renovation 7.6% (ALL SYSTEMS)
- Upgrade Equipment 6.9% (ALL SYSTEMS)
- Plug Loads 5.2% (ELECTRONICS)
- Solar 1.7% (ELECTRICAL)

= Additional 21% TOTAL



# TREES ATLANTA

Atlanta, Georgia

Smith Dalia Architects 2008



**Geothermal + Solar Thermal**  
**35% Energy savings**  
**7,500 Gallon cistern**







**7,500 Gallon cistern  
for Irrigation & Flushing**

**Daylighting & Efficient  
Fixtures & Controls**



# Lavin-Bernick Center for University Life

New Orleans, LA VJAA 2007



Zoned Passive Cooling  
Perimeter = 42% Savings





- **Variable Shading**
- **Passive Cooling**





# TOP STRATEGIES

## Comprehensive Improvement

- Lighting Upgrade 8 - 20%
- Envelope Improvement 7 - 40%
- Upgrade Equipment 5 - 20%

**20 - 80%**



# TOP STRATEGIES

- Lighting Upgrade
  - Relamping / Ballasts
  - New Fixtures & Controls
  - Daylight Harvesting
- Envelope Improvement
  - Weatherization
  - Insulation / Cool Roof
  - Reglazing / Daylighting
- Upgrade Equipment
  - Steam to Hydronic Conversion
  - High Efficiency Package Units
  - EMS/BMS Controls





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# **INNOVATIVE FUNDING UPDATE**

Free Money | Borrow-to-Buy | Self Funding Options



# The **POWER** of **ZERO**



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