

# NET-ZERO ENERGY

## Schools that Make the Grade

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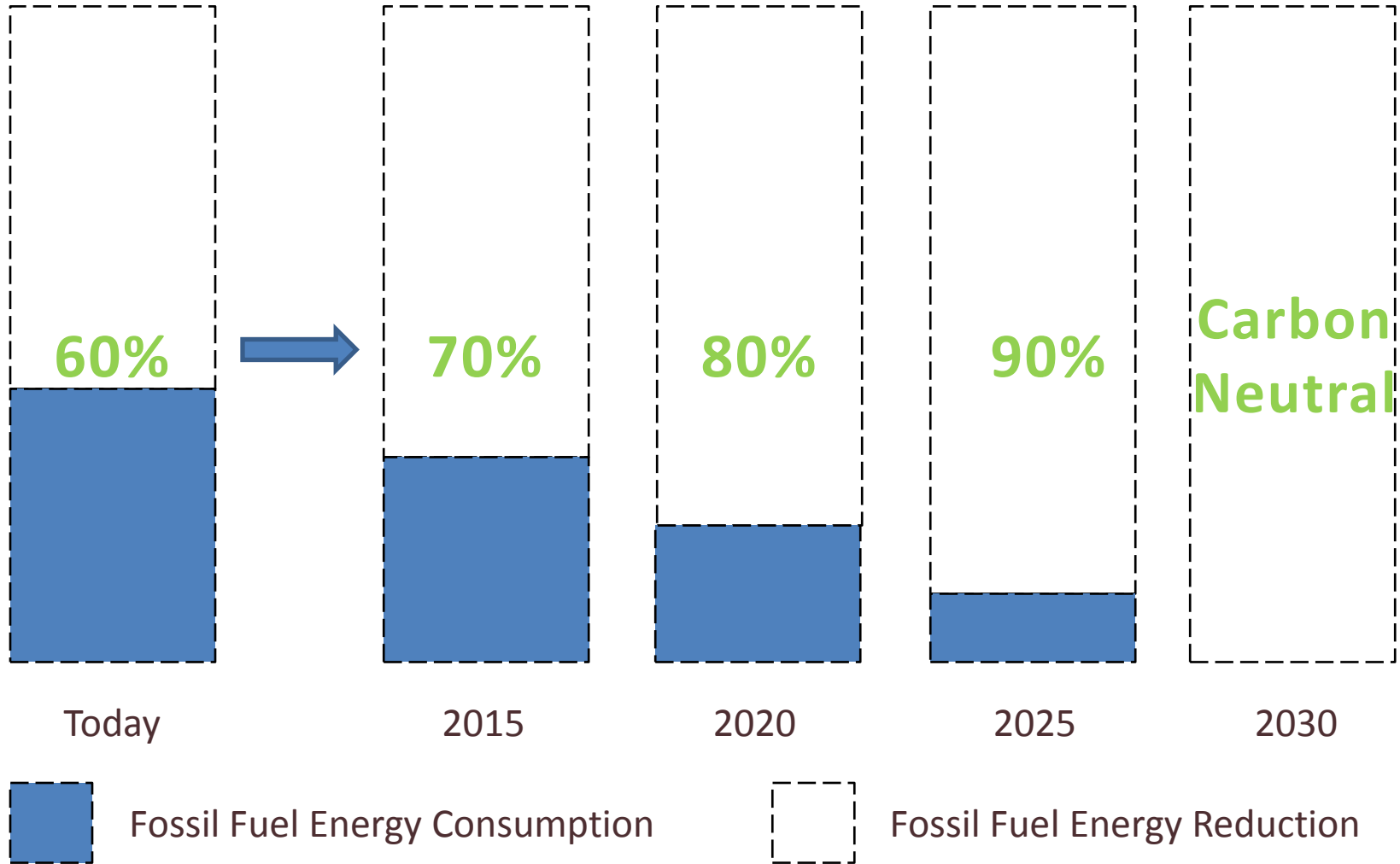
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Associate, Director of Marketing & Business Development  
Interface Engineering | Portland, OR



# 2030 Challenge

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# HOOD RIVER MIDDLE SCHOOL



## Music & Science Building

LEED PLATINUM + NET-ZERO ENERGY

### Location

Hood River, Oregon

### Building Size

6,000 sf renovation and 5,600 sf addition

### Project Cost

\$2.72 million

### Architecture

Opis Architecture



**Andy Frichtl** PE, LEED AP

MANAGING PRINCIPAL, SR. MECHANICAL ENGINEER



# NET-ZERO ENERGY: THREE YEARS AND RUNNING

The Music and Science Building is the latest addition to the Hood River Middle School (HRMS) campus in Hood River, Oregon. The facility has received much recognition, including a Top Ten Green Projects award from the AIA's Committee on the Environment, and it was recently recognized as the first Net-Zero Energy Certified public school. The building is home to a new music room, practice rooms and teacher offices. It also houses the school's remarkable Food and Conservation Science Program, with a science lab and greenhouse adjacent to the garden.

*"Wouldn't it be nice if someday we didn't have to have a whole conference about sustainability—if it was just the way things were done?"*

MICHAEL BECKER, SCIENCE TEACHER  
HOOD RIVER MIDDLE SCHOOL

# Sustainable Strategies

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High Performance Envelope

35-kW PV array

Heat-recovery ventilators

Solarwall

Displacement ventilation

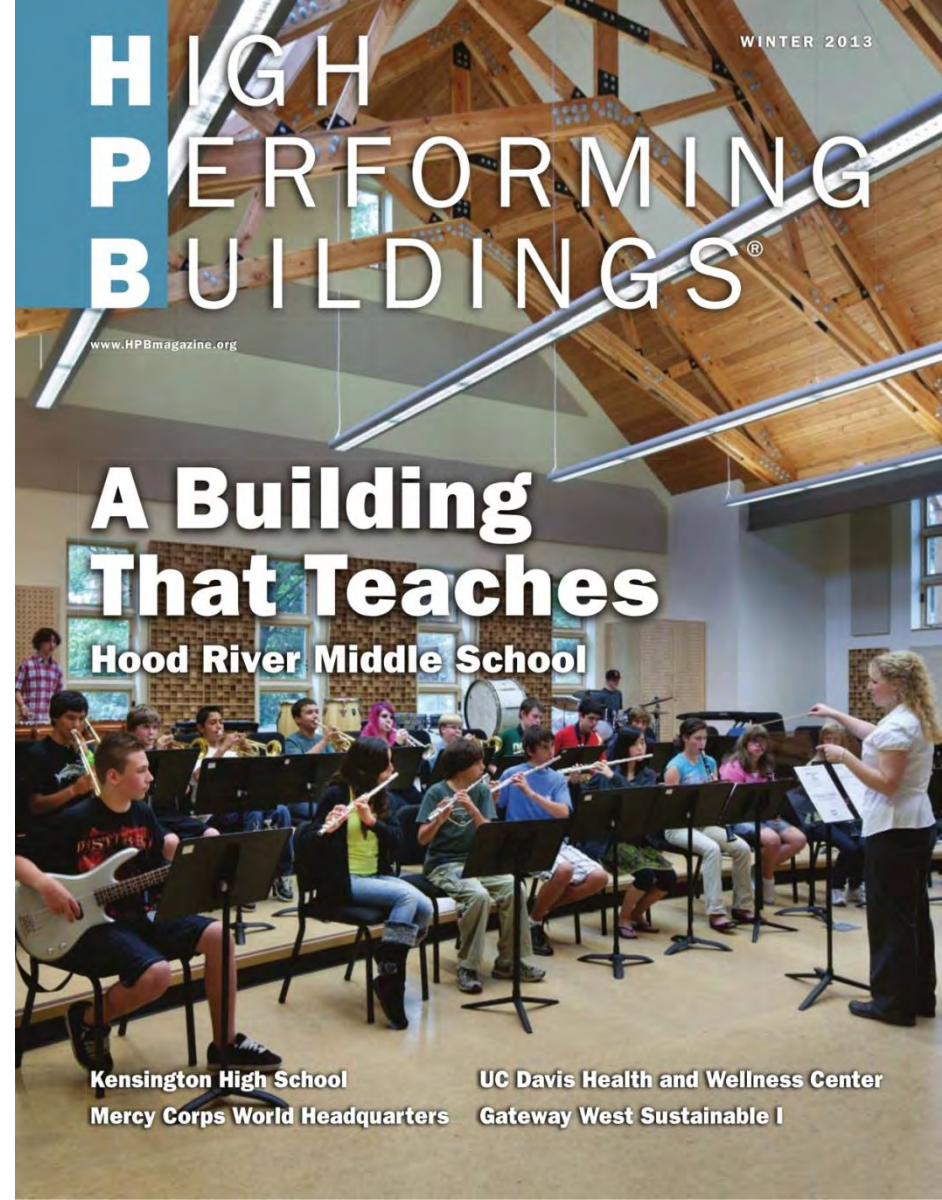
Radiant slabs

Horizontal geothermal ground loop  
and irrigation coupled systems

Plug loads controlled by occupancy  
sensors

Rainwater harvesting

Low-flow fixtures



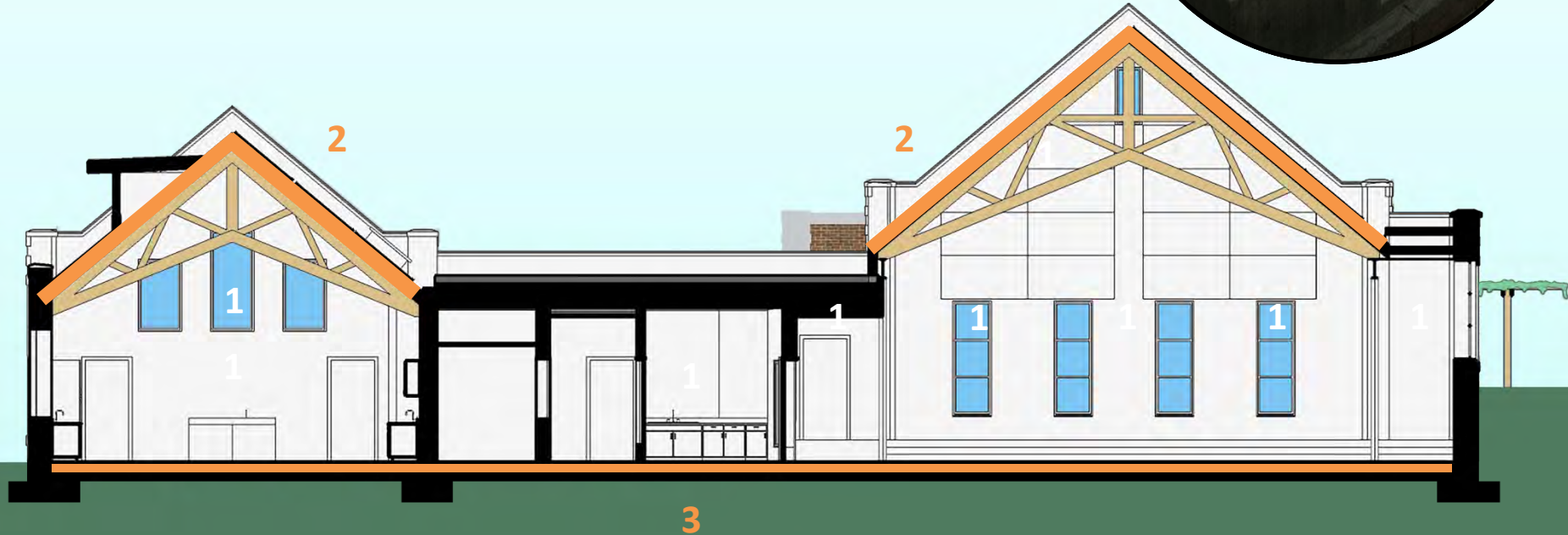
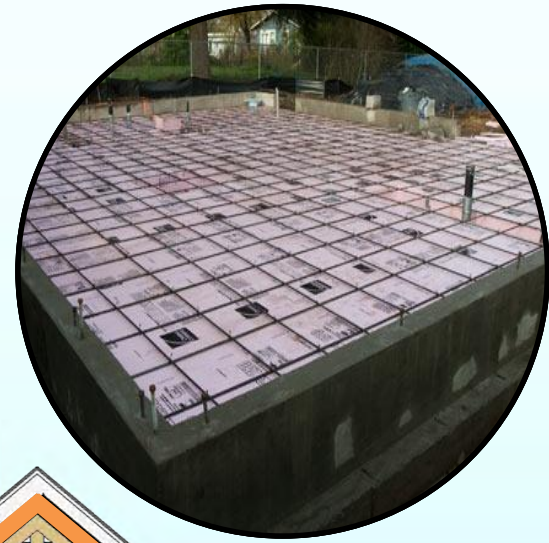


# Sustainable Strategies



## High performance envelope

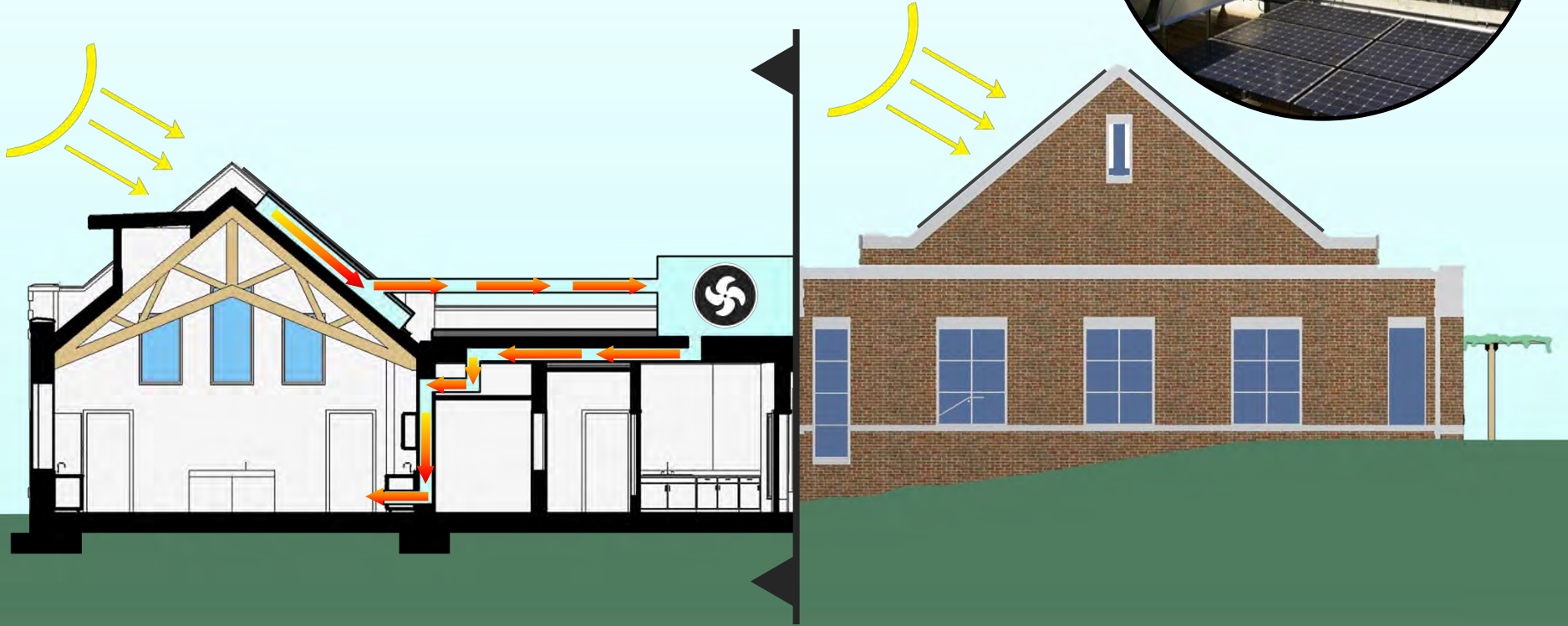
1. ICF/Brick walls and triple glazing for thermal mass, cultural context
2. R-38 roof insulation
3. R-15 under-slab insulation



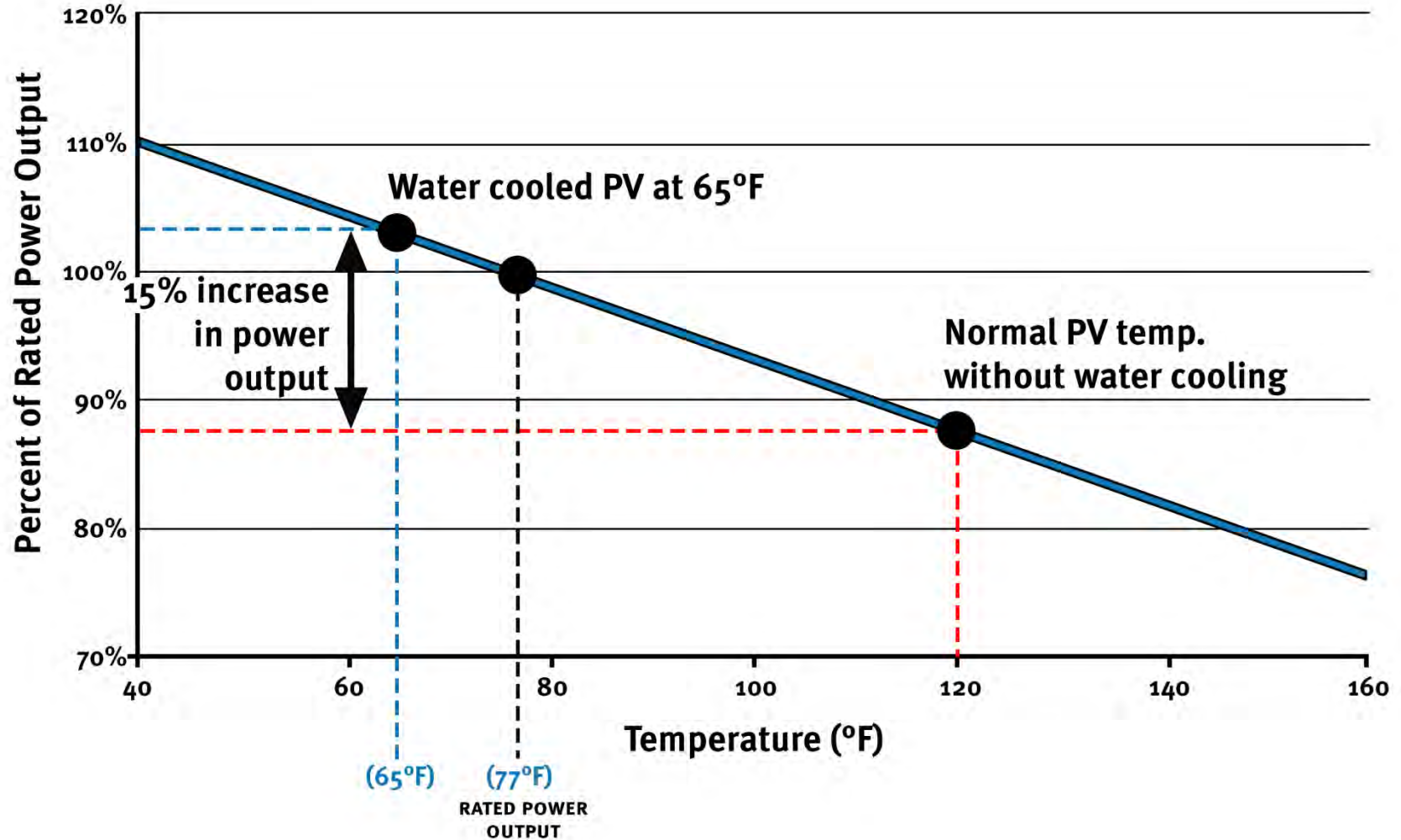
# Sustainable Strategies



PV panels convert sun energy into electricity while a solar wall pre-heats incoming air for use in the building and increases PV output.




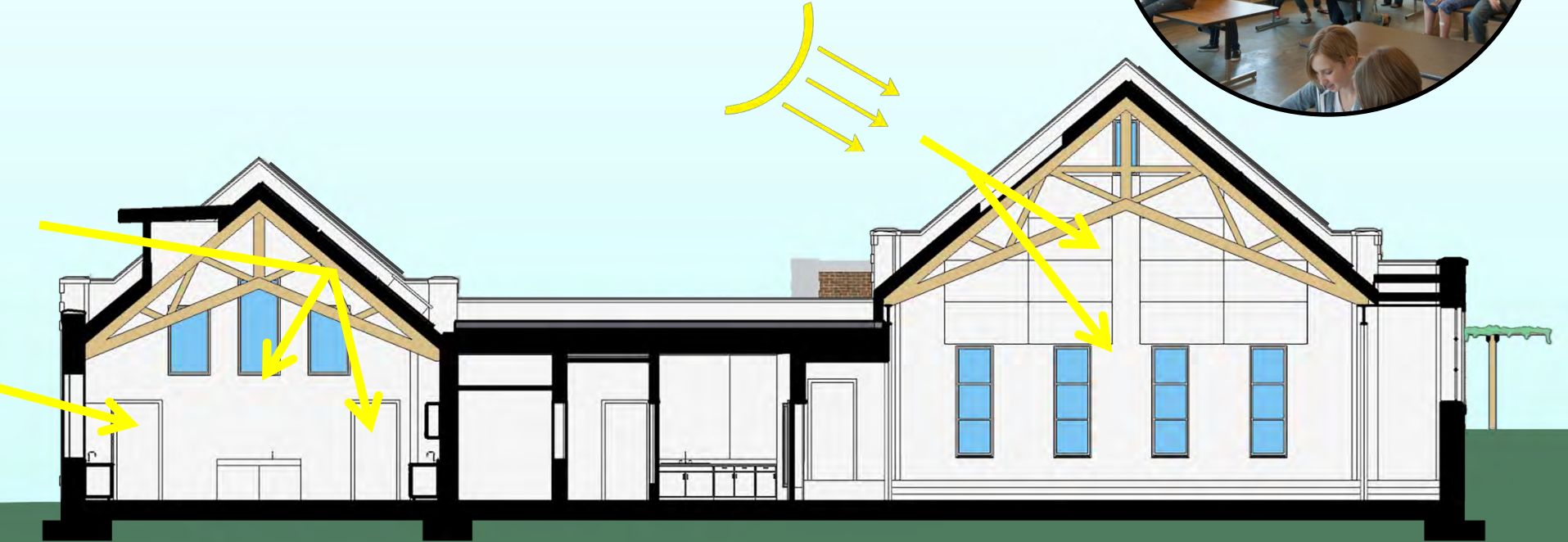
# PV Efficiency vs. Cell Temperature






# Sustainable Strategies

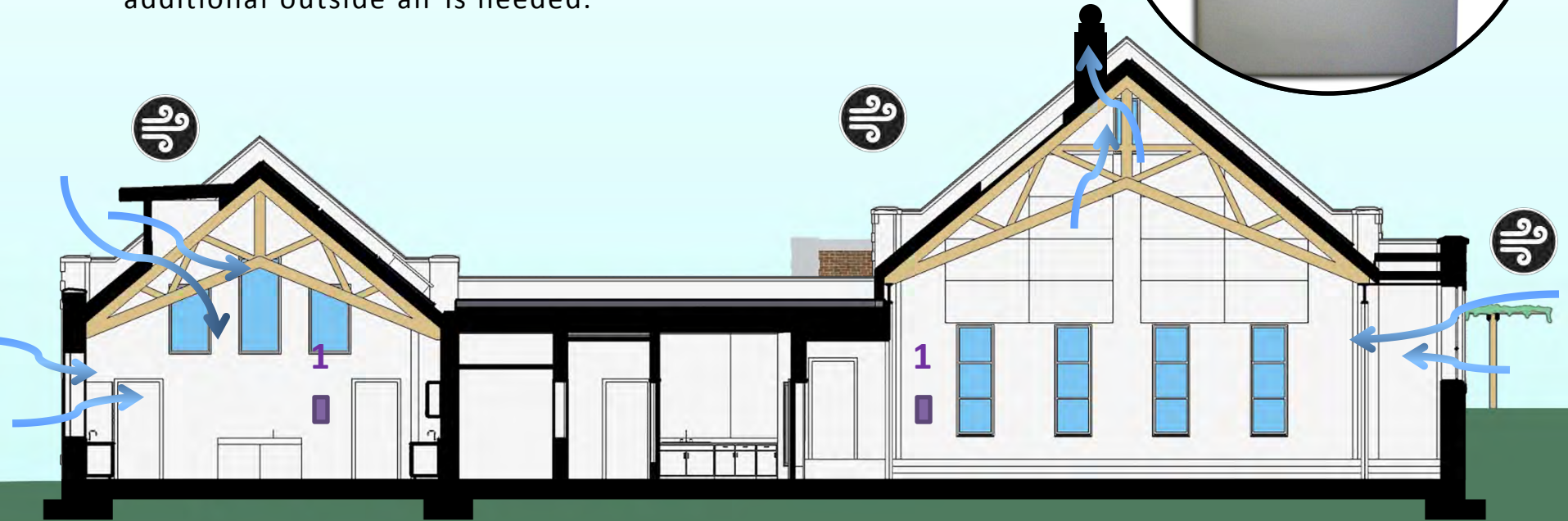
 Skylights and clearstory windows create an even distribution of daylight to classrooms, reducing glare and the need for electric lighting.



# Sustainable Strategies

 Windows and rooftop ventilators are activated when outside temperatures are optimal to allow fresh air into the building.

1. CO<sub>2</sub> sensors are monitored by students to determine when additional outside air is needed.

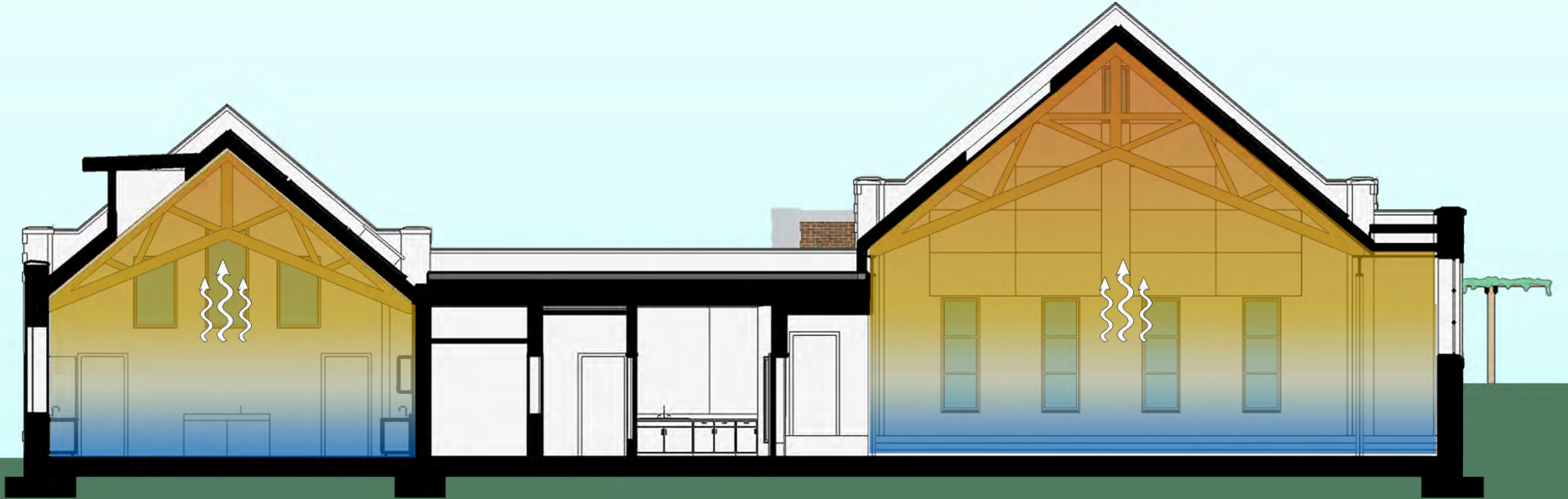


# Sustainable Strategies

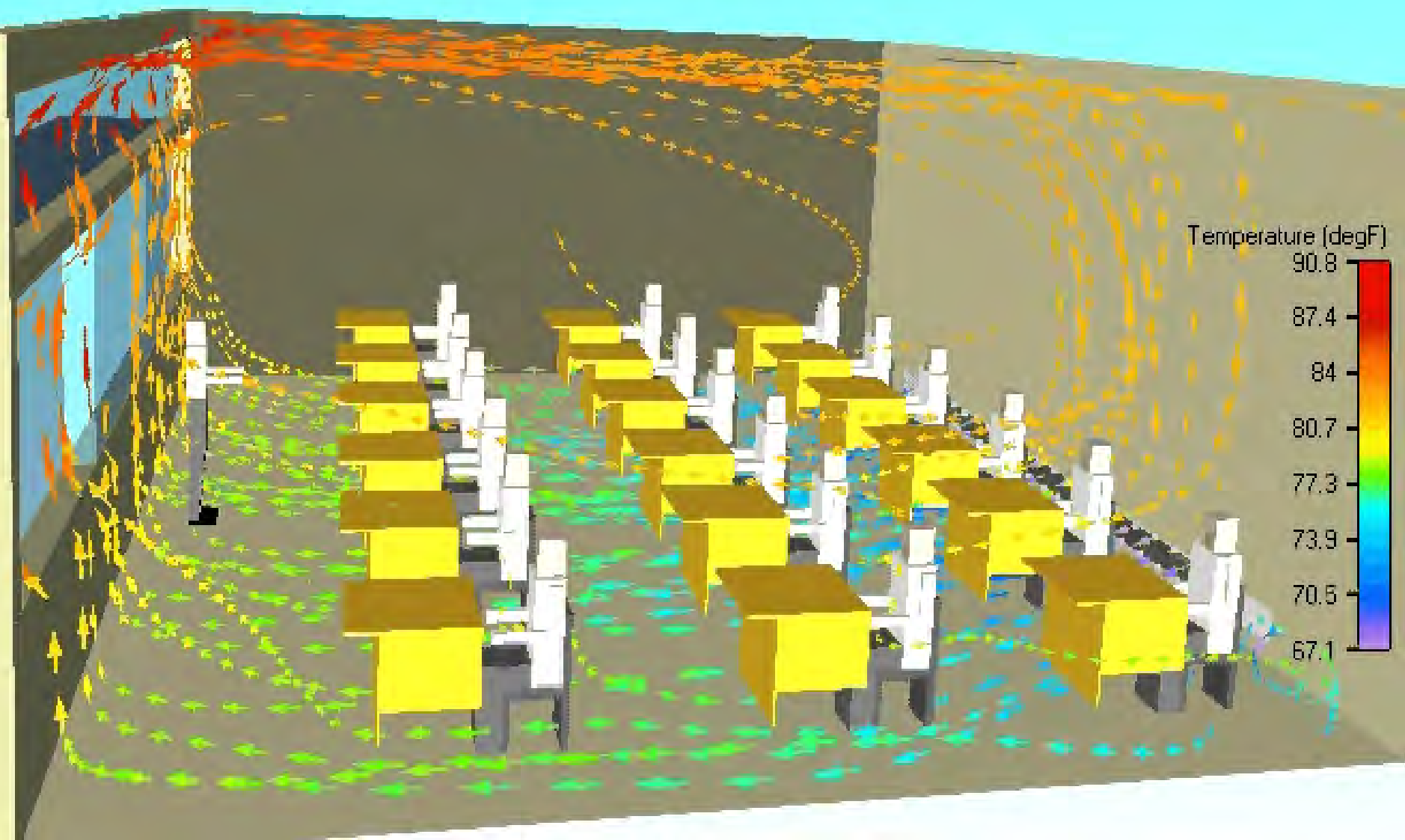
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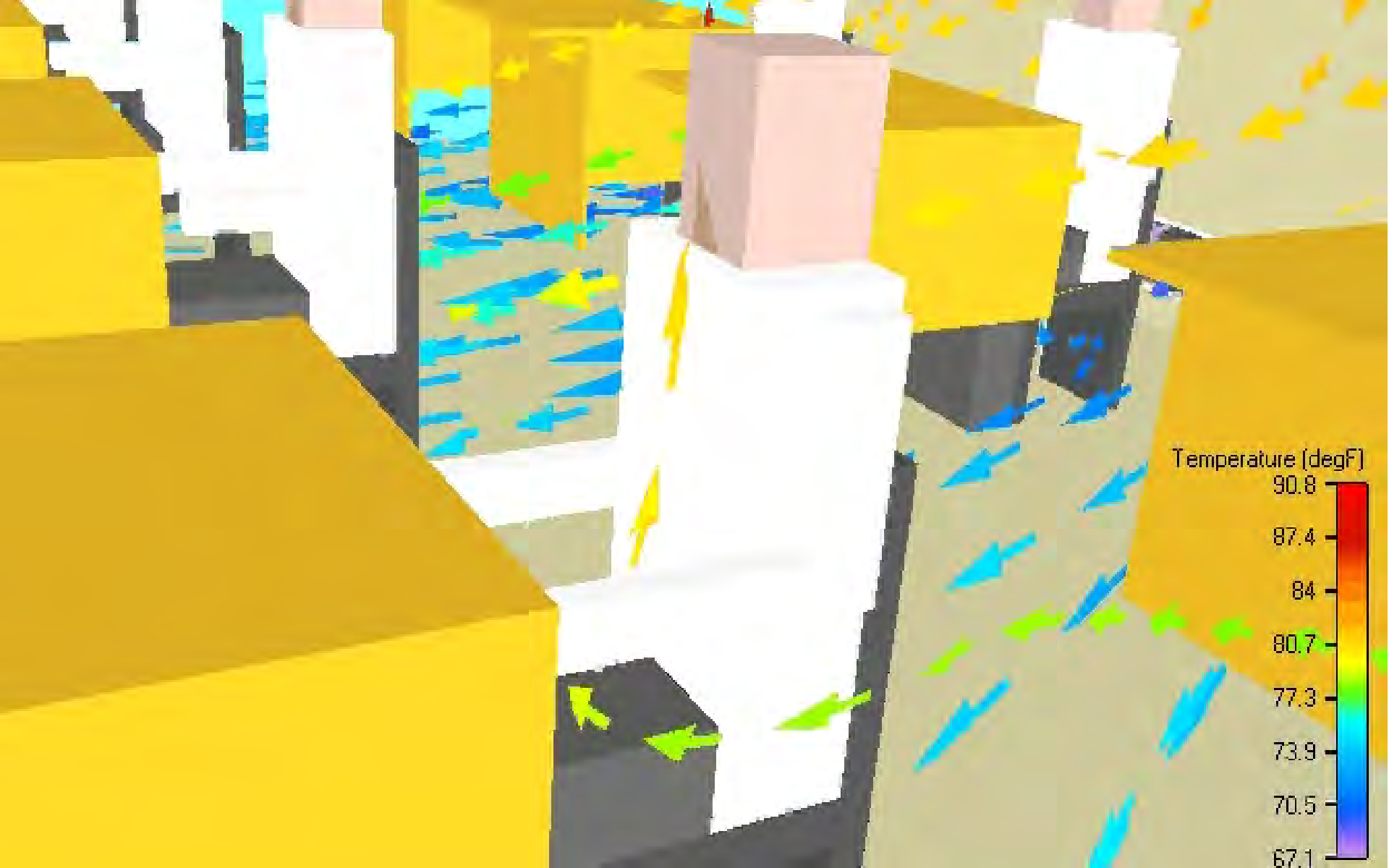


Displacement Ventilation in classrooms provides superior indoor air quality while saving energy use.






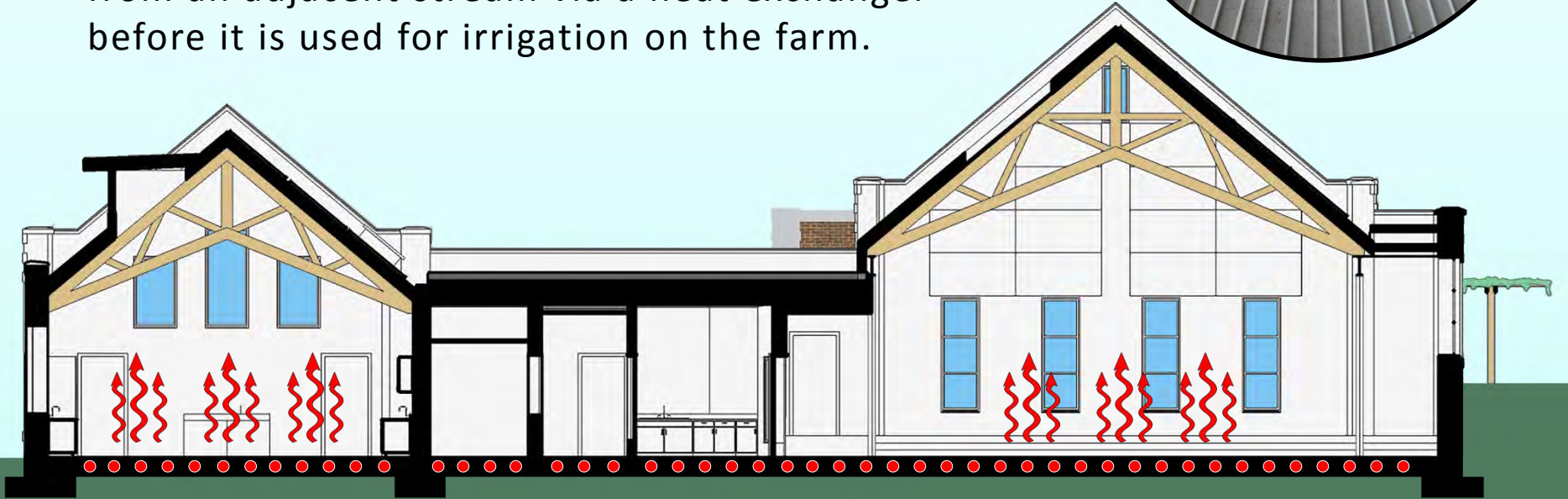




# Sustainable Strategies

 Radiant slabs provide heating and cooling, while below grade insulation minimizes energy transfer into the ground.

The system also takes advantage of cold water from an adjacent stream via a heat exchanger before it is used for irrigation on the farm.



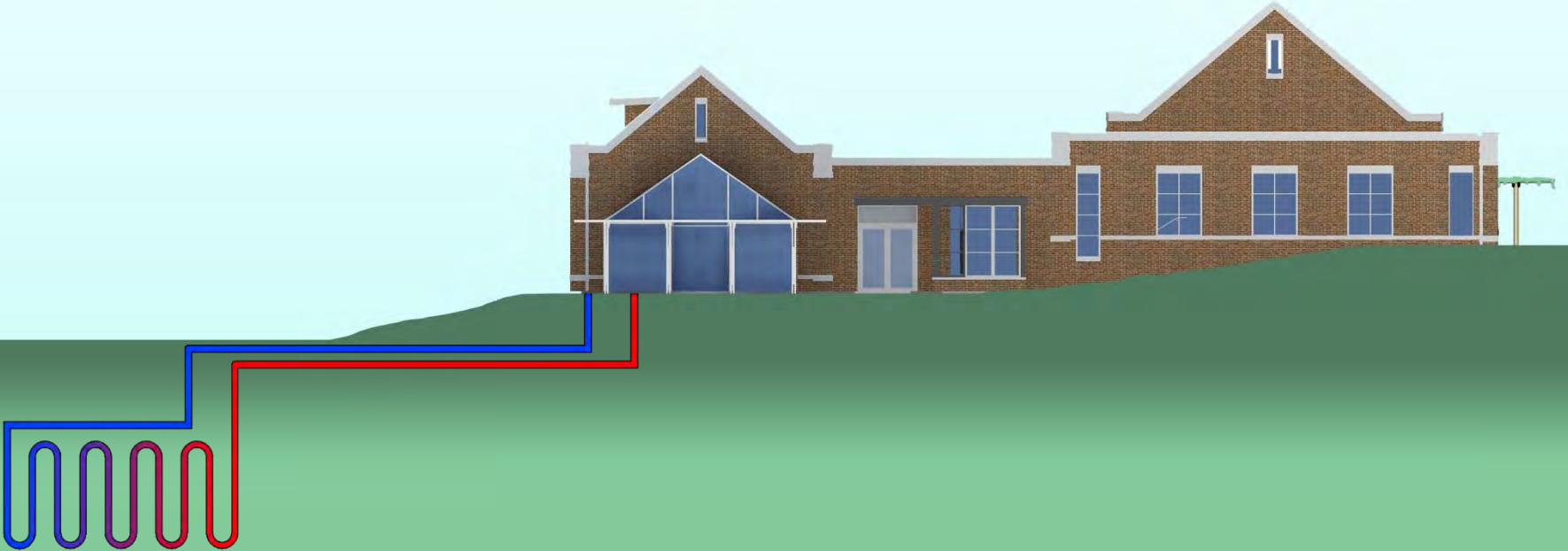


# Sustainable Strategies

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Radiant heating and cooling supplied by a horizontal geothermal ground loop, which is coupled to an irrigation system.



# GeoThermal & GeoExchange Installation Options

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Horizontal Directional Drilling  
(HDD)

Horizontal Trenching or Open Cut

Pond Loop System

Slinky Loops

Vertical







# GeoExchange Field

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# Energy Budget

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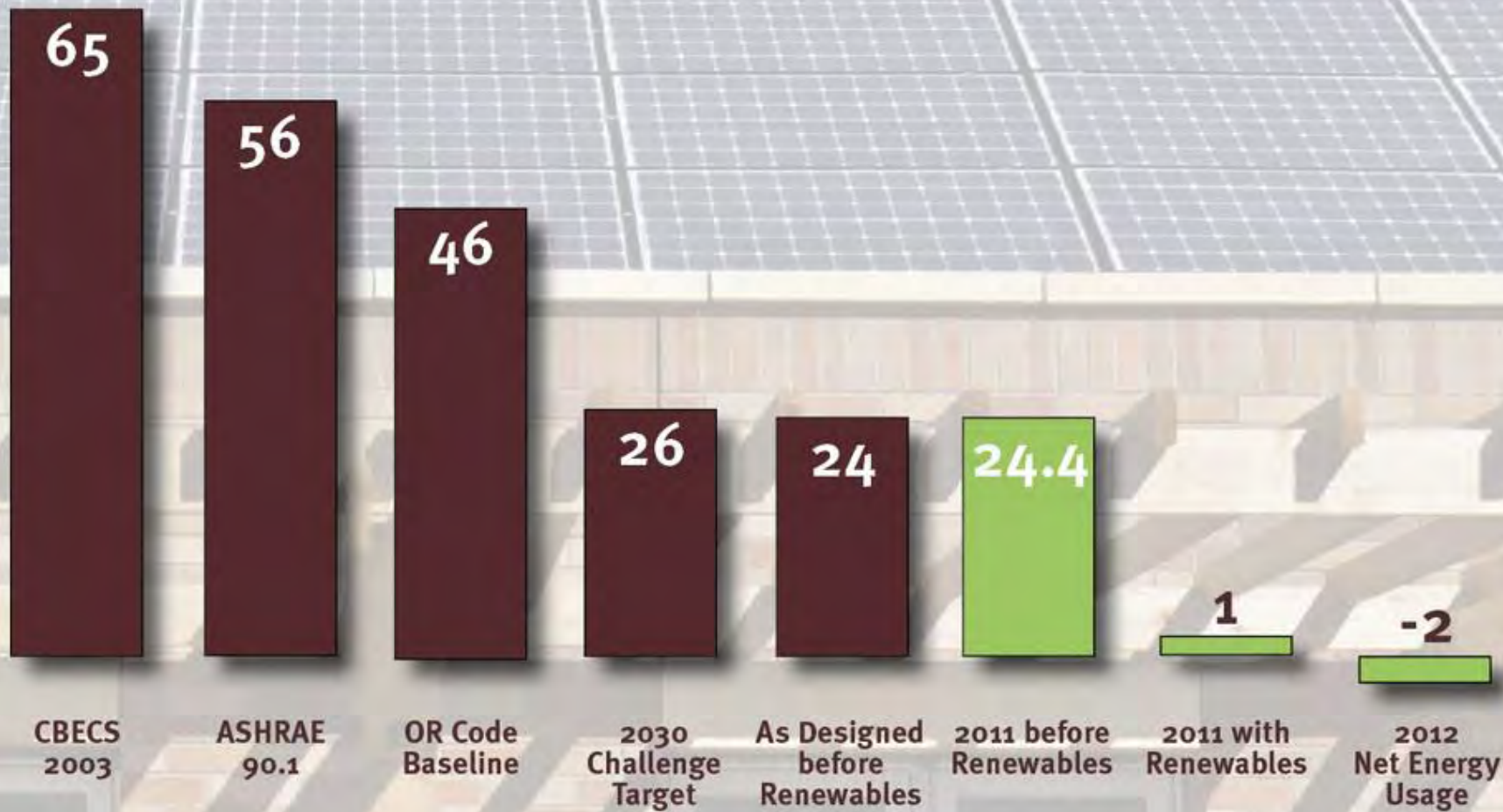
Students play a key role in keeping with the energy budget.

Energy is monitored daily. If it's out of balance, students will use a handsaw instead of a table saw in shop class. As Becker tells his students, ***"You have to eat your conservation vegetables before your solar cookies."***



Hood River Middle School / Net-Zero  
Hood River, OR

Energy Consumption  
EUI (kBtu/sf/yr)





# Post Occupancy Evaluation

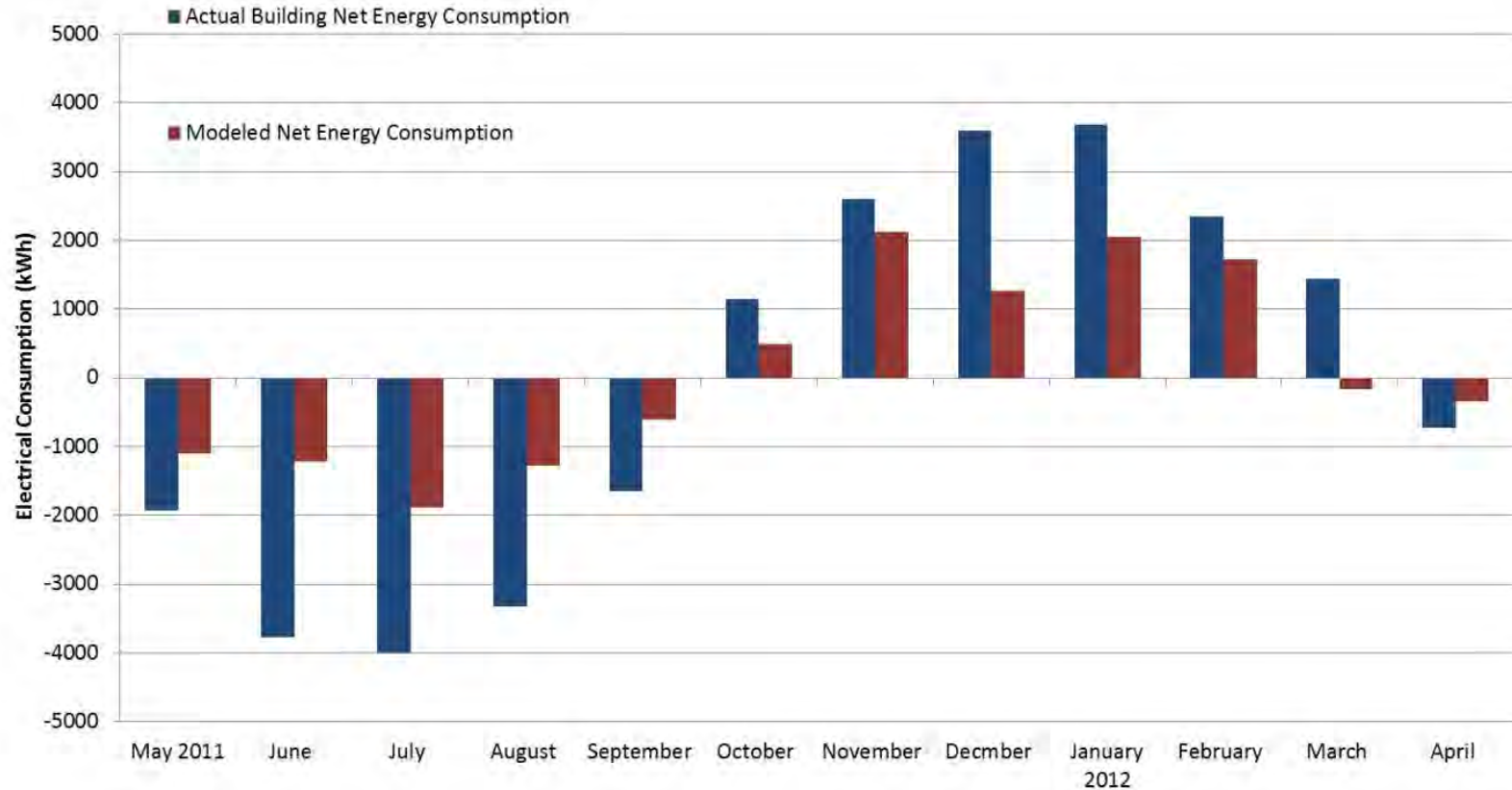


Figure 17: Original vs. Modeled Net Energy Usage (kWh)

# Net-Zero Economics

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## Added Project Costs For Net-Zero

Energy Efficiency Measures: \$57,640

Renewable Energy Systems: \$227,000

**Total Added Cost: \$284,640**

ETO Efficiency Incentives: \$15,000

ETO Renewable Incentives: \$45,000

BETC LEED Platinum Incentive: \$13,600

BETC Photovoltaic Incentive: \$80,400

**Total Incentives: \$154,000**

**Total Net Added Cost: \$130,640**

6,565 per year (annual cost savings) =

**19.89 year payback**



# SACRED HEART

## Lower & Middle Schools

LEED PLATINUM + NET-ZERO ENERGY



**Location**  
Atherton, California

**Building Size**  
35,000 sf

**Project Cost**  
\$30 million

**Architecture**  
WRNS Studio



**Hormoz Janssens PE, LEED AP**  
MANAGING PRINCIPAL, SR. MECHANICAL ENGINEER



# Sustainable Strategies at the Campus

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Photovoltaics

Displacement ventilation

Variable refrigerant system

Lighting + daylighting controls

Natural ventilation

Indirect evaporative cooling

Heat pump heating

Solar chimney

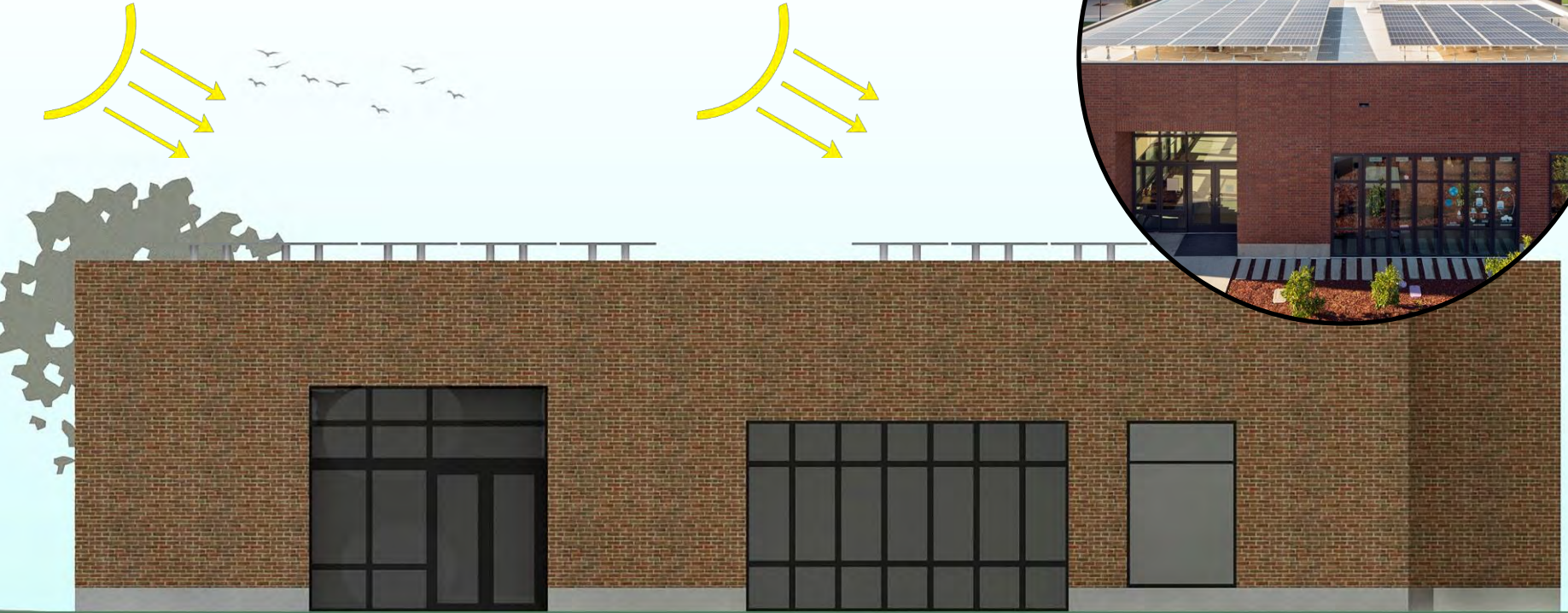
100% water recycle



# Sustainable Strategies



42.5 kW photovoltaic system.

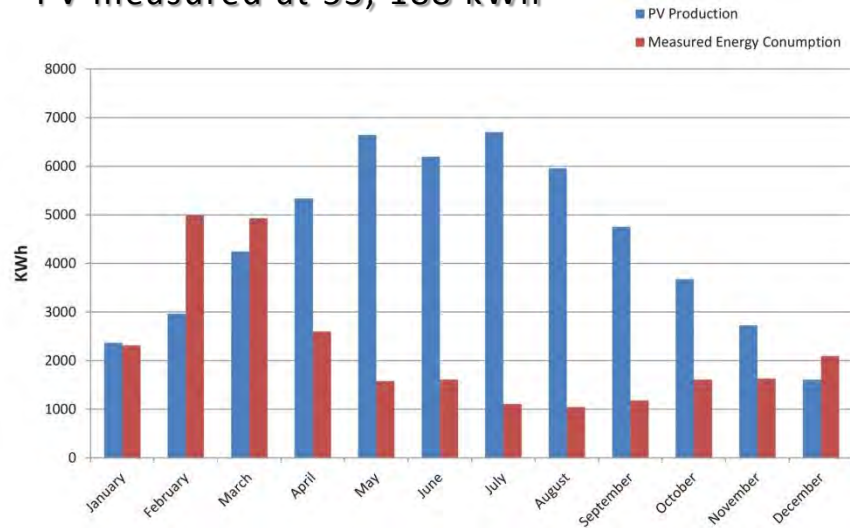




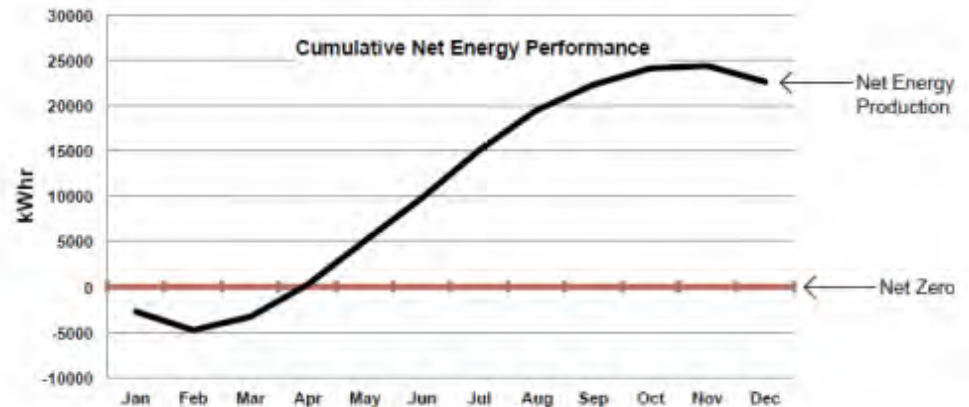
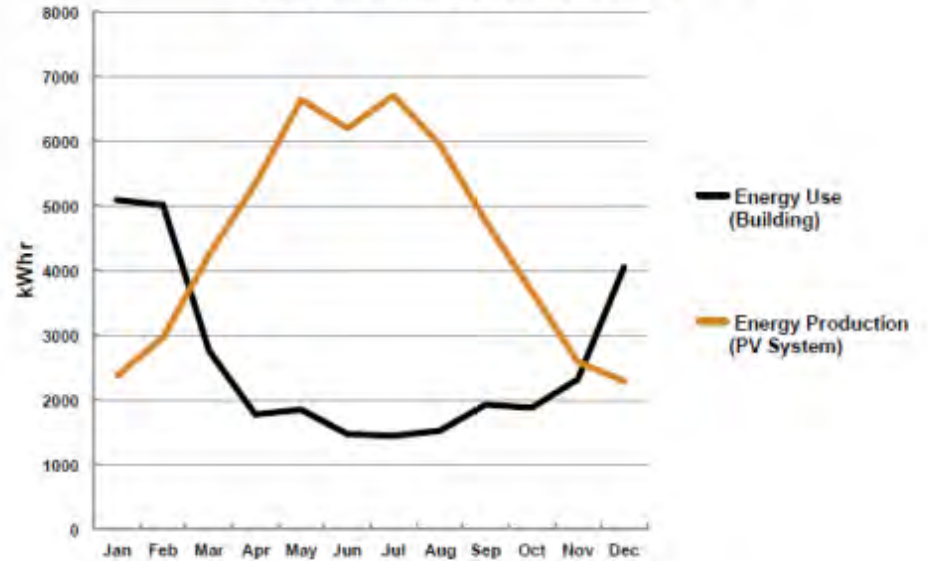
# PV System Performance

PV predicted at 50,832 kWh

PV measured at 53,188 kWh



Stevens Library at Sacred Heart Schools  
Solar Photovoltaic System Performance

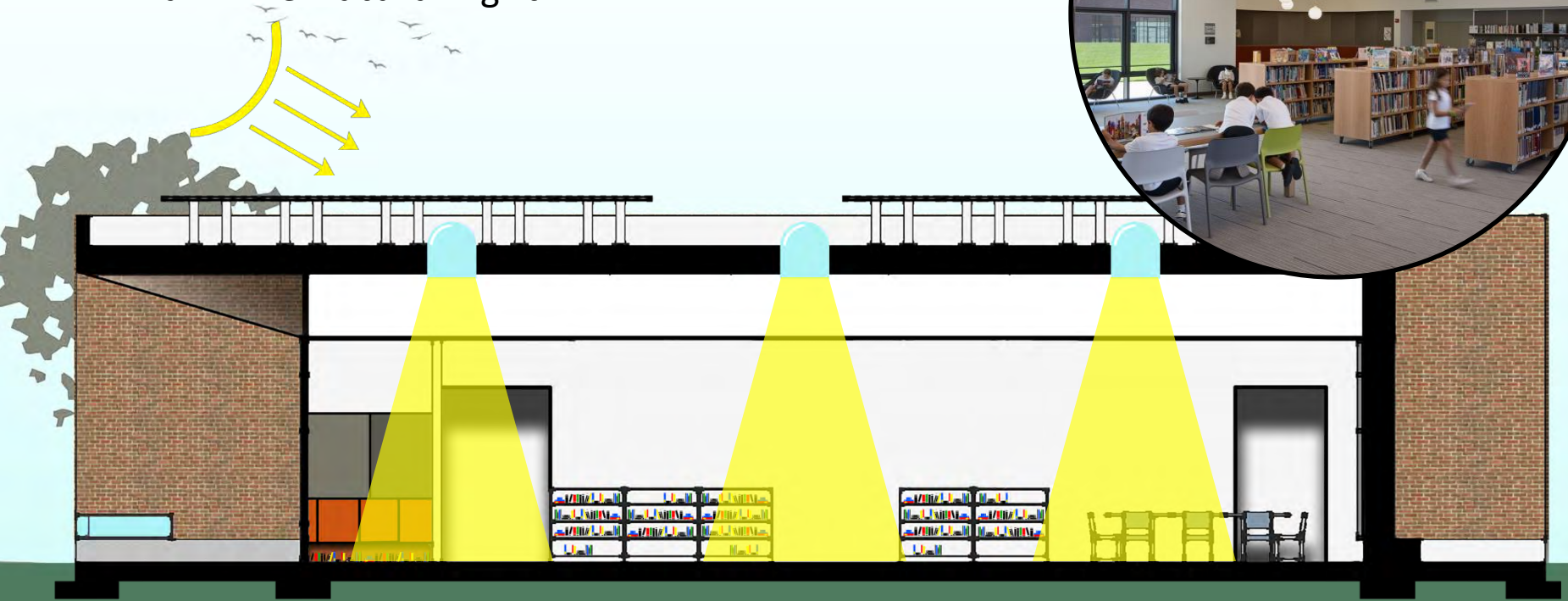




# Sustainable Strategies



Solar tubes, building shading, daylight monitoring systems, and occupancy sensors maximize natural light.



# Sustainable Strategies

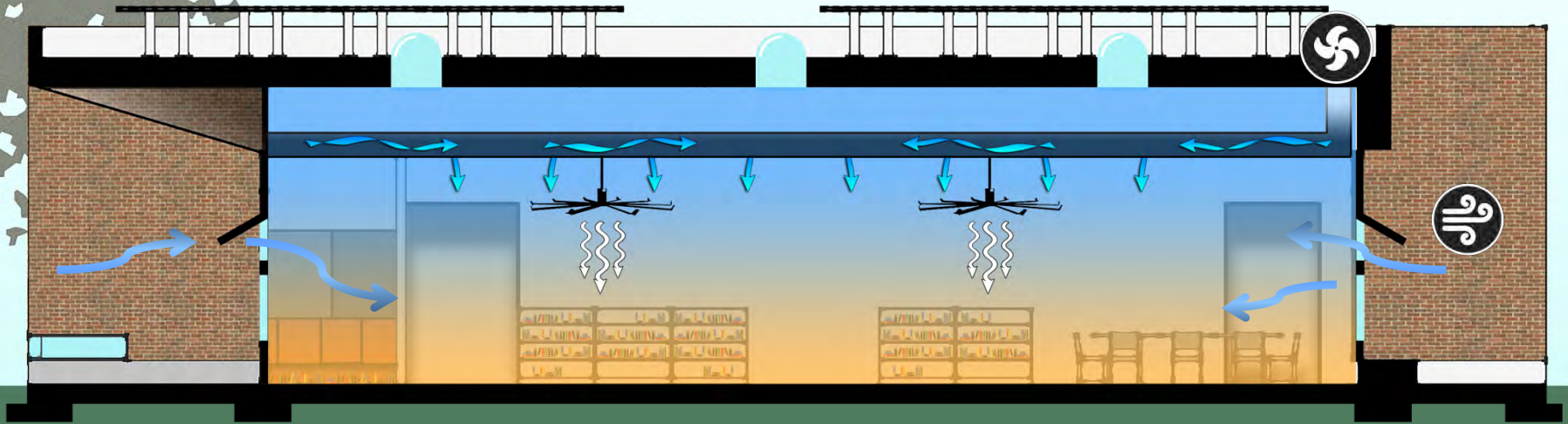
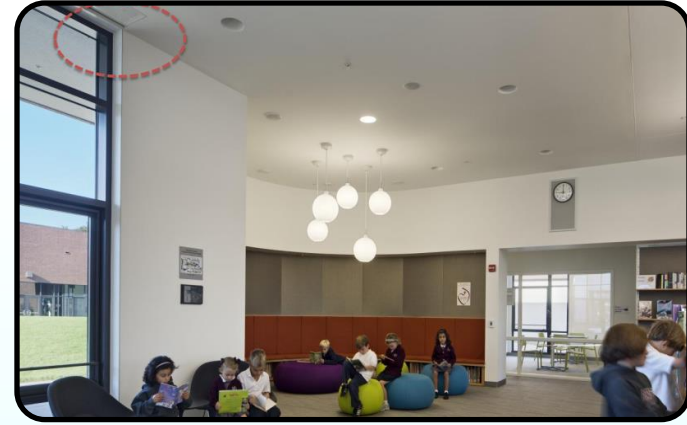


Displacement ventilation using special diffusers located high in the ceiling.

Two stages of evaporative cooling (indirect and direct).



Operable windows supply fresh air.



# Energy Breakdown\*

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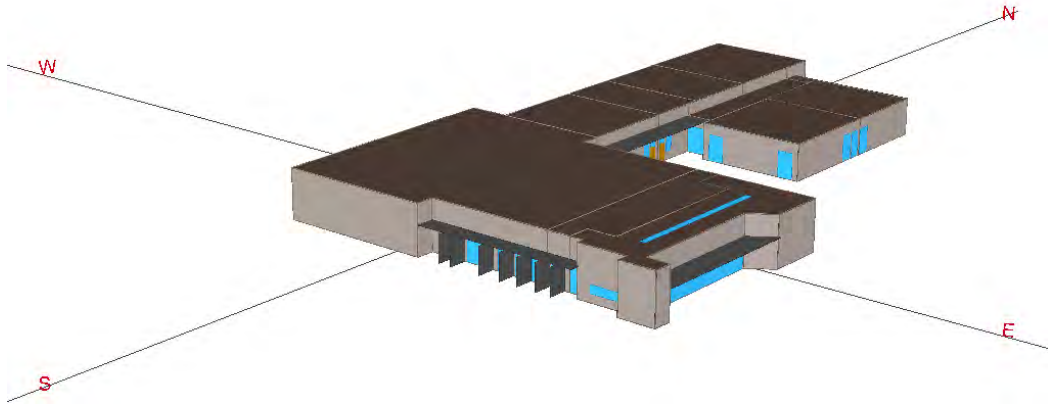
Annual Energy Use: **50,361 kWh**

Actual Energy Use: **26,686 kWh**

Actual Energy Use Intensity: **16.9 kbtu/sf/yr**

Actual Electricity Generated: **53,188 kWh**

Net Energy Generation: **26,501 kWh**



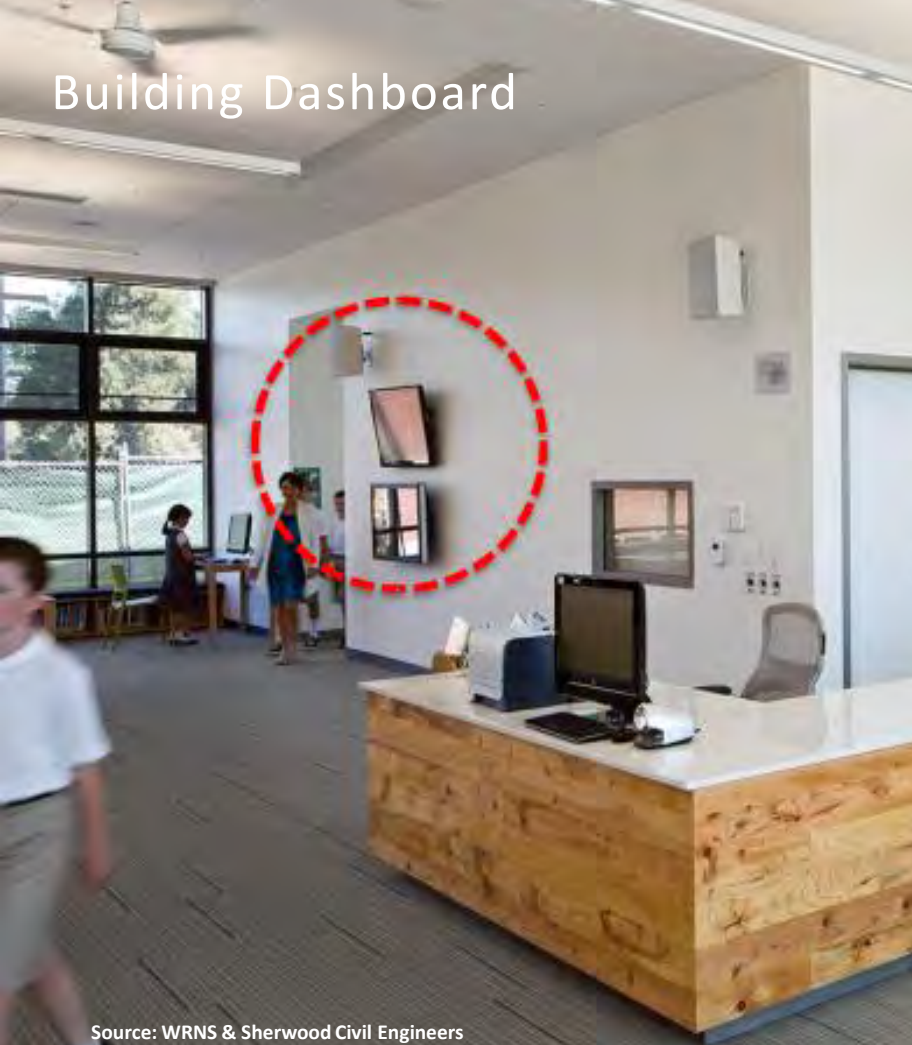
\*Source: International Living Future Institute



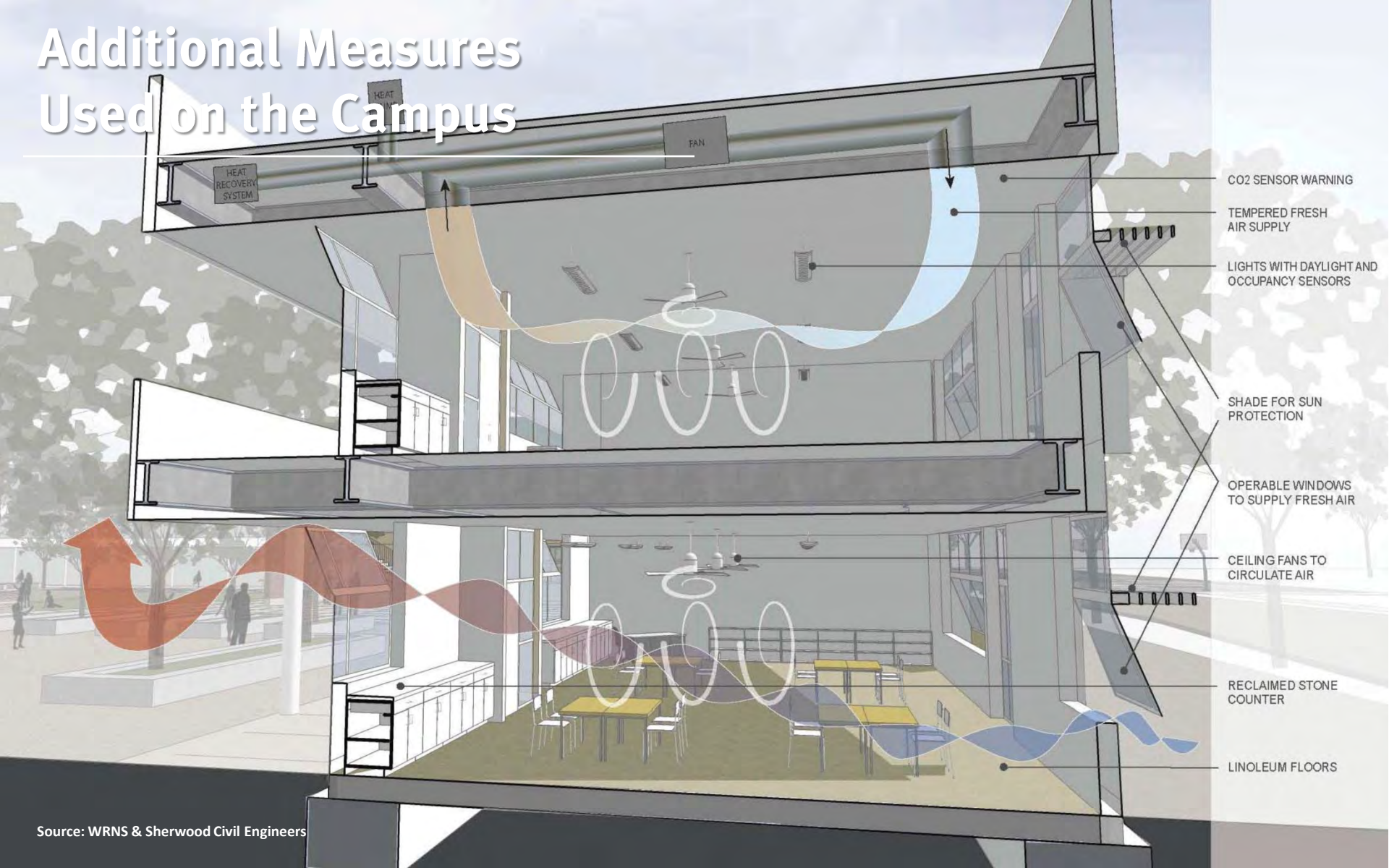


# Building as a Learning Tool

## Building Dashboard



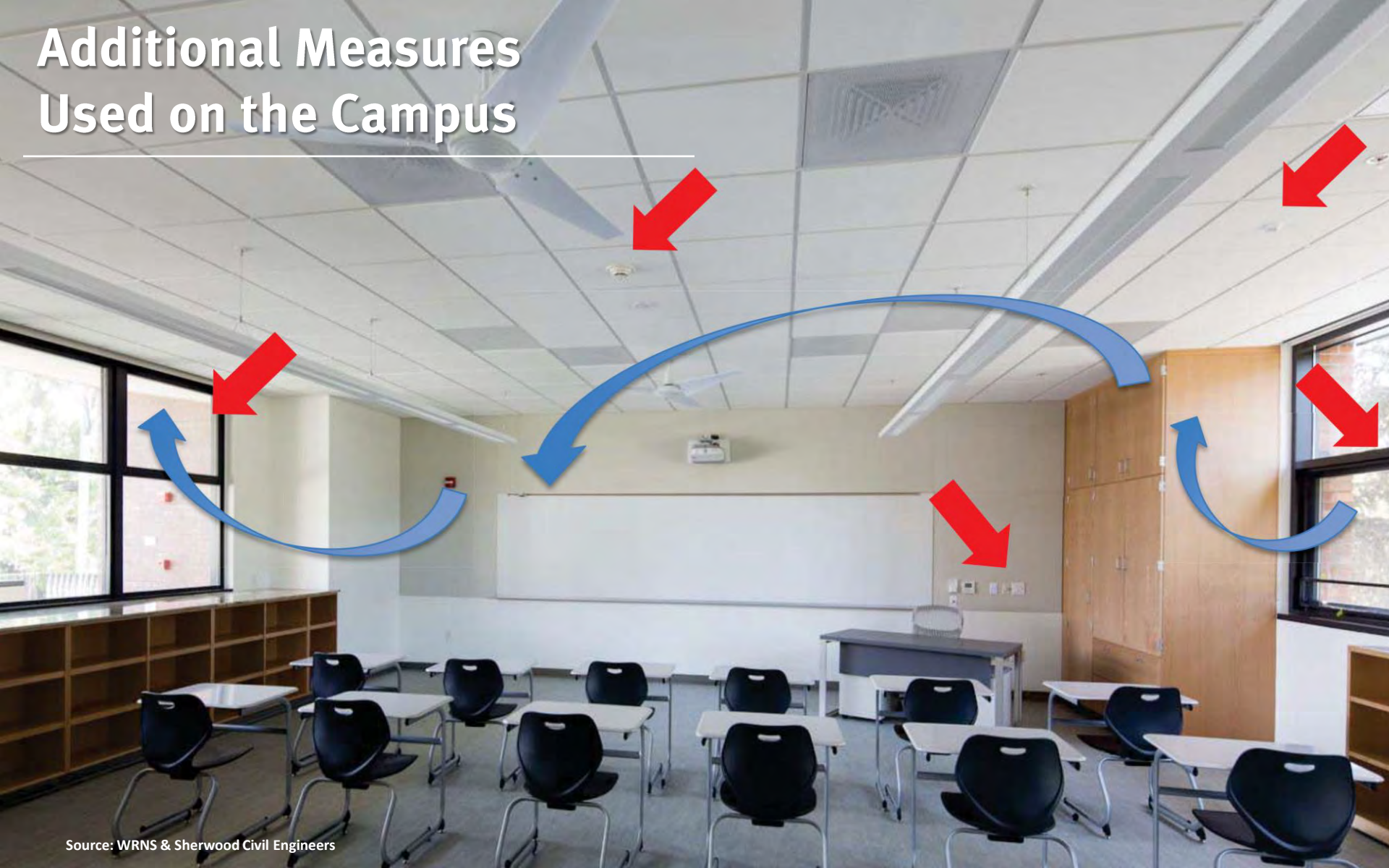
# Additional Measures Used on the Campus





# Additional Measures Used on the Campus


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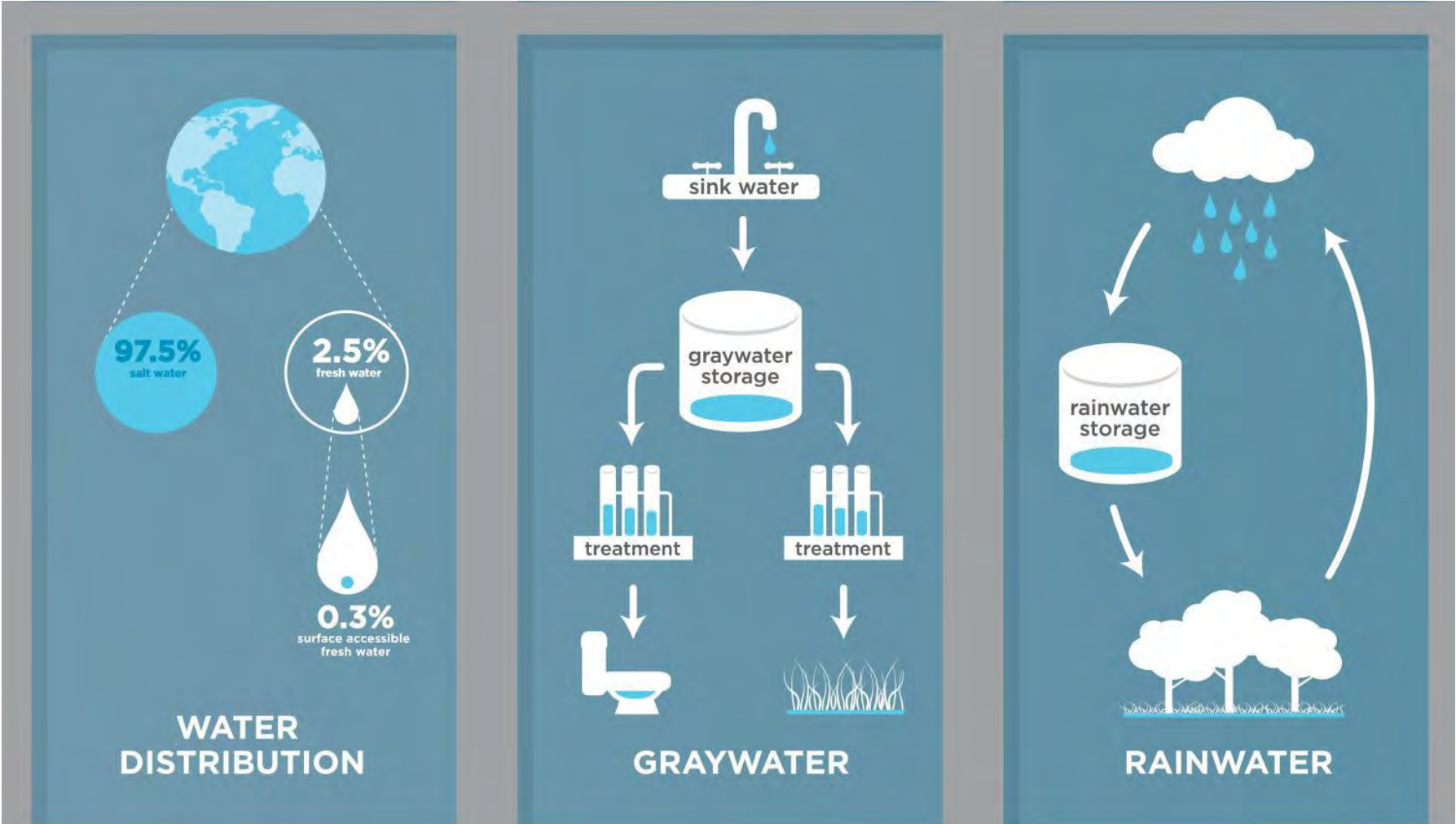
# Additional Measures Used on the Campus

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**Reduced EUI for all buildings**  
**Theater :** 31.7 kbtu/sf yr  
**Classrooms:** 23.4 kbtu/sf yr  
**Admin/ Chapel/ Classrooms:** 25.1 kbtu/sf yr  
**CBECS for Schools:** 69 EUI

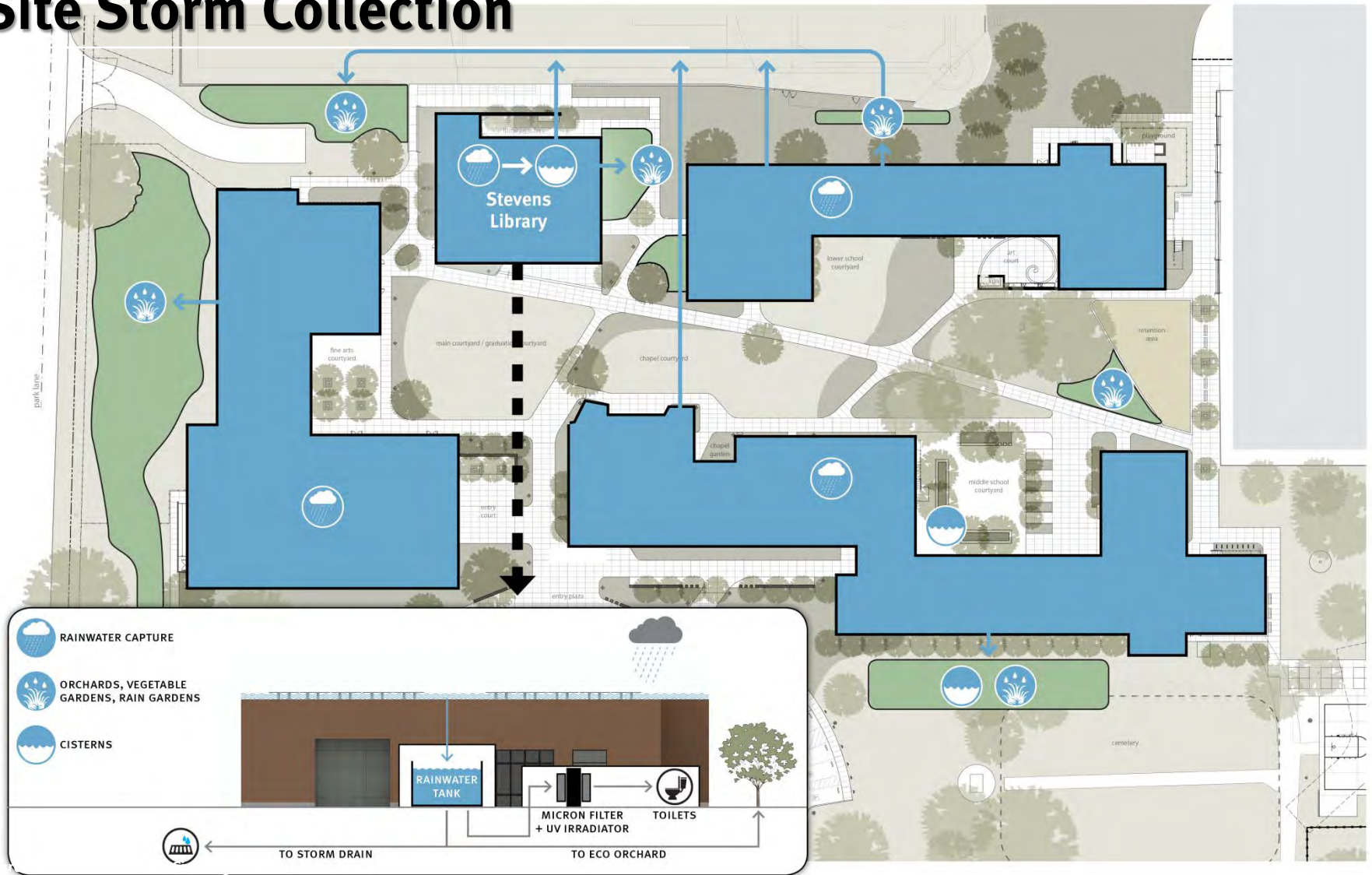
# Water Conservation



Source: WRNS & Sherwood Civil Engineers



# Site Storm Collection





# Additional Learning Opportunities

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# ABINGDON ELEMENTARY

## Renovation & Addition

NET-ZERO ENERGY READY + LEED SILVER GOAL

**Location**  
Arlington, Virginia

**Building Size**  
27,000 sf

**Project Cost**  
\$28 million

**Architecture**  
Hord Coplan Macht

 **Roger Frechette PE, LEED AP**  
MANAGING PRINCIPAL, SR. MECHANICAL ENGINEER

# Sustainable Strategies

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VRF System (Air cooled)

Solar PV

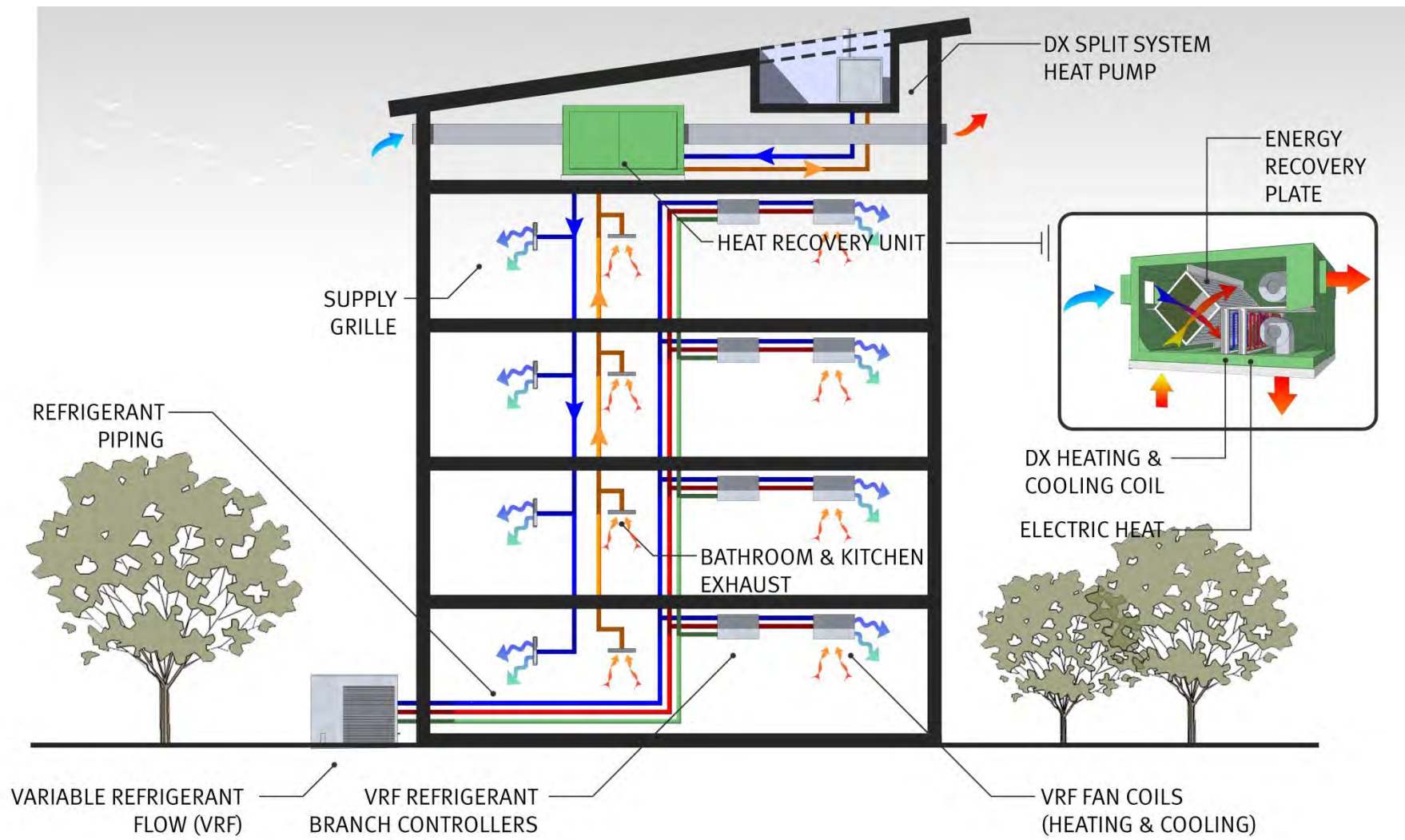
Daylighting

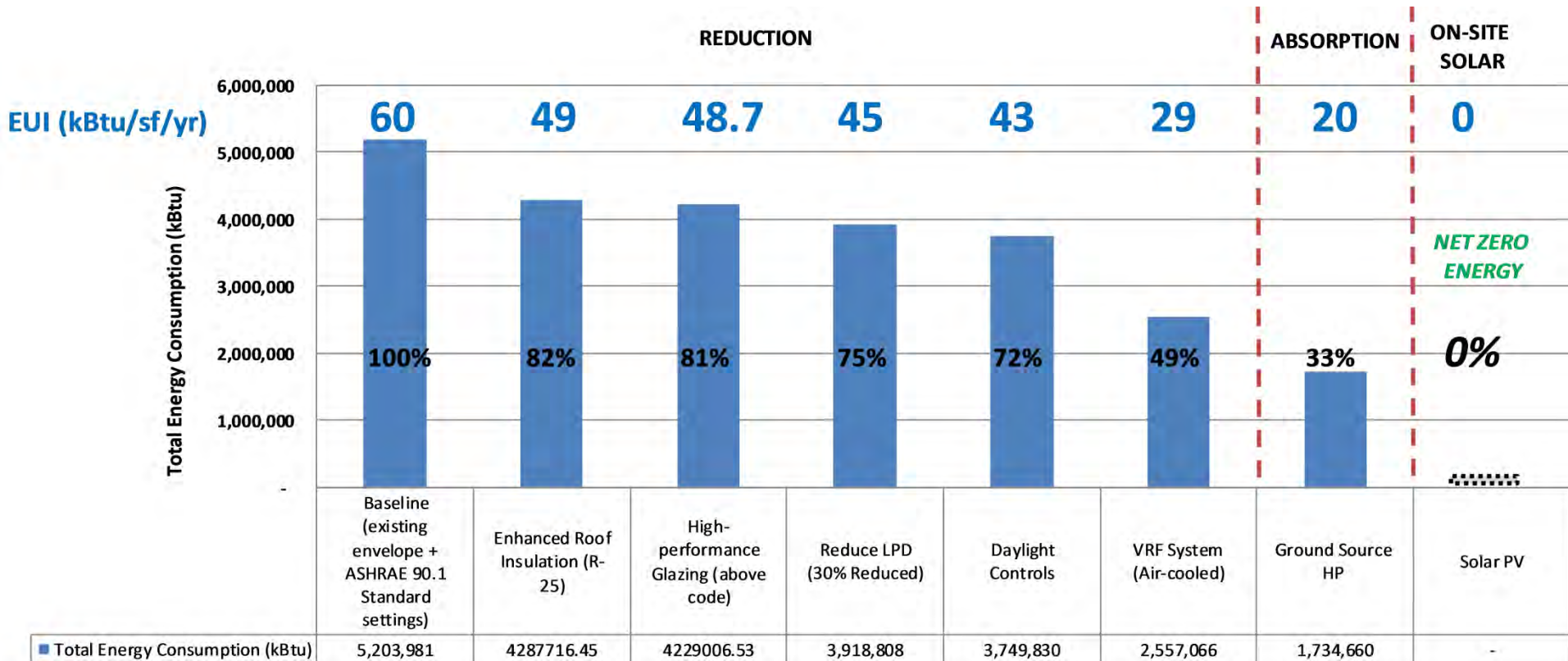
Ground Source Heat Pump



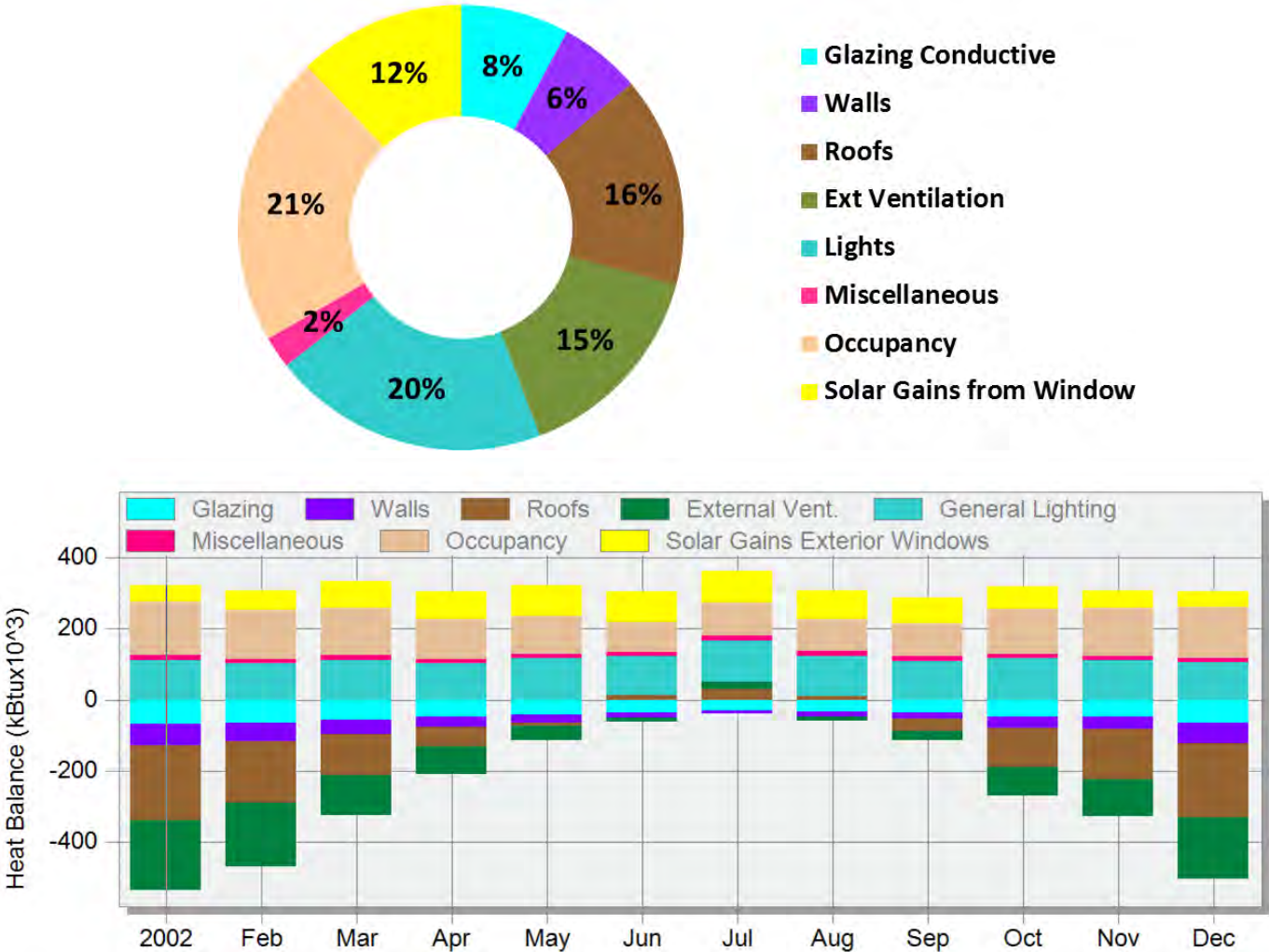


# VRF System



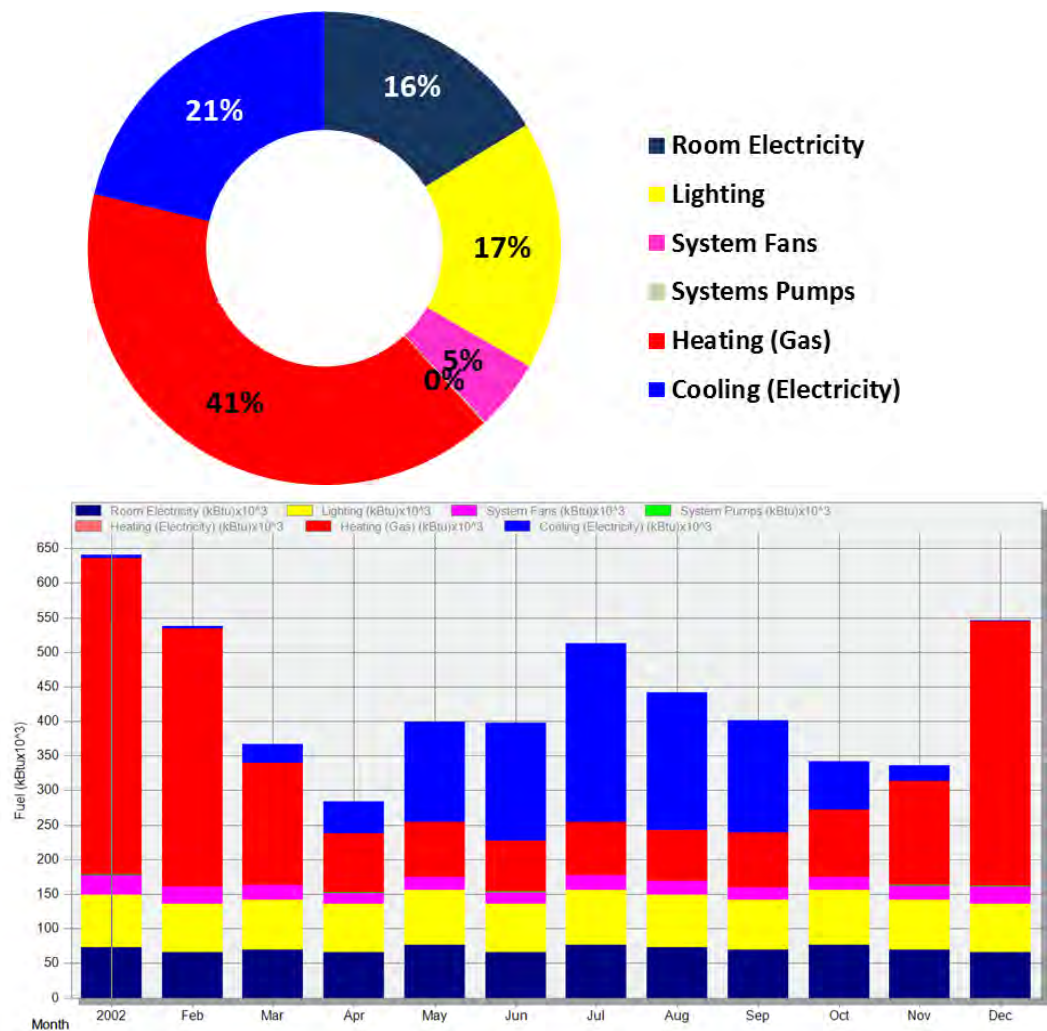


# Heat Gains / Losses





# End Use Energy



# WILSON SECONDARY SCHOOL

NET-ZERO ENERGY READY

## Location

Arlington, Virginia

## Building Size

240,000 sf

## Architecture

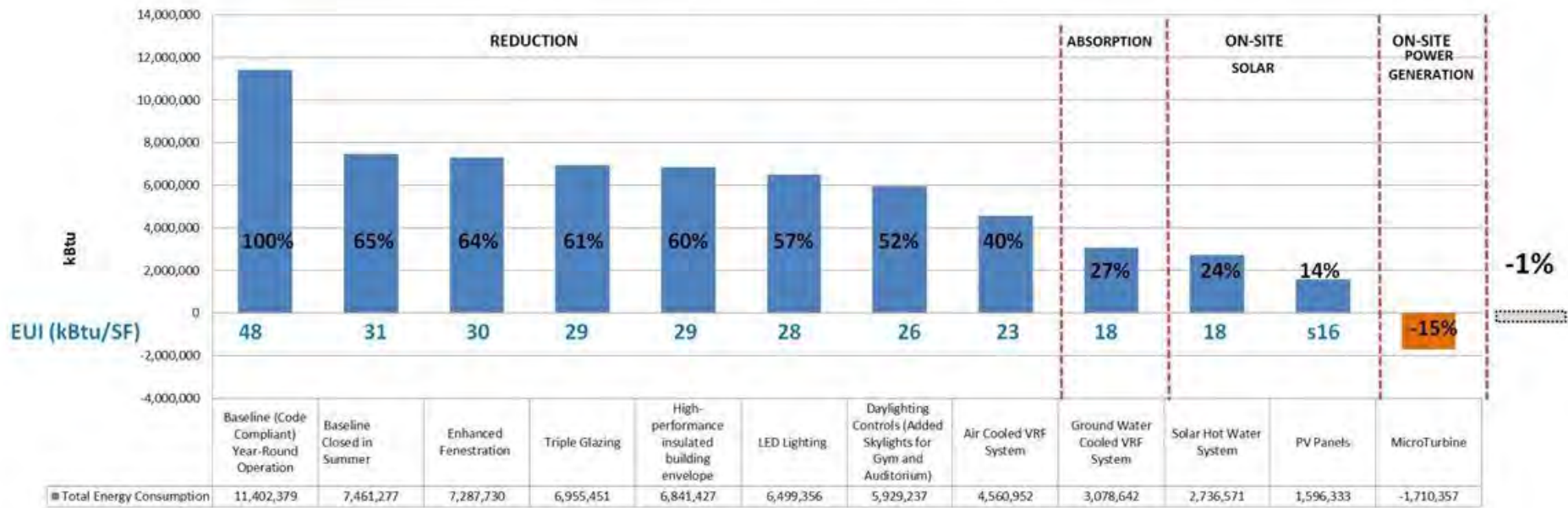
Leo A. Daly

**Roger Frechette PE, LEED AP**

MANAGING PRINCIPAL, SR. MECHANICAL ENGINEER



Wilson School Energy Reduction Strategies



1. Walls R-value=20  
2. Roof R-value= 25  
3. Ground floor R-value= 15  
4. Glazing: U-value= 0.38, SHGC=0.4  
WWR South =90%  
North=60%  
East and West=20%

Glazing Type:  
Double Glazing  
LoE Spectrally  
Selective Tinted  
6mm/13mm Air  
U-value= 0.287,  
SHGC=0.30

triple glazing with  
LoE Clear  
(3mm/13mm Air)

1. Walls R-value=25  
2. Roof R-value= 30

LED Uses 70% less  
energy than typical  
lamps (and its  
radiant fraction is  
lower)

25% of the roof    70% of the roof





*Creating optimal environments for learning*

**Andy Frichtl** PE, LEED AP

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