Prop 39 Zero Net Energy School Retrofits Workshop

ZNE Technical Training for Schools & Building Industry Professionals

Tuesday, November 1, 2016

Pasadena Green Schools Conference

Pasadena, CA

zero net energy

Prop 39 ZNE School Retrofit Workshops

The Prop 39 ZNE Pilot Program is funded by California utility customers and administered by Pacific Gas and Electric Company, San Diego Gas & Electric Company, Southern California Edison Company, and Southern California Gas Company under the auspices of the California Public Utilities Commission. The California investor-owned utilities are not responsible for the preparation of this presentation, nor do any of them make any representation concerning the quality, accuracy or suitability of the information set forth herein. As the author of this presentation, the New Building Institute is solely responsible for this presentation and its contents.

Welcome & Introductions

10:00 – 10:45 a.m.

Introduction to CA ZNE Goals & Policies

Overview of the IOU Prop 39 Zero Net Energy Pilot

Technical Introduction to ZNE – NBI National ZNE Research

Proposition 39: ZNE / Deep Retrofit Pilot for Schools

- D.14-10-046 directs **IOUs to design a new deep retrofit and ZNE pilot for K-12 schools** and community colleges to be run in conjunction with Prop 39
- **Comprehensive plan** that is scalable for the full term of Prop 39
- **Incorporate best practices** from other states and jurisdictions
- **IOUs to consult and coordinate with stakeholders**: state agencies, schools/CCs, ZNE experts, etc.

PHOTO: Turkeyfoot ZNE Middle school, Kentucky

NBI Support for Prop 39
ZNE Schools/Deep Retrofit Pilots

- **6 Technical Training Workshops**

  (3 in Northern CA, 3 in Southern CA)

- **6 Institutional Trainings**

  (3 in Northern CA, 3 in Southern CA)

- **5 ZNE School Case Studies**

PHOTO: Turkeyfoot ZNE Middle school, Kentucky

- **Development of Training Materials & Presentations**

- **ZNE Schools Recognition Program Support (2016)**

Pilot Overview

The ZNE Pilot will provide:

- Design assistance
- Trainings on how to socialize the ZNE concept with stakeholders (e.g. parents, teachers, students, board members)
- Ongoing commissioning and construction inspection
- Training on how to maintain ZNE operations
- Monitoring, verification

And the ZNE Pilot will require:

- Written commitment to the Pilot
- A willingness to design and deeply retrofit an existing building
- A healthy budget
- A willingness to share experiences with other interested schools

Element 1: ZNE Demonstrations

- Small scale, proof-of-concept demonstrations for 13-18 schools statewide.
- The Pilot will focus on existing public school buildings
- Each IOU will implement the demonstrations independently except SCG who will partner with SCE or PG&E dependent on service territory.
- Support began in 2015 and continue for ~3 years
- Pilot funds will reflect Prop 39 allocations with the majority (60-80%) dedicated to K-12 schools and the remainder to community colleges.

Round II - Demonstration Projects

Per Utility (Remaining Projects Available):

PG&E	2-4
SCE/SoCalGas	4-6
SDG&E	2-3
Total	8-13

Per School Type:

CCC	3-5
K-12	5-8
Total	8-13

Our Agenda

10:00 – 10:45	Welcome & Introductions
10:45 - 11:30	Developing your ZNE Plan and Targeting ZNE
11*:30 - 11:40*	*Break*
11:40 - 12:15	Designing to the ZNE Target – Part 1: Design for performance
12:15 - 1:00	*Lunch*
1:00 – 2:00	Case Study Presentations
2:00 - 2:30	Designing to the ZNE Target – Part 2: Design for Operations
2*:30 - 2:45*	*Break*
2:45 - 3:15	Building to the ZNE Design
3:15 - 3:45	Operating to the ZNE Design
3:45 – 4:00	Closing Discussion

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ZNE Workshop Expectations

Zero Net Energy – What is it?

A ZNE building is an ultra-efficient building that generates as much energy as it consumes annually. Also known as Net Zero Energy.


Marin Country Day School (Photo: Michael David Rose)

“Big Bold” Goals for ZNE in California

Exploratorium | San Francisco, CA

1 All new commercial construction will be ZNE by 2030

2 50% of existing buildings will be retrofit to ZNE by 2030

3 All new residential construction in California will be ZNE by 2020

The California Efficiency Strategic Plan (Sep 2008)
californiaenergyefficiency.com/docs/EEStrategicPlan.pdf

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Foundation of State Policies

Global Warming Solutions Act (2006)

AB 32 — Reduces statewide greenhouse gas (GHG) emissions to 1990 levels by 2020 and to 20 percent of 1990 levels by 2050.

Energy Efficiency Program for Existing Buildings (2009)

AB 758 — Requires the Energy Commission to develop and implement a comprehensive program to achieve greater energy savings in the state of California's existing residential and nonresidential building stock.

Long Term Energy Efficiency Strategic Plan (2008)

State's first integrated framework–a single roadmap to achieve maximum energy savings across all major groups and sectors.

Leading by Example

California's Policy for Public Buildings

Executive Order B-18-12 requires state buildings to significantly reduce over the next two decades.

- Any proposed new or major renovation of State buildings larger than 10,000 square feet use clean, on-site power generation, such as solar photovoltaic, solar thermal and wind power generation, and clean back-up power supplies

- 50% of new facilities beginning design after 2020 to be Zero Net Energy.
- 100% of new State buildings & major renovations beginning design after 2025 to be ZNE

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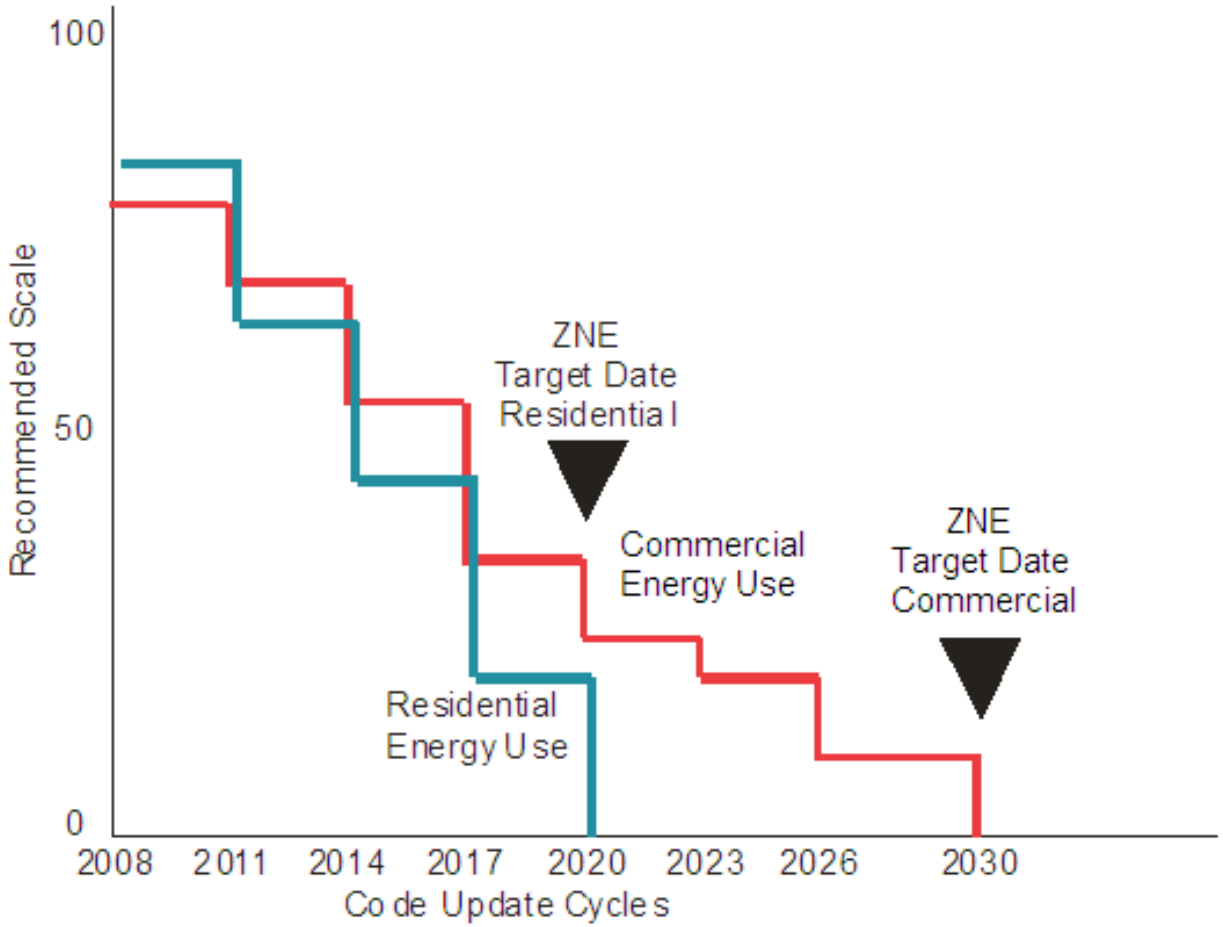
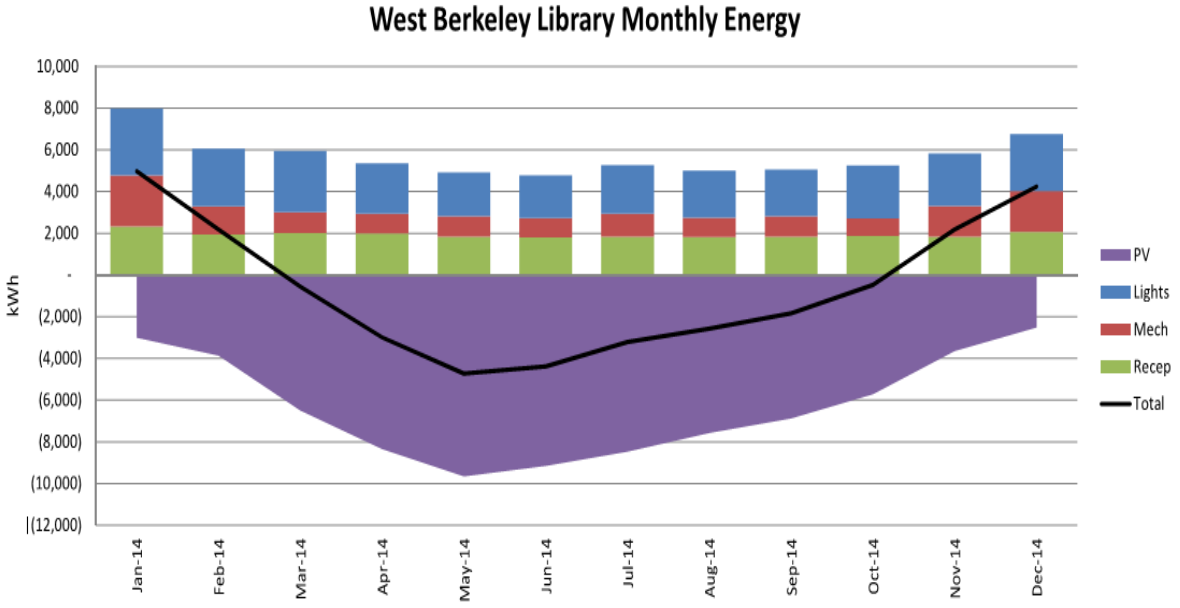
Code Cycles to Net Zero in CA



Code Cycles to ZNE, Source: SCE & AEC, 2009

How do you Measure ZNE?

- ***Time Dependent Value (TDV)***
- ***ZNE Code Building***
- ***Energy Use Intensity (EUI)***



Defining & Measuring ZNE

Time Dependent Valuation (TDV): This is the California metric

*"**A Zero-Net-Energy Code Building** is one where the net amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single "project" seeking development entitlements and building code permits, measured using the CEC's **Time Dependent Valuation** metric."*

"A zero-net energy code building meets an energy use intensity value designated in the Building Energy Efficiency Standards by building type and climate zone that reflect best practices for highly efficient buildings." ***- IOU Advice Letter to CPUC on Prop 39 ZNE School Pilot***

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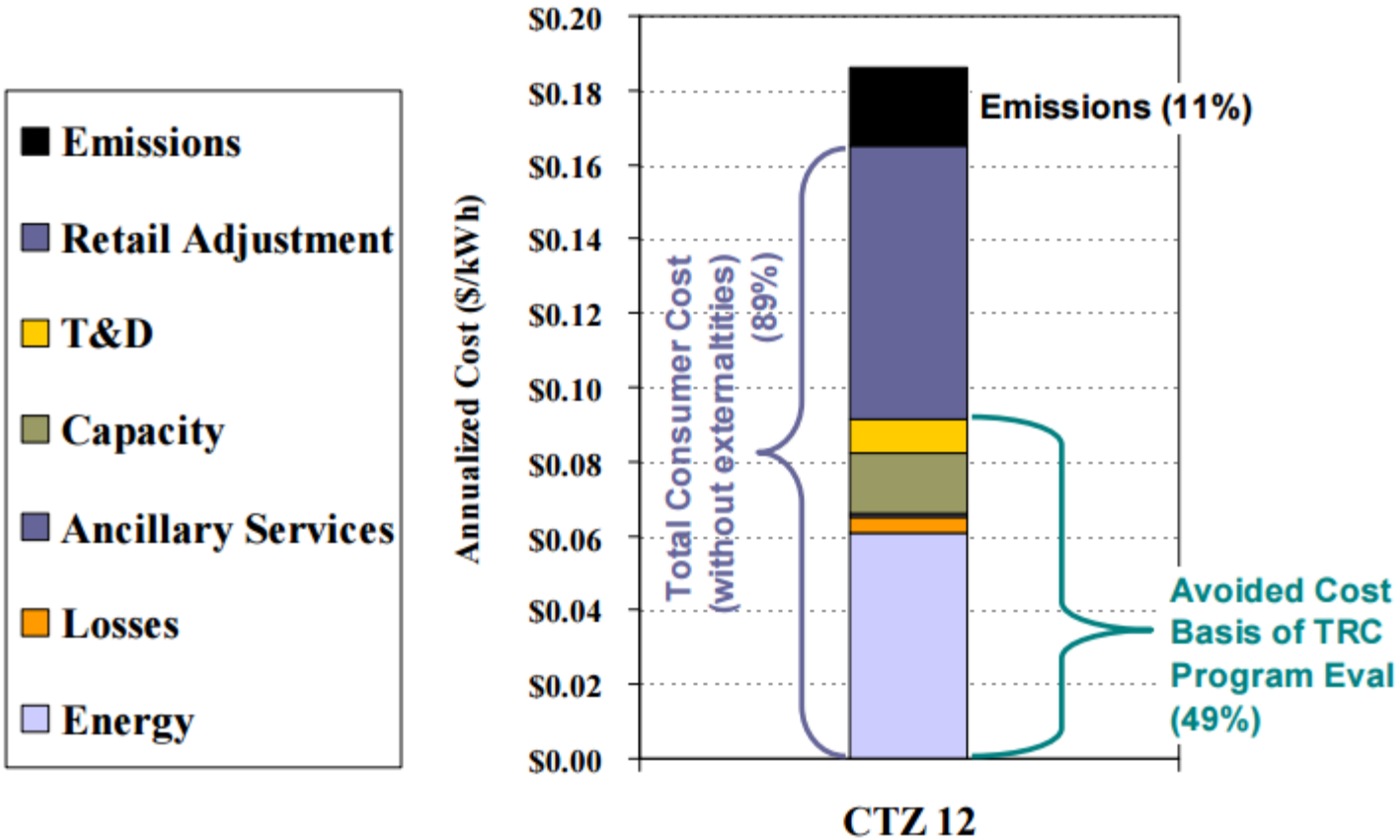
Time Dependent Value of Energy

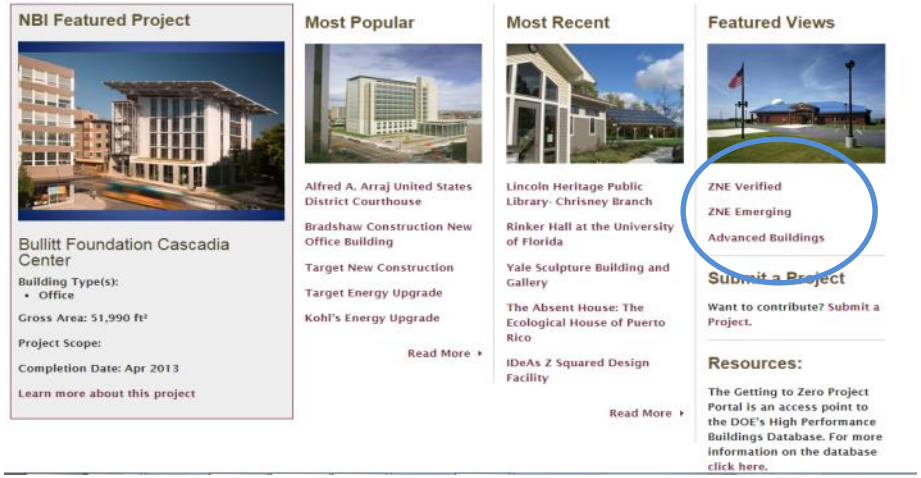


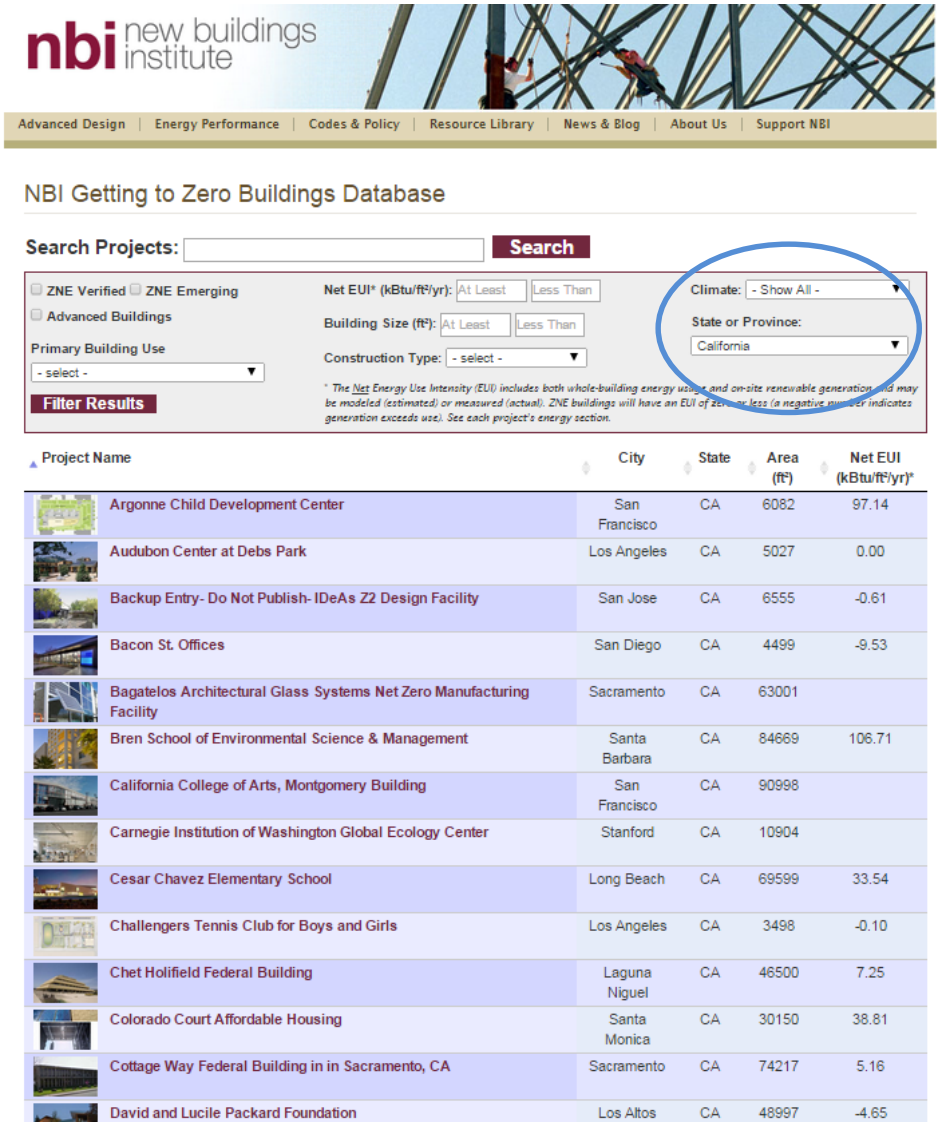
Close approximation of consumer cost with approximately 10% added for emissions

http://www.energy.ca.gov/2011_energypolicy/documents/2011-07-20_workshop/presentations/Revised_Zero_Net_Energy_Definition.pdf

GETTING TO zero BUILDINGS DATABASE

New Buildings Institute is proud to introduce our Getting to Zero Buildings Database.

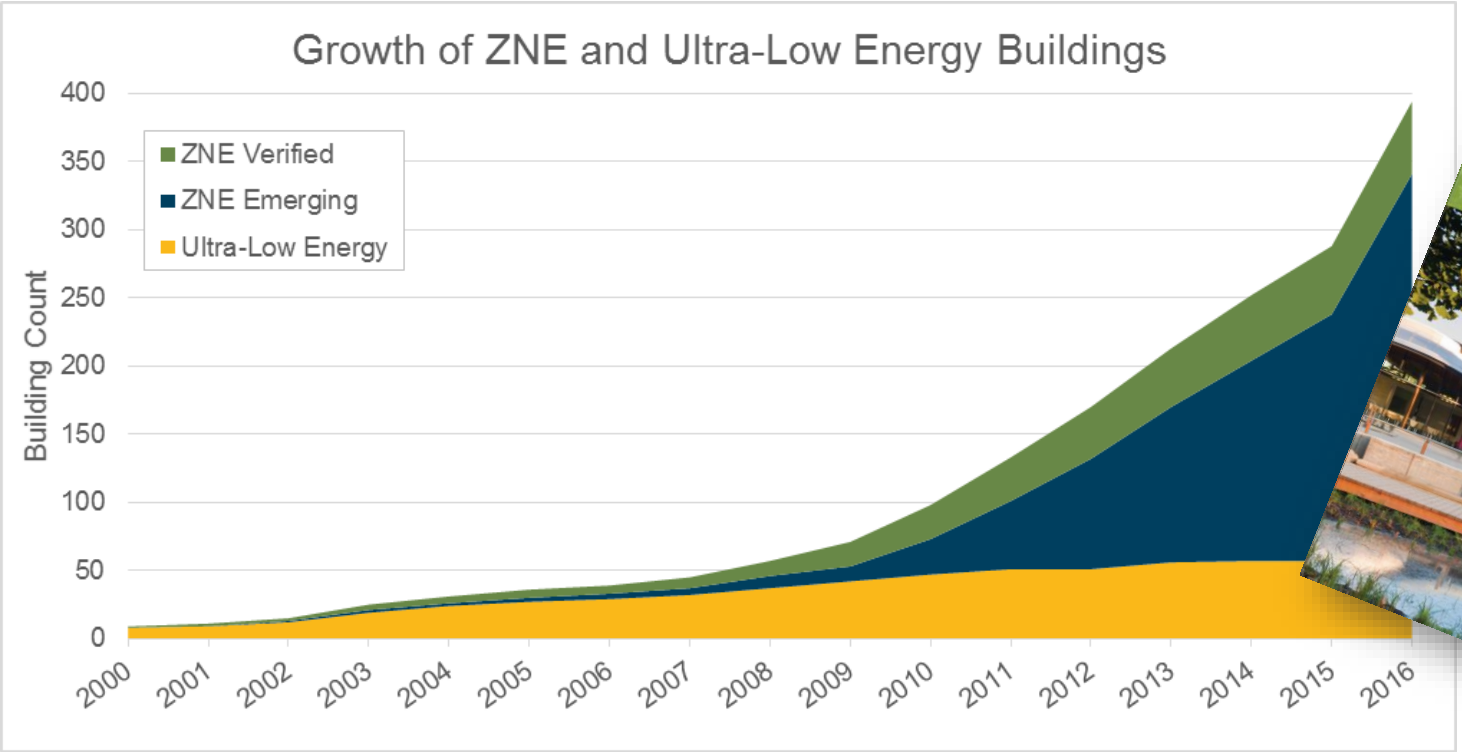


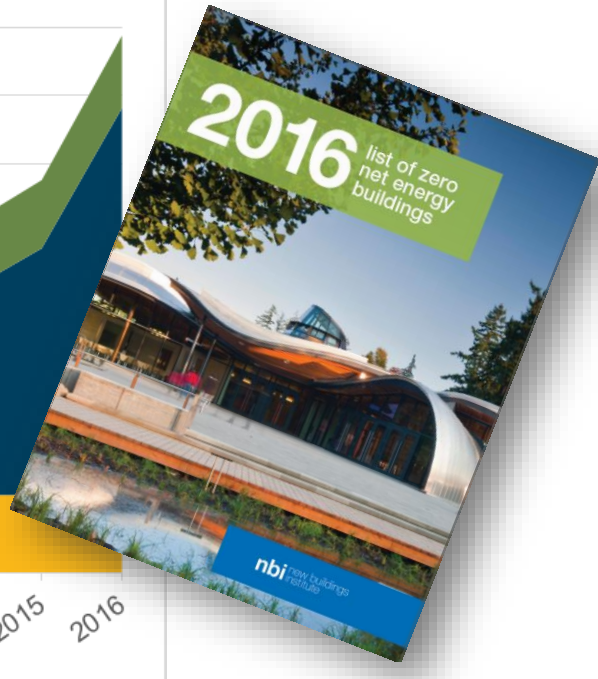


The largest database on ZNE buildings in North America and the only database searchable by ZNE Status & Energy Performance

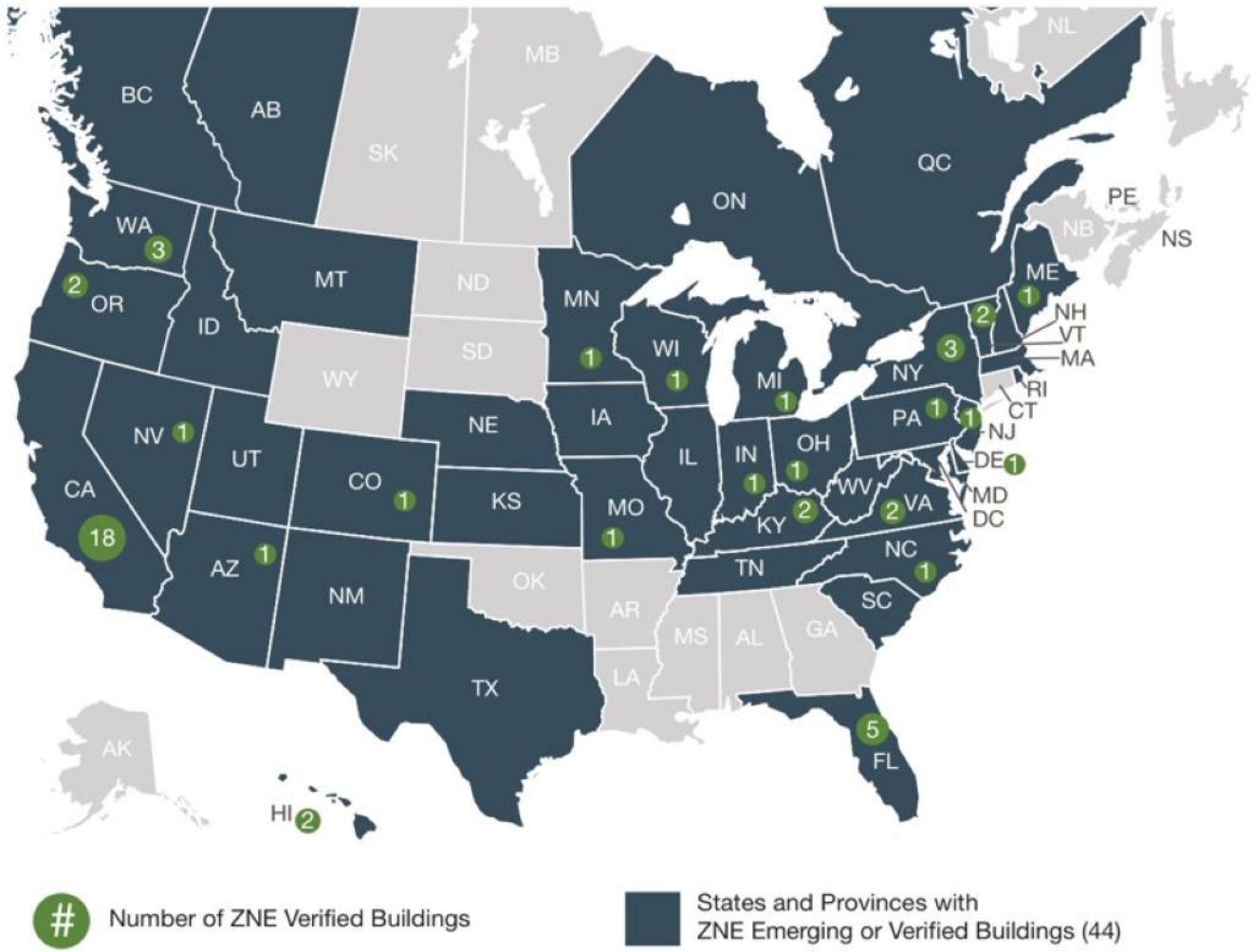
http://newbuildings.org/getting-to-zero-buildings-database

Growth in ZNE Buildings





Where are ZNE Projects?



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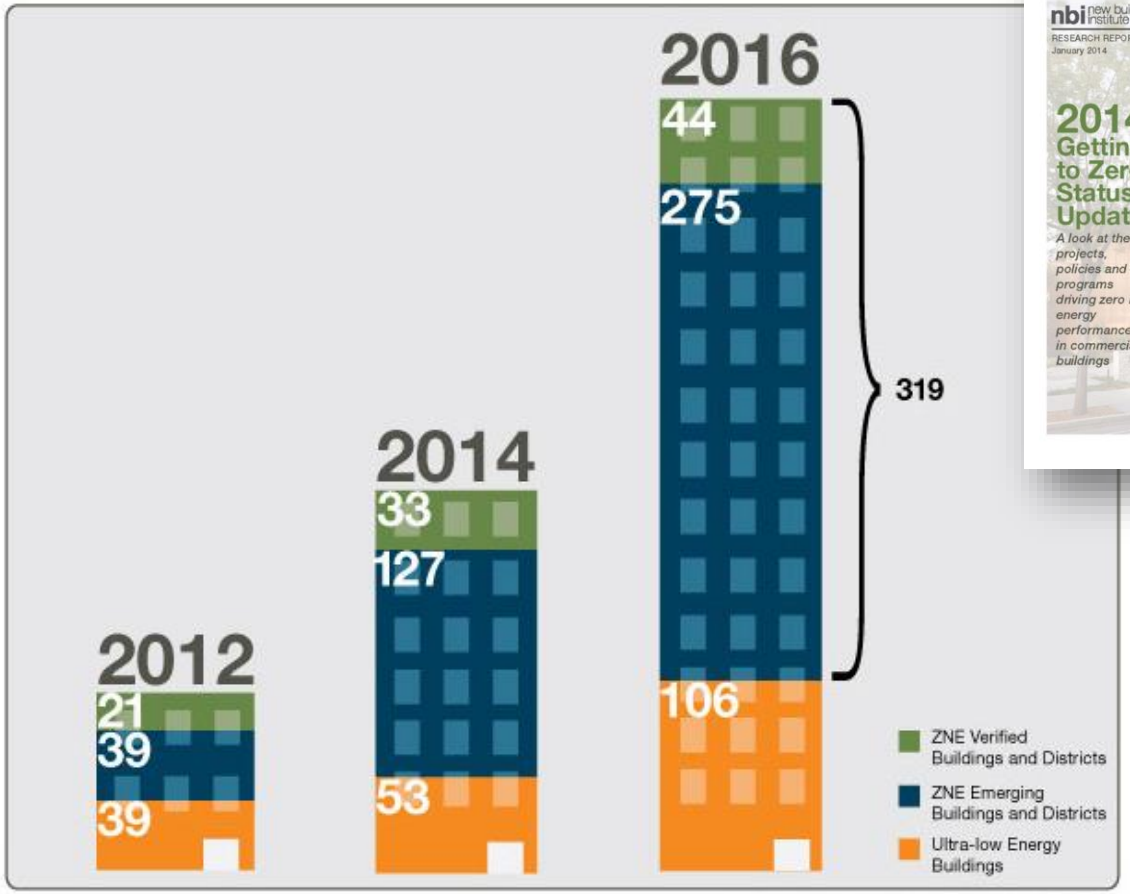
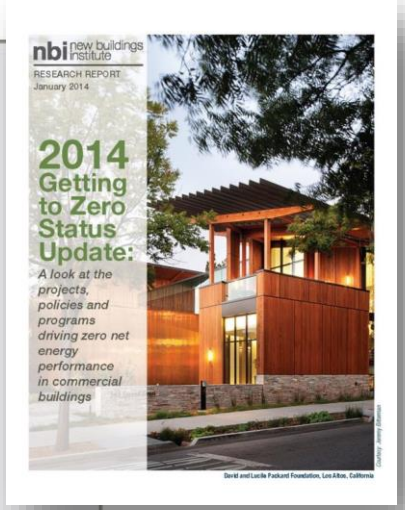
Zero Energy Buildings



Courtesy of New Buildings Institute | newbuildings.org



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ZNE and Ultra-Low Buildings are Possible in Many Building Types Across the US

Small-Med Commercial Offices

K-12 Schools

Large Office Facilities

Environmental Centers

Higher Education Institutions

Government Offices

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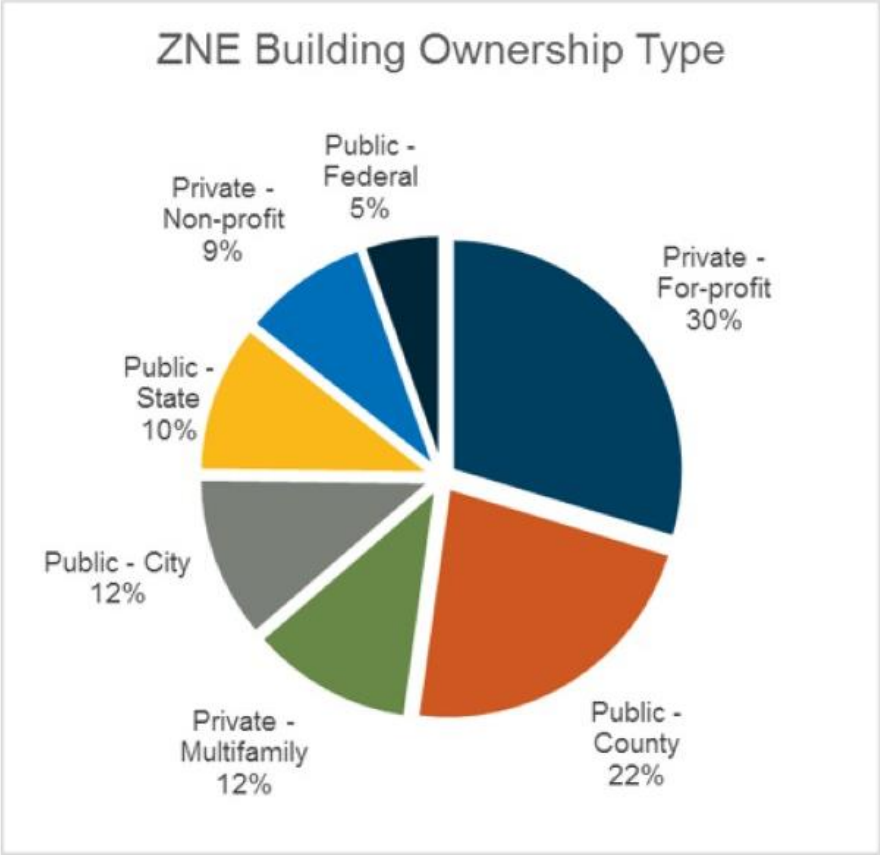
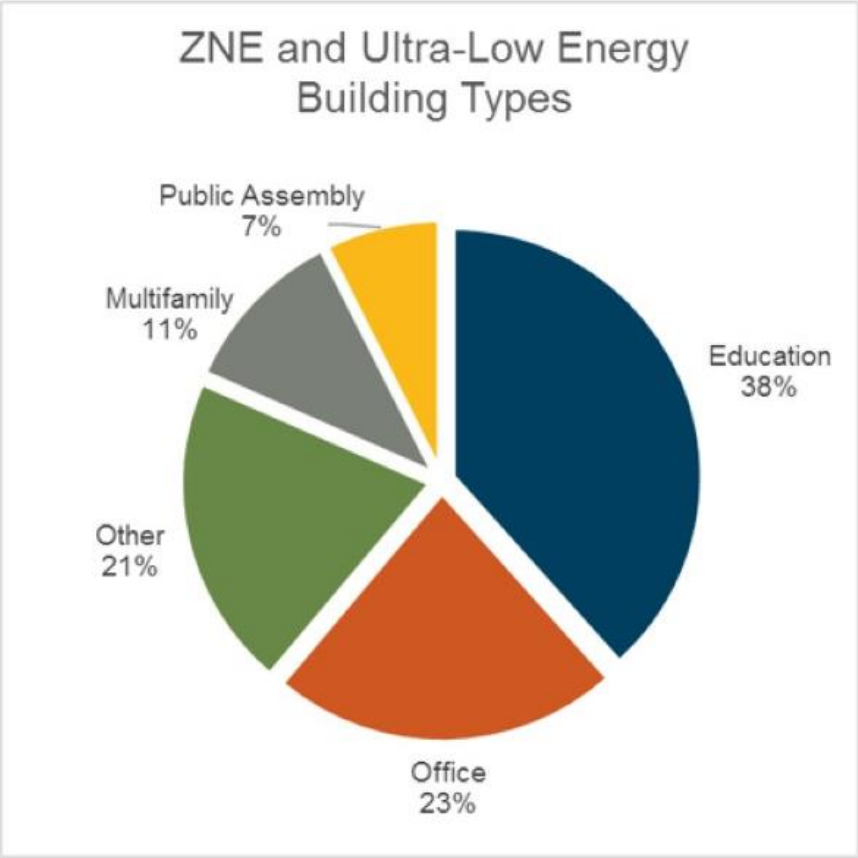
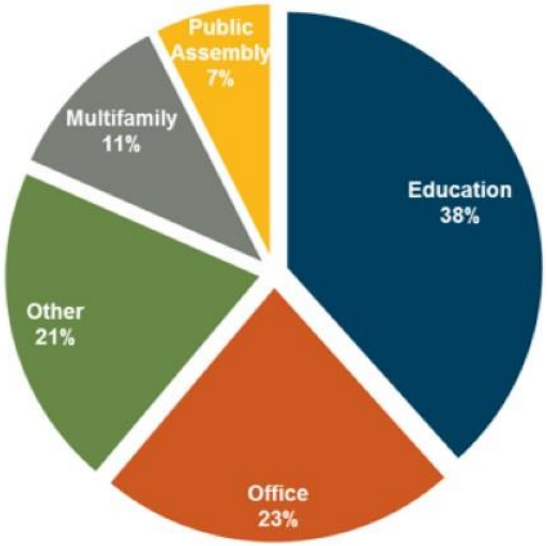
Who is Aiming for ZNE?



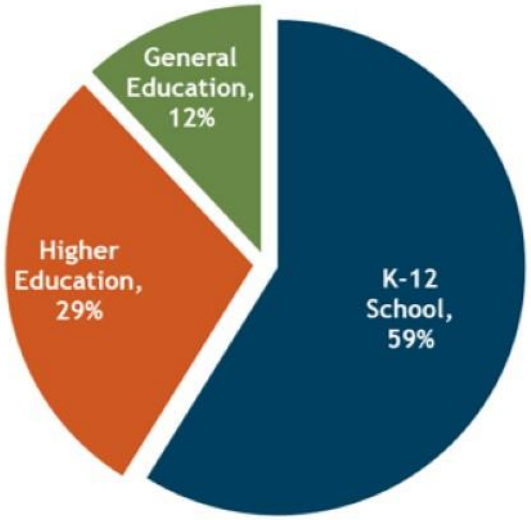


Schools are Leading

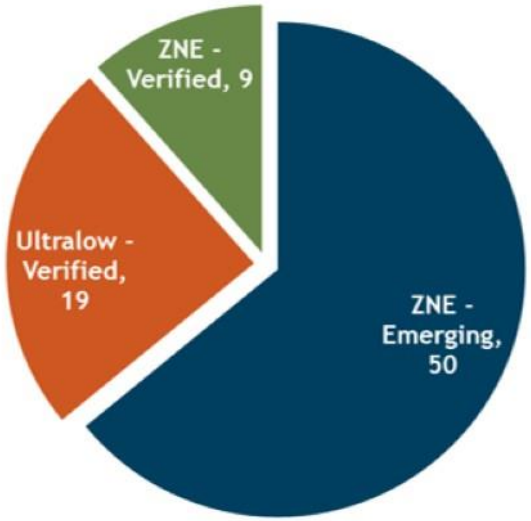
ZNE and Ultra-low Energy Building Types



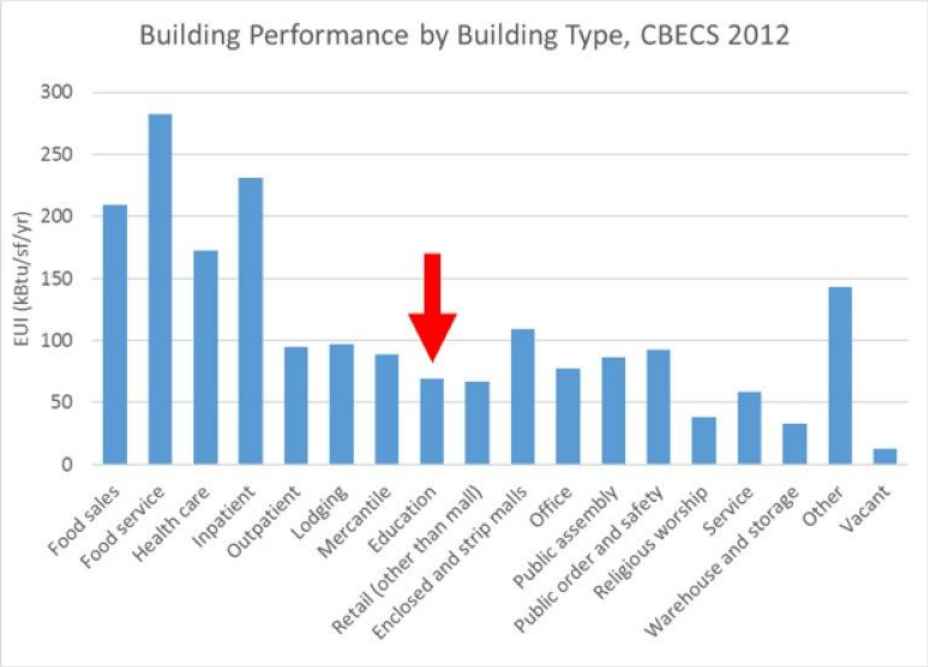
Breakdown of Education Building Types

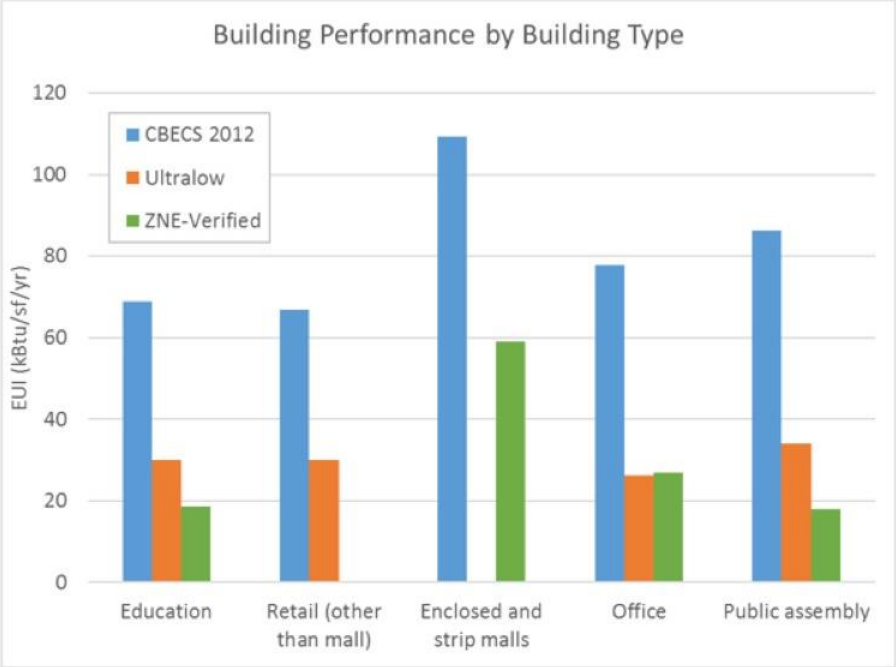


K-12 School Building Count

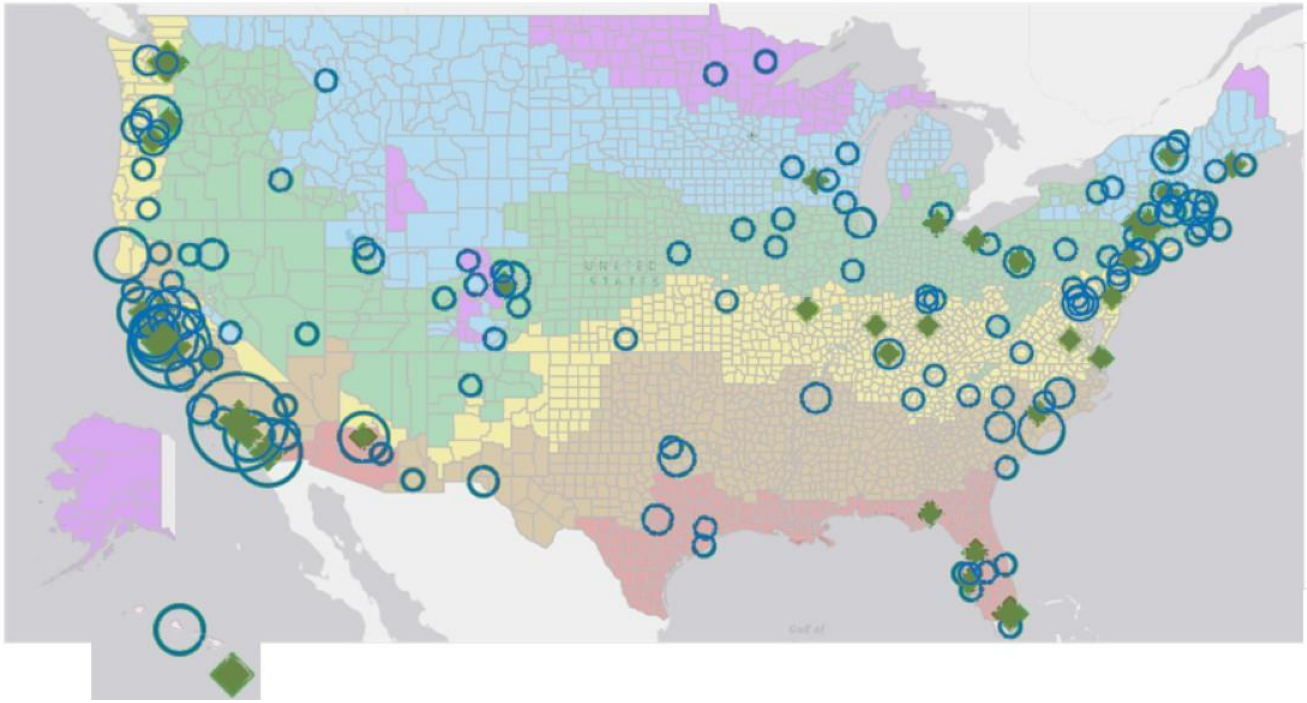


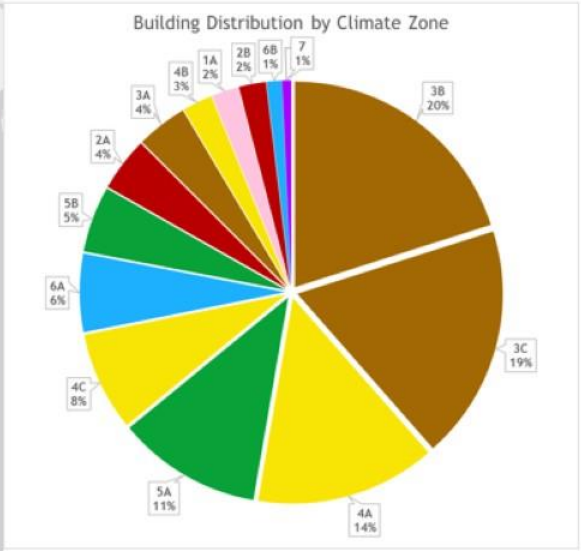
Performance By Building Type





ZNE Buildings in Every Climate Zone





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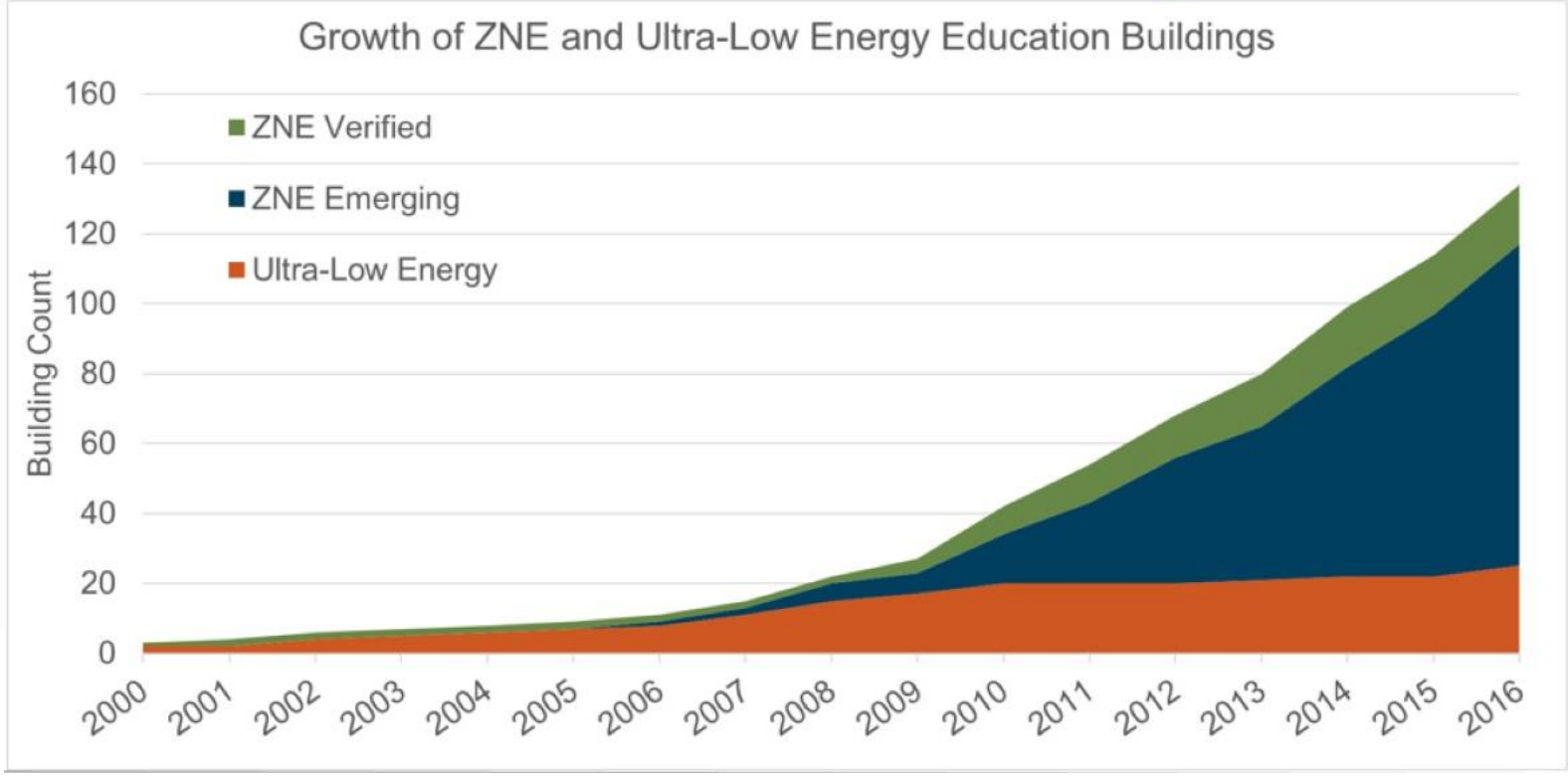
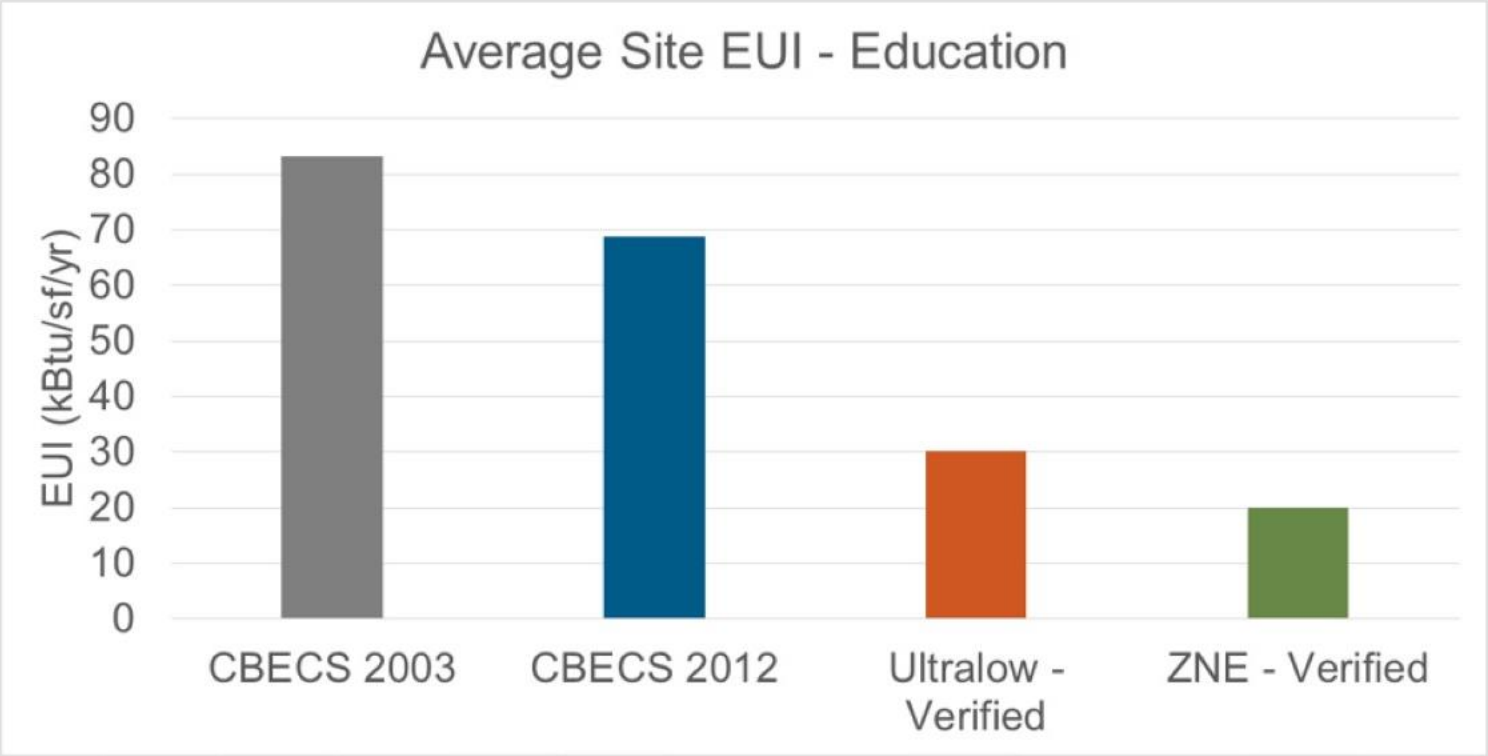
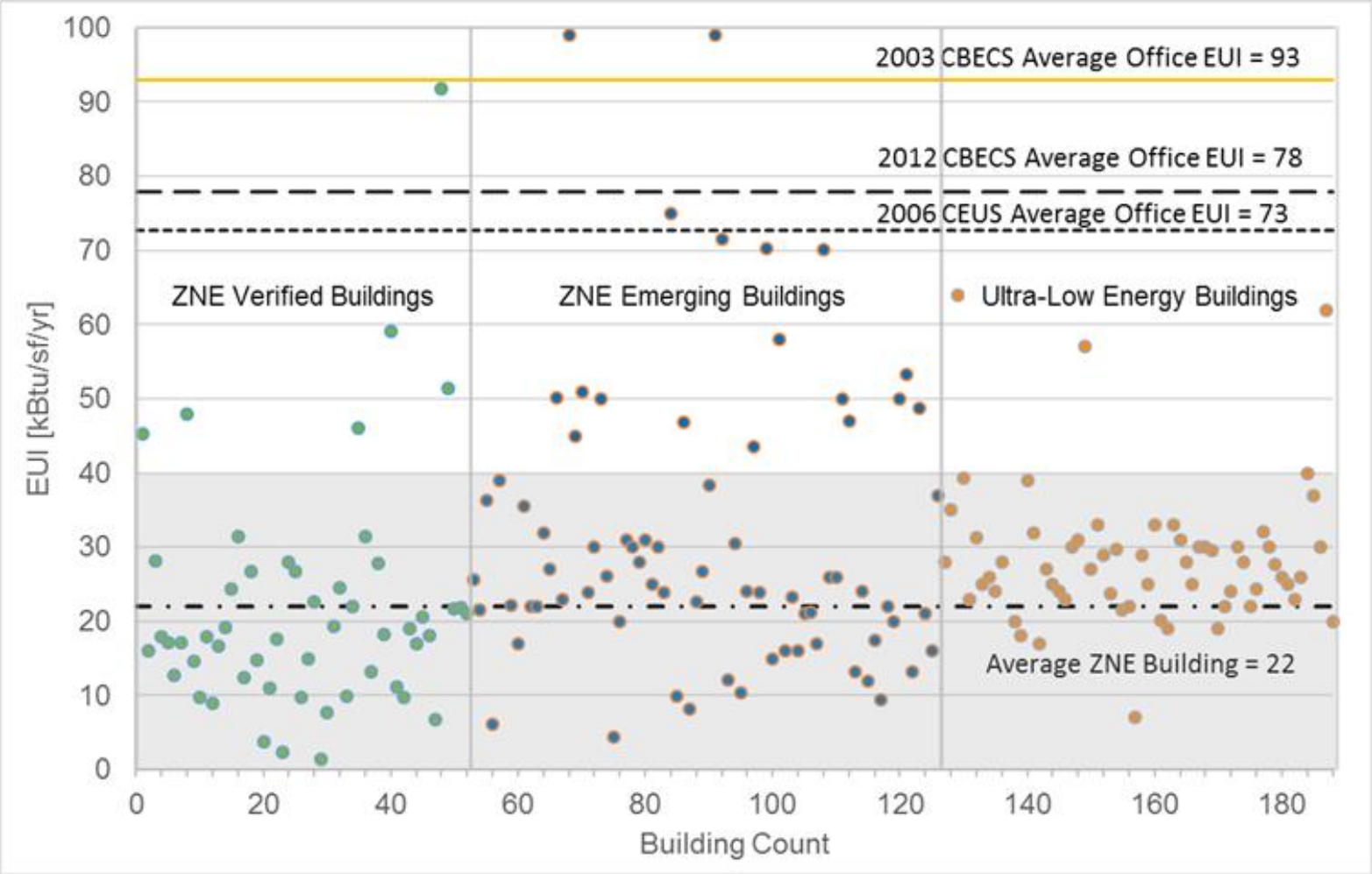
Growth in ZNE and Ultra-Low Energy Education Buildings



Education Sector Energy Performance: ZNE vs. National Averages



ZNE Performance



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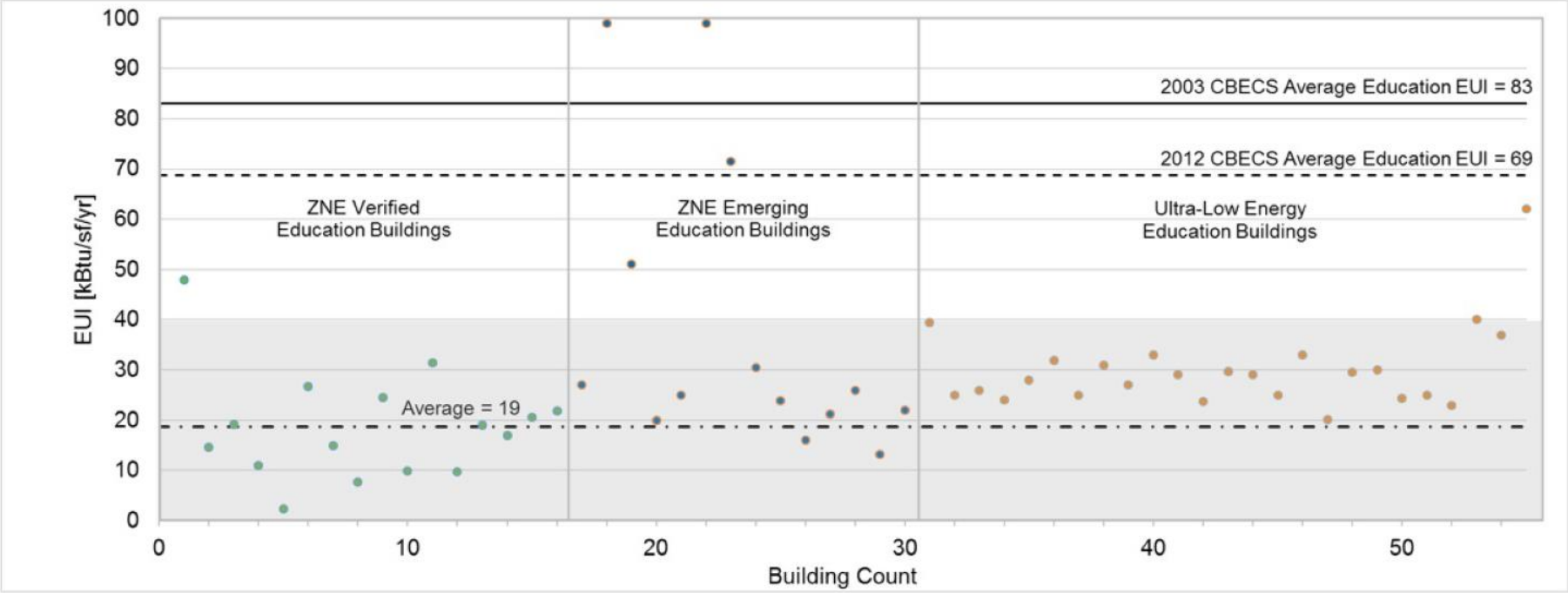
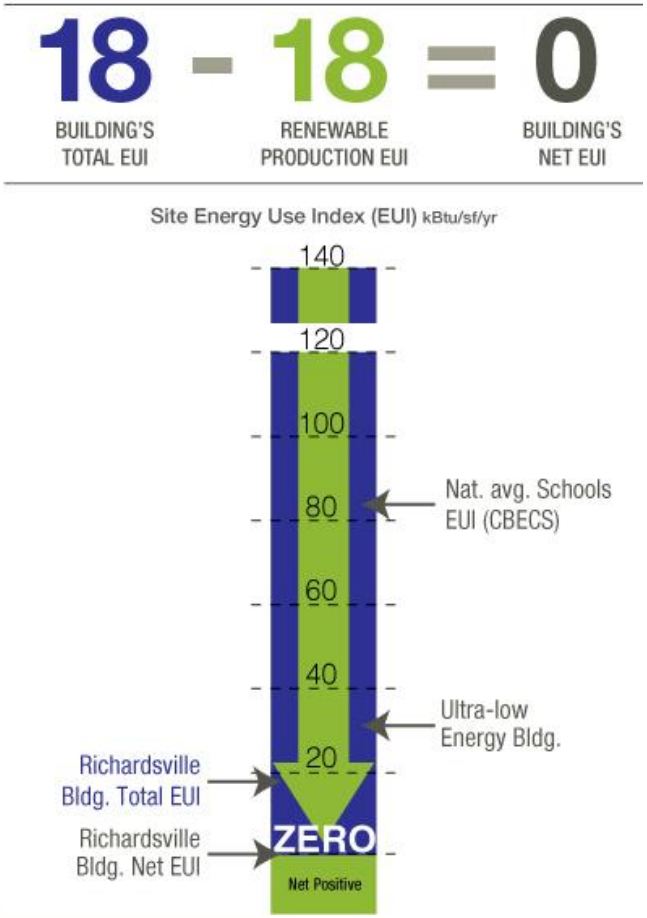
Gross EUI Performance Ranges: Education Buildings



Richardsville Elementary School



Efficiency Measures:

- Ground source heat pump
- DOAS
- CO2 sensors
- Daylighting
- High performance lighting system with controls
- EMS & Energy Dashboard

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Common Technologies for Ultra-low Energy

- Ground Source Heat Pumps
- Ventilation: Natural, Dedicated Outdoor Air Systems (DOAS), Demand Control Ventilation (DCV)
- Highly Efficient Thermal Envelope
- Building Orientation & Glazing ratio
- Solar Control - shading
- Daylighting Access and Controls
- Energy Management Systems
- Building Dashboards
- Radiant Heating/Cooling & Chilled Beams
- Plug load Reductions
- Energy Recovery Systems

Redding School for the Arts, CA

Courtesy : Trilogy Architecture Steve Whittaker Photography

Challenges

- Perception of cost
- PV delayed due to cost
- Getting the metering right
- Using meter data correctly
- Projects not occupied or operated as modeled
- Commissioning – new form of ZNE Cx
- Fear of disclosure - ZNE seen as an end-all

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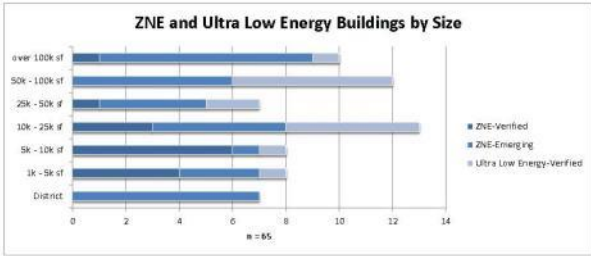
California ZNE Watchlist

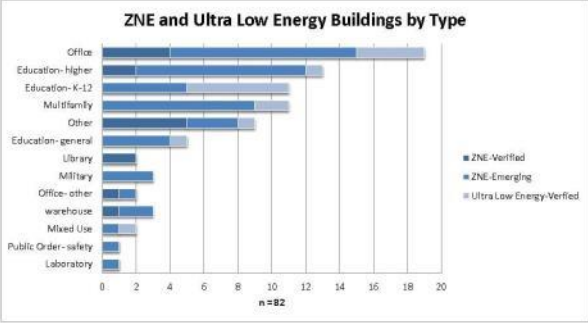
energy upgrade CALIFORNIA

California leads the country in both policy and projects that are laying the path to a zero net energy (ZNE) future. California state agencies have adopted goals for 100% of new and 50% of existing commercial buildings to be ZNE by 2030. Leading design firms and owners have already recognized the real estate and occupancy advantages of these high performance buildings and today California has over 50 commercial buildings either verified (15) as ZNE or emerging (34) toward that target.

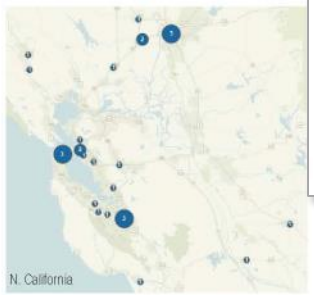
This CA ZNE Watchlist tracks commercial buildings (including multi-family) based on information gathered by New Buildings Institute (NBI) from multiple sources including designers, owners, utility programs, private and public organizations, articles, e-news, research, and commercial real estate professionals. It serves, along with other available ZNE resources[1], to support the awareness, acceptance and adoption of ZNE goals and outcomes throughout California and the nation. Buildings with ultra-low energy performance comparable to ZNE are also included.

The graphics below show the trends in location, type and size of the ZNE buildings in California.





Locations of CA ZNE Verified and Emerging ZNE Building. Dot size represents volume of buildings.



[1] **For more resources:** CPUC (http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Zero+Net+Energy+Buildings.htm) and NBI (www.newbuildings.org/zero-energy)

nbi new buildings institute

Produced by New Buildings Institute. For more information, visit **www.newbuildings.org**.

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List of Zero Energy & Ultra-Low Energy Buildings in California

This ZNE Watchlist provides examples of commercial buildings that have verified zero net energy (ZNE) performance, are emerging toward a ZNE goal or reflect comparable ultra-low energy performance. These are defined as:

- **ZNE Verified** buildings (or districts) have been documented to have met, over the course of a year, all net energy use through onsite renewables. The energy use of all fuels (electric, natural gas, steam, etc.) is counted and offset by production from onsite renewables.
- **ZNE Emerging** buildings (or districts) have a publically stated goal of ZNE but do not yet meet the definition of ZNE verified. These may be in the planning or design phase, under construction or have been in operation for less than a year. Others may have been operating for 12 months or longer, but their measured energy has either yet to achieve net zero or the measured data to document ZNE verified status was not available.
- **Ultra-low Energy Verified** buildings have 12 or more months of metered data that documents energy performance comparable to ZNE buildings (typically 60-80% better than the national industry average). They expand the set of building examples with design strategies and technologies that have resulted in ultra-low energy use. They may have limited renewable resources onsite but do not have a known stated goal of ZNE.

There are, undoubtedly, other projects that belong on this list and/or corrections and updates to this directory. Provide information or add new projects through the NBI Registry located at: http://newbuildings.org/share or email us at info@newbuildings.org.

Building Name	Year Completed	Location	Building Type	Size SF	Total EUI	Site RPI	Net EUI
Verified ZNE							
Audubon Center at Debs Park	2003	E Los Angeles	Other	5,000	17.1	17.1	0.0
Bacon St. Offices	2009	San Diego	Office	4,500	12.7	22.2	-9.5
Challengers Tennis Club							
David and Lucile Packard Fo							
Diamond X Ranch Student Im							
DPR Construction San Diego							
Environmental Nature Center							
Environmental Tech. Center S							
Davis ZZ Design Facility							
Jesse Jackson Sustainable Wo							
Leslie Shao-Ming Sun Field S							
Sacred Heart Schools Stevens							
Vacaville Transportation Cente							
Watsonville Water Resources							
West Berkeley Public Library							

Energy Use Intensity (EUI) is the
EUI meaning the renewable product
Renewable Production Intensity

energy upgrade CALIFORNIA

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Building Name	Year Completed	Location	Building Type	Size SF	Total EUI	Site RPI	Net EUI
ZNE Emerging Buildings							
435 Indio	2013	Sunnevale	Office	31,800	28.9		
Aquarium of the Pacific Watershed Addition	2008	Long Beach	Education - general	2,500			
Astor Place	2012	Eureka	Multifamily	NA			
Bagatelle Architectural Glass Solutions (M)	2008	Sacramento	warehouse	63,000	10.4	6.1	2.3
BBSI Center at Loney College	under construction	Oakland	education - higher	[illegible]			
Blackford School - Multi-Use Build							
California Department of Motor Ve							
California DGT S708B Phase 2 Ve							
Camp Parks							
Church Hill Townhomes							
College of the Desert, West Valley C Phase 1							
Corning N. High Renovation							
DPR San Francisco Office							
Eagle Crest							
Family Fort Hospital							
Forest Service Technology & Tra							
Fort Irwin Upgrade							
George V. Lewis Middle School Adt San Jose							
Hanover Page Mill Building							
IBEW Local 595 Zero Net Energy							
Kaiser Permanente Antelope Valley Medical Office Building							
La Escuela Del Education Center							
La Verontina North							
Los Angeles Harbor College Solar							
Los Surinose Correctional Facility							
LPL Financial Center at La Jolla Go							
Marchese Architecture Studio (M)							
Mutual Housing at Spring Lake							
Net ZERO Plus Electric Training In							
Oak Park High School							
Ohlone Campus Dove Replacement							
Pierce College Maintenance & Op Facility and Net Zero Central Plant							
Plaza Point							
Reading School for the Arts (M)							
Rio Vista							

Energy Use Intensity (EUI) is the total
EUI meaning the renewable production e
Renewable Production Intensity (RP

(M) after the name indicates measured

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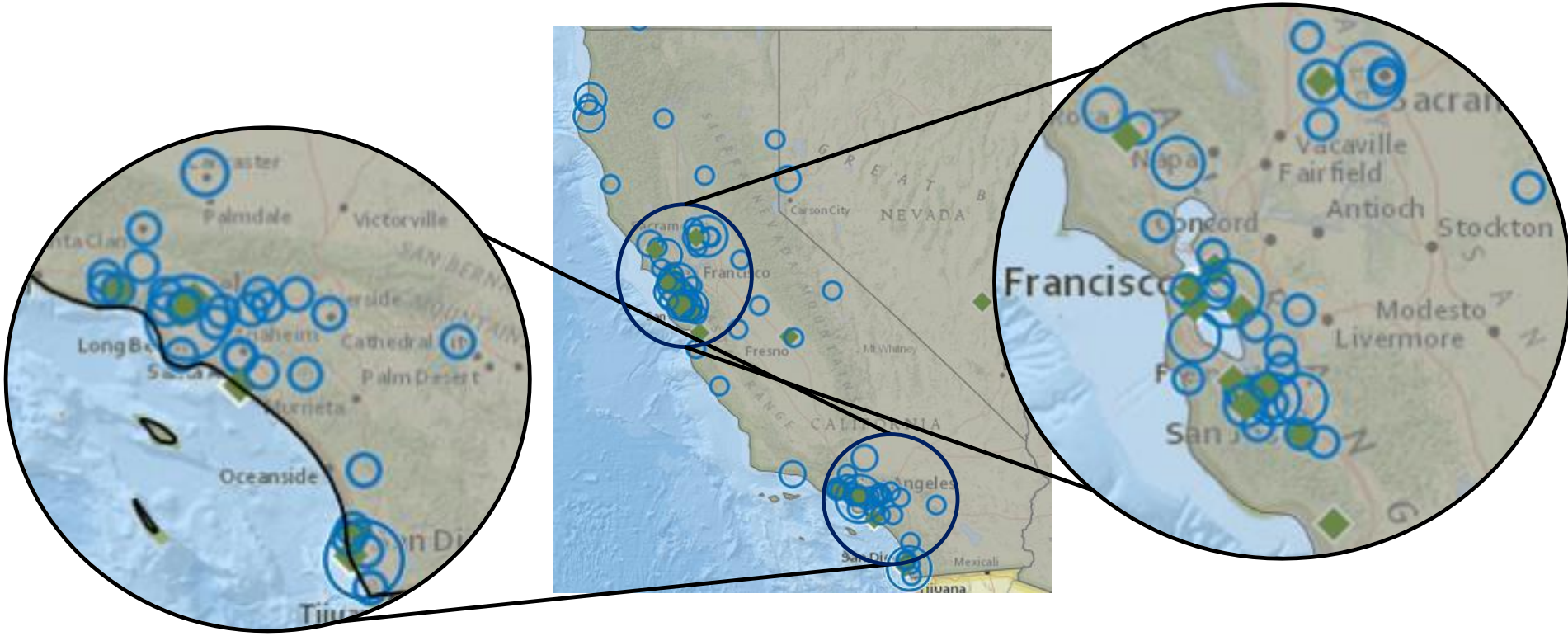
Building Name	Year Completed	Location	Building Type	Size SF	Total EUI	Site RPI	Net EUI
[illegible] village	2013	Victorville	Multifamily	NA			
Sail - National Wildlife Refuge Complex headquarters and Visitor Center	2012	Los Banos	Education - general	14,000	6	6	0
Sierra Army Depot		Herlong	Military	District			
Sierra Nevada Aquatic Research Lab Multi-use Classroom and Dormitory	2015	Mammoth Lakes	Education - higher	9,865			
SMUD Die Zero Carbon - East Campus Operations Center	2015	Sacramento	Office	350,000			
Solana Ranch Renewable Schools	2014	San Diego	Education - K-12	65,000			
Solitt Ta Lo Luxury Apartments	2013	San Diego	Multifamily	NA			
Solano Court	2014	Hayward	Multifamily	NA			
Student Services Center at Mesa College	2011	San Diego	Education - higher	85,000			
Student Success and Retention Center at Pasadena City College	2014	Los Angeles	Education - higher	139,000			
UC Davis West Village eco-district	2012	Davis	Mixed Use	District			
UC Merced	2009	Merced	Education - higher	District			
UC San Diego - Kavli Nanoscience Institute	2013	La Jolla	Laboratory	45,000	50		
UC Santa Barbara Recreation Center	under construction	Santa Barbara	Education - higher	NA			
UC Santa Barbara Student Services Buildings		Santa Barbara	Education - higher	District			
Vi Outdoor HQ	2013	Alameda	Office	50,000			
Ultra Low Energy Verified Buildings							
850 Hill Street - The Metropolitan Apartments Mixed-Use Building	2010	San Francisco	Mixed Use	14,000	0	0	-
Aventine	2005	La Jolla	Office	212,000	23	0	23
Better Hills Modernization	2005	Santee	Education - K-12	65,598	26.0	0.0	26.0
Better Oaks Modernization	2005	Santee	Education - K-12	67,575	24.0	0.0	24.0
Center for Children & Families - Sea Breeze Academy	2007	San Marcos	Education - general	20,200	20.0	0.0	20.0
California & Cornerstone Winery	1995	Santa Ana Orland	Office	2,595	20.0	0.0	20.0
Cambridge Court Apartments Housing	2002	Santa Monica	Multifamily	29,400	30.0	2.4	28.4
Carey at Bell - Homestead School	2007	Los Altos	Education - K-12	71,741	33	0	33
Fall Creek High - Creek Plate	2009	Creek Plate	Education - K-12	44,320	40.3	14.2	26.1
Jordan Apts - House of Hospitality	2005	San Rafael	Other	6,250	7.0	0.0	7.0
Mark Clarke Performing and Visual Arts at Pasadena College	2005	Los Altos	Education - higher	21,600	33	16	22
Los Madrones - Multifamily	2009	Santa Rosa	Multifamily	61,000	19.2	9.0	10.2
Meg Building 930		Fort Hueneme	Office	17,000	15	11	15
Mesa Verde Office Building	2005	San Diego	Office	76,000	24	0	24
Symphony Science Mathematics	2005	Santee	Education - K-12	67,500	28.0	0.0	28.0
Westmont High School Science Education Facility	2004	Campbell	Education - K-12	12,012	10.8	0.0	10.8

Energy Use Intensity (EUI) is the total energy use of the building in MBtu/sf/yr. Site energy is the energy used at the building. EUI is a negative number when EUI is negative the renewable production exceeds the energy use.
Renewable Production Intensity (RPI) is the energy production of the site in MBtu/sf/yr. This term was created by NBI to work with the scale.
(M) after the name indicates measured energy use. All others are estimated / modeled.

Page 4 of 4

California ZNE Watchlist Spring 2015

ZNE Buildings in California



ZNE Schools: Top Five States

State	ZNE Verified	ZNE Emerging	Ultra-Low Energy Verified	Grand Total
CA	1	18	6	25
KY	2	3	4	9
NC	1	4	2	7
TX	0	5	1	6
SC	0	5	0	5
Total	**9**	**50**	**19**	**78**

What Buildings Make Sense for ZNE?

Most Building Types are feasible

- Administrative buildings
- Classrooms
- Service buildings
- Warehouses
- Recreation & environmental centers
- Libraries
- Low occupancy buildings/facilities

Priority Buildings

New school buildings/campuses

- Buildings needing major replacement, big energy hogs, buildings where systems are needing major retrofits

How are Schools Getting to ZNE?

- **Assessment of existing building stock** to find opportunities
- **Capital improvement projects** - Look at pipeline of coming up needed
- **Existing building renewal -** Making major retrofits get to ZNE when significant system or structural upgrades are made
- **Prototype Approach** – Campbell School District targeting 8 ZNE schools

Scaling ZNE

- **ZNE Building** for new and existing facilities – LA Harbor College
- **Campus-wide ZNE** – San Mateo Community College
- **Portfolio-wide Policy Approach** – IUSD, LASD energy and solar investments
- **District Approach -** FortZED

Why ZNE Schools?

Why ZNE Schools?

Why not?! Reverse the argument/conversation - Start from ground up with educating students about ZNE + sustainability - Set an example for ZNE/Env. Leadership - Current path is unsustainable -Need a more financially sustainable route - Also spreading the message to school + broader community - Healthier buildings (e.g., daylighting, or relating to higher test scores) - Schools can be resilient resource centers - Wise use of public funds - Increased savings in operations, brings more money for programs - Showing students what is possible - Demonstrating how schools play a part in meeting state and city goals - Demonstrating good stewardship and leaving a positive legacy for future generations - Students are good advocates with parents - Owner occupied buildings have best payback over long term - Not an unlimited amount of energy - Carbon footprint - Next generation of leaders - Energy savings goes back to programs - Mandate is looming - Next step after LEED - Cost savings - School district as model for community - As a building type, it is ideal – low occupancy, sufficient land, owner-occupied - Greenhouse gas reductions and climate goals - Fiscally responsible with taxpayer dollars - Better financing terms - Education next generation of leaders - Better financing terms - Education next generation of leaders - Increased population, increased need for more schools, will be more cost-effective to build now - Learning/teaching benefits: daylighting enhances student performance and wellbeing, biophilia (connection to nature) - Easier to operate - Maintenance - Energy savings - Retention rates - School as teaching tool - Save planet one building at a time - Necessity - Electricity is expensive - Reinvest savings for other programs - Set a good example for kids - see us doing this - demonstrate leadership - Technology creates a better, more convenient building - Attract and retain students and faculty - Quantitative benefits - Integrate into curriculum - Building awareness - Stay with them whole lives - Change expectations of students - We are doing our part - Better test scores and health

Why ZNE Schools?

- **Innovation & Leadership** - When public sector leads, others will follow. A commitment to zero energy buildings is an important demonstration of leadership and innovation in education.
- **Resiliency** – School facilities often serve as community centers for refuge in times of emergency.
- **Climate & Environmental Sustainability Goals** – Climate Action Plans, State goals, Green Schools Sustainability Roadmap
- **Energy & Cost Savings mean more financial resources are available** to support students, educational programs and facilities
- **Long Term Savings** in efficiency, cost, operations, climate
- **Innovative Educational Approaches** – Experiential Learning

Developing your ZNE Plan & Targeting ZNE

10:45 – 11:30 a.m.

Benchmarking and assessing your existing school building. Setting performance targets: more than just EUI. Making ZNE a part of the designer contract and using the Owners Project Requirements to guide the ZNE process

Developing your ZNE Plan & Targeting ZNE

KEY TOPICS:

- Developing your **ZNE project plan**
- **Engaging Stakeholders** - ZNE Communication Toolkit
- Project **funding and financing strategies** (benefits of reduced operating budget) (ESCO model)
- **Benchmarking and assessing** existing school facility performance
- **Setting performance targets**: more than just EUI
- Making ZNE a part of the **designer contract**
- Selecting your **project team**
- Owners Project Requirements & the ZNE process

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EARLY ADOPTERS NETWORK

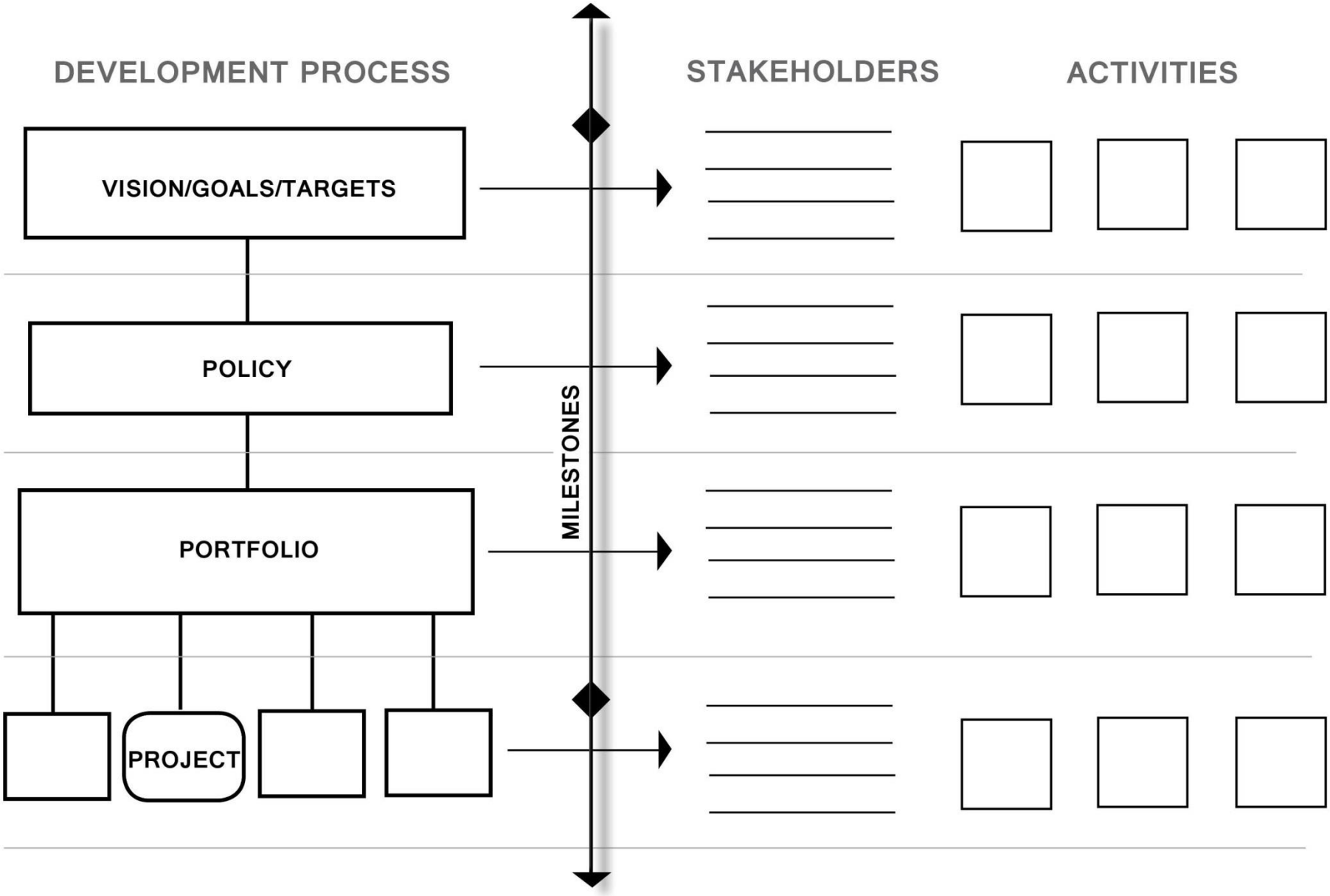
TOOLS & RESOURCES FOR ZNE PLANS

1 Laying the FOUNDATION

2 Orchestrating RESOURCES

3 Developing a ZNE PLAN

BUILDING BLOCKS FOR ZNE PLANNING



Assembling the Building Blocks of your ZNE Plan

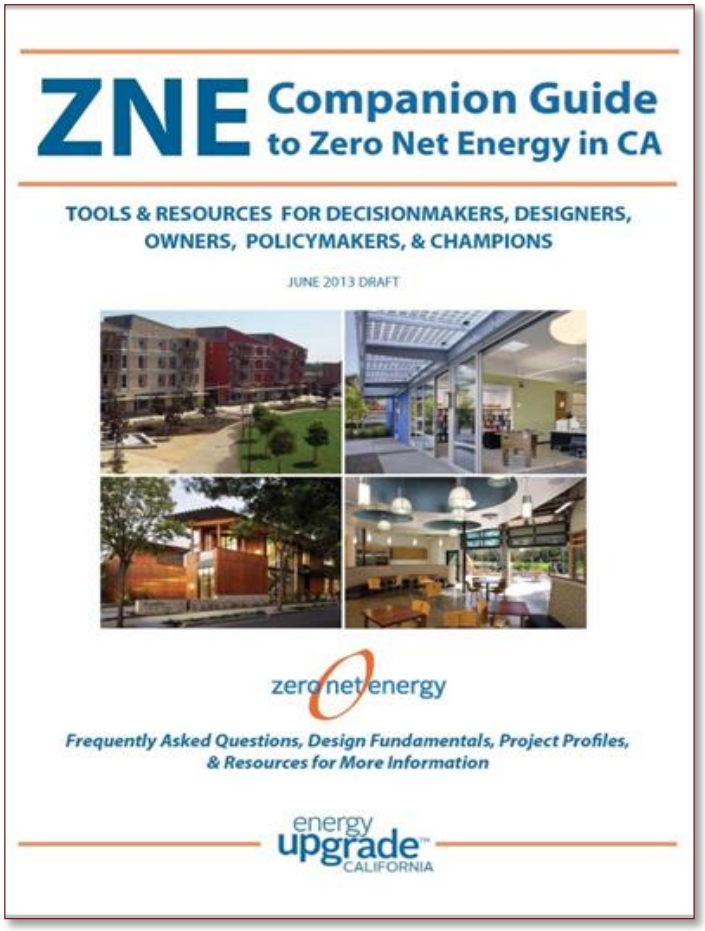
1. **Set your goals** & milestones (Worksheet)
2. **Backcast** how you will get to ZNE (Worksheet)
3. I**dentify your key stakeholders and communication goals**, then map stakeholder interaction (Worksheet)
4. **Develop your Communication & Outreach Plan**, then engage stakeholders
5. **Conduct a gap analysis** & create a plan for alignment (Worksheets)
6. **Review your current/future building & retrofit plans** for ZNE opportunities and develop criteria for prioritizing

Assembling the Building Blocks of your ZNE Plan

7. Identify & conduct any **special research/studies** needed
8. **Select a pilot project**
9. **Evaluate available delivery method options** for best likely ZNE result (Worksheet)
10. **Explore alternative financing approaches** to help offset costs
11. **Create RFQ/RFP that sets clear owner requirements and targets for ZNE**
12. Conduct an **integrated design process** and **use proven technologies & design** strategies

ZNE Communication Toolkit

1. **ZNE Action Bulletin**
   News, case studies, policy, research, events and trainings
2. **Message Platform**
   Key target audience messages
3. **Intro to ZNE Presentation**
   ZNE What, Why & How
4. **Case Studies**
   California project examples, including design strategies, planning, cost, and lessons learned
5. **ZNE Companion Guide/Fact Sheets**
   General info, key audiences messages



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www.newbuildings.org/zne-communications-toolkit

energy upgrade CALIFORNIA

ZERO NET ENERGY BUILDINGS
BACKCASTING TIMELINE

1 Laying the FOUNDATION
2 Orchestrating RESOURCES
3 Developing a ZNE PLAN

BUILDING SCALE

Begin with the End in Mind

2014 — 1 Year — 2015 — 5 Year — 2017 — 10 Year — 2020 — 2025 — 2030 — ZNE

- *Envelope*
- *HVAC*
- *Lighting*
- *Space Planning*
- *Finance - Strategies + Opportunities*
- *Process - Planning, Contracting, Design*
- *People - Stakeholder Engagement, Education + Outreach*

2015 GOALS	2020 GOALS	2030 GOALS

Developing your ZNE Plan & Targeting ZNE

- Project funding and financing strategies
- Life-Cycle Cost Analysis
- Budget Guidelines

Fundraising & Financing Strategies

1. **Utility Program Support -** Savings By Design
2. **Pilot Research Program**
3. **Technology Demonstrations**
4. **Use an Upgradable Design Strategy** (e.g. Redding School for the Arts)
5. **External Grant Funding**
6. **District Approach to Energy** (FortZED)
7. **Solar Financing District** (e.g PACE)
8. **Prop 39 funding for schools**

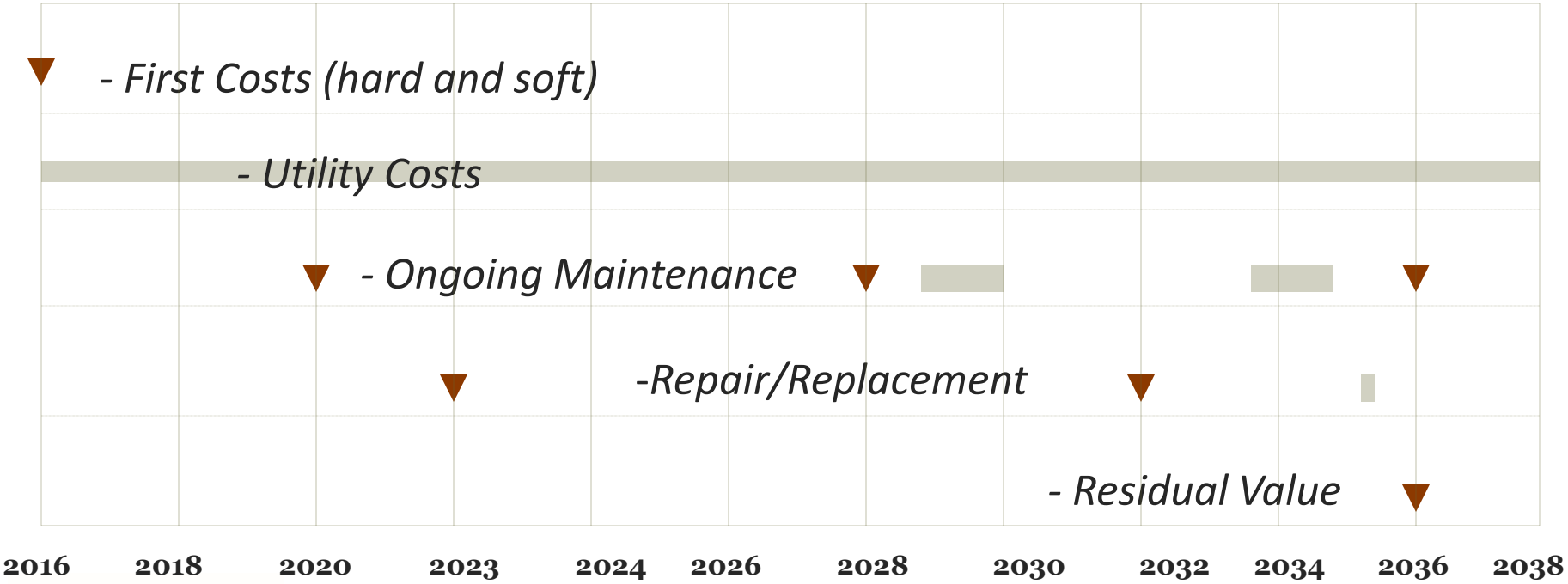
Fundraising & Financing Strategies

9. **Prototypical Design for replication of standard buildings** (Campbell School District's 8 new schools)
10. **Reduction of operation costs = increased capital project budgets**
11. **Power purchase agreements** (PPAs)
12. **Energy Service Companies** (ESCo)
13. **Emerging Tech programs** through utilities
14. **Urban development tools** (if they are in local government redevelopment area)
15. **FEMA or hazard mitigation financing** for resiliency planning and critical building upgrades

Life Cycle Cost Analysis - LCCA

What is the full price of a building?

Life Cycle Cost =
Net Present Value of:



5.1-energy-life-cycle-cost [Compatibility Mode] - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW

Y35

Figure 5.1 ENERGY LIFE CYCLE COST SPREADSHEET

ELCCA2005.xls 18-Apr-16

----------PROJECT DATA----------

PROJECT: Facility Name (Firm Name)

ALT. No.: Description (Analyst's Name)

----------DISCOUNT & ESCALATION Real Rates as of November 2004----------

Enter 1 or 0 for each fuel type:			Years:	Rate:
	1 = Yes	Real Discount Rate (i)	2005 - 2,040	2.0%
	0 = No	Electricity	2005 - 2,015	1.0%
IOU Electricity Source*	1	(Investor Owned Utility)	2,016 - 2,025	2.0%
POU Electricity Source*	0		2,026 - 2,040	2.0%
Natural Gas Fuel?	1	Natural Gas	2005 - 2,015	1.0%
Propane Fuel?	0	And other fossil fuels	2,016 - 2,025	1.0%
Oil Fuel?	0		2,026 - 2,040	1.0%
		Maintenance	2005 - 2,040	2.0%
		Inflation (Nominal , not used)	2005 - 2,040	3.0%

* IOU = Invester Owned Utility

** POU = Publicly Owned Utility

$3,312,896 =30-year LCC

----------ANNUAL REAL CASH FLOWS----------

(Begin) Year	First & Replace. Costs	Annual Maint. Costs	Annual Nat.Gas Costs	Annual Electric Costs	Total Annual Costs	Present Worth Factor	Present Worth of Annual Costs	Present Worth of Cumulative Costs
2,005	$200,000	$1,000	$12,000	$100,000	$113,000	(1+i)^-n		
2,005	$200,000	--	--	--	$200,000	1.00	$200,000	$200,000
2,006	0	1,020	12,120	101,000	114,140	0.98	111,902	311,902
2,007	0	1,040	12,241	102,010	115,292	0.96	110,815	422,717

Instructions:

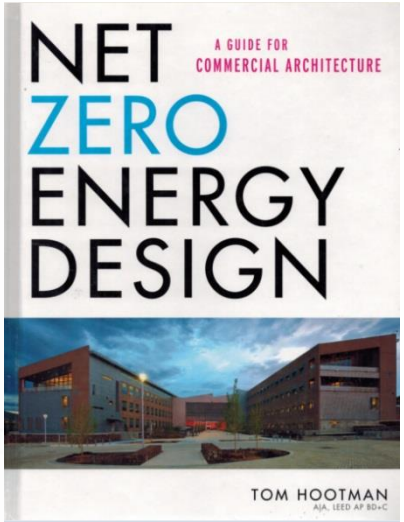
1. C14..C18 plug in 1 if true, 0 if false
   C14 : If electric utility is privately owned enter 1
   C15 : If electric utility is publicly owned (e.g. PUD, municipality, rural electric) enter 1
   C16 : If natural gas escalation factors are desired enter 1
   C17 : If propane fuel is used enter 1
   C18 : If oil fuel is used enter 1
2. A29: Enter first analysis year
3. B29: Estimated construction cost would be the differential cost between the subject systems.
   (Including overhead & profit, tax, design fees, etc.)
   (If this was the least cost baseline system, the construction cost would be zero.)
4. C29: "Annual Maint Cost" includes boiler water
   and cooling tower water treatment,
   air filter changes, lubrication,
   spot replacement of lamps and ballasts,
   luminaire cleaning, boiler tune up,
   condenser cleaning, controls calibration,
   and other routine maintenance.
   e.g. 2% of lighting system construction cost.
5. D29: "Annual Gas Costs" (or other heating fuel).
   Apply current utility rate structure to monthly
   consumption from the building computer model.
   Enter first year dollar total in this cell.

http://des.wa.gov/services/facilities/Energy/ELCCA/Pages/default.aspx

Budget Guidelines for ZNE

Budget Guidelines for Net Zero Energy Projects

- **Life-cycle value:** Seek long-term, life-cycle value and budget for quality and performance, keeping in mind that net zero energy buildings are all about exemplary energy performance and value.
- **Selection and pricing:** Project team selection and pricing methods used for the project are as important as the budget for overall cost control. (The pros and cons of selection and pricing methods are addressed later in this chapter.)
- **Soft costs:** It is important to budget for additional soft costs, which include the effort and investment in smart design required during the front end of the design phase. Along with the investment in smart design comes the investment in a more rigorous energy modeling process. The additional soft costs also fund participation of all project delivery team members, to ensure an integrated project delivery.
- **Renewable energy:** Consider the cost of renewable energy systems as a separate investment from the construction cost. They can be a sizable investment, but one that virtually buys the future energy for the building up front. In this sense, it is also a financial investment and should be analyzed as such. (Refer to Chapter 9 for more on financial analysis of renewable energy systems.)



Net Zero Energy Design: Tom Hootman

"The prevailing industry perception is that zero energy is cost prohibitive and suitable only for showcase projects with atypical, large budgets; however, ***there is mounting evidence that zero energy can, in many cases, be achieved within typical construction budgets****."*

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www.nrel.gov/docs/fy14osti/62752.pdf

George V. Leyva Middle School Administration Building

"The perception is that green schools cost more than conventional schools, but Evergreen understands that investing in sustainable design technologies now is actually a fiscally responsible strategy." *- Assistant Superintendent Kathy Gomez*

George V. Leyva Middle School Administration Building

PROFILE DATA

- K-12 School Building
- Evergreen Elementary School District
- San Jose, CA
- Climate Zone 4
- 9,200 ft^2 New Construction
- Completed in June 2011
- \$640/ft^2

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Developing your ZNE Plan & Targeting ZNE

Benchmarking and assessing existing school facility performance

- Starting with Energy Star Portfolio Manager/CEUS: how CA schools perform
- Understanding energy end uses (using FirstView) and opportunities for EE upgrades
- Determining the technical potential of your facility

Benchmarking Existing Facilities: How CA Schools Perform

Comparison K-12 EUIs from Two Data Sources:

- CBECS (K-12) = 58.2 kBtu/sf/yr

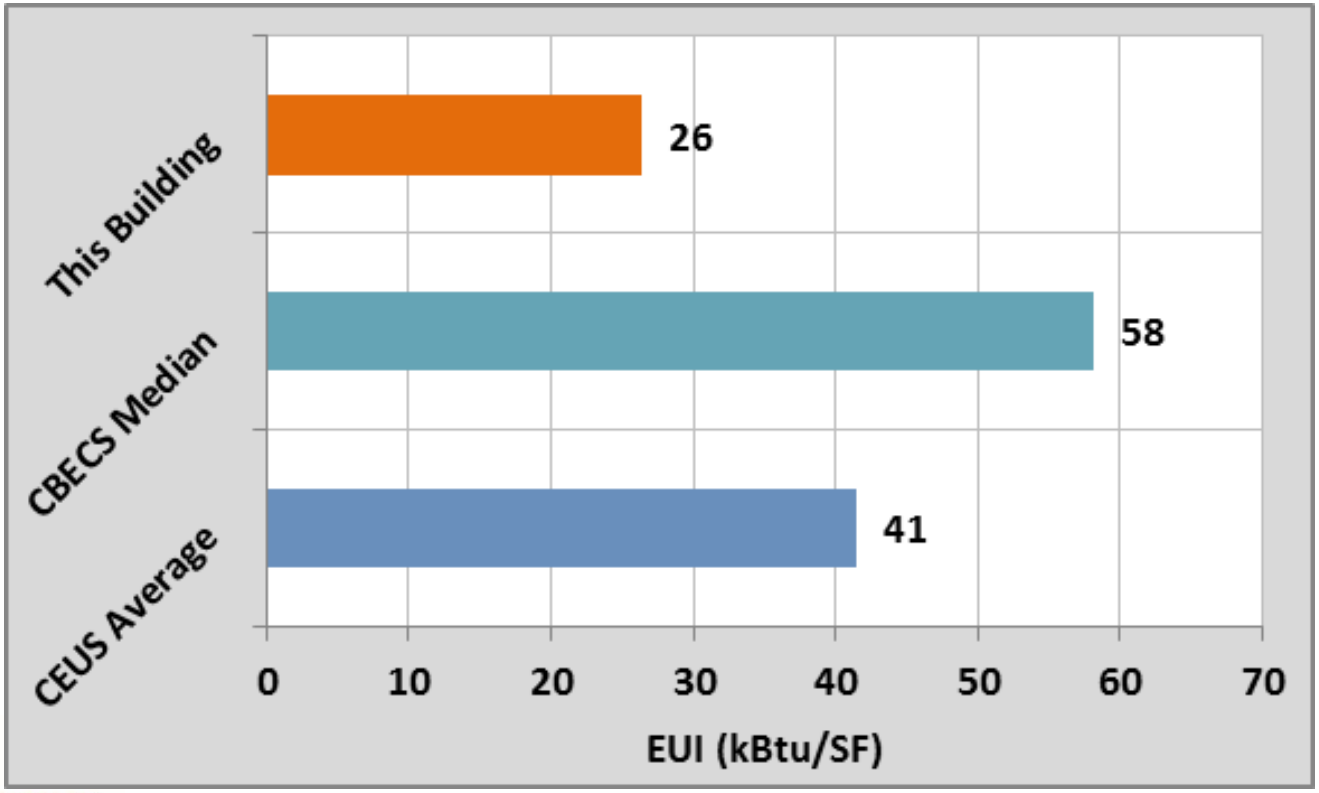
  Nationwide Median, released 2003
- CEUS (K-12) = 41.4 kBtu/sf/yr

  CA Specific Average, released 2006

ZNE Threshold: Approx EUI = 20-25 kBtu/sf/yr

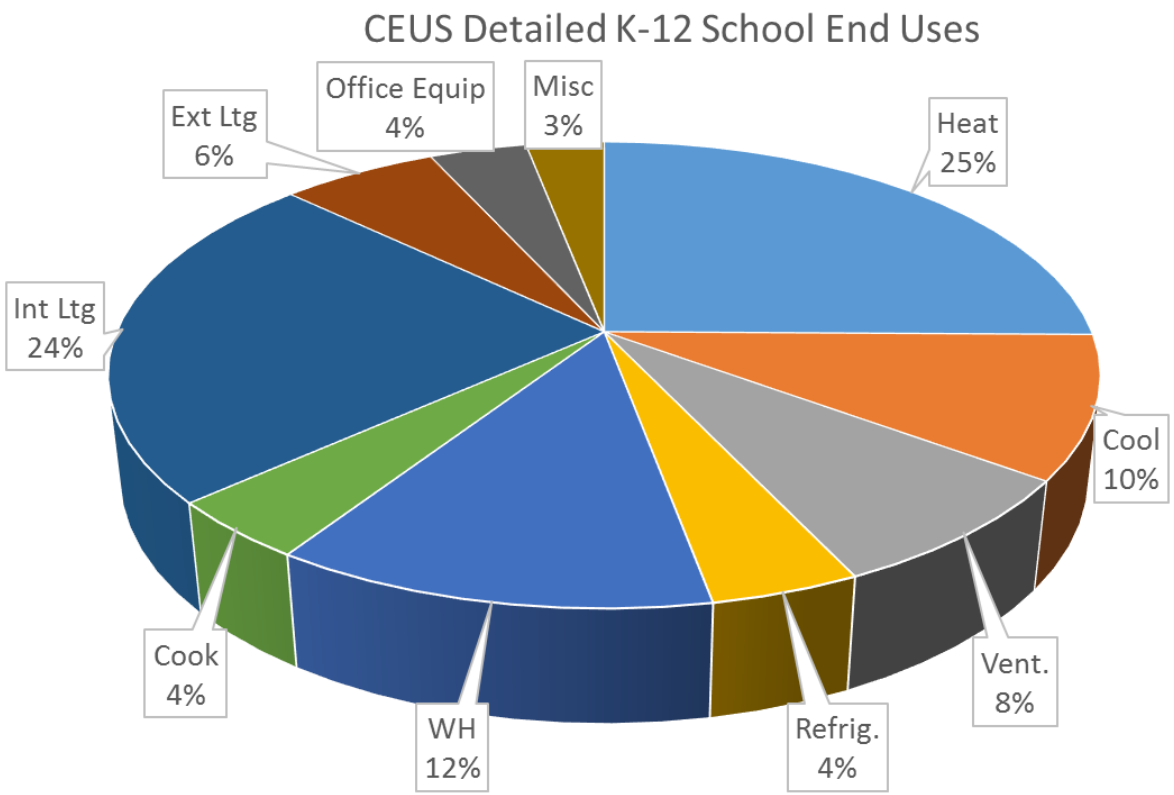
Benchmarking Existing Facilities: How CA Schools Perform

Example from analysis with NBI's FirstView®



Benchmarking Existing Facilities: Understanding Energy End Uses

Detailed average end uses (CEUS – site visits)



Heating, Cooling, Ventilation
= **Envelope & HVAC Equip.**

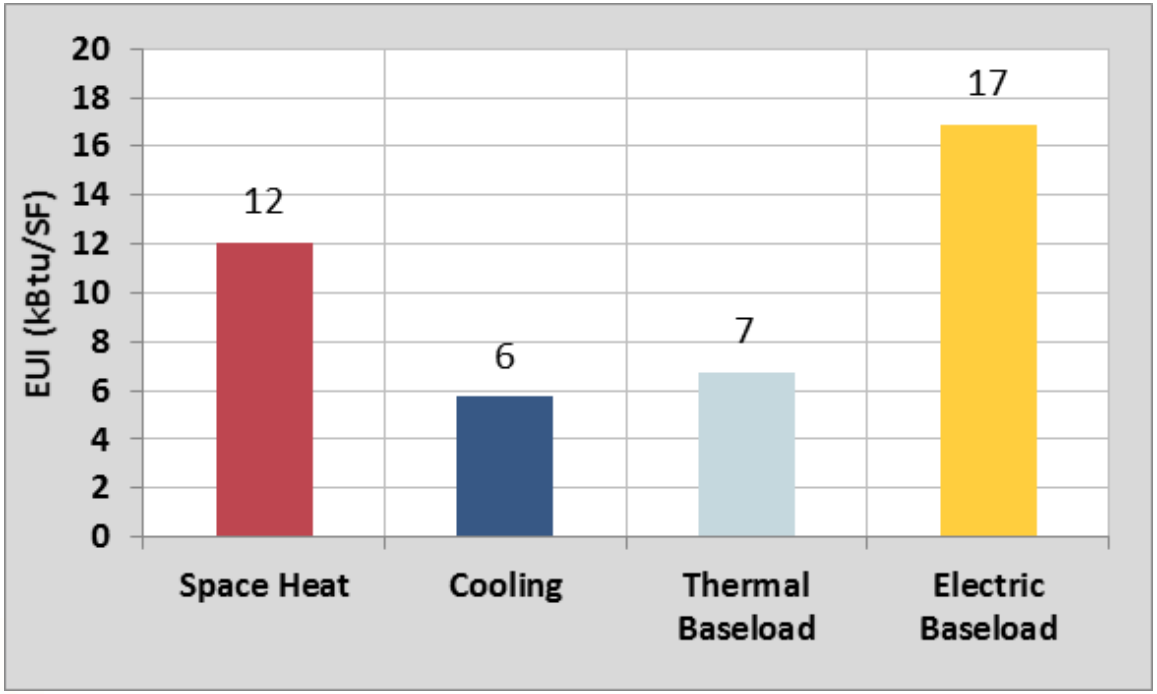
Lighting, Plugs, Cooking, Refrig.
= **Interior Equipment**

All Usage
= **Controls & Occupants**

Benchmarking Existing Facilities: Understanding Energy End Uses

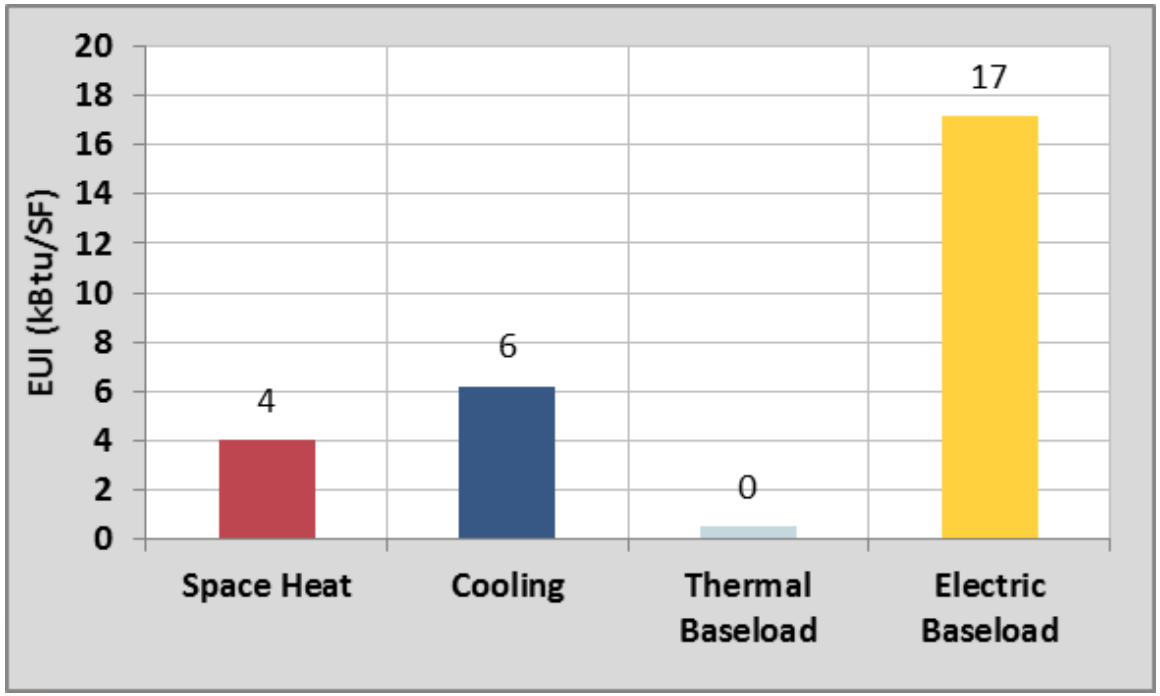
Energy usage by end use: CEUS averages

- Combined to four basic categories

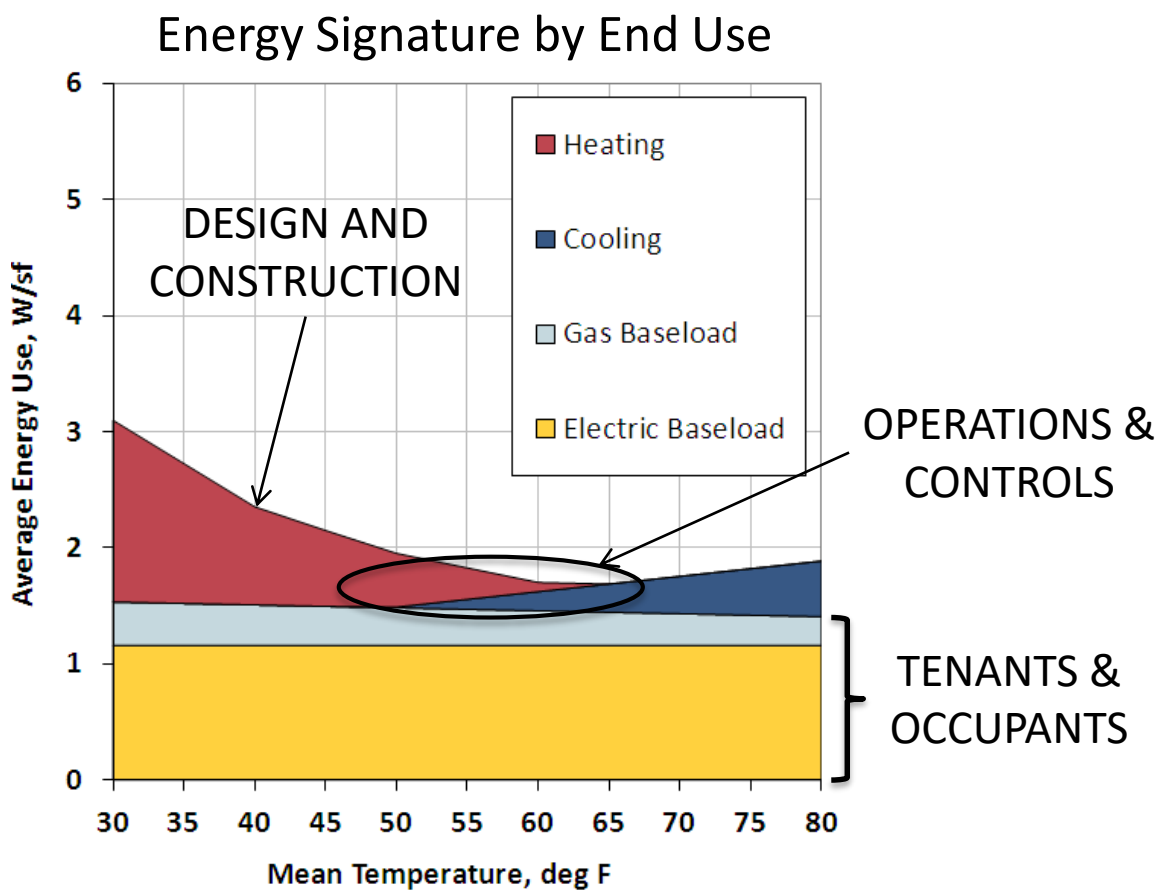


Benchmarking Existing Facilities: Understanding Energy End Uses

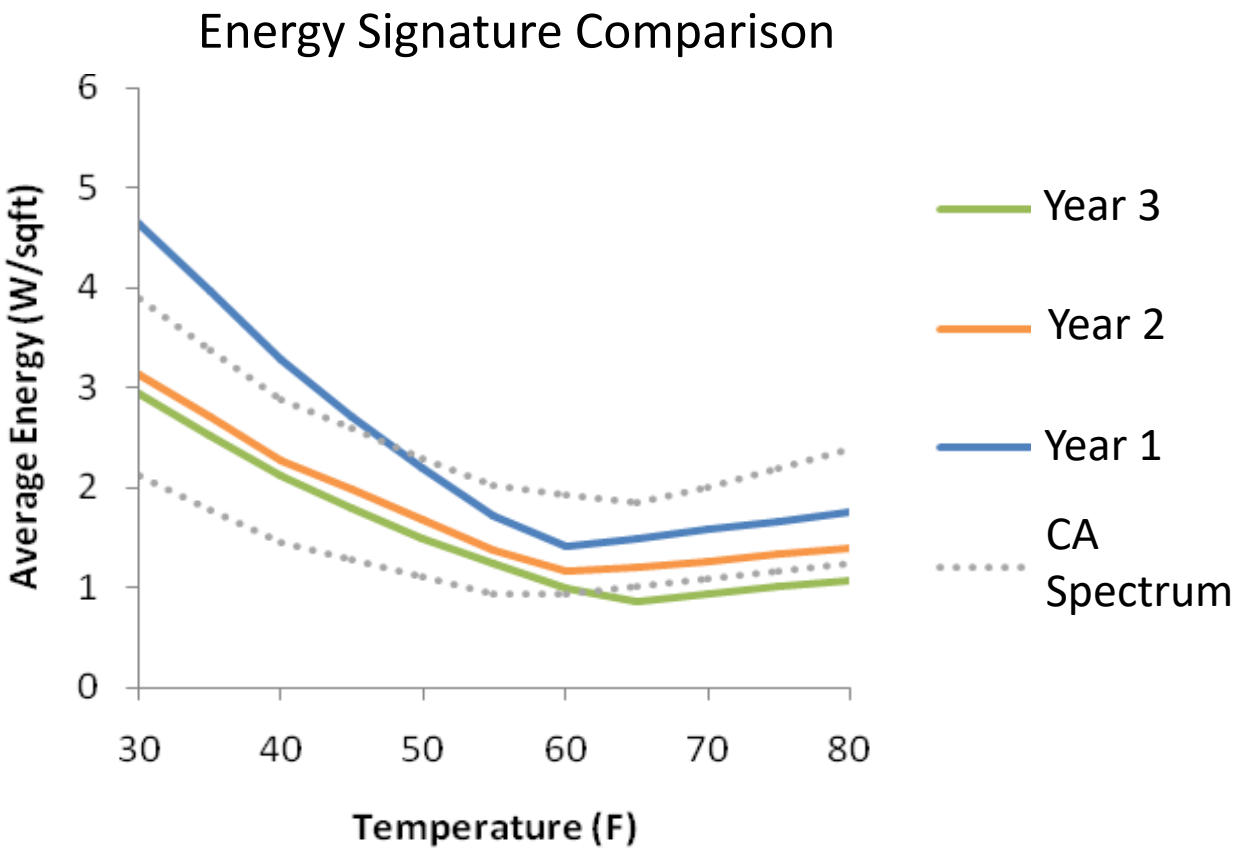
Example: FirstView analysis of a CA Prop 39 ZNE Retrofit Pilot Candidate School:



FirstView:
Energy Signature by End Use

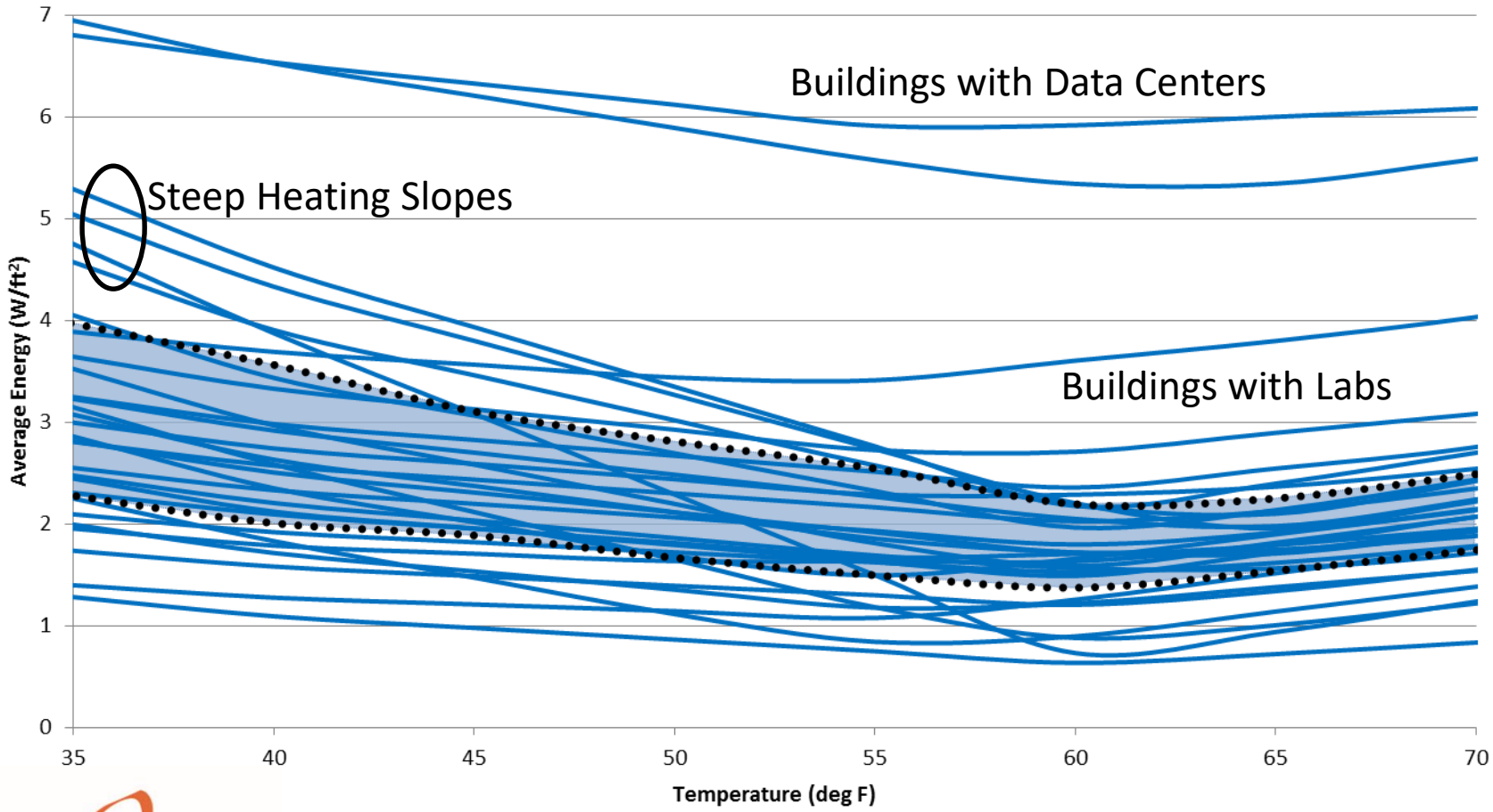


FirstView: Trending Analysis



Trending allows owners to observe performance patterns over time. Paired with the collection of key indicators such as occupancy/vacancy, operational changes and system modifications, the FirstView tool's energy signatures can track changes in performance.

FirstView:
Portfolio Analysis



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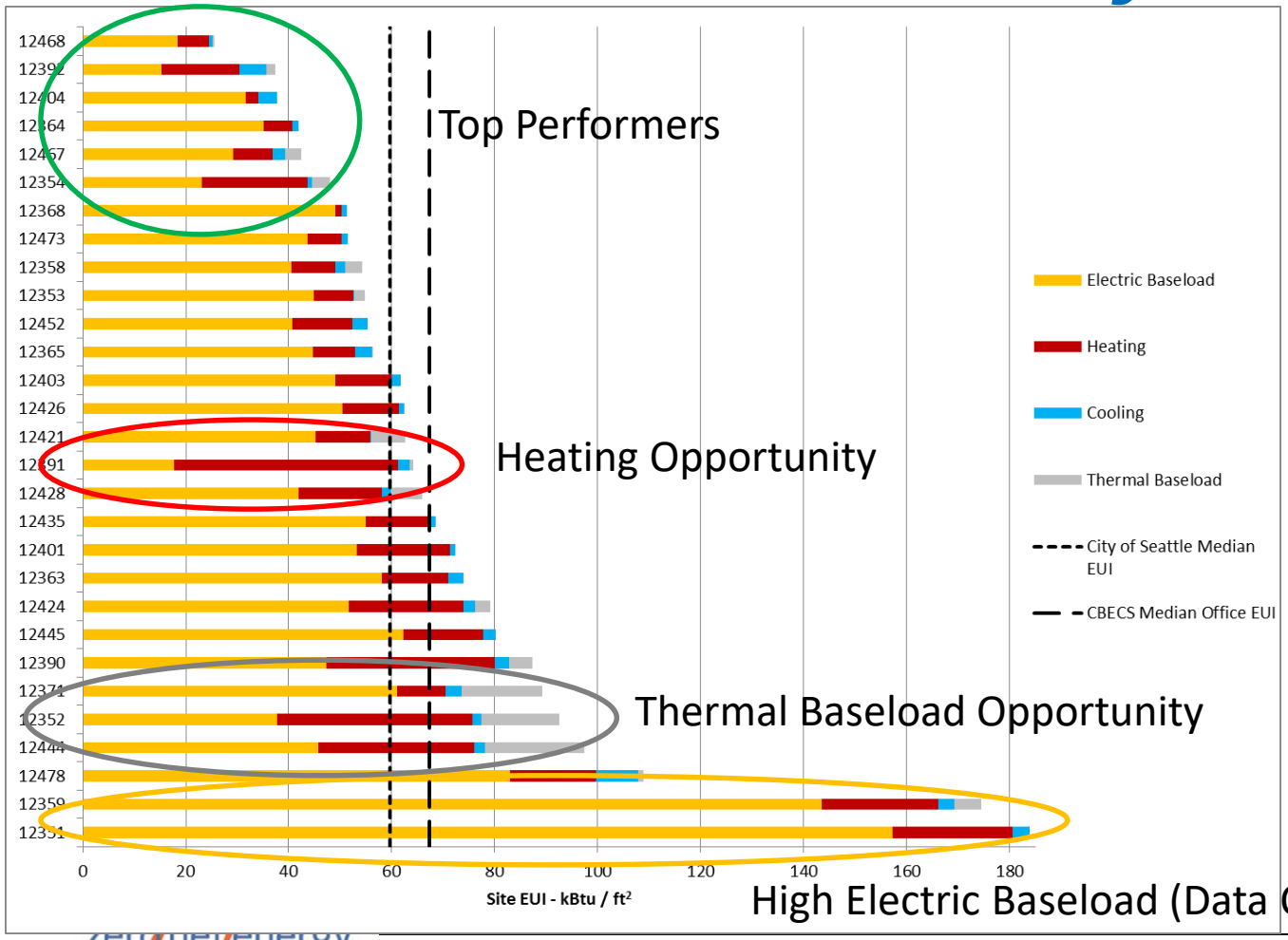
FirstView:
Portfolio Analysis



Seattle 2030 District Portfolio Analysis (NBI, 2014)

Benchmarking Existing Facilities: Determining Technical Potential

1. **Remote analytics for retrofit prioritization**

Diagnostics

Category	Status
Heating and Ventilation Efficiency	Poor
Cooling Efficiency	Good
Controls	No apparent problems
HVAC Reheat	No apparent problems
Thermal Baseload	Typical
Light and Plug Loads	High
External/Process Load	No apparent problems
Data Consistency	Orderly

Automated diagnostics are generated b analyzing the shape of the Energy Signature and comparing it to aggregate data collected from other office buildings. Learn more here.

Additional Notes

This building may be a good candidate for potential heating system improvements. Excess outside air rates, high outside air infiltration, poor control settings, and 24-hour fan schedules may be present. Demand controlled ventilation and heat recovery systems may provide significant savings.

The very low summer gas usage means that the model inferred a very low thermal baseload (water heating, cooking, etc.). If there is electric water heating in the building, this may account for the high electrical baseload, and trigger the high lighting and plug loads flag.

2. **Full energy audit with recommendations**
3. **Prioritize and select retrofit EE measures**

Developing your ZNE Plan & Targeting ZNE

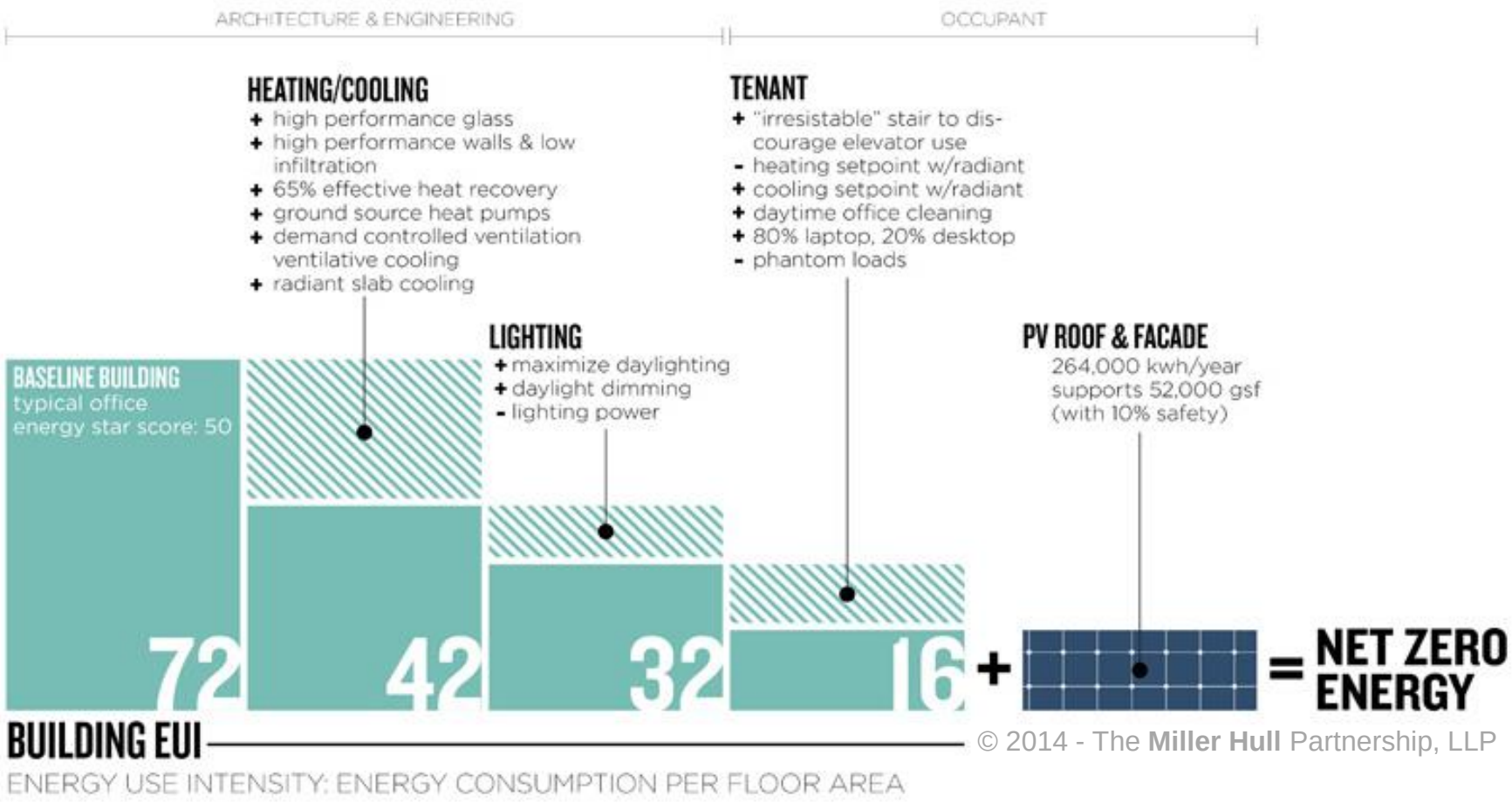
The Energy Loading Order

Two ZNE Building Typologies

Renewable-Oriented	Efficiency-Oriented
Minimally to moderately sensitive to the grid	Highly grid-integrated and responsive
Higher gross energy use	Lower gross energy use
Higher renewable generation	Lower renewable generation
Active Strategies Focus: Mechanical HVAC Systems, Thermal Storage, Night Flush with Fans, Demand Response	**Passive Strategies Focus**: Daylighting, Building Orientation, High Insulation Levels, Passive HVAC, Built-In Shading

Developing your ZNE Plan & Targeting ZNE

Establishing your solar and energy budget



Developing your ZNE Plan & Targeting ZNE

Defining your EUI Target:

1. Define cost effective EEMs from Audit
2. Define your operating schedule compared to annual renewable energy generation
3. Develop iterative energy model (include TDV)
4. Understand PV feasibility
5. Determine solar budget

(Example) ZNE Retrofit Energy Efficiency Measures (EEM)

Measure 1: Reduced Building Equipment Energy Use
Strategy 1a. Receptacle Controls
Strategy 1b. Plug Load Management
Strategy 1c. Plug Load Equipment
Measure 2: Heating and Cooling Strategies
Strategy 2a. Dedicated Outdoor Air System (DOAS)
Strategy 2b. HVAC Zone Control
Measure 3: Improved Overall Building Envelope Performance
Strategy 3a. Thermal Load Intensity
Strategy 3b. Air Infiltration Testing
Measure 4: Reduced Lighting Energy
Strategy 4a. Luminaire Level Lighting Control
Strategy 4b. Interior LPDs and Exterior Lighting Efficacies Based on Solid-state Lighting

Jeffrey Trail Middle School & Irvine Unified School District

PROFILE DATA

- New Middle School
- Irvine Unified School District
- Irvine, CA
- 73,178 ft^2
- Climate zone 8

Jeffrey Trail Middle School & Irvine Unified School District

PEOPLE, POLICY & PROCESS

- CHPS High Performance schools resolution
- Irvine pursued a district-wide approach to energy efficiency
- Bonded for solar on all schools
- Power Purchase Agreement (PPA) to fund solar
- Capital outlay=$0

Irvine Unified School District saves money and enriches learning with solar

Located in Orange County, California, the Irvine Unified School District (IUSD) comprises a community of learners, committed to the highest quality educational experience. IUSD educates a diverse population of more than 30,000 K-12 students in 22 elementary schools, six middle schools, four comprehensive high schools and one continuation high school.

Project Profile: Irvine Unified School District	System Type: Roof and Canopy-Mounted Solar Panels
Industry: K-12 Education	System Size: 5 MW over 27 Operational Projects
Location: Irvine, California	Savings: $5-11 million over 20 years
Company: Irvine Unified School District	Capital Outlay: $0

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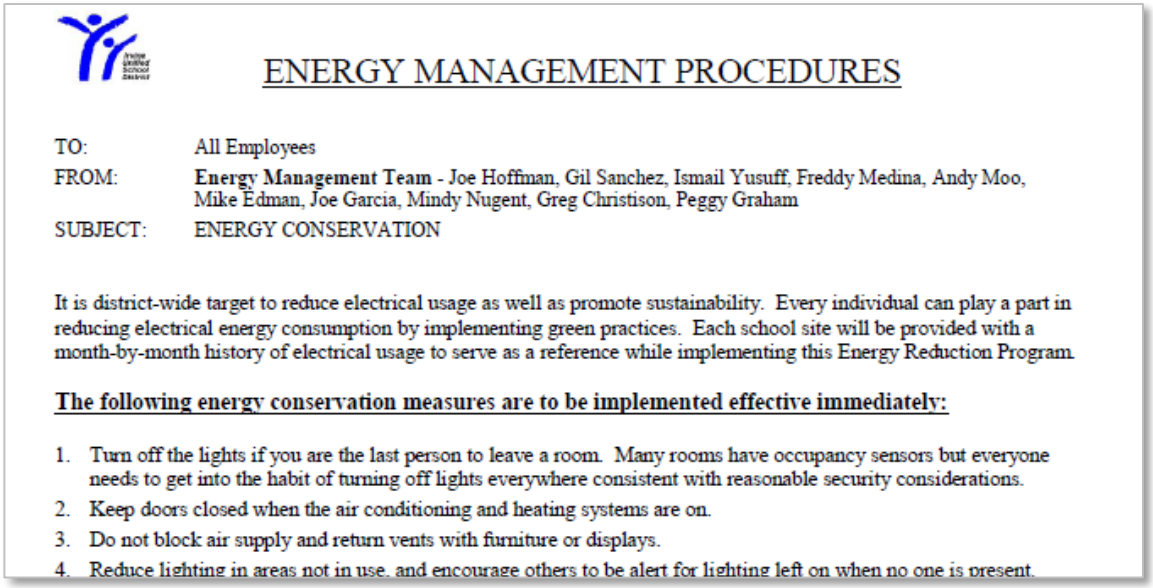
Jeffrey Trail Middle School & Irvine Unified School District

PEOPLE, POLICY & PROCESS

- Behavior - Energy Conservation/Management Protocols

IUSD set energy-wise guidelines to help make its heating, ventilation, and air conditioning systems (HVAC) more efficient. The District also issued conservation mandates for lighting, thermostat settings, classroom and office equipment, and a variety of other areas. These measures are intended to reduce district-wide electrical usage by 15 percent.



ENERGY MANAGEMENT PROCEDURES

TO: All Employees

FROM: **Energy Management Team** - Joe Hoffman, Gil Sanchez, Ismail Yusuff, Freddy Medina, Andy Moo, Mike Edman, Joe Garcia, Mindy Nugent, Greg Christison, Peggy Graham

SUBJECT: ENERGY CONSERVATION

It is district-wide target to reduce electrical usage as well as promote sustainability. Every individual can play a part in reducing electrical energy consumption by implementing green practices. Each school site will be provided with a month-by-month history of electrical usage to serve as a reference while implementing this Energy Reduction Program.

The following energy conservation measures are to be implemented effective immediately:

1. Turn off the lights if you are the last person to leave a room. Many rooms have occupancy sensors but everyone needs to get into the habit of turning off lights everywhere consistent with reasonable security considerations.
2. Keep doors closed when the air conditioning and heating systems are on.
3. Do not block air supply and return vents with furniture or displays.
4. Reduce lighting in areas not in use, and encourage others to be alert for lighting left on when no one is present.

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Jeffrey Trail Middle School & Irvine Unified School District

PEOPLE, POLICY & PROCESS

- **Buildings & Technologies inform the district's Curriculum -** Science, Technology, Energy, Math (STEM)

"We have developed our own fifth and sixth grade curriculum that lets students learn about a variety of types of renewable energy.

We discuss the pros and cons of different types of renewable energy. We are hearing that kids are more aware of things like conservation, recycling, and global warming. And the community appreciates the nonpartisan way we present the education."

– Mark Sontag, UC Irvine Energy Consultant

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Jeffrey Trail Middle School & Irvine Unified School District

DESIGN STRATEGIES & EFFICIENCY MEASURES

- Solar photovoltaics above parking canopies
- Daylighting
- Pyramid skylights
- Lighting controls
- Single building design for energy efficiency
- Whole Building Commissioning

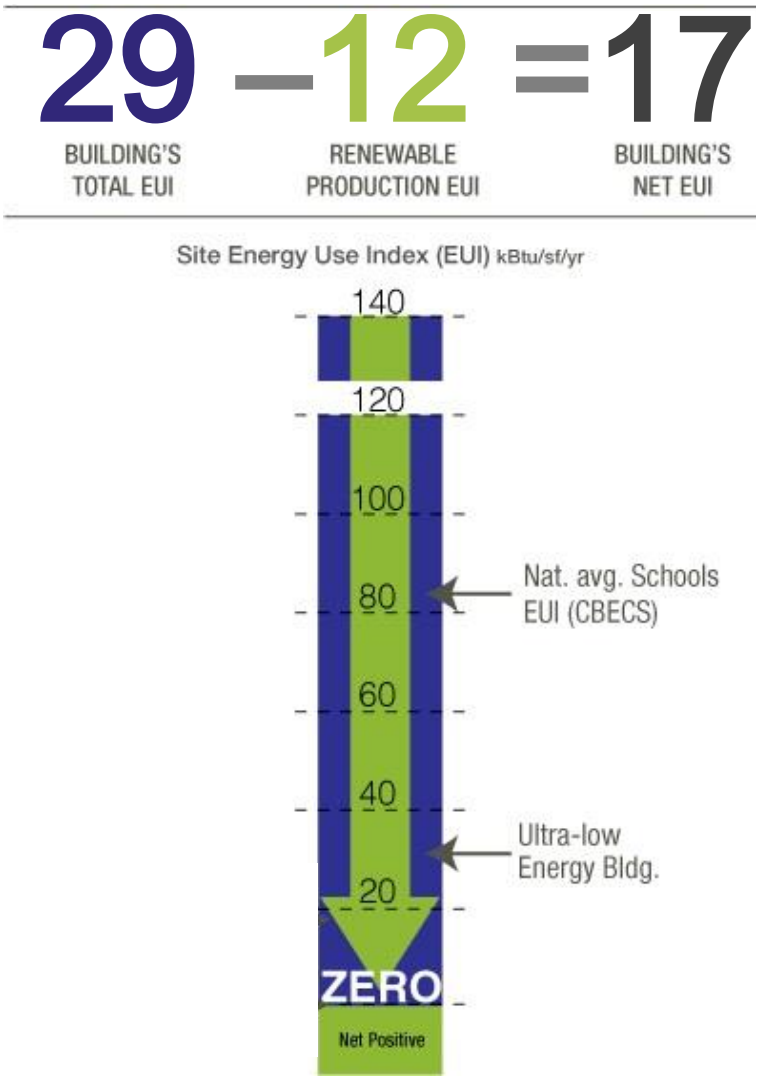
Jeffrey Trail Middle School & Irvine Unified School District

Systems commissioning included:
Ductwork, air door, zone damper terminal, building automation system, packaged gas/electric units, exhaust fans, make-up air units, fan coil/outdoor condensing units, domestic hot water heaters and associated circulating pumps and controls, lighting controls, and occupancy sensors.

Jeffrey Trail Middle School & Irvine Unified School District

METRICS

- Verified Ultra-Low Energy Performance



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Jeffrey Trail Middle School & Irvine Unified School District

RESULTS & SUCCESSES

- CHPS Verified School
- Leadership in energy efficiency and operations district-wide
- Solar installed on 27 sites
- Long term cost savings of $5-11 million - puts more resources back into student programs

Savings Analysis (4% Utility Escalator + Net-Metering)

School	System Size	First Year Solar Offset	Utility Rate	PPA - 3% Escalator	Year 1 Total Savings	20 Year Savings*
Alderwood Elementary School	334	87.37%	0.1649	0.1495	$ 20,544	$665,782
Canyon View Elementary School	307	85.31%	0.1709	0.1561	$ 27,919	$781,973
Irvine High School	705	72.68%	0.1435	0.1400	$ 48,992	$1,367,004
Northwood High School	911	75.72%	0.1592	0.1480	$ 56,443	$1,777,936
Oak Creek Elementary School	225	55.60%	0.1656	0.1496	$ 33,329	$975,474
Sierra Vista Middle School	242	83.23%	0.1896	0.1540	$ 12,716	$508,241
Stonegate Elementary School	244	73.09%	0.1654	0.1540	$ 10,135	$381,167
University High School	710	85.35%	0.1375	0.1300	$ 107,459	$2,490,472
Vista Verde Elementary School	335	80.86%	0.1808	0.1577	$ 18,527	$664,145
Woodbridge High School	426	42.71%	0.1479	0.1400	$ 27,128	$799,130
Woodbury Elementary School	295	94.76%	0.1694	0.1493	$ 15,692	$503,760
Jeffrey Trail Middle School	502	74.15%	0.1500	0.1400	$ 29,766	$823,875
Total	**5236**				**$ 378,885**	**$11,838,957**

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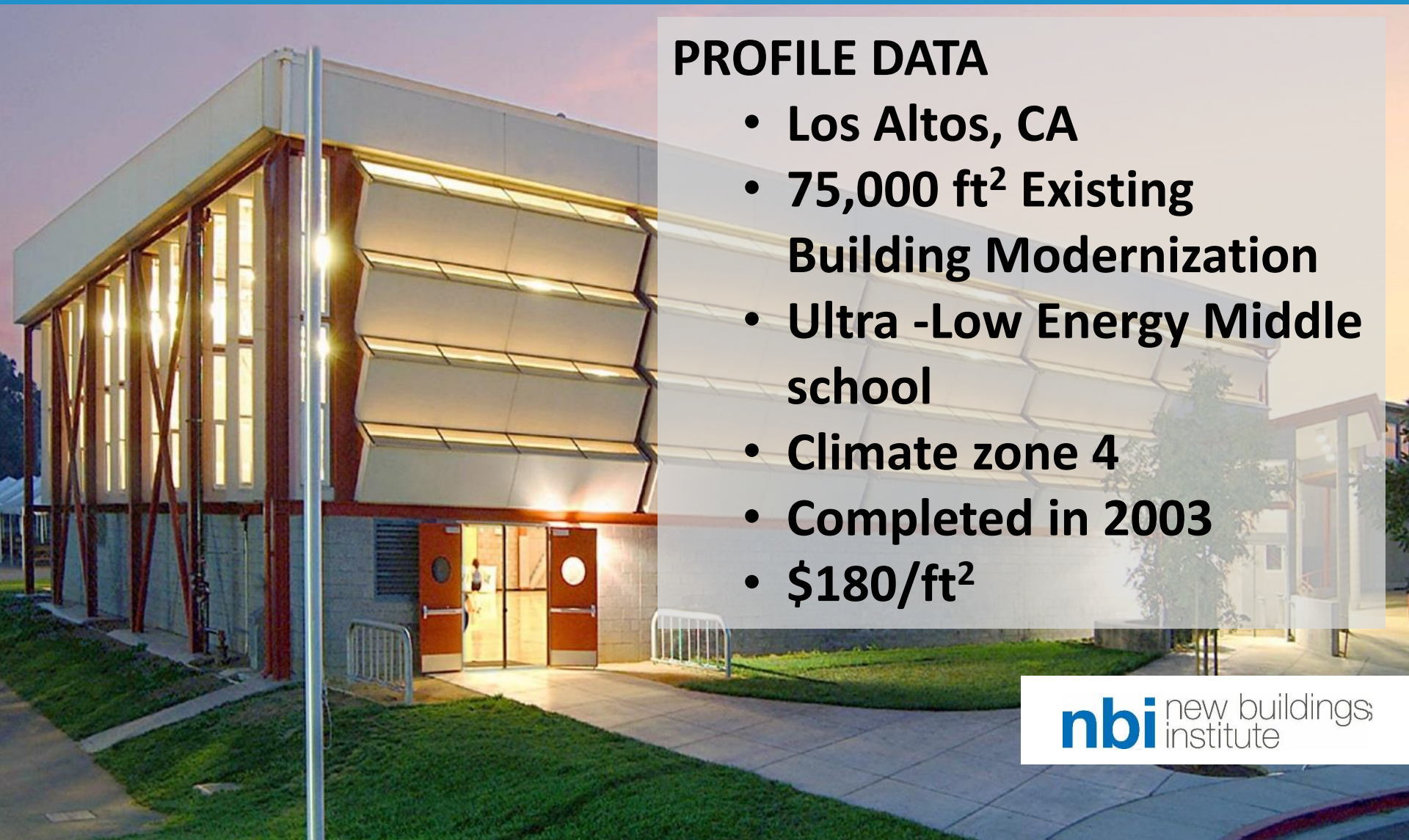
Georgina Blach Intermediate School



PROFILE DATA

- Los Altos, CA
- 75,000 ft^2 Existing Building Modernization
- Ultra -Low Energy Middle school
- Climate zone 4
- Completed in 2003
- \$180/ft^2

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Georgina Blach Intermediate School

DESIGN STRATEGIES & EFFICIENCY MEASURES

- Re-use of existing structure
- Large north facing façade for indirect daylight
- BAS controls artificial lighting levels
- Natural ventilation

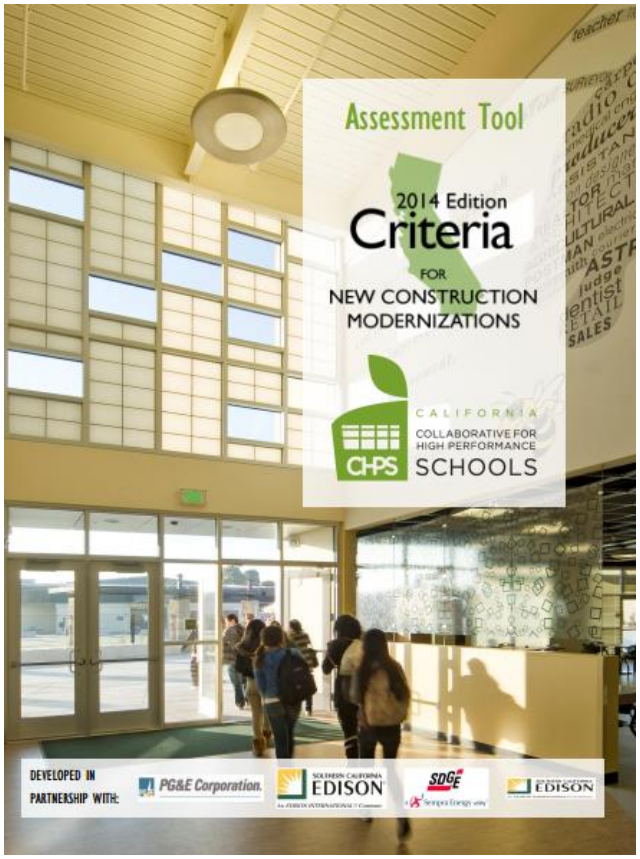
Georgina Blach Intermediate School

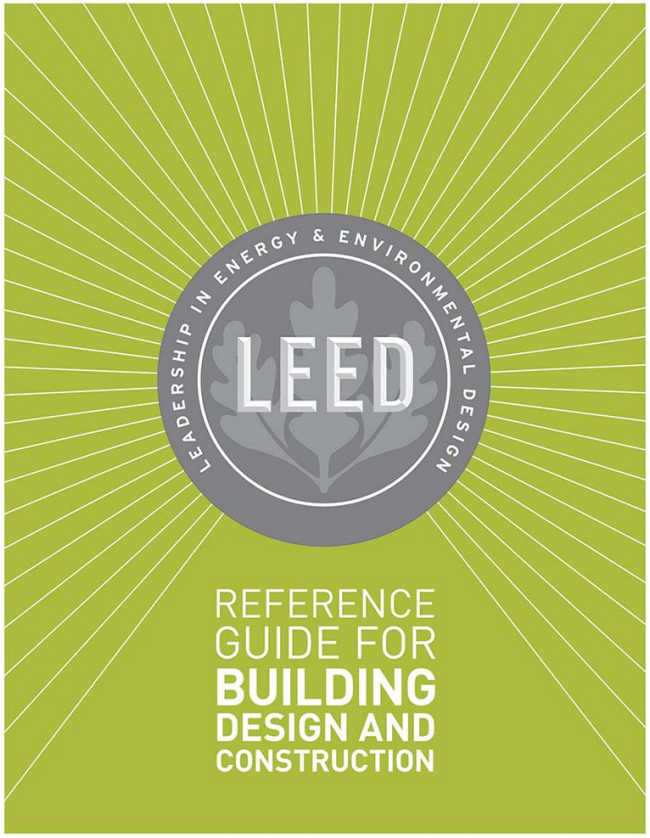
DESIGN STRATEGIES & EFFICIENCY MEASURES

- **Automatic sensors modulate direct/indirect lighting to harvest daylighting**
- **Stack ventilation reduces active cooling**
- **Right sized mechanical equipment increases efficiency and reduces capital costs**

Developing your ZNE Plan & Targeting ZNE

CHPS, LEED and other green goals





zero net energy

Developing your ZNE Plan & Targeting ZNE

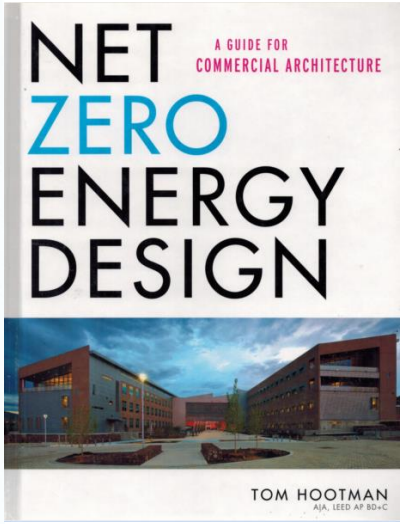
Making ZNE a Part of the Designer Contract:

- Developing RFP language
- Defining scopes of work
  - Design through operations
  - Energy modeling
  - ZNE Commissioning
  - Controls integration

Request for Proposals & Qualifications (RFPs & RFQs)

RFP Guidelines for Net Zero Energy Projects

- Establish net zero energy as one of the key project objectives.
- Set an annual energy use target appropriate for the net zero energy objective.
- Clarify whether or not on-site renewable energy systems will be part of the RFP; in either case, consider how they will be coordinated with building design and construction.
- Provide a well-crafted project definition, one that takes into account the opportunities and challenges of net zero energy.
- If a separate RFQ is not used prior to the RFP, integrate the guidelines for RFQs stated in the previous RFQ section.
- Establish the selection process and delivery method in support of forming a trust-based, integrated delivery team, whose members are aligned with the project objectives.



Net Zero Energy Design: Tom Hootman

Developing your ZNE Plan & Targeting ZNE

Selecting your project team:

- Pre-bid and pre-construction conferences, project team interviews

Developing your ZNE Plan & Targeting ZNE

Using the Owners Project Requirements to guide the ZNE process:

- Defining Owner's Project Requirements (OPR)
- Establishing the Basis of Design (BoD)(the design team approach)

Example OPR Table of Contents

Owner's Project Requirements (OPR)

template revised November 2009

NOTE to PM/Author: Enter the project # in the footer, left side ... delete this + other notes-to-author)

17.1 INTRODUCTION

Along with the other sections of this Facilities Program, this Owner's Project Requirements (OPR) document outlines functional requirements of the project and expectations of how the facility and its systems will be used and operated. The OPR is required for LEED certification of the project, but also serves three broader vital purposes:

zero net energy

Developing your ZNE Plan & Targeting ZNE

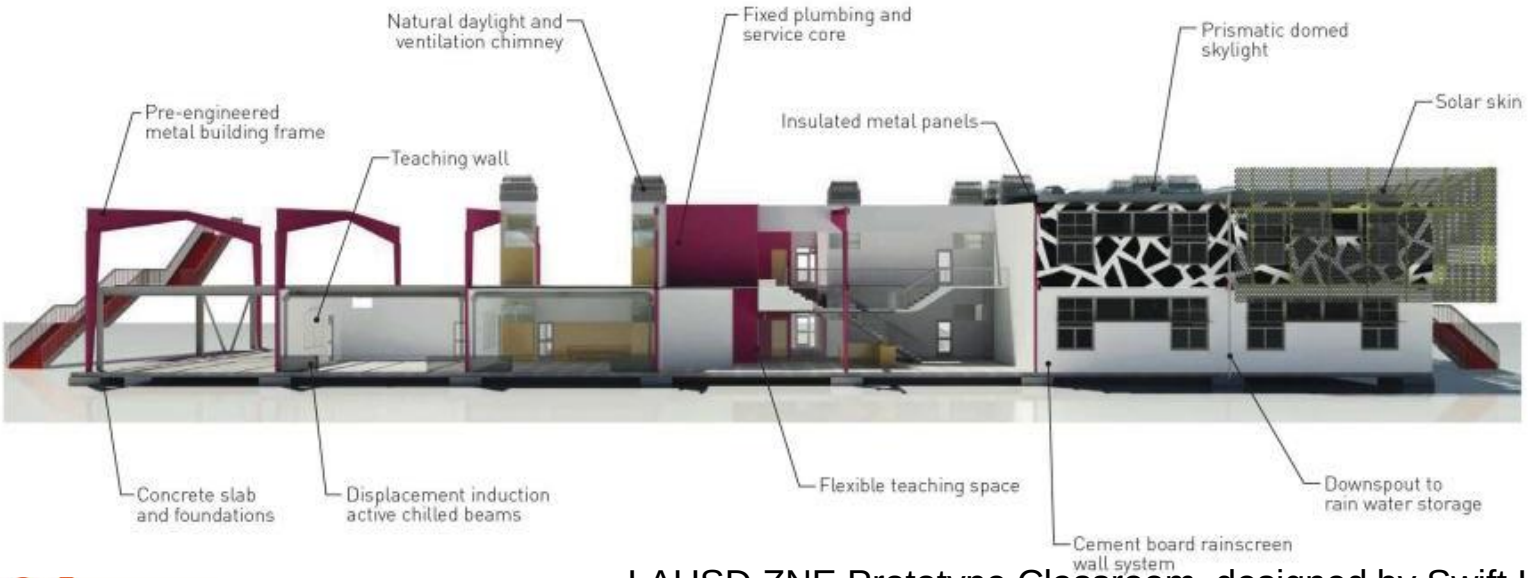
Questions & Answers

Break

11:30 – 11:40 p.m.

Designing to the ZNE Target
Part 1: Design for performance

11:40 a.m. - 12:15 p.m.



LAUSD ZNE Prototype Classroom, designed by Swift Lee

Designing to the ZNE Target
Part 1: Design for performance

KEY TOPICS:

- Using Case Studies as a Guide
- Implementing an integrated design process
- Optimizing existing building features
- A design focus on energy conservation and efficiency
- Getting to ZNE with renewables and grid-friendly technologies

Designing to the ZNE Target
Part 1: Design for performance

Using Case Studies as a Guide: *The technologies and design approaches that have a proven track record in ZNE projects, including daylighting, radiant heating/cooling, lighting controls, plug load controls, LEDs and beyond*

New Prop 39 Case Studies:

- Berkeley West Branch Library (Net Positive NC)
- Georgina Blach Middle School, Los Altos (Ultra-low Retrofit)
- George V. Leyva Middle School (Emerging ZNE)
- City College of San Francisco (Ultra-Low Energy)
- Jeffrey Trail Middle School, Irvine (Ultra-Low Energy)

Designing to the ZNE Target
Part 1: Design for performance

Using Case Studies as a Guide: More CA Examples

- Stevens Library at Sacred Heart Elementary (ZNE Verified)
- Redding School for the Arts (Emerging ZNE)
- Marin Country Day School (Ultra-Low Energy)
- Solano School (Emerging ZNE)
- Blackford (Emerging ZNE as part of Campbell SD's 8 new ZNE schools)
- La Escuelita (OUSD) – (Emerging ZNE)

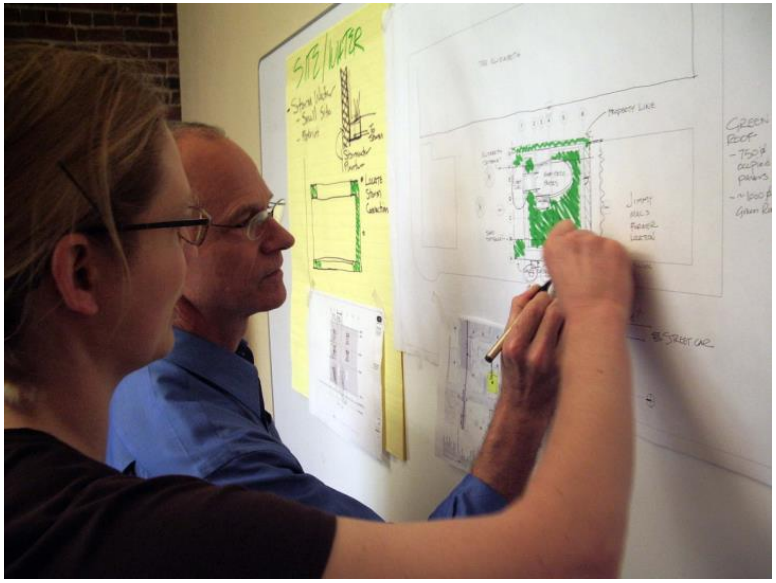
Designing to the ZNE Target
Part 1: Design for performance

Implementing an integrated design process:

ZNE Workshop

ZNE Workshop: Team Building

- Sets green building **goals**
- Identifies **strategies**
- Develops an **action plan**



ZNE Workshop: Outcomes

- Vested stakeholders
- Consensus
- Guiding Principles
- An action plan
- A report for reference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Madison Supportive Housing Eco-Charrette

Heartland Housing

Prepared by: New Buildings Institute

Authors: Ralph DiNola, Executive Director
Heather Flint Chatto, Project Manager

Date: June 26, 2014

Prepared for: Heartland Housing

HEARTLAND ALLIANCE HOUSING

advanced buildings

1601 Broadway Street, Vancouver, WA 98663-3435 | PHONE (360) 567-0990 | FAX (360) 213-1065

www.newbuildings.org

Designing to the ZNE Target
Part 1: Design for performance

Optimizing existing building features:

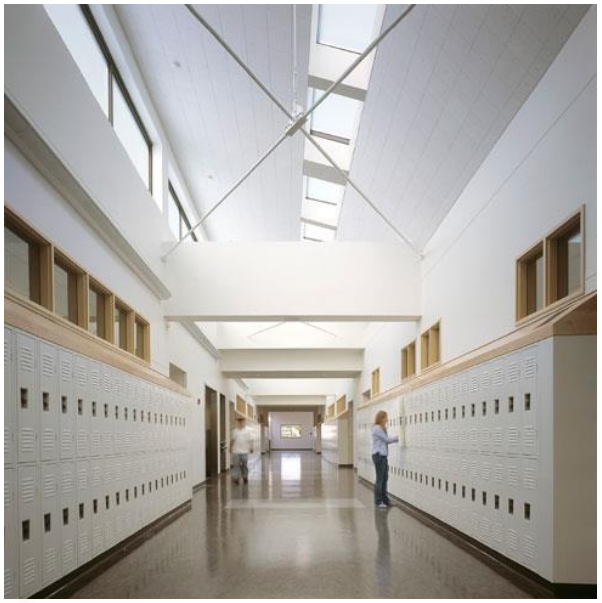
Designing to the ZNE Target Part 1: Design for performance

ZNE design strategies: Passive design approaches and designing for OFF

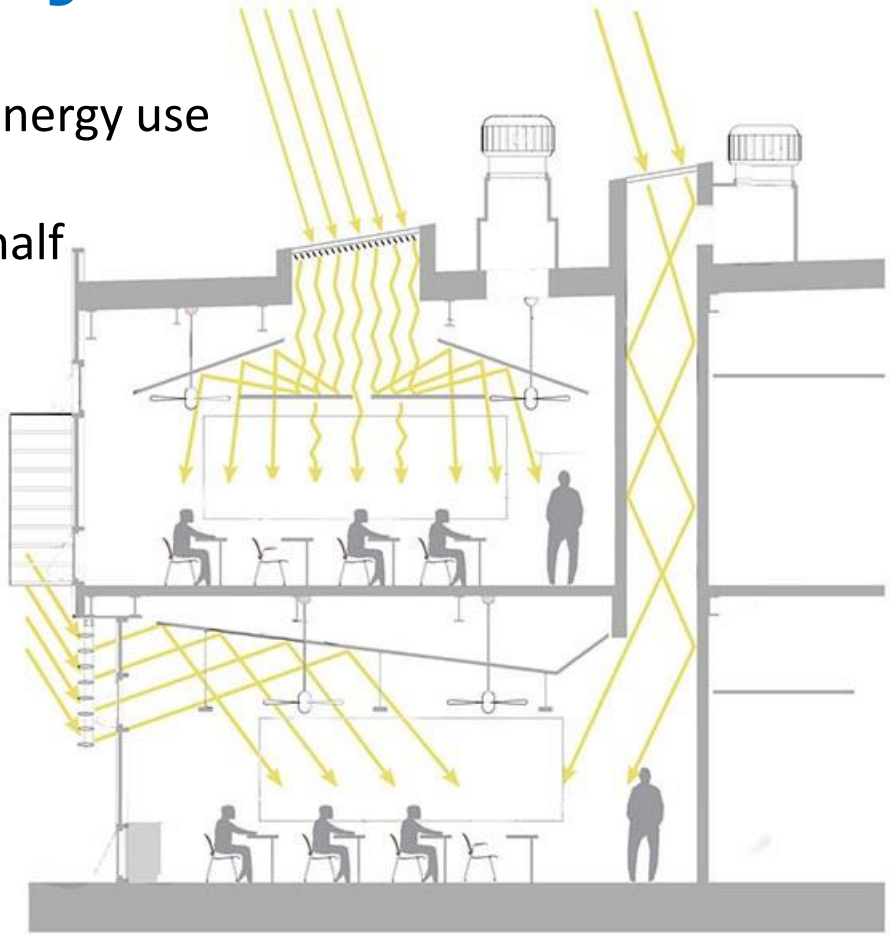
- Lighting and daylighting controls
- Occupancy/vacancy sensors
- Plug load controls

Integrated Daylighting and Occupancy Controls

- Lighting can reach 20% of energy use
- School hours are optimal
- Cut lighting energy use by half



Source: Boora Architects



Source: http://www.srgpartnership.com/

Integrated Daylighting and Occupancy Controls

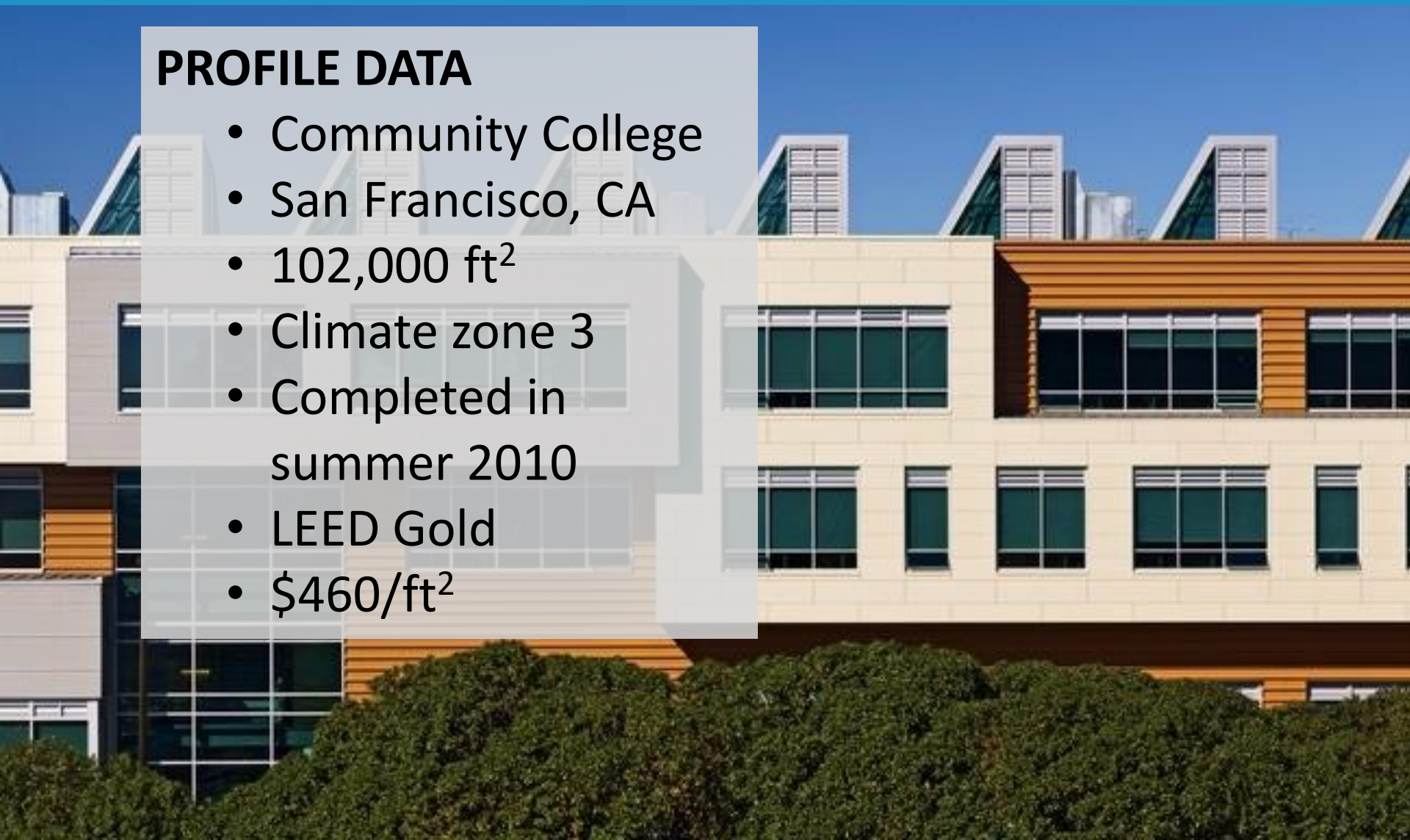
zero net energy

Integrated Daylighting and Occupancy Controls

IDeAsZ^2 Office Building San Jose, CA

City College San Francisco (CCSF)

City College San Francisco (CCSF)



PROFILE DATA

- Community College
- San Francisco, CA
- 102,000 ft^2
- Climate zone 3
- Completed in summer 2010
- LEED Gold
- \$460/ft^2

City College San Francisco (CCSF)

RESULTS & SUCCESSES

- Ground source central plant will serve up to 5 other buildings
- One of the largest modern buildings fully reliant on natural ventilation

Common ZNE Technologies

High Efficiency Technologies

- Ground source heat pump
- Radiant heating and cooling
- Condensing Boilers, Furnaces, etc.
- Demand control Ventilation
- Energy Recovery
- Variable Refrigerant Flow (VRF)
- Daylighting Controls
- LED Lighting
- Energy Star Equipment

Energy Generation

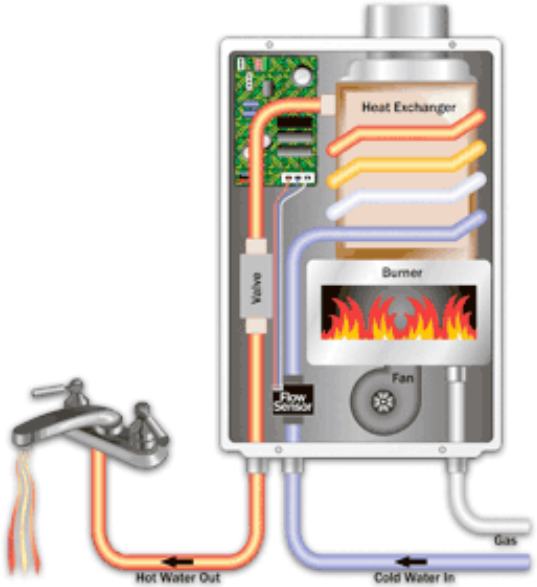
- Solar PV
- Solar Thermal
- Biogas
- Biomass
- Wind
- Combined Heat & Power

Operations and Occupancy

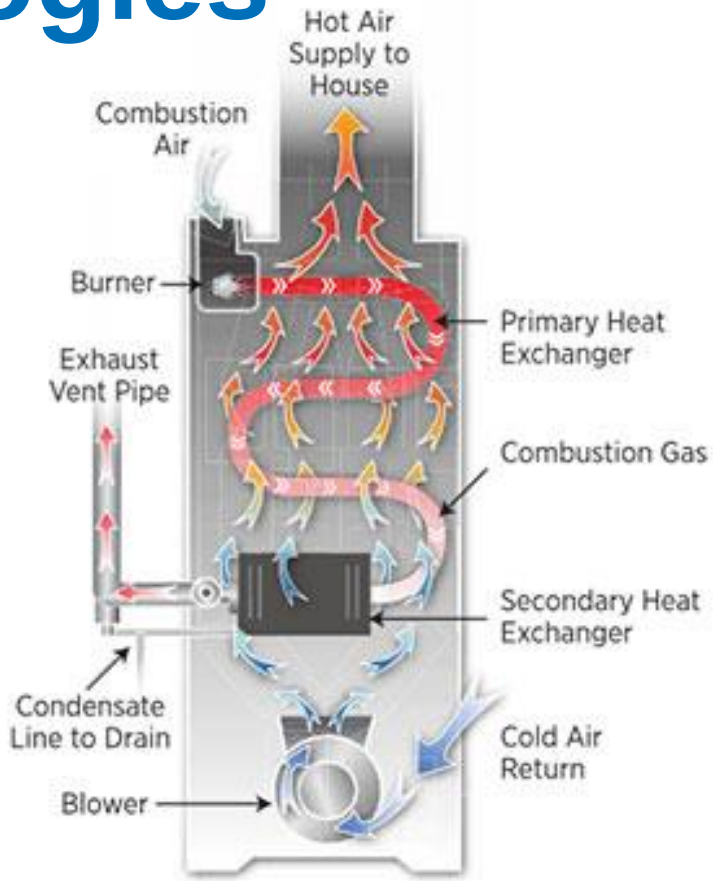
- Intelligent controls (scheduling, sensing, metering, etc.)
- Occupant engagement and training
- Energy Displays (i.e. Dashboards)

Gas Technologies

- Condensing Furnace
  - Up to 98% efficiency
- Tankless Water Heating
  - On demand use
- Energy Star Appliances



Source: http://www.faucetdepot.com/



High-Efficiency Gas Furnace

Source: https://www.precisionheatac.com/

ZNE Retrofit Actions

What systems present a challenge for you?

ZNE Retrofit Actions

Low intervention:

- Remote Audit
- Retro-commissioning
- Controls: Building Tuning
- Plug Load Savings/Policy
- Operator and Occupant Training
- Infiltration Reduction Measures

Medium intervention:

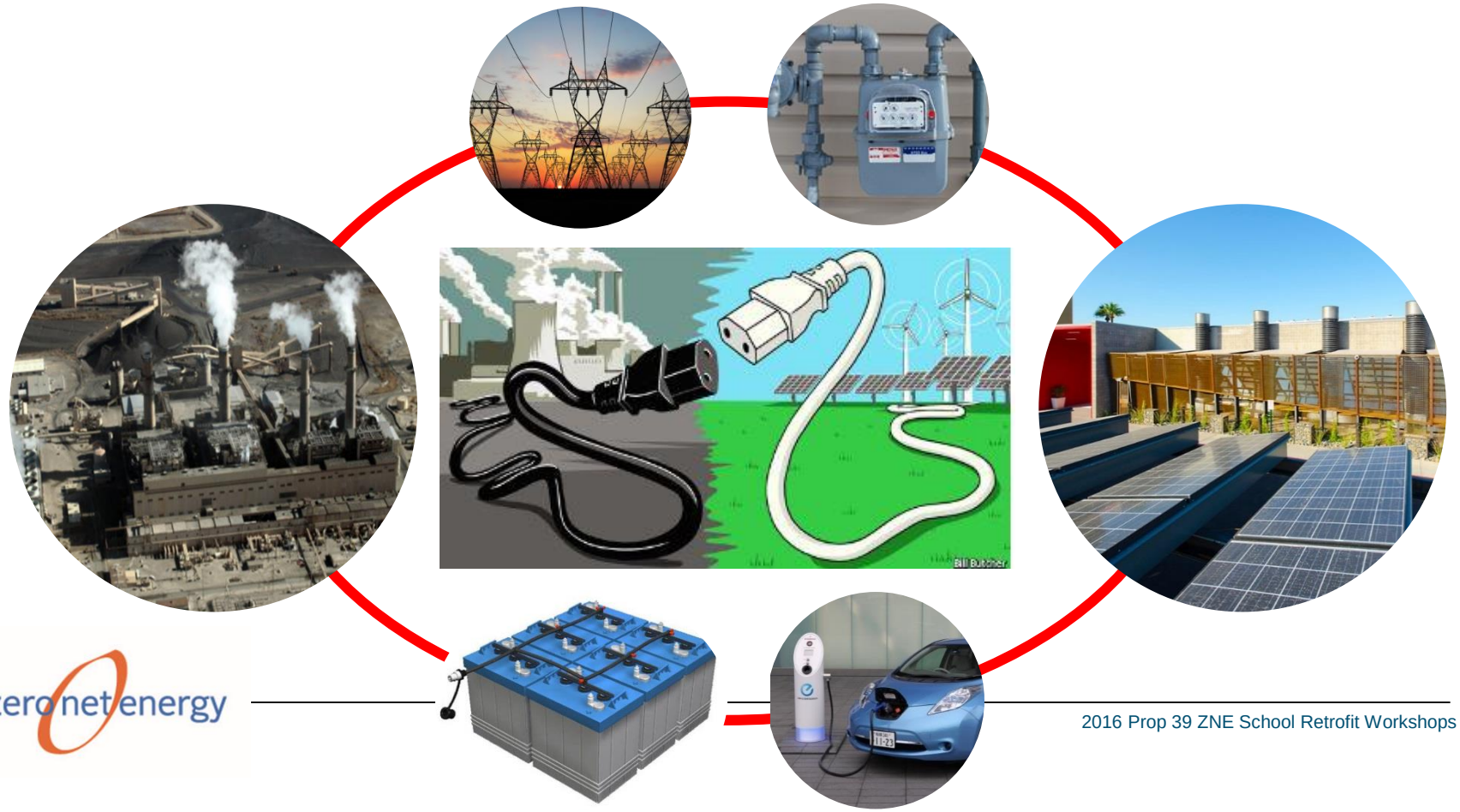
- Lighting/Daylighting
- HVAC Equipment Upgrades
- Controls: System Upgrade
- Opportunistic Envelope Insulation

High intervention:

- HVAC System Switching
- Envelope Upgrade
- Window Replacement
- Renewable Energy System

Designing to the ZNE Target
Part 1: Design for performance

Developing a grid friendly building

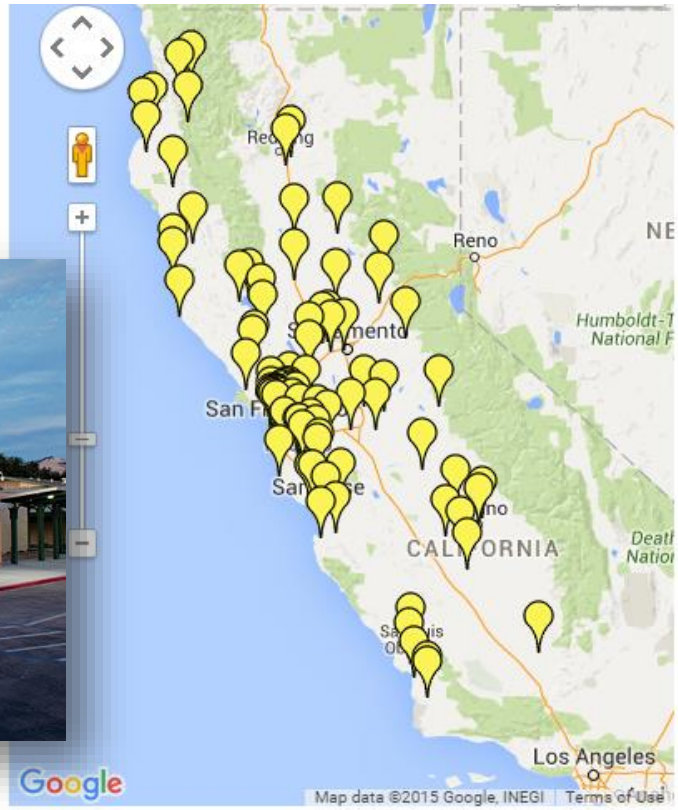


zero net energy

Renewable Energy Integration

- The Final step
- Solar most common
- Size as feasible

Photo Credit: KaraGeorge Studios



- Alvarado Elementary
- Ahwahnee Middle
- Anderson New Technology High
- Arena Union Elementary
- Argonne Elementary
- Arroyo Grande High
- Ayer Elementary
- Bahia Vista Elementary
- Balboa High
- Barry Elementary
- Battles Elementary
- Bauer Speck Elementary
- Bellevue Elementary
- Bessie Carmichael
- Burrel Union Elementary
- Cabrillo Elementary
- Camp Arroyo Outdoor and YMCA Camp
- Cesar Chavez Elementary
- Center for Advanced Research and Technology (CART)

Designing to the ZNE Target
Part 1: Design for performance

Questions & Answers

Lunch Break

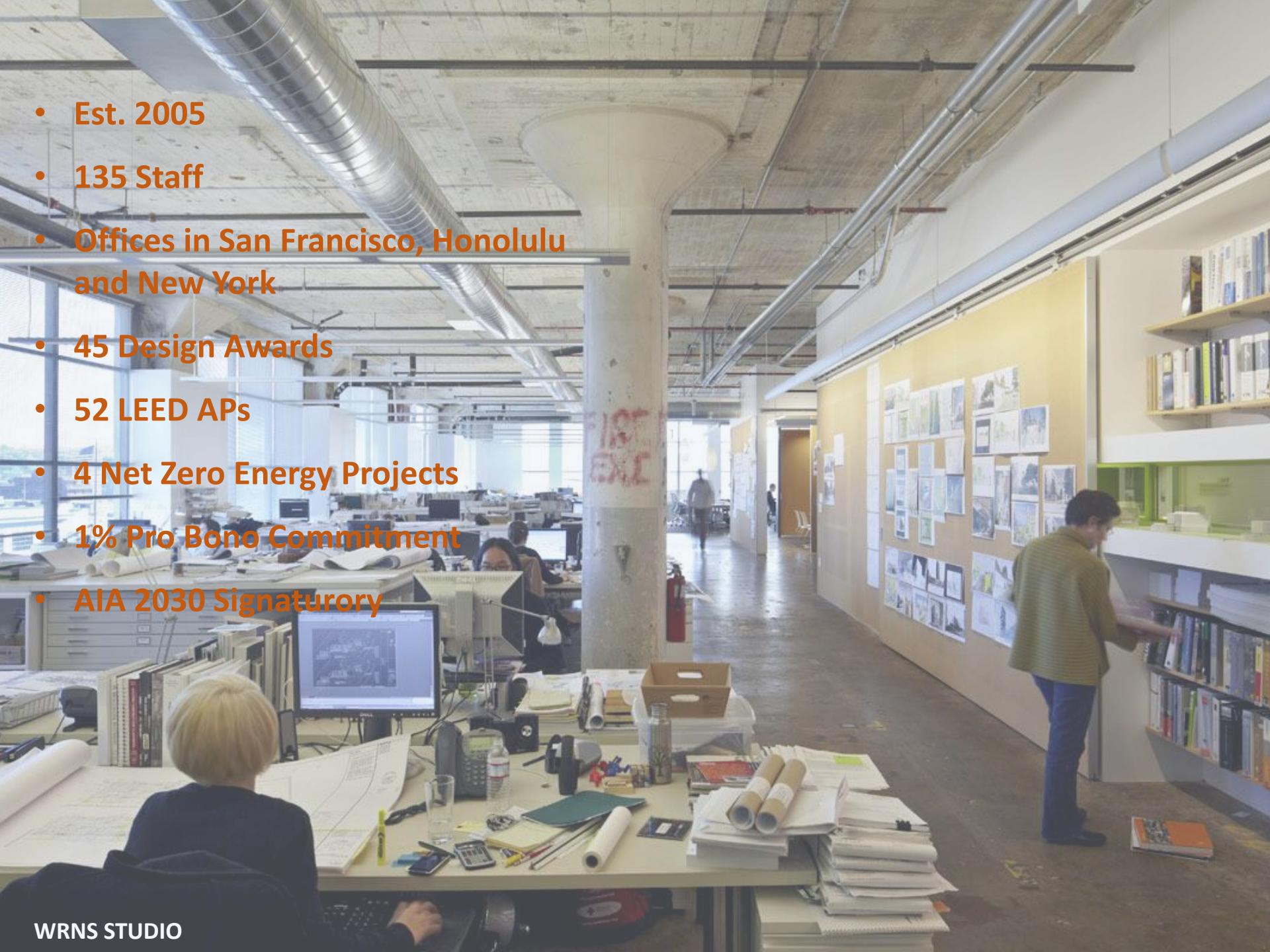
12:15 – 1:00 p.m.

Case Study Presentations

1:00 – 2:00 p.m.

Stevens Library case study : ZNE evolution and lessons learned

Pauline Souza
WRNS Studio
psouza@wrnsstudio.com



- Est. 2005
- 135 Staff
- Offices in San Francisco, Honolulu and New York
- 45 Design Awards
- 52 LEED APs
- 4 Net Zero Energy Projects
- 1% Pro Bono Commitment
- AIA 2030 Signaturory

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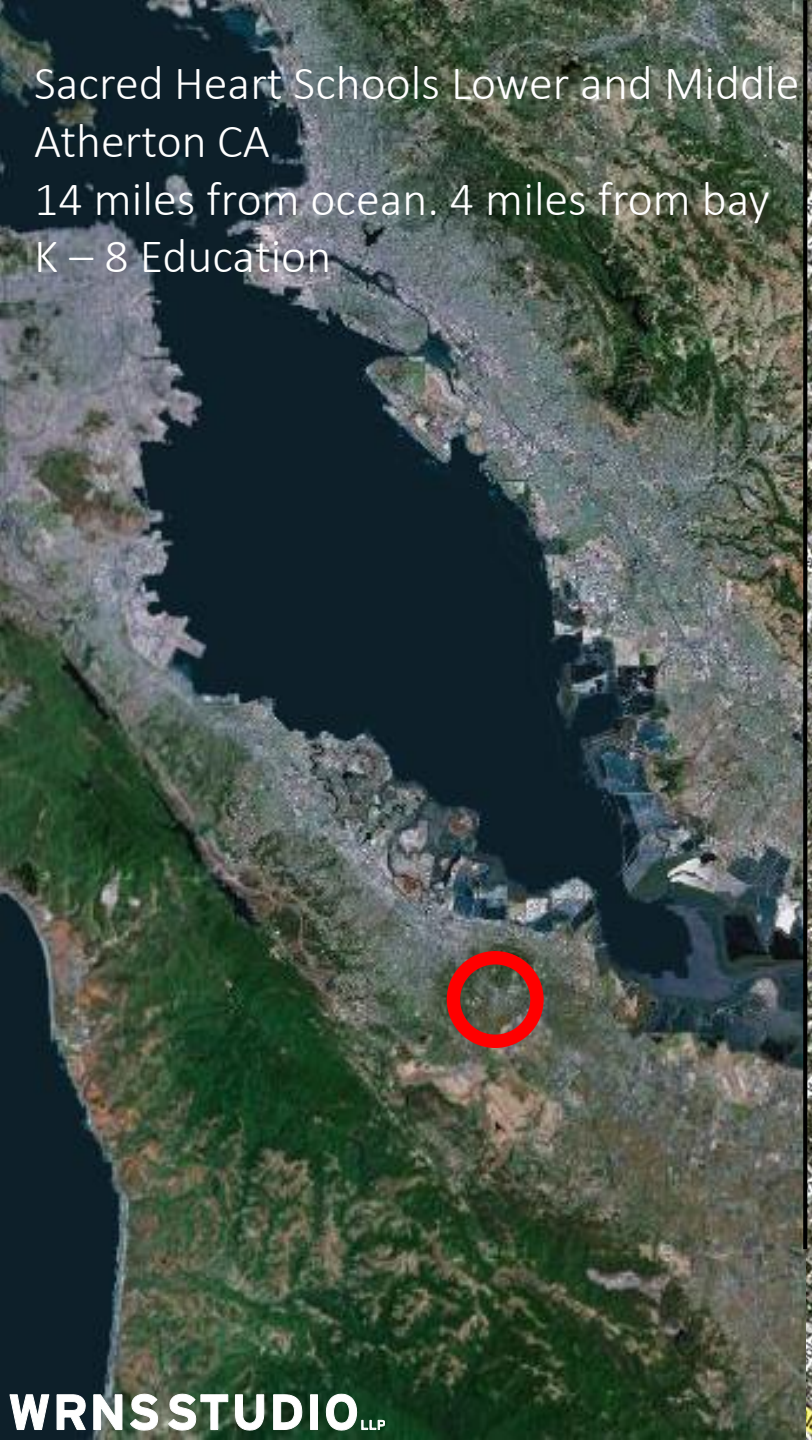
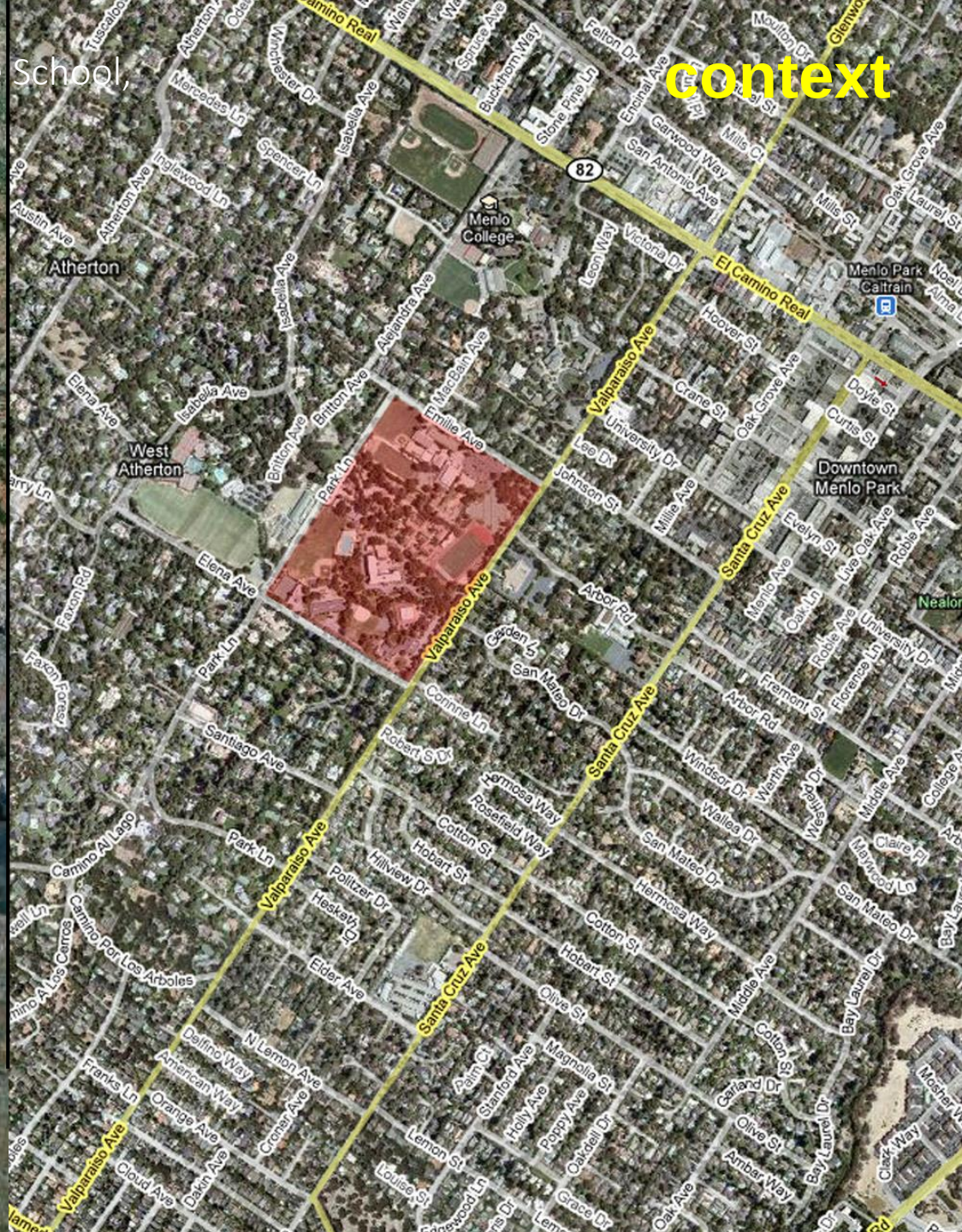
Sacred Heart Schools Lower and Middle School, Atherton CA
450 students
Low budget Y2009
Fast Paced: 9 mo. design, 14 mo.construction

Sacred Heart Schools Lower and Middle School,
Atherton CA
14 miles from ocean. 4 miles from bay
K – 8 Education





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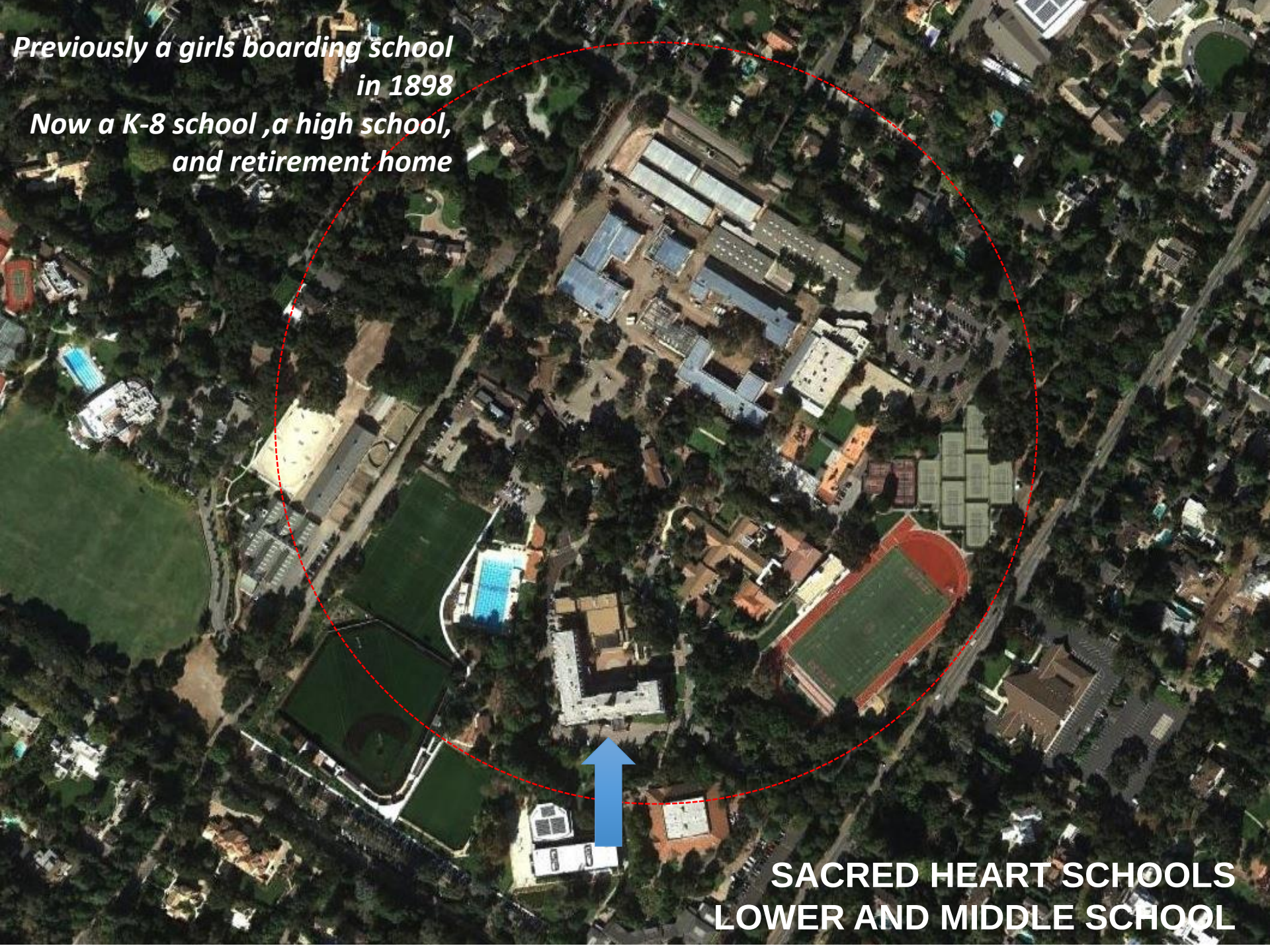

Previously a girls boarding school
in 1898
Now a K-8 school ,a high school,
and retirement home
SACRED HEART SCHOOLS
LOWER AND MIDDLE SCHOOL

- Interested client with inspiring mission statement
- Amazingly creative design team –
- Wonderful program

Starts with the vision and mission

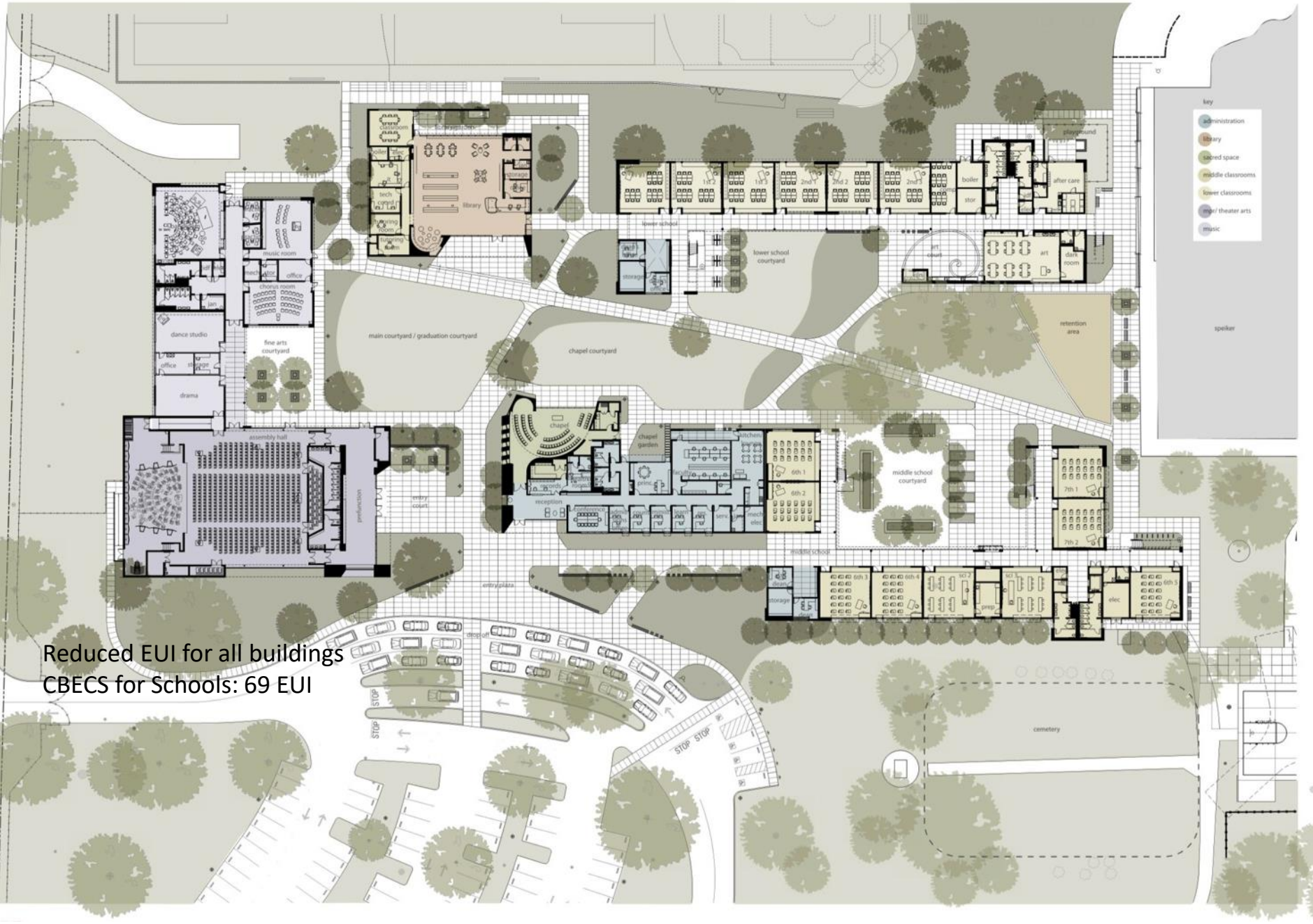
- ***educate children to become exceptional leaders***

work in partnership with students, parents, and other community members to educate the whole child in a nurturing environment and empower each student to become a contributing member and responsible participant in our changing world.

Limited dollars - $250 - $300/sf – approximately 20% less than the current construction dollar

No green


Lower School
Middle School
Library
Administration
Performing Arts



Reduced EUI for all buildings
CBECS for Schools: 69 EUI

63 acres plus

Local code requirements:

2 year storm

accommodate a 25 year storm for 48 hours

Permeability of soils – coefficient less than 10^{-8} cm/sec

Clay Soils – hydraulic soil group "D"

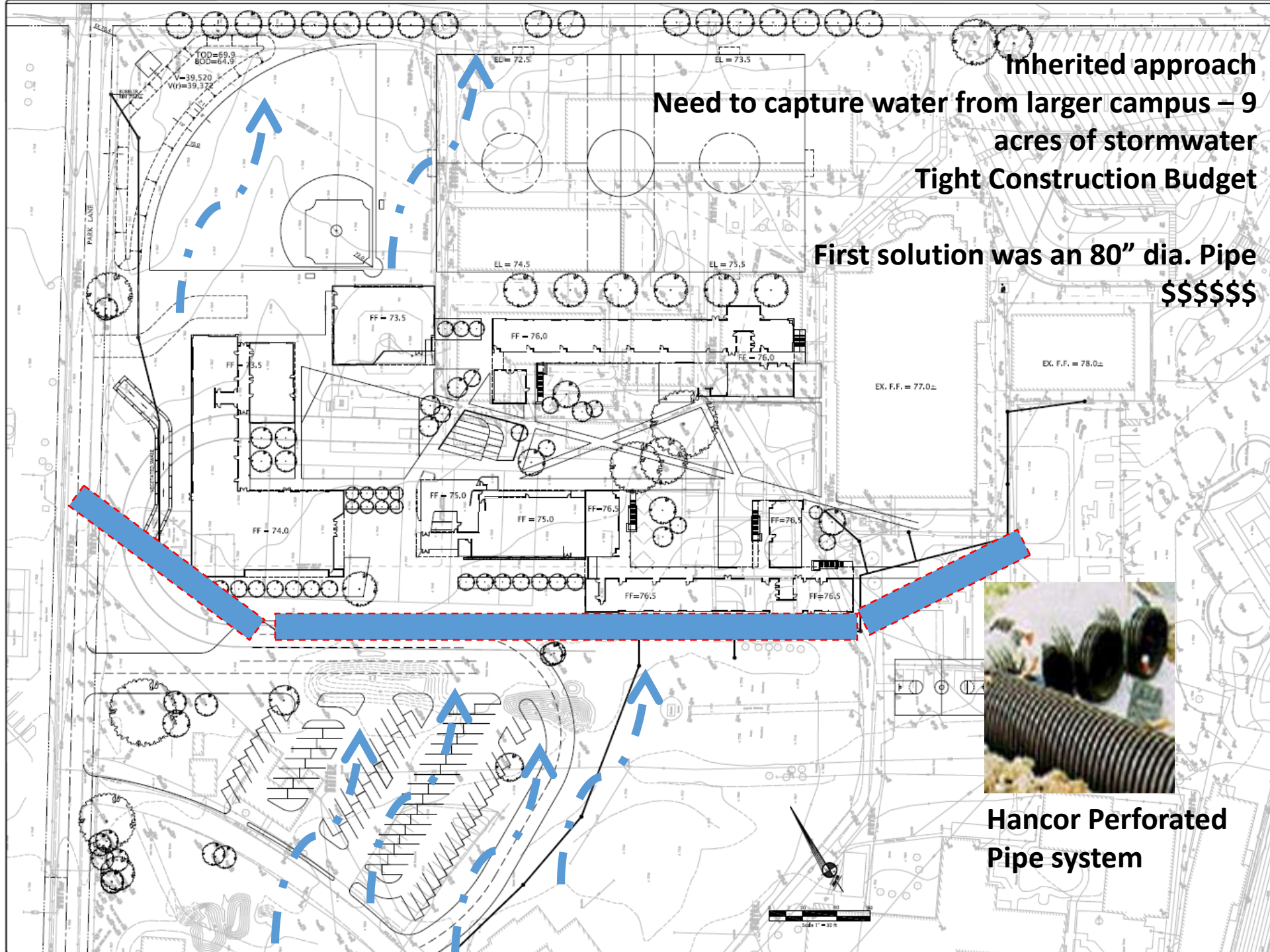
Site water management

Detention

c) The Town requires stormwater detention for the purpose of reducing peak flows to downstream creeks and channels. Stormwater detention is required for projects that create or replace greater than 5,000 square feet impervious surface, with no credit given for existing impervious surface that is removed. Stormwater detention shall be based on storing 2-inches of rainfall over the proposed impervious area. The peak release rate shall be the 48-hour inflow volume over a 36 to 48-hour period. A higher rate of release is allowed if the calculated orifice size would be less than 1 inch diameter for a gravity release or less than that pumped by a 1/3 horsepower pumping unit, in which case, these minimum sizes are acceptable. Storage is required in all portions of the Town and within the Atherton Channel Drainage District. Detentions basins may discharge to groundwater, gravity flow to the Town storm drain system, which includes gutter flow if no storm drain line is present, or be pumped to the Town storm drain system.

d) Percolation from detention ponds is allowed only if a Geotechnical Report shows that there will be at least a 10-foot separation from the groundwater table and that percolating water will not seep onto other properties. Raising the groundwater table by seepage is accepted. If the bottom of the storage basin is within 10 feet of the groundwater table or affects seepage to other properties, a low permeability barrier designed to mitigate the effects of the seepage is required. Infiltration devices shall be located at least 100 feet away from water supply wells.

If percolation is used, the Geotechnical Report shall verify that all soils to the groundwater level will percolate at the minimum rate recommended for design.


Inherited approach
Need to capture water from larger campus – 9 acres of stormwater
Tight Construction Budget
First solution was an 80” dia. Pipe $$$$$$
Hancor Perforated Pipe system
PARK LANE
EL = 72.5
EL = 73.5
EL = 74.5
EL = 75.5
FF = 73.5
FF = 76.0
FF = 74.0
FF = 75.0
FF=76.5
EX. F.F. = 77.0±
EX. F.F. = 78.0±

06

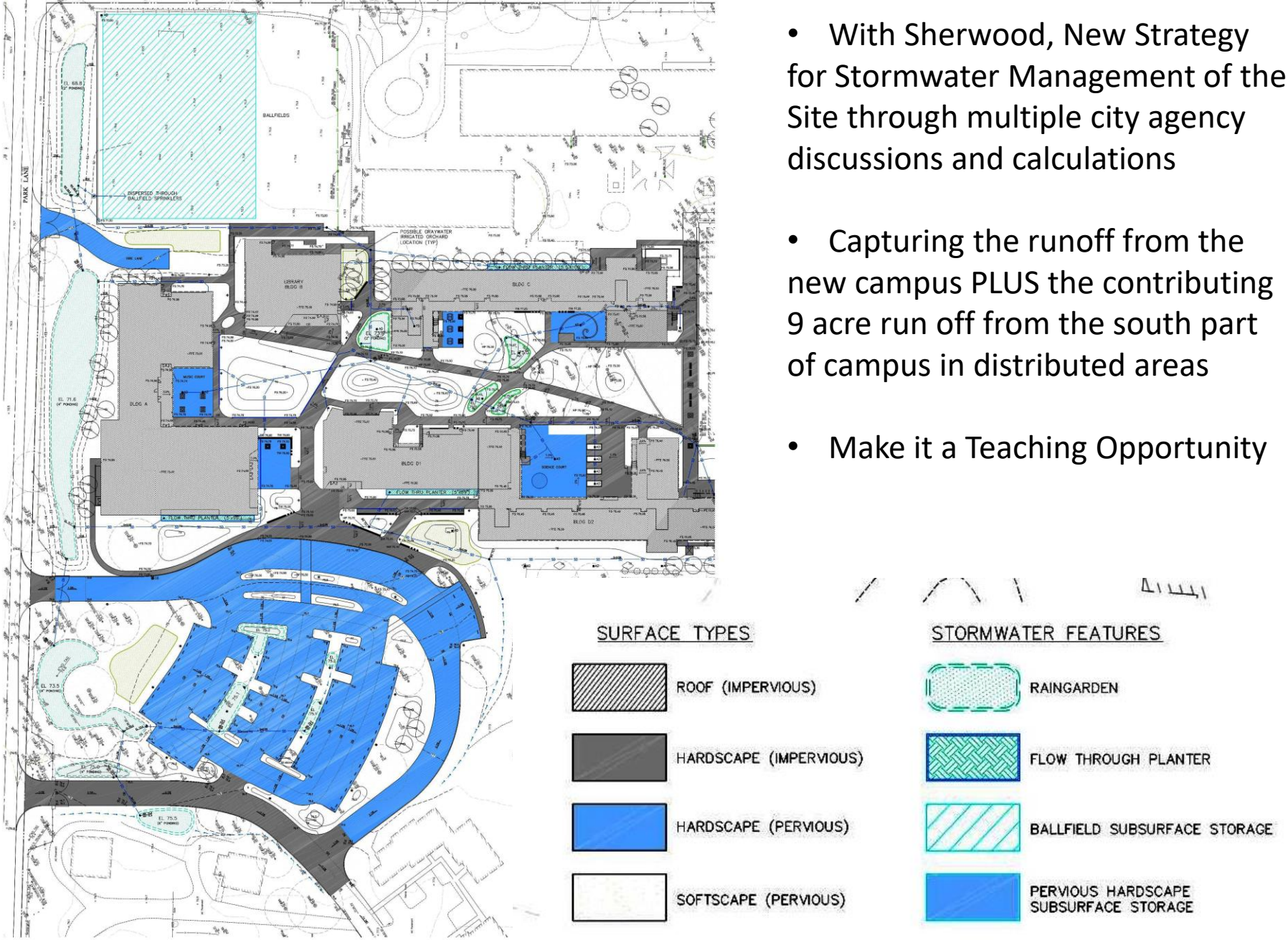
ECOLOGICAL WATER FLOW

100% of storm water and used, project water discharge must be managed onsite to feed the project's internal water demands or released onto adjacent sites for management through acceptable natural time-scale surface flow, groundwater recharge, agricultural use or adjacent property needs.

A different way of looking at the same problem – multiple discussions – regulatory education Sherwood and BFS

Stormwater cleansed through landscape based natural treatment – meets C3 regulatory requirements

Stormwater flow rates are reduced through maximized pervious paving and Increased landscape – calculate and prove



- With Sherwood, New Strategy for Stormwater Management of the Site through multiple city agency discussions and calculations

- Capturing the runoff from the new campus PLUS the contributing 9 acre run off from the south part of campus in distributed areas

- Make it a Teaching Opportunity

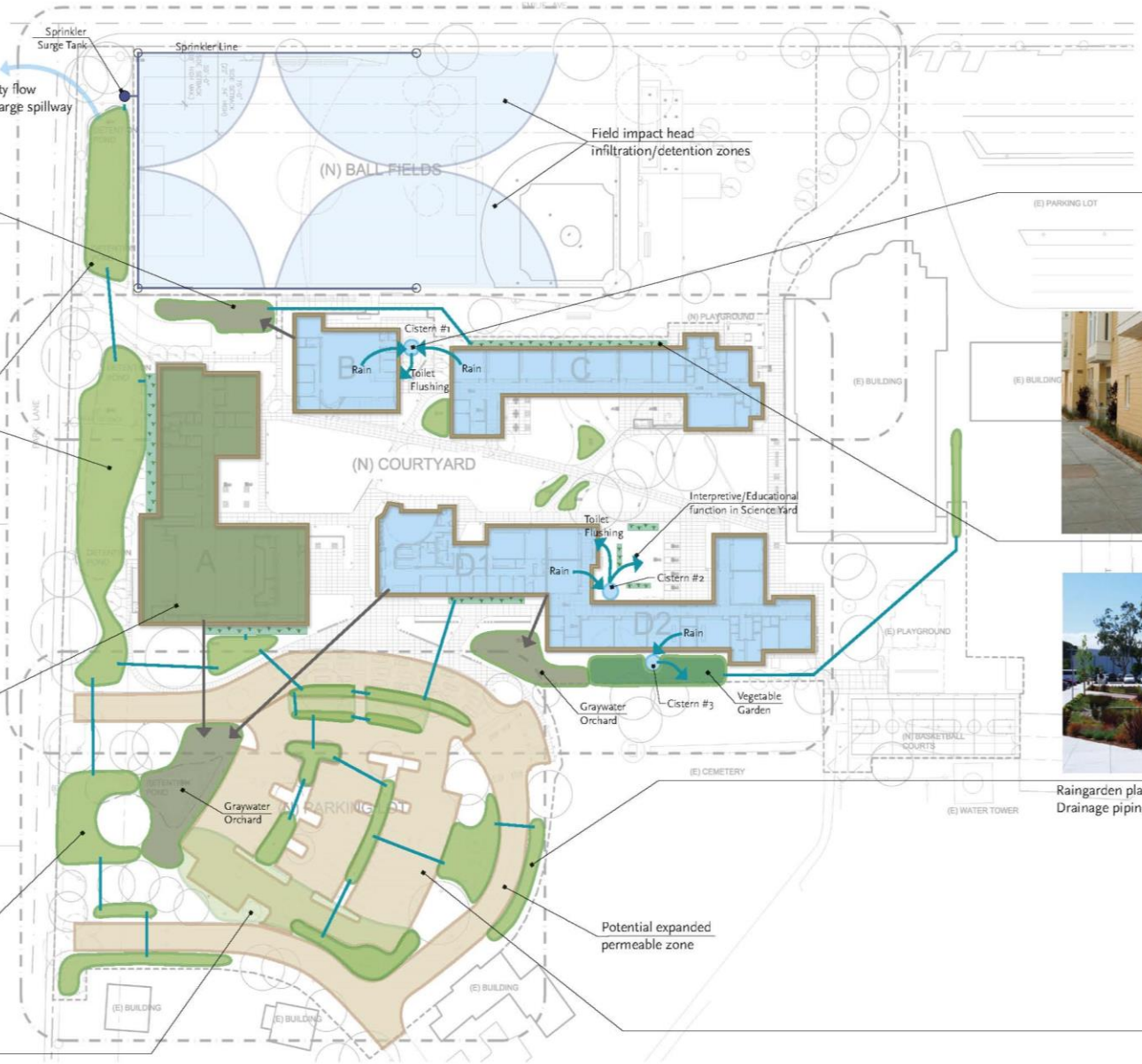
Graywater irrigated orchard

Large raingarden areas, assumed to provide 12" storage depth, max.

Green roof creates 30% or greater runoff reduction vs standard roof

Stormwater management areas

Alternative detention area
Surface storage area during large and infrequent storm events



Rainwater harvesting cistern

Flow-through planter, 6" storage depth, ty

Raingarden planting, assumed 3"-4" retention depth.
Drainage piping to be adjusted to accommodate these ar

Parking lot surfaced in pervious paveme

SHERWOOD
Design Engineers

Stormwater Diagram

SAINT JOSEPH ACADEMY

ATHERTON, CALIFORNIA


WRNS STUDIO


Pervious paving at courtyard and entry areas


Bioswales and retention areas


Flow through planters serve as seating

Flow through planters serve as waiting seating at front of campus


Connecting art and science
WRNS STUDIO


the change in the place you usually sit, here the sound of the rushing water


Experience how it changes


JOHNSON PERFORM


Notice how the water doesn’t puddle

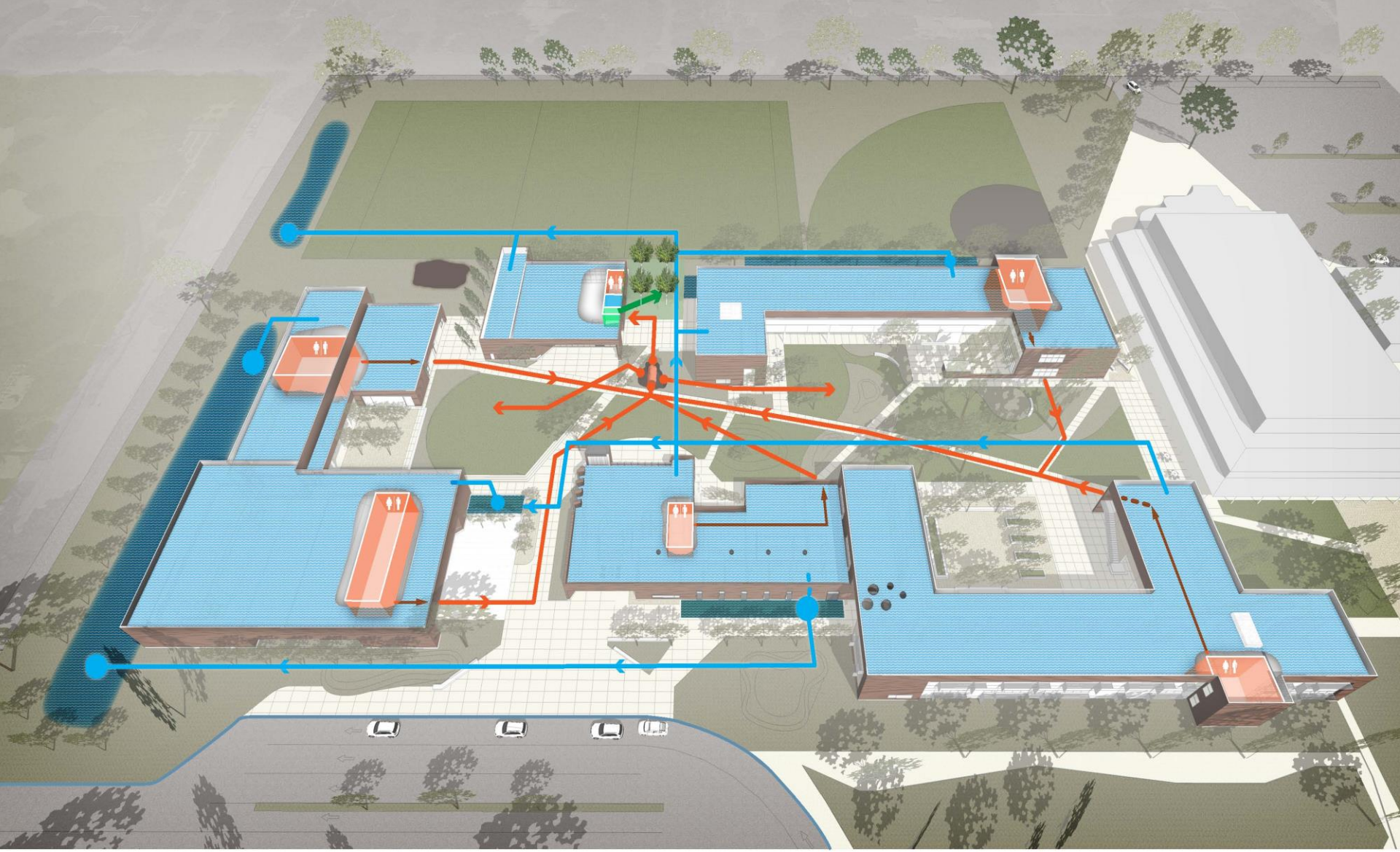
Collection from all sinks to GREYWATER filtration system and to landscape and Library toilets

Use of RAINWATER for potable uses

Library Demand:

2 lavatory sinks, I service sink, 2 water fountains
113 gallons a day
33,750 gallons per year
Max Flow: 4 gpm

Greywater and Rainwater reuse



SACRED HEART SCHOOLS

ATHERTON, CA

LOWER & MIDDLE SCHOOLS

STORMWATER, RAINWATER, GREYWATER COMPOSITE DIAGRAM

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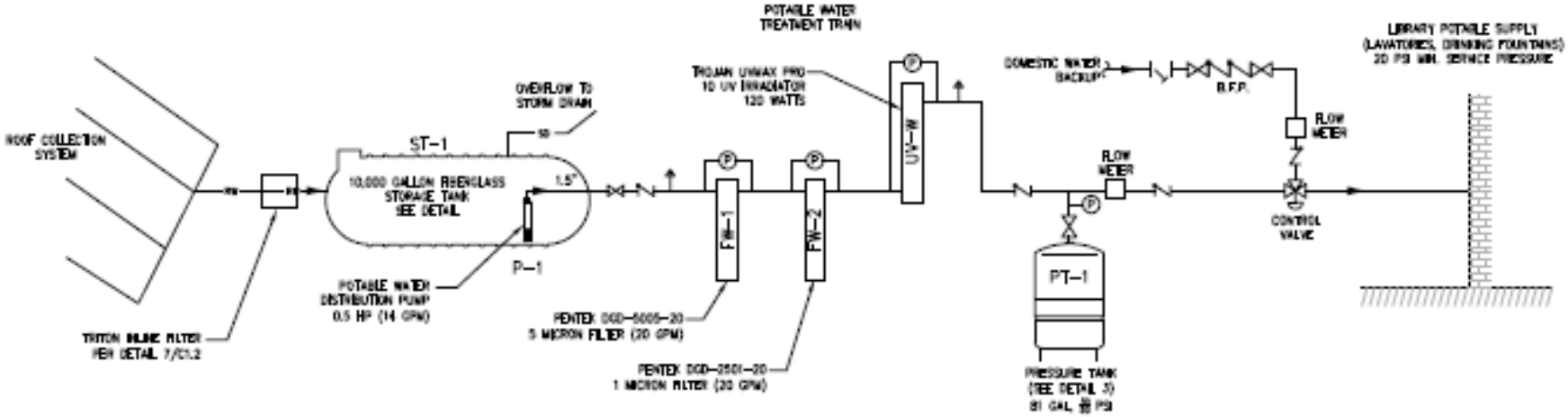
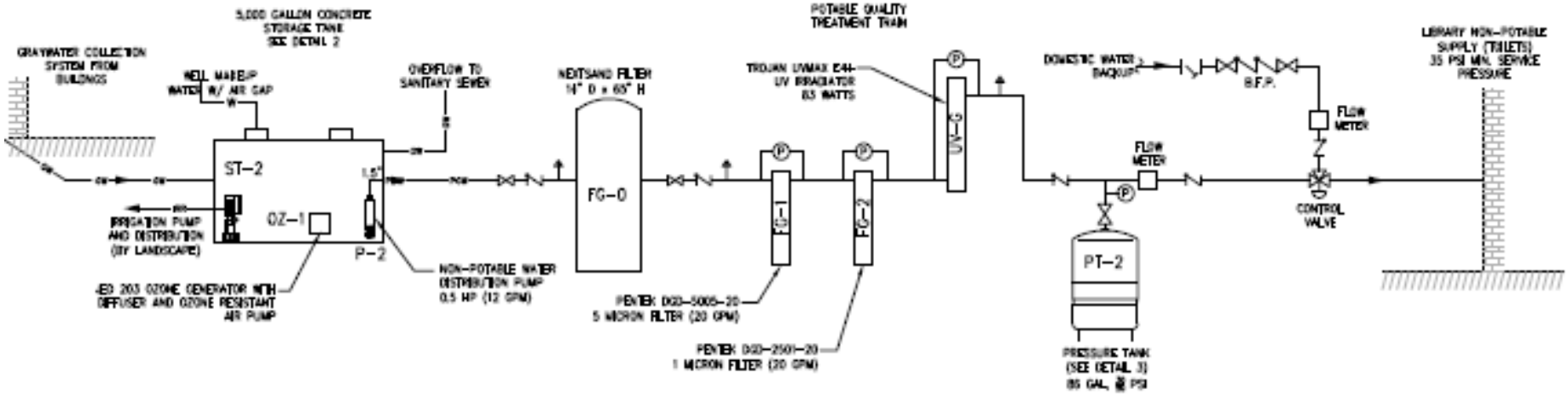


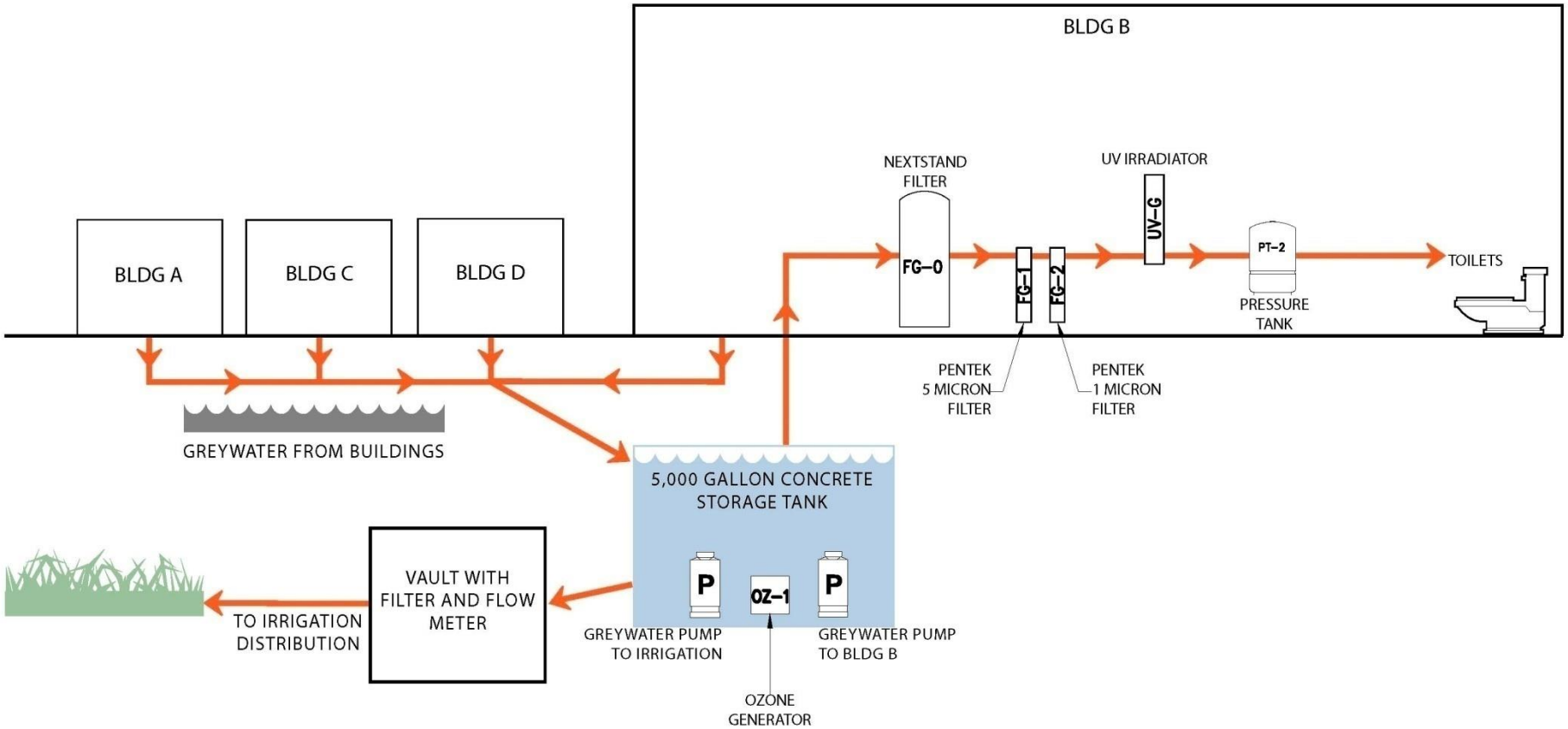
RAINWATER SYSTEM SCHEMATIC

NTS



GRAYWATER SYSTEM SCHEMATIC

NTS



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SACRED HEART SCHOOLS

ATHERTON, CA

LOWER & MIDDLE SCHOOLS

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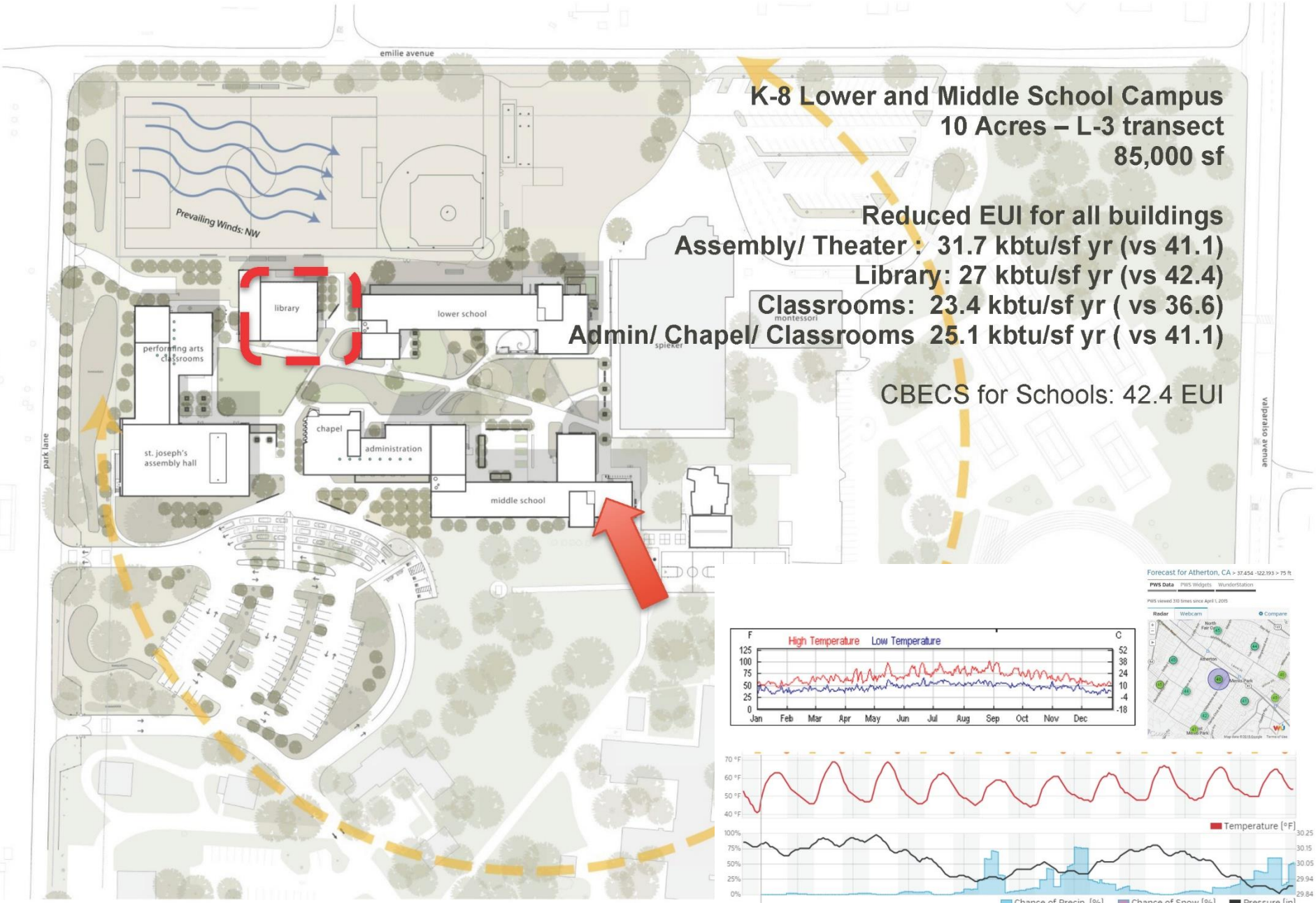

K-8 Lower and Middle School Campus
10 Acres – L-3 transect
85,000 sf

Reduced EUI for all buildings
Assembly/ Theater : 31.7 kbtu/sf yr (vs 41.1)
Library: 27 kbtu/sf yr (vs 42.4)
Classrooms: 23.4 kbtu/sf yr (vs 36.6)
Admin/ Chapel/ Classrooms 25.1 kbtu/sf yr (vs 41.1)

CBECS for Schools: 42.4 EUI

SACRED HEART SCHOOLS
ATHERTON

Lower & Middle School - Site Plan

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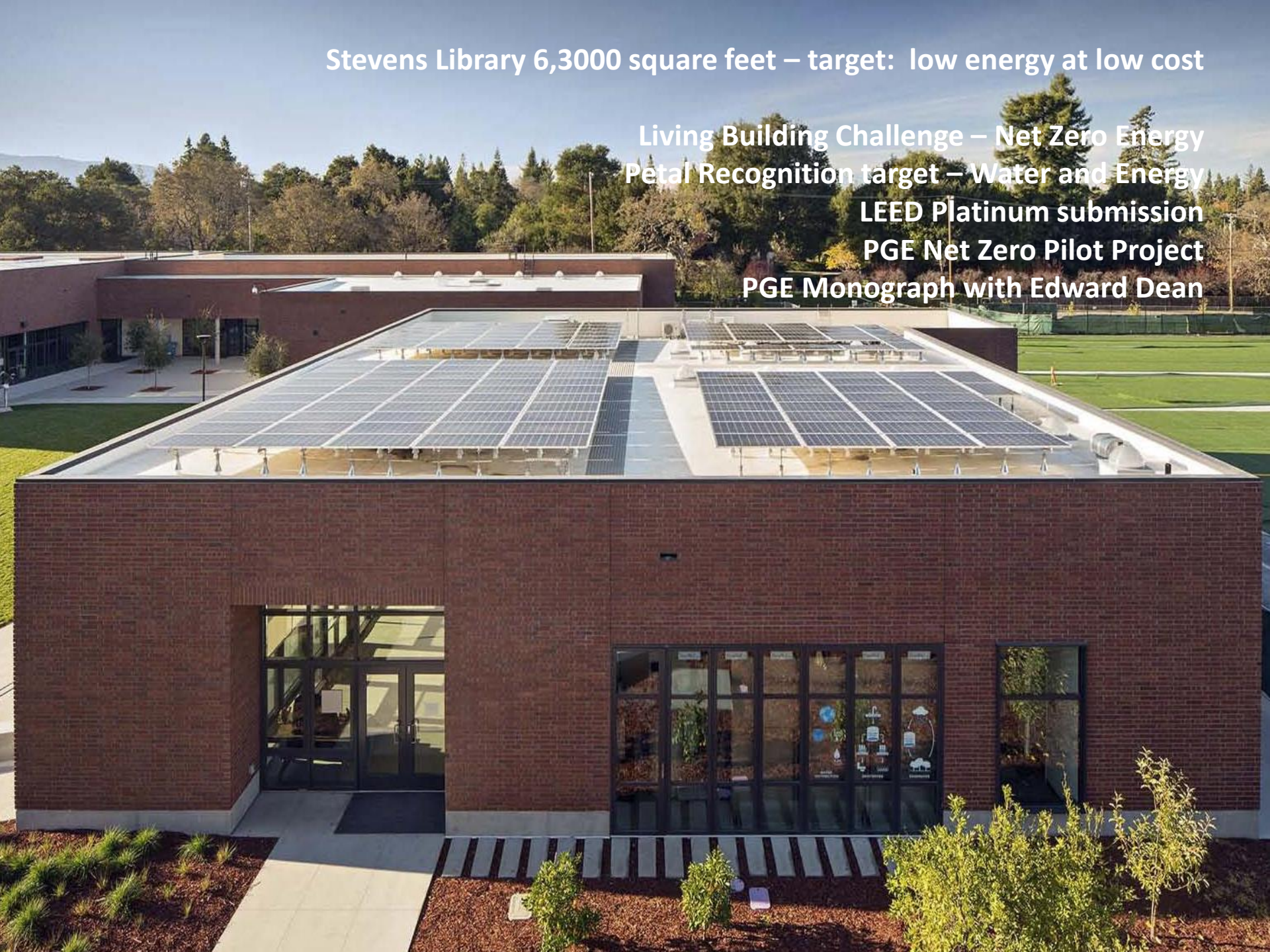
Greywater tank location
WRNS STUDIO


Stevens Library 6,3000 square feet – target: low energy at low cost
Living Building Challenge – Net Zero Energy
Petal Recognition target – Water and Energy
LEED Platinum submission
PGE Net Zero Pilot Project
PGE Monograph with Edward Dean

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Zero-Net Energy in California Schools – A Case Study and more

LeyVa Middle School ZNE+E Administration Building (2012)

nbi new buildings institute

Learning Objectives:

- *Learn an approach to introducing ZNE to schools*
- *Understand the technical aspects of ZNE*
- *A glimpse into the future of "Net Zero" thinking*

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"ROADBLOCKS"

"We have to focus on un-met needs like classrooms and technology"

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"ROADBLOCKS"

"We have our District Standards. We can't maintain a fancy EMS"

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"ROADBLOCKS"

"We just can't afford it. We have to save money"

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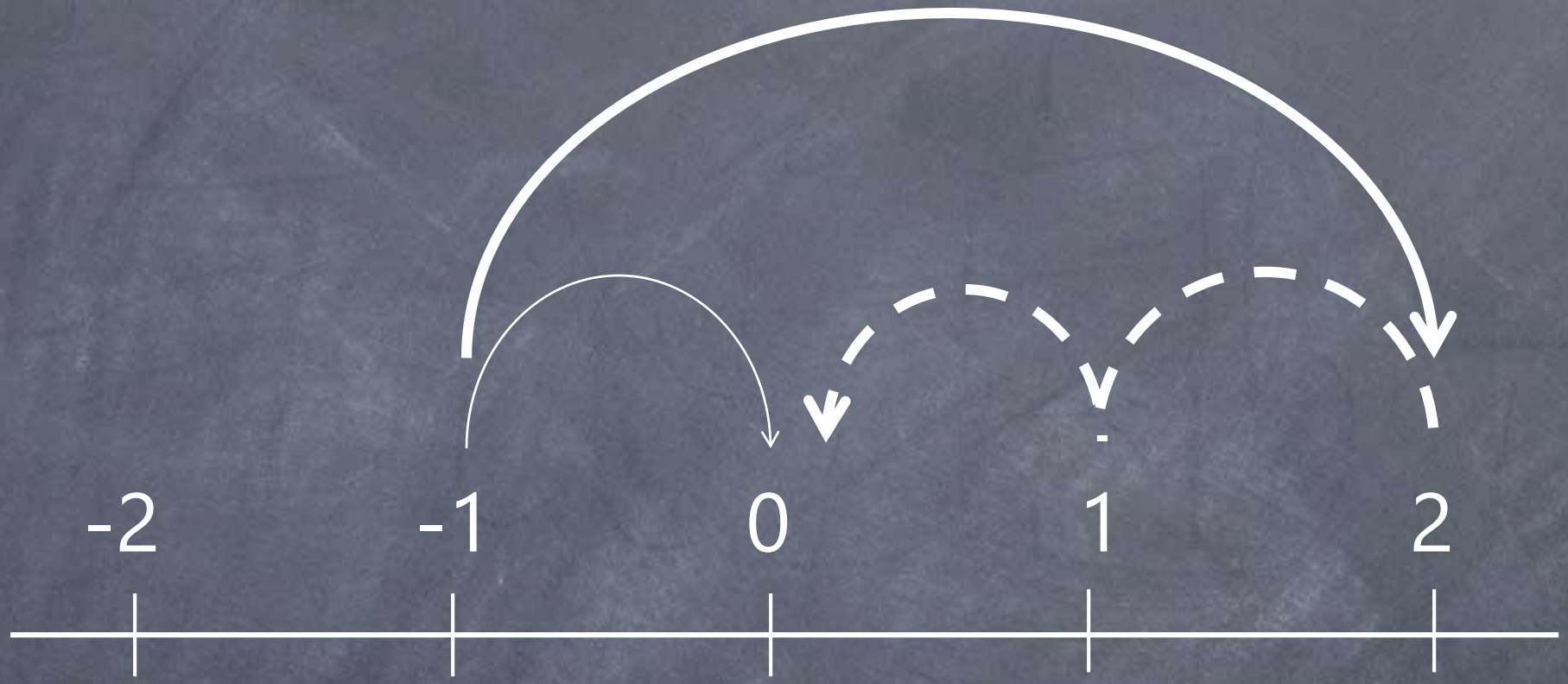
-2
-1
0
1
2

" OPPORTUNITIES "

" We save money everyday thanks to the investment in high quality design from the beginning"

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" OPPORTUNITIES "

"We have a safe and healthy learning environment in which students, teachers and staff thrive together"

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Biophilic Pattern		Stress Reduction	Cognitive Performance	Emotion, Mood & Preference
Visual Connection with Nature		**Lowered Blood Pressure and heart rate** (Brown, Barton and Gladwell, 2013, van den Berg, Hartig $ Staats, 2007; Tsunetsugu and Miyazaki 2005	**Improved mental engagement and attention** Biederman & Vessal 2006	**Attitude and overall happiness** Barton & Pretty 2010
Thermal & Airflow Variability		**Positively impacted comfort, well being and productivity** Heerwagen, 2006; Tham & Willem 2005; Wigo 2005	**Positively impacted concentration** Hartig et al., 2003; Hartig et al, 1991; R Kaplan & Kaplan 1989	**Improved perception of temporal and spatial pleasure** Parkinson de Dear & Candido 2012; Zhang Arens Huizenga & Han 2010; Arens, Zhang & Huizenga 2006; Zhang 2003; de Dear & Brager 2002; Heschong 1979
Dynamic & Diffuse Daylight		**Positively impacted circadian systems functioning** Figueiro, Brons, Plitnick et al 2011; Beckett & Roden 2009	**Positive effect on student test scores** Heshong Mahone 1999	**Increased Visual Comfort** Elyezadi, 2012; Kim & Kim 2007
Connection with Natural Systems and Materials		**Decreased diastolic blood pressure** Salingaros 2012; Joye 2007; Taylor 2006; S Kaplan 1988	**Improved creative performance** Lichtenfeld et al 2012	**Enhanced positive health responses, shifted perception of environment** Kellert et al. 2008

Reference: 14 Patterns of Biophilic Design, Terrapin Bright Green LLC, 2014

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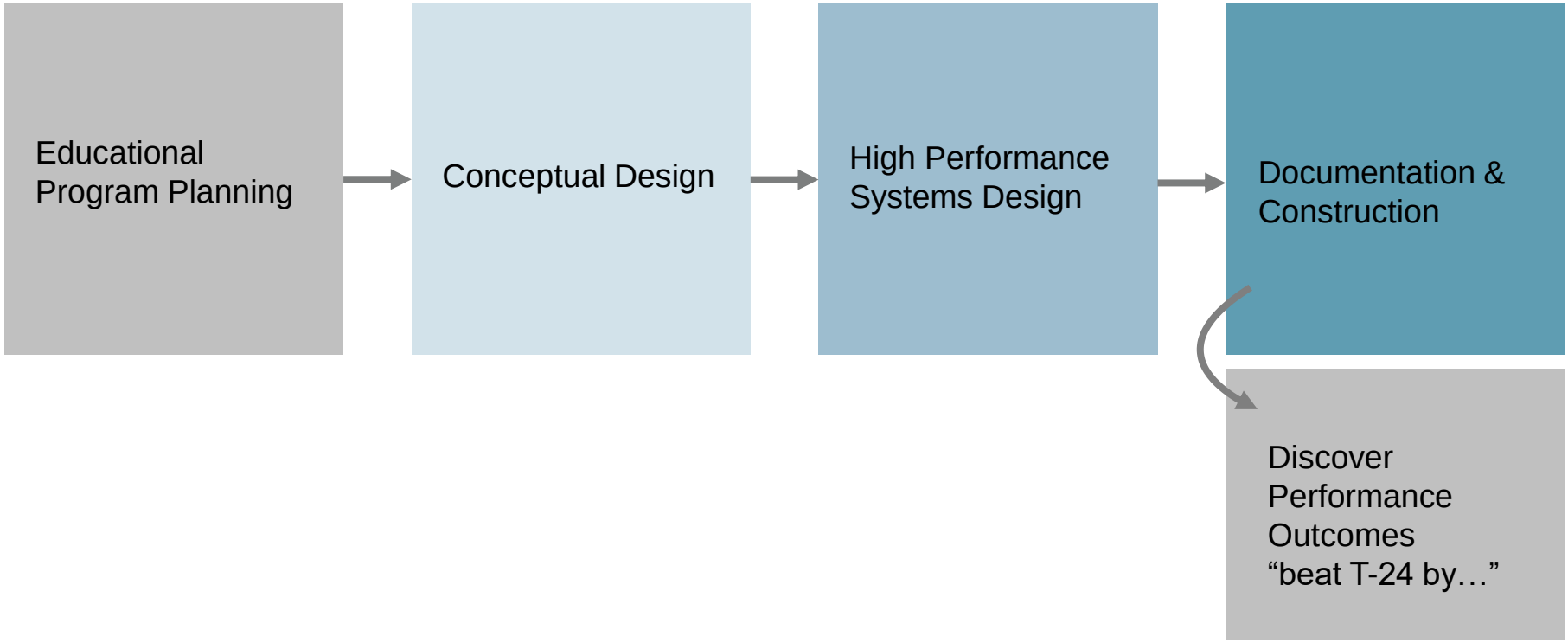
DEVELOPING A NEW APPROACH:

TRADITIONAL APPROACH



Integrated Design Is…

*"a **collaborative** method for designing buildings which emphasizes the development of a holistic design"*

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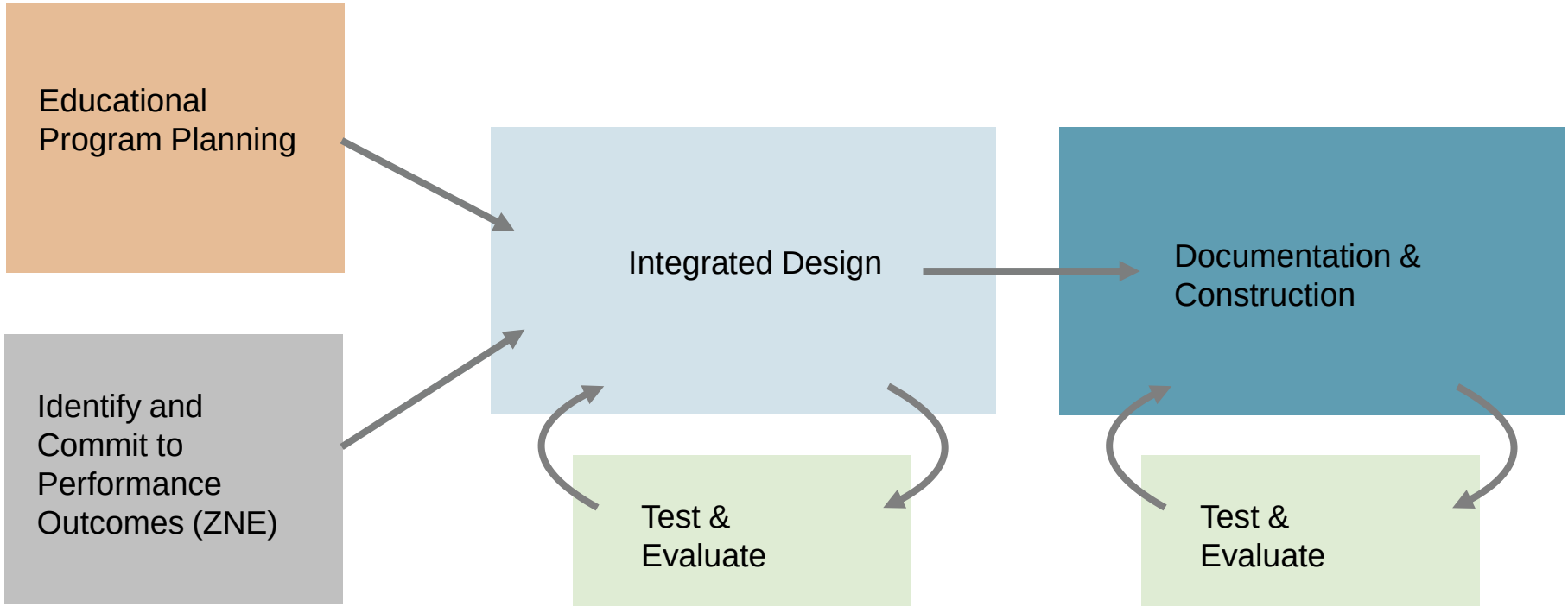
DEVELOPING A NEW APPROACH:

INTEGRATED APPROACH



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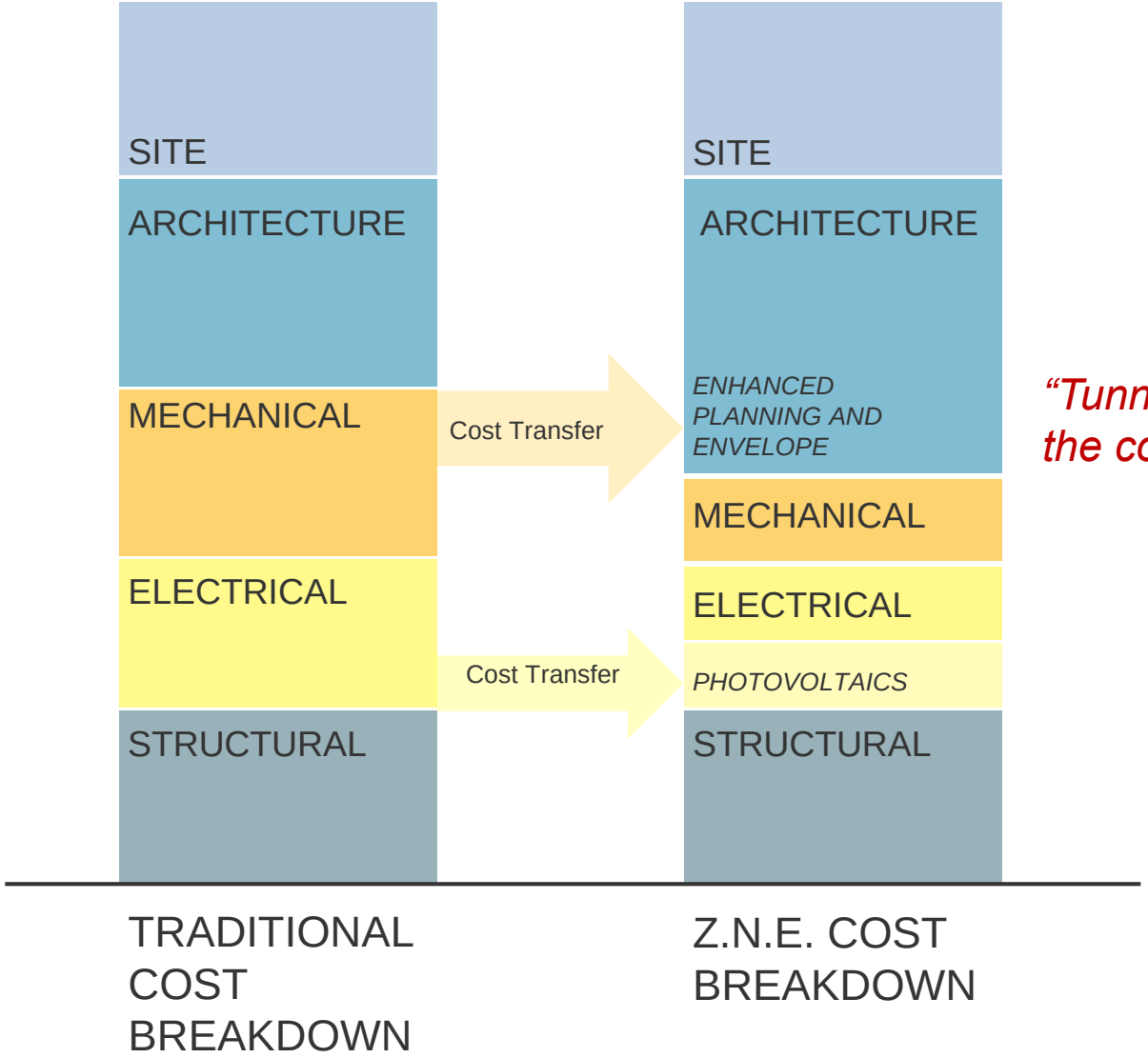
PROJECT BUDGETING:



"Tunneling through the cost barrier"

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Case Study: LeyVa Middle School Administrative Office Building

*"The first **Net Zero Energy/Net Zero Carbon Emissions** Public School Building in California"*

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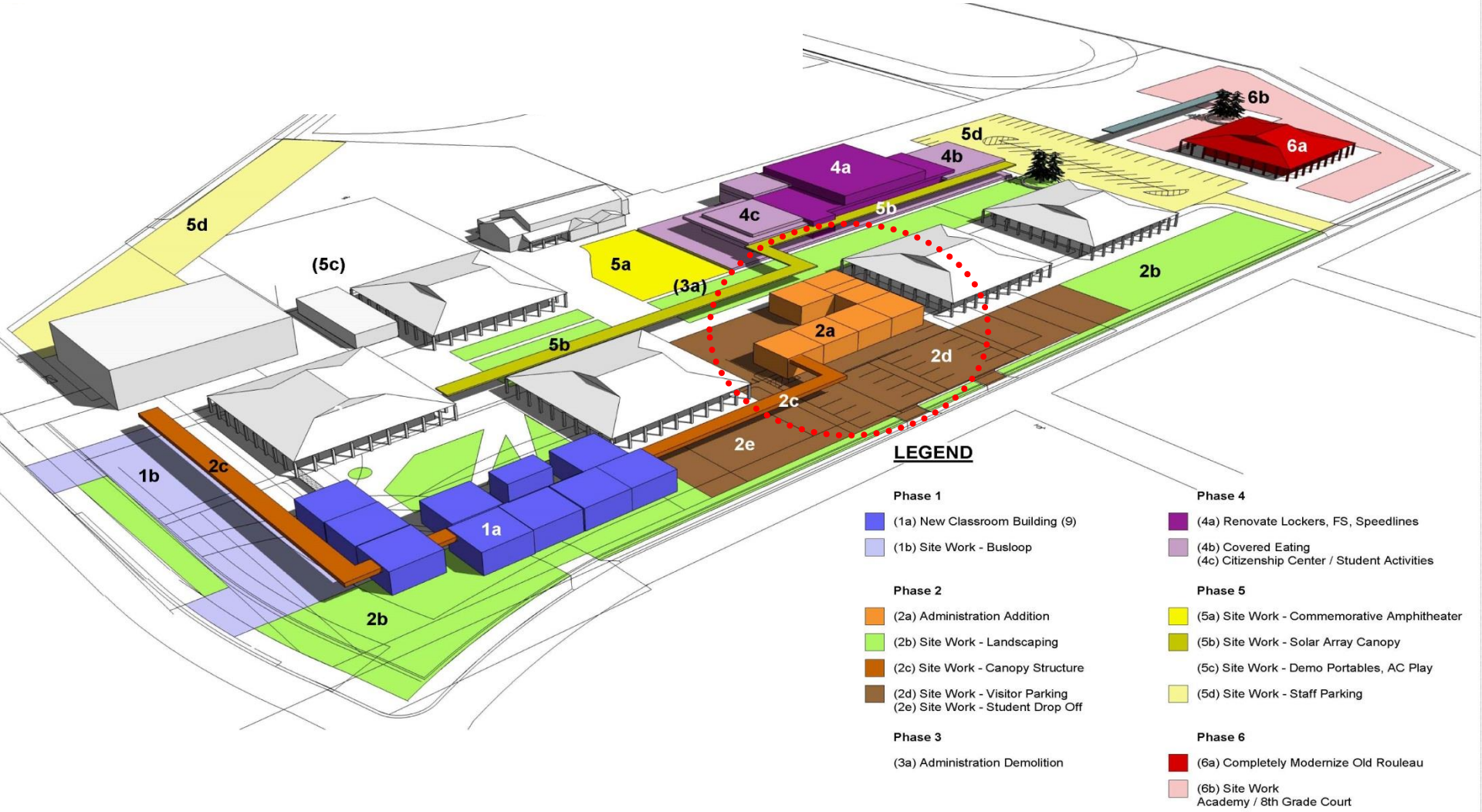
Un-"Conventional" Project?



Un-"Conventional" Project?

OUTCOMES:

- **Technical Intentions**
  - Reduce Cooling loads
  - Reduce Lighting loads
  - Reduce Electrical demand
  - Eliminate Gas fired equipment
  - **Zero Net Energy and Emissions**

- **Architectural Intentions**
  - Define a new welcoming image and entry gateway to the school
  - Light, Space, and Fresh Air

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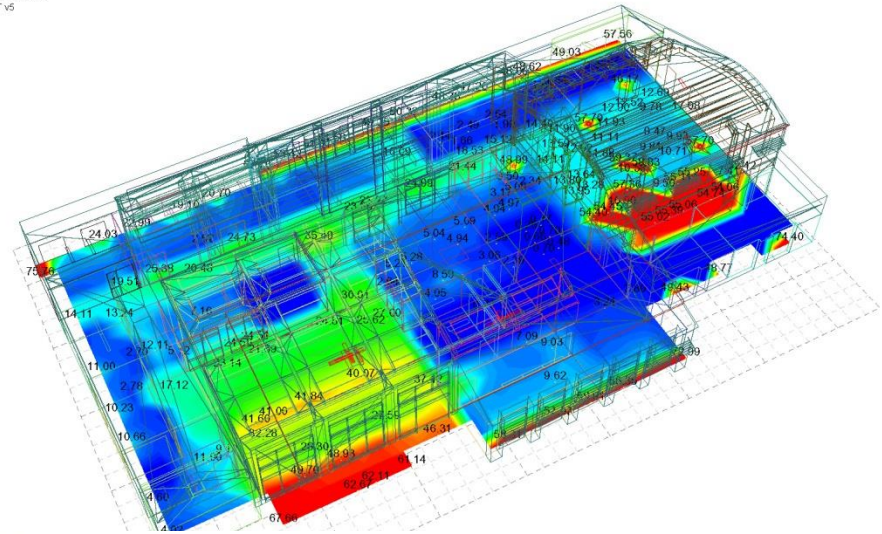
Daylight Analysis

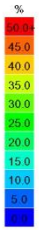
Daylight Factor

Contour Range: 0.0 - 50.0 %

In Steps of: 1.0 %

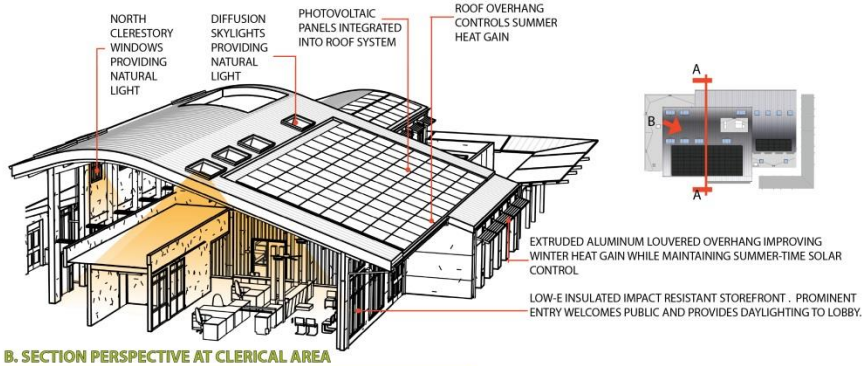
© ECOTECT v5





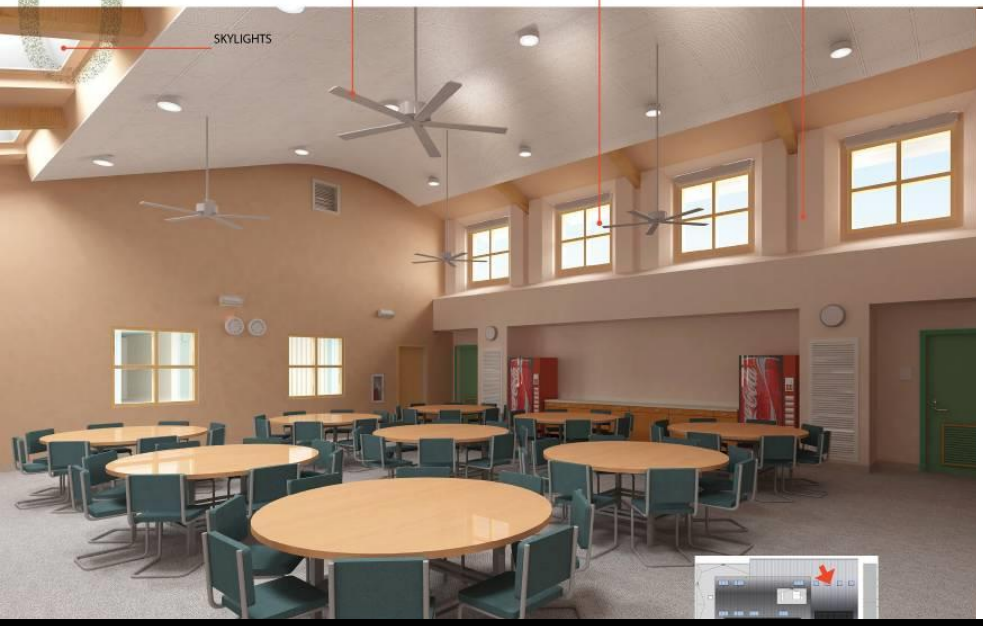
NET ZERO ENERGY
NET ZERO CARBON EMISSION

A-A. SECTION AT CLERICAL AREA

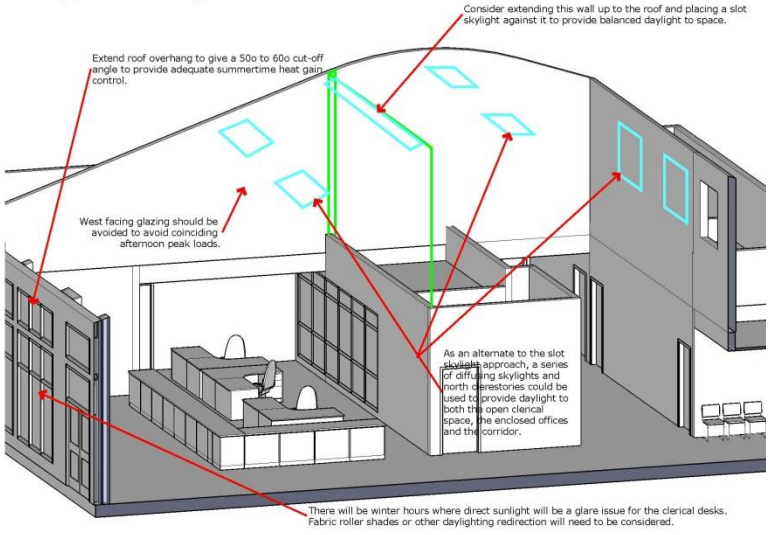


B. SECTION PERSPECTIVE AT CLERICAL AREA

NET ZERO ENERGY
NET ZERO CARBON EMISSION



Lobby / Clerical Design Recommendations

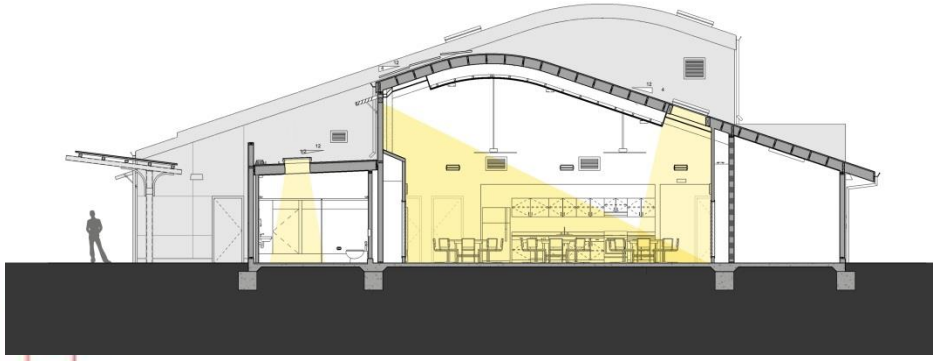


NET ZERO ENERGY
NET ZERO CARBON EMISSION

BUILDING WITHIN A BUILDING

REFLECTED DAYLIGHT REDUCES GLARE, DIFFUSES LIGHT AROUND ROOM

CEILING FANS FOR AIR CIRCULATION



A. CLERICAL AREA

B. HALL WAY

Energy Modeling

- **Energy Pro 4.4**
  - CA Accepted Compliance Software
  - Best Modeling Solution for this Project
- **E Pro Equivalent to ASHRAE 90.1**
  - Based on DOE2 algorithms
  - LEED accepted E Pro for Modeling

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Energy Modeling

- **T24 Compliance**
  - 41% Better than CA Energy Code Compliance
  - Obtained thru Integrated Design of Envelope, Mechanical, and Lighting Systems

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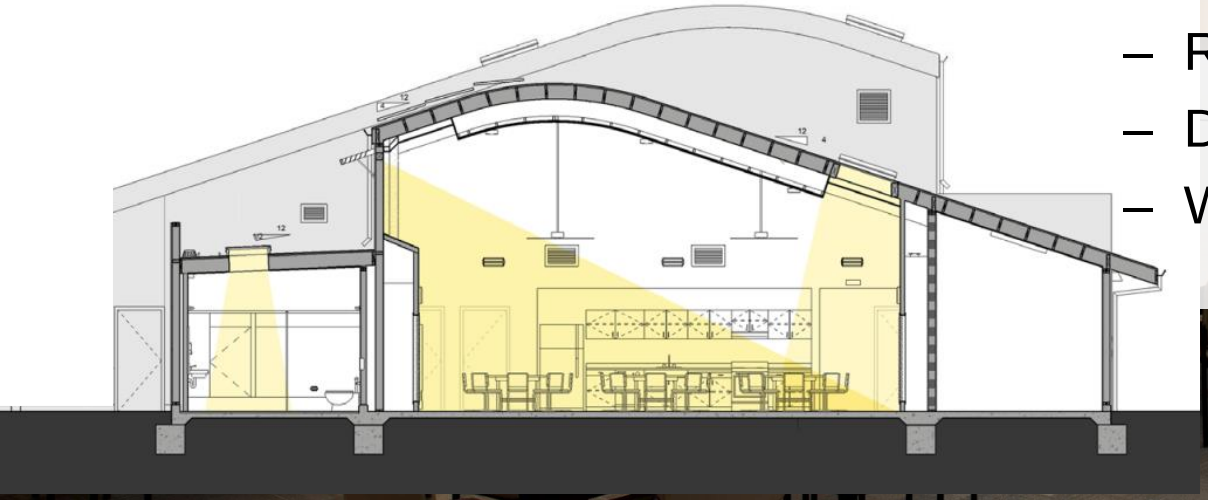
Energy Strategies

Envelope

- Greater than R30 Roof Insulation
- R19 Wall Insulation
- Dual Pane Low-e Glazing
- Window shading



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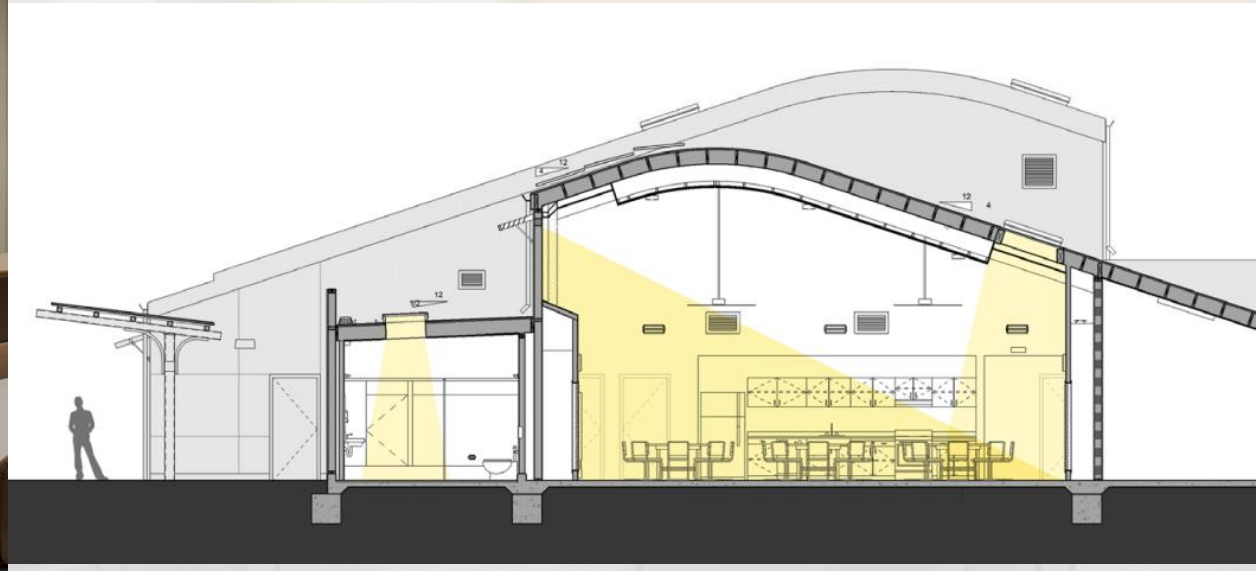
Energy Strategies

- **Electrical**
  - High Efficiency Lighting
  - Daylighting



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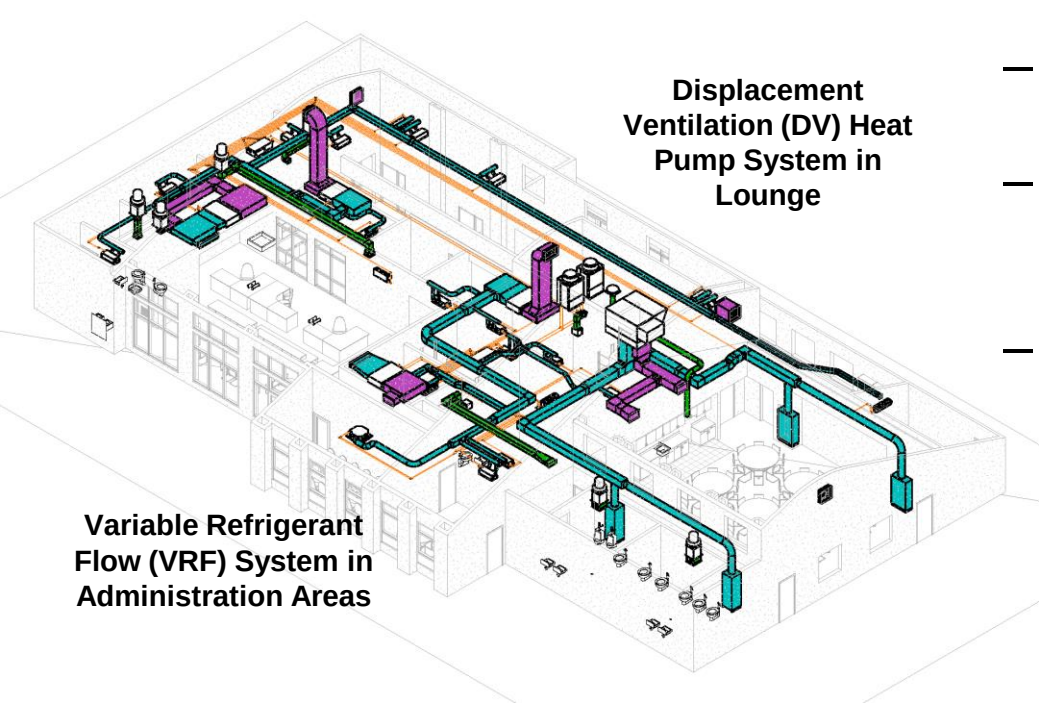
Energy Strategies



- **Mechanical**
  - Variable Refrigerant Flow (VRF) in Admin
  - High Efficiency Displacement Ventilation (DV) Single Zone VAV Heat Pump in Work Room
  - Energy Management System (EMS)

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Energy Strategies

Variable Refrigerant Flow (VRF)

- Energy transfer using refrigerant instead of central fans uses less fan energy
- Allows simultaneous heating and cooling between zones with little compressor power
- Variable speed compressors match changing building loads and provide high part load efficiency
- Superior Zone Temperature Control, zones are not over cooled or heated

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Energy Strategies

Displacement Ventilation

Heat Pump

- Use of higher supply air temperature (65°F) allows extended economizer operation
- Low velocity = low static = low fan power = low sound
- Heat pump operation allows heating with solar power
- Variable air supply volume reduces fan energy

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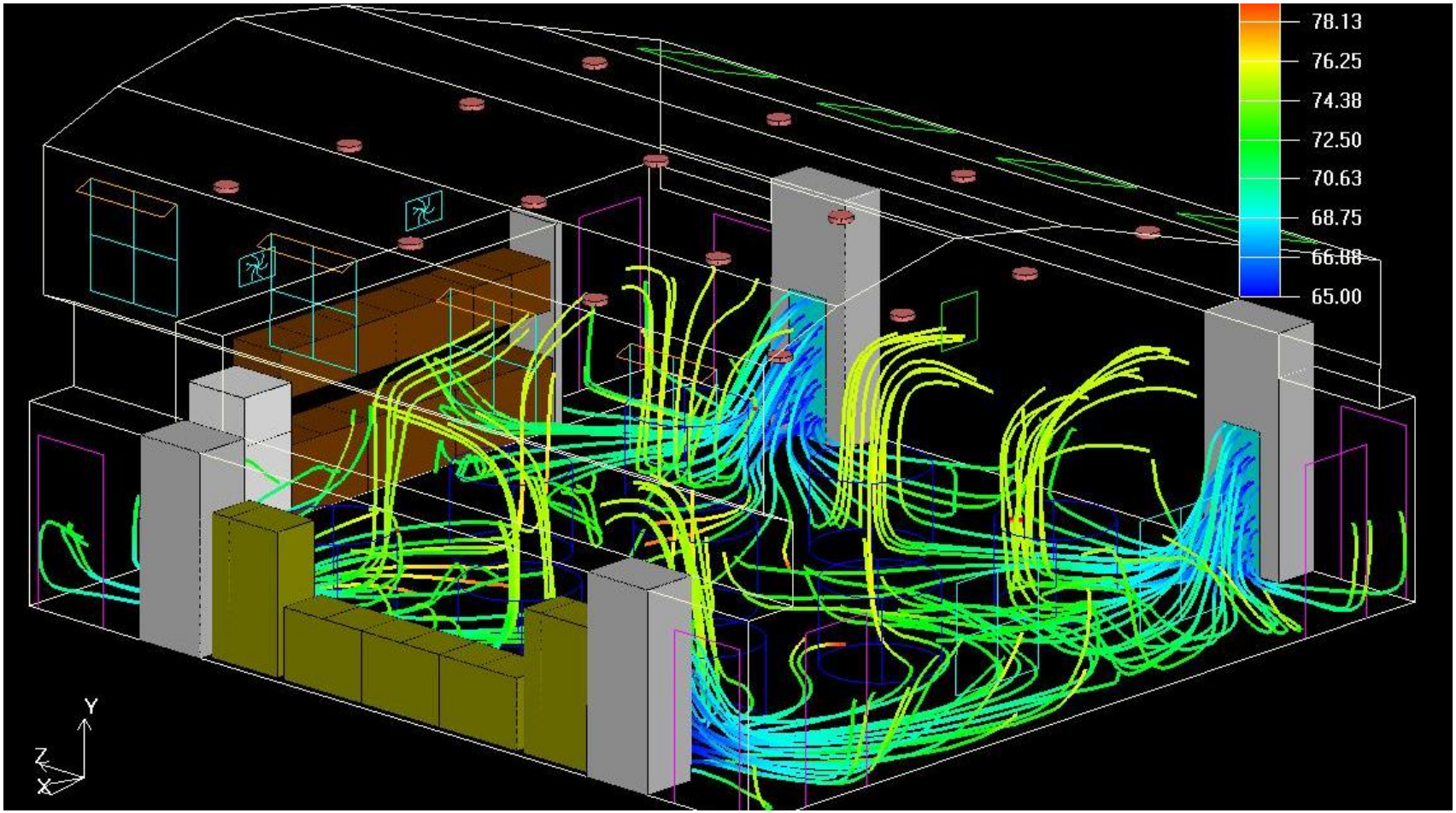
Particle trace graphic

Note how cool air delivered from diffusers at low velocity drops to floor and rises up around the occupant heat load at the tables providing room set point.



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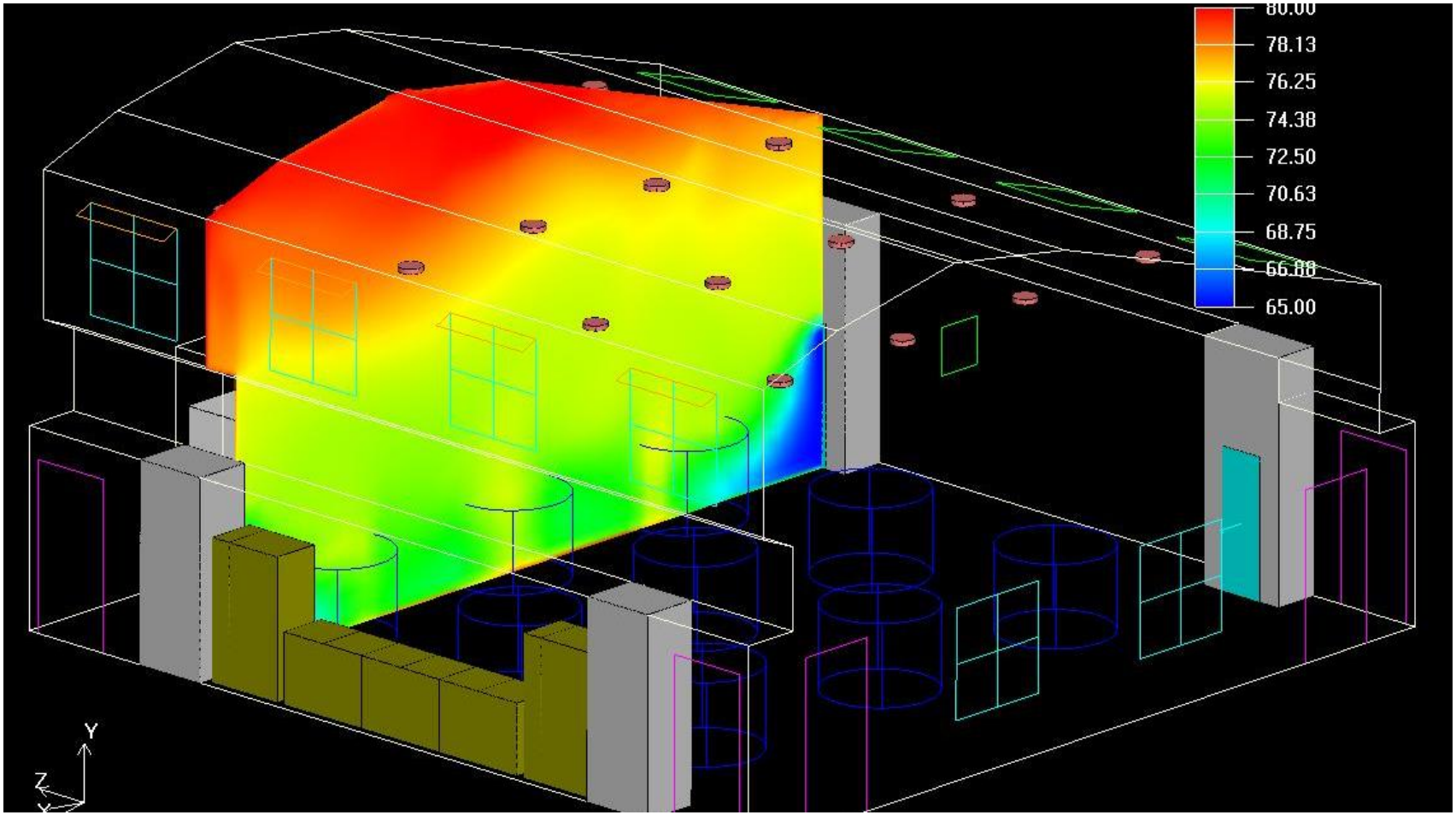
Temperature slice graphic in z direction

Note stratification of air with cool air at diffusers, room set point temperature air at occupants at tables, and warm air above the occupants.



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Energy Modeling

- **Compliance vs. Actual**
  - Compliance run uses code defined baseline model
  - Non-compliant run needed to calculate actual energy use
  - Redefine occupancy schedules
  - Redefine daylight lighting power levels

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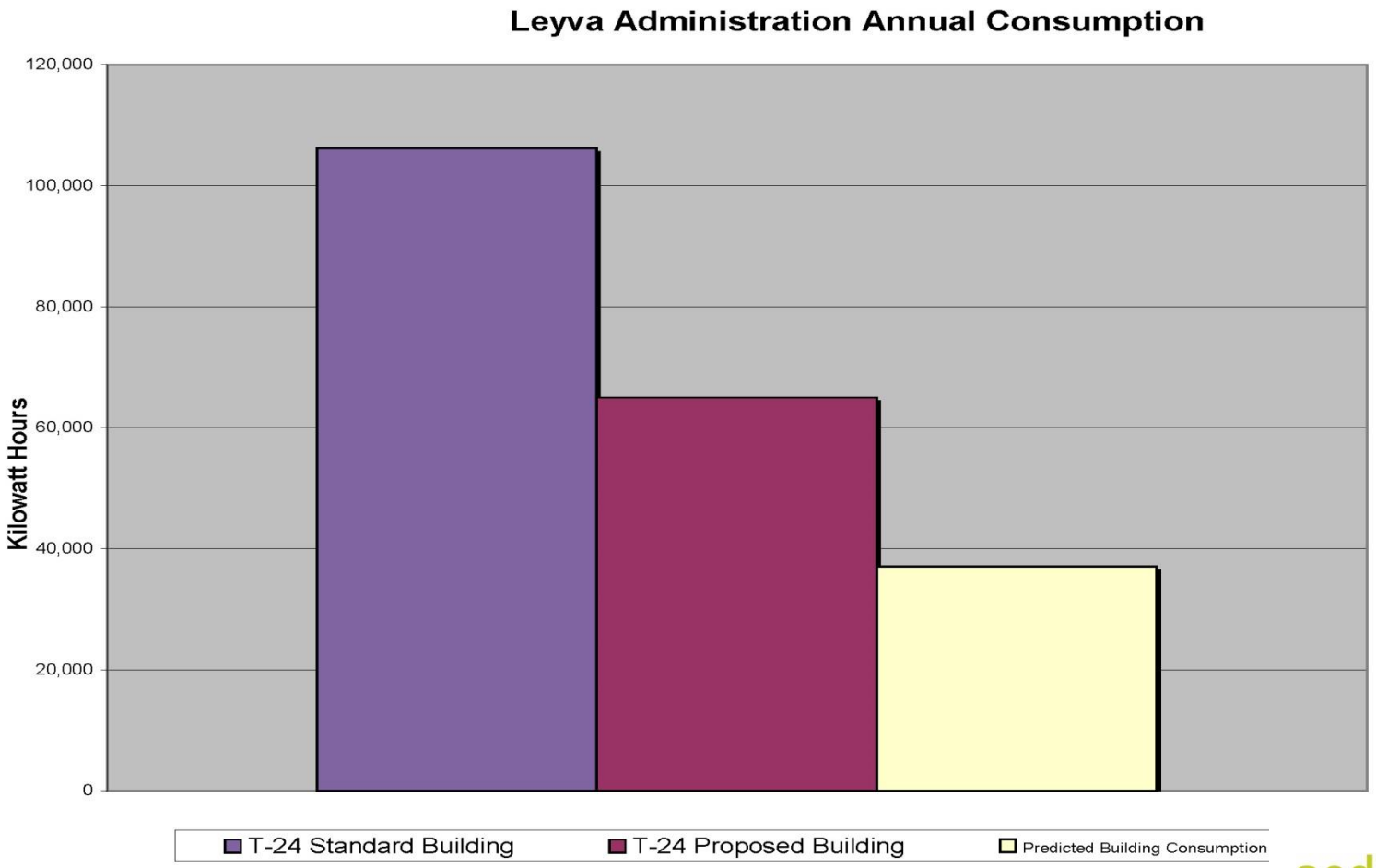
Energy Modeling

- **Estimated Annual Consumption**



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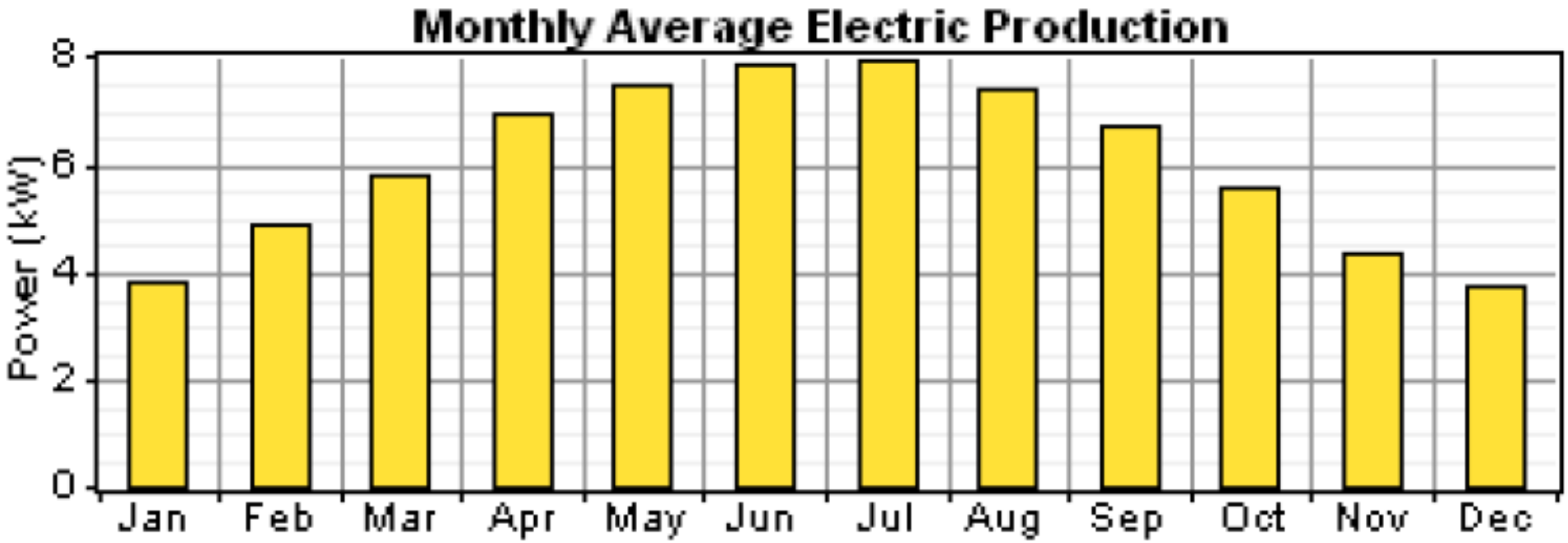
Photovoltaic Technologies

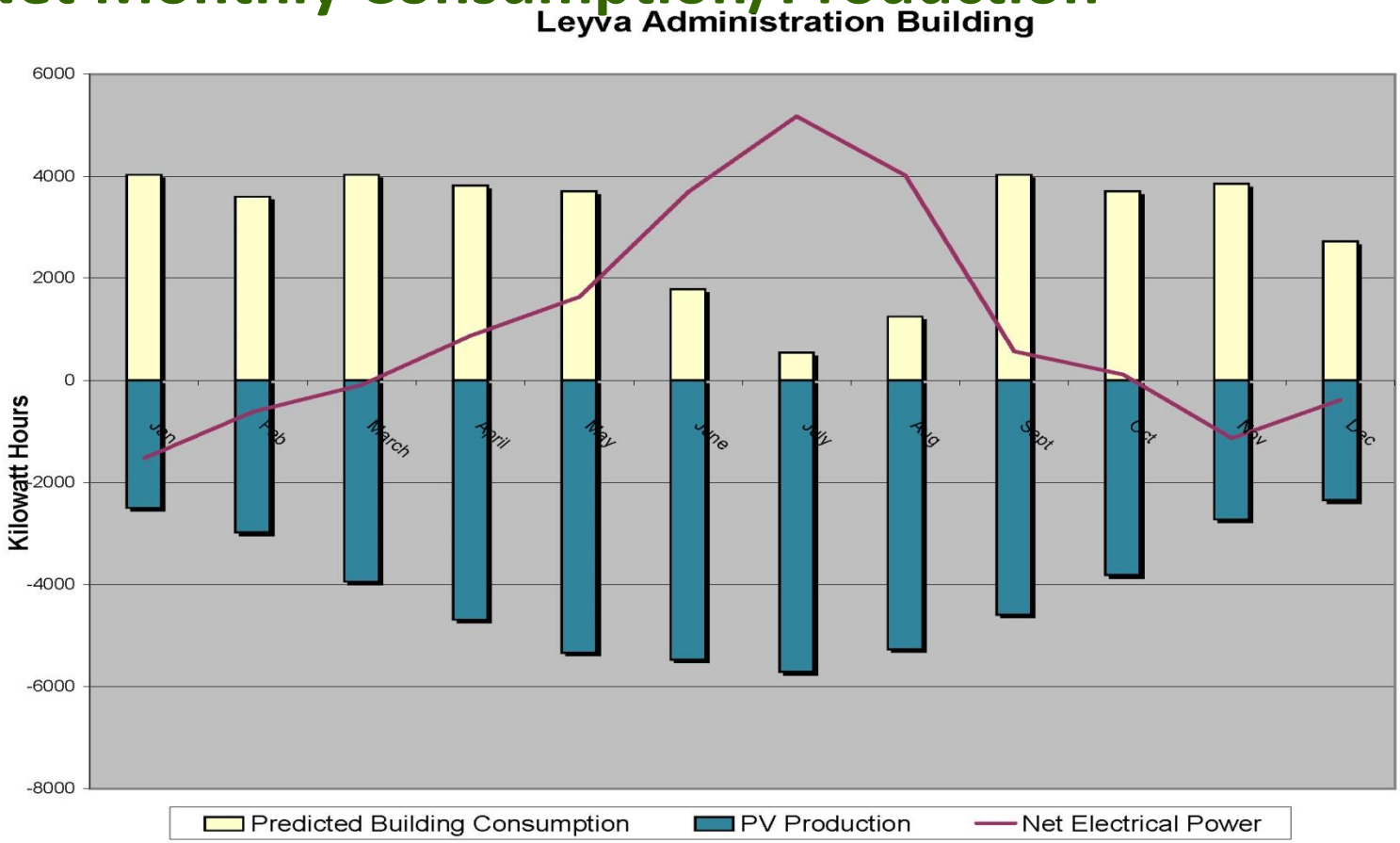
Energy Modeling



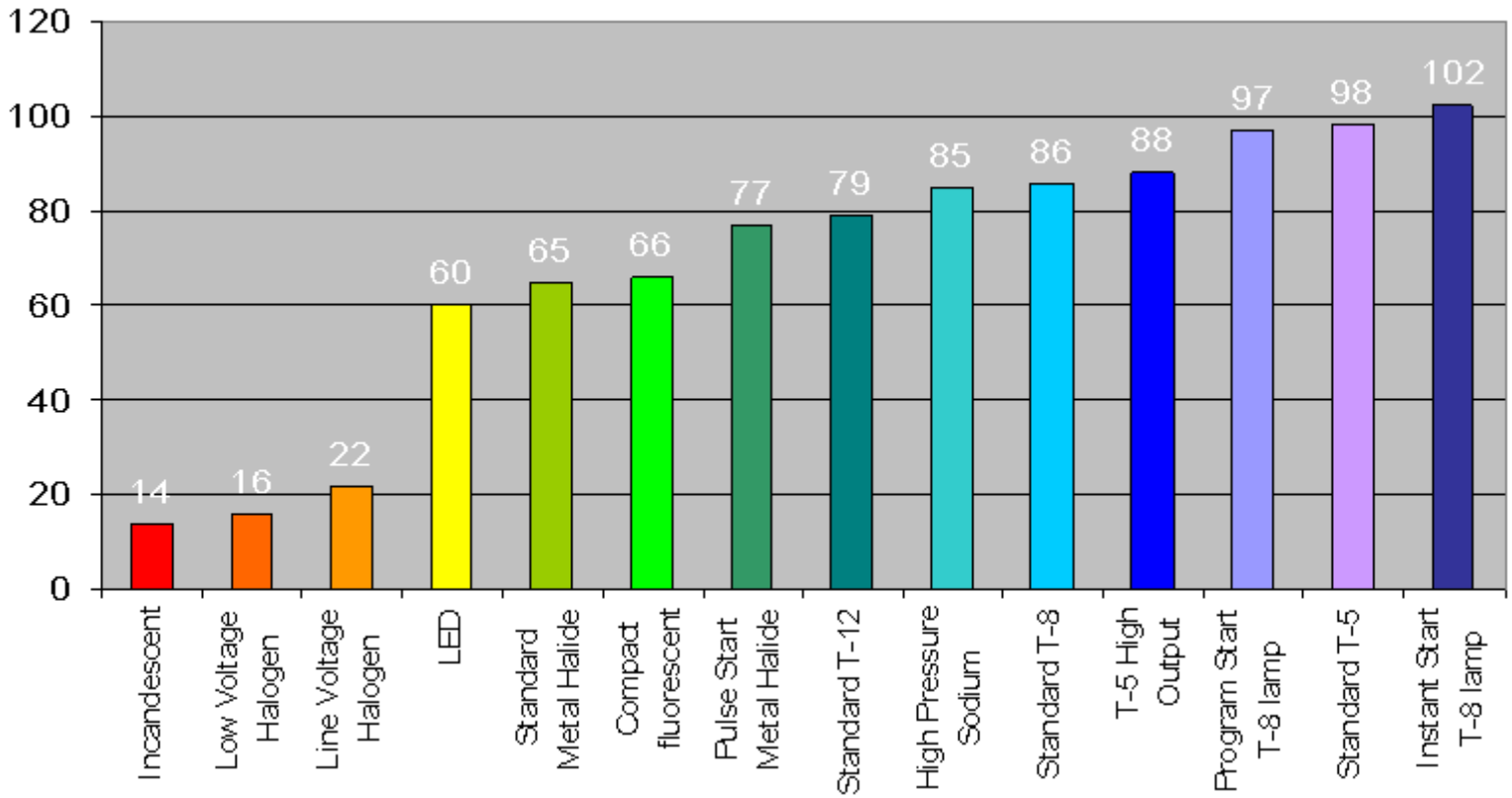
38.4kW Photovoltaic System

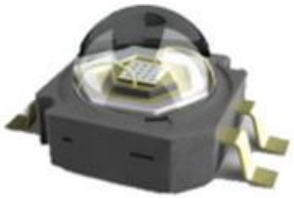
Energy Modeling

- **Net Monthly Consumption/Production**

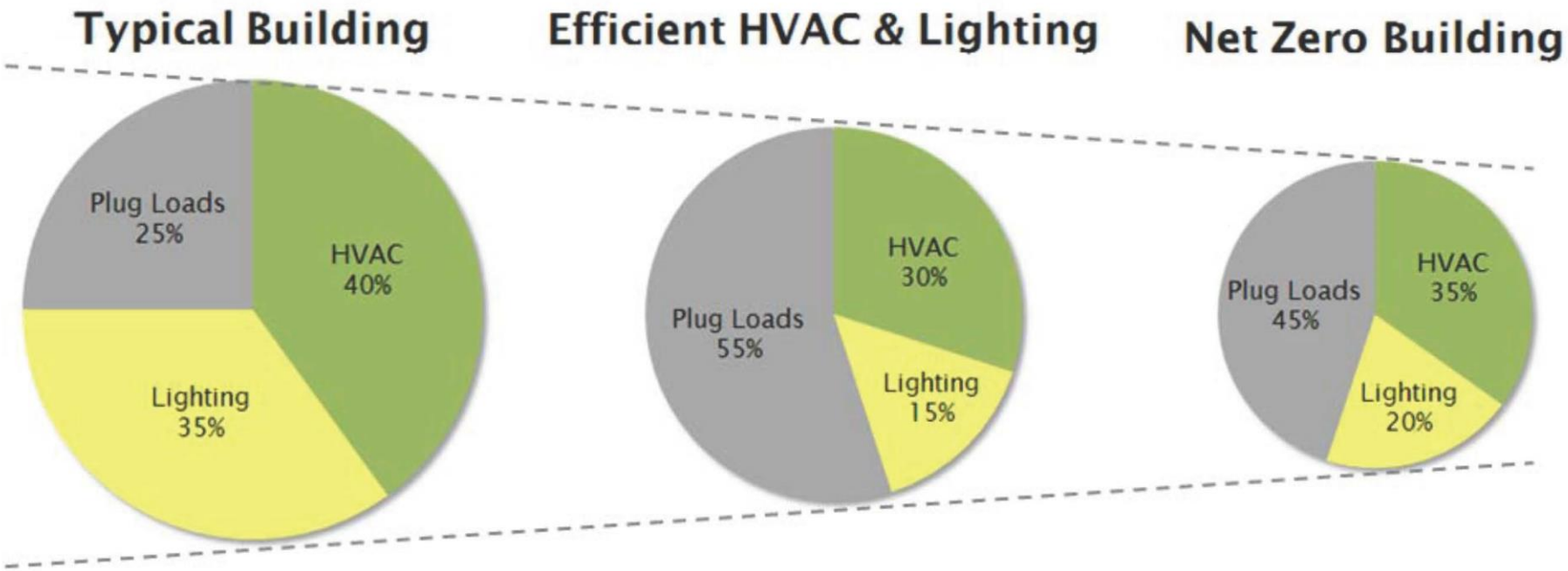


Lighting: High Efficiency





IMPORTANCE OF USER BEHAVIOR



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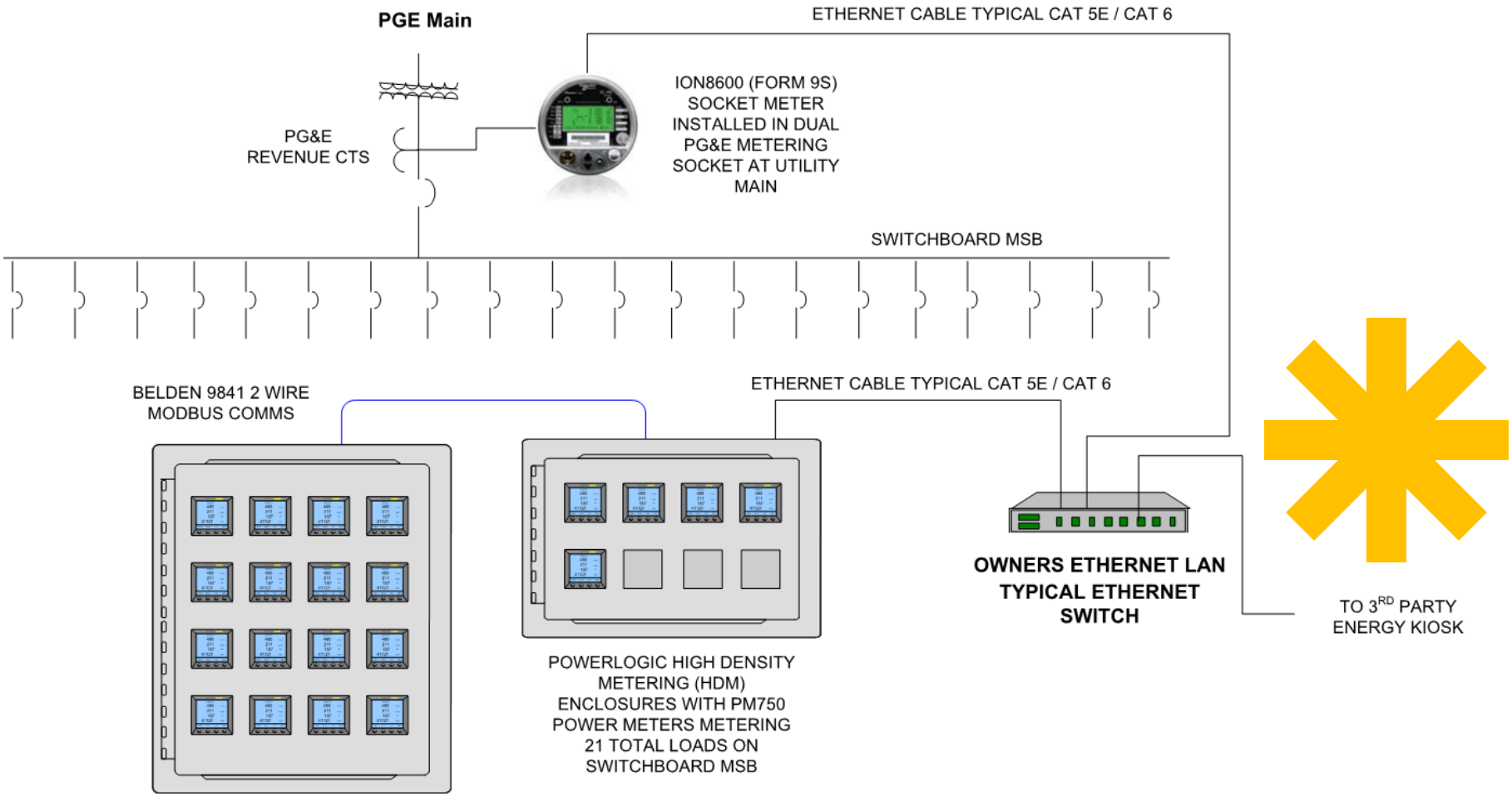
LEVYA MIDDLE SCHOOL POWER MONITORING DIAGRAM



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Energy Kiosk PV System Dashboards

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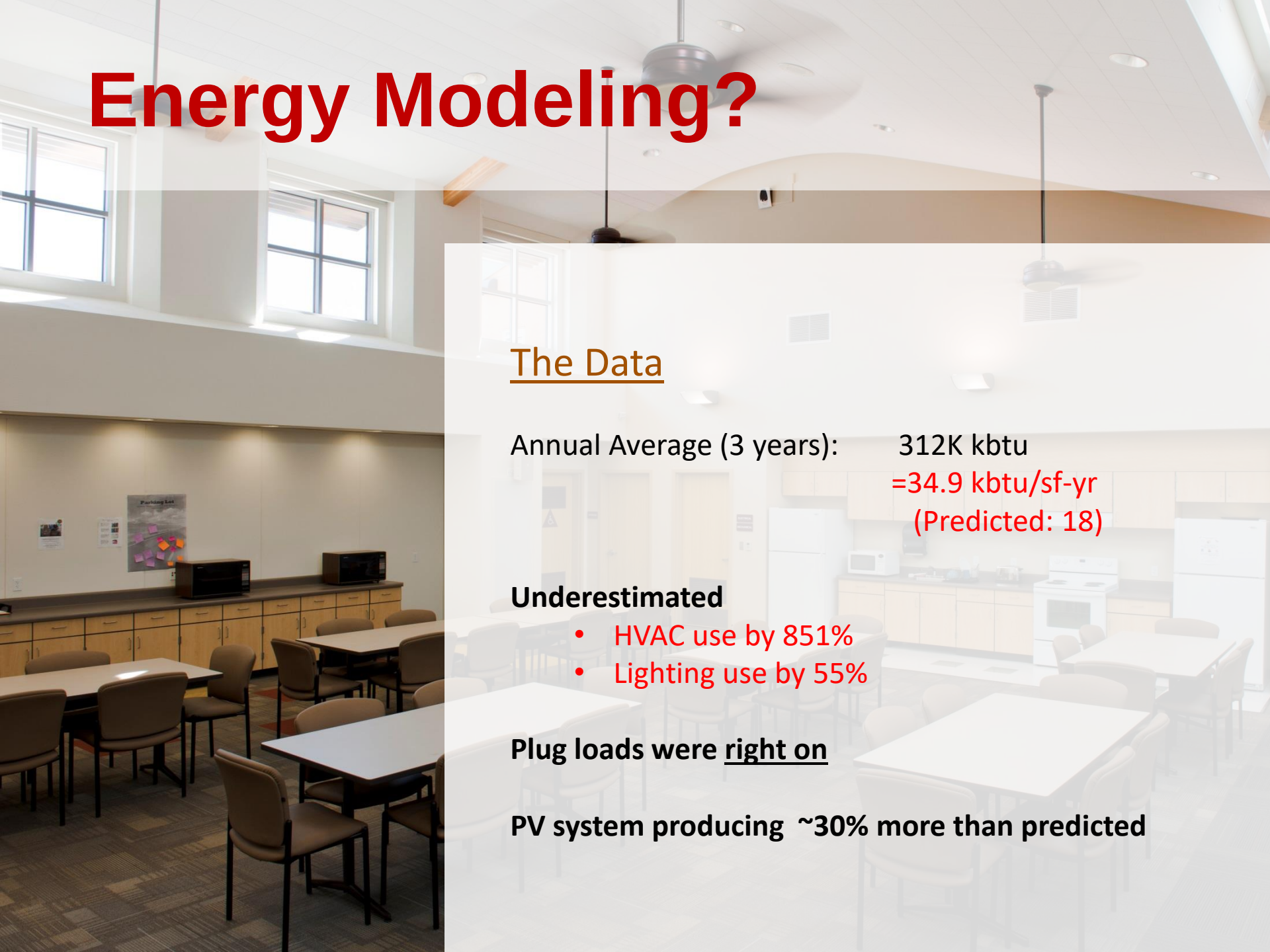
Energy Modeling?



The Data

Annual Average (3 years): 312K kbtu
=34.9 kbtu/sf-yr
(Predicted: 18)

Underestimated

- HVAC use by 851%
- Lighting use by 55%

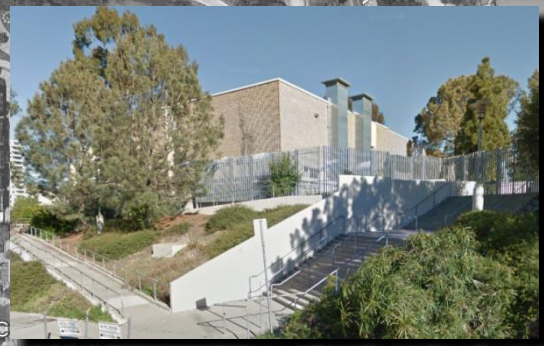
Plug loads were <u>right on</u>

PV system producing ~30% more than predicted

SOME ERRORS TO AVOID

- Allowing **Energy Monitoring Systems** and **Energy Data Dashboards** to be "Value-engineered" out of the project
- Lack of **organizational capacity** and institutional memory for new technology
- Improper or insufficient Commissioning and follow-through
- Allowing **Critical Envelope enhancements** and to be "Value-engineered" out of the project, like high performance glazing and insulation

SAN DIEGO HIGH SCHOOL



DSA DIVISION OF THE STATE ARCHITECT
DEPARTMENT OF GENERAL SERVICES

7x7x7 | DESIGN ENERGY WATER
7 ARCHITECTS 7 SCHOOLS 7 INNOVATIONS

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NET ZERO ENERGY TARGET

CAMPUS NET ZERO ENERGY

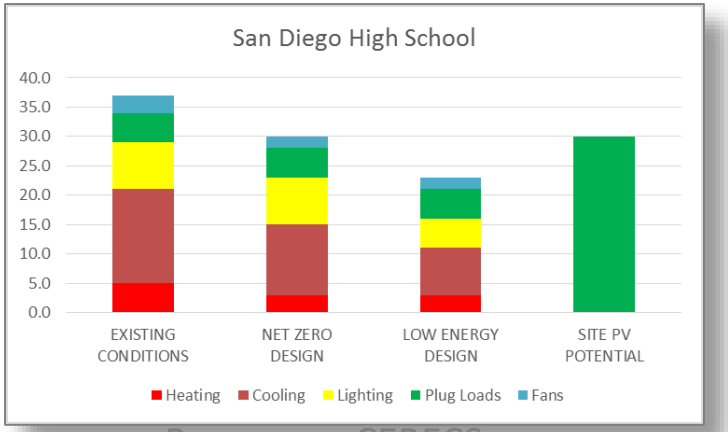
IF THE AVAILABLE SPACE ON THE ROOFS IS COVERED IN HIGH EFFICIENCY PV PANELS, THE SITE AVERAGE **ENERGY UTILIZATION INTENSITY** TO ACHIEVE **NZE** IS:

EUI = 30 KBTU/SF/YEAR

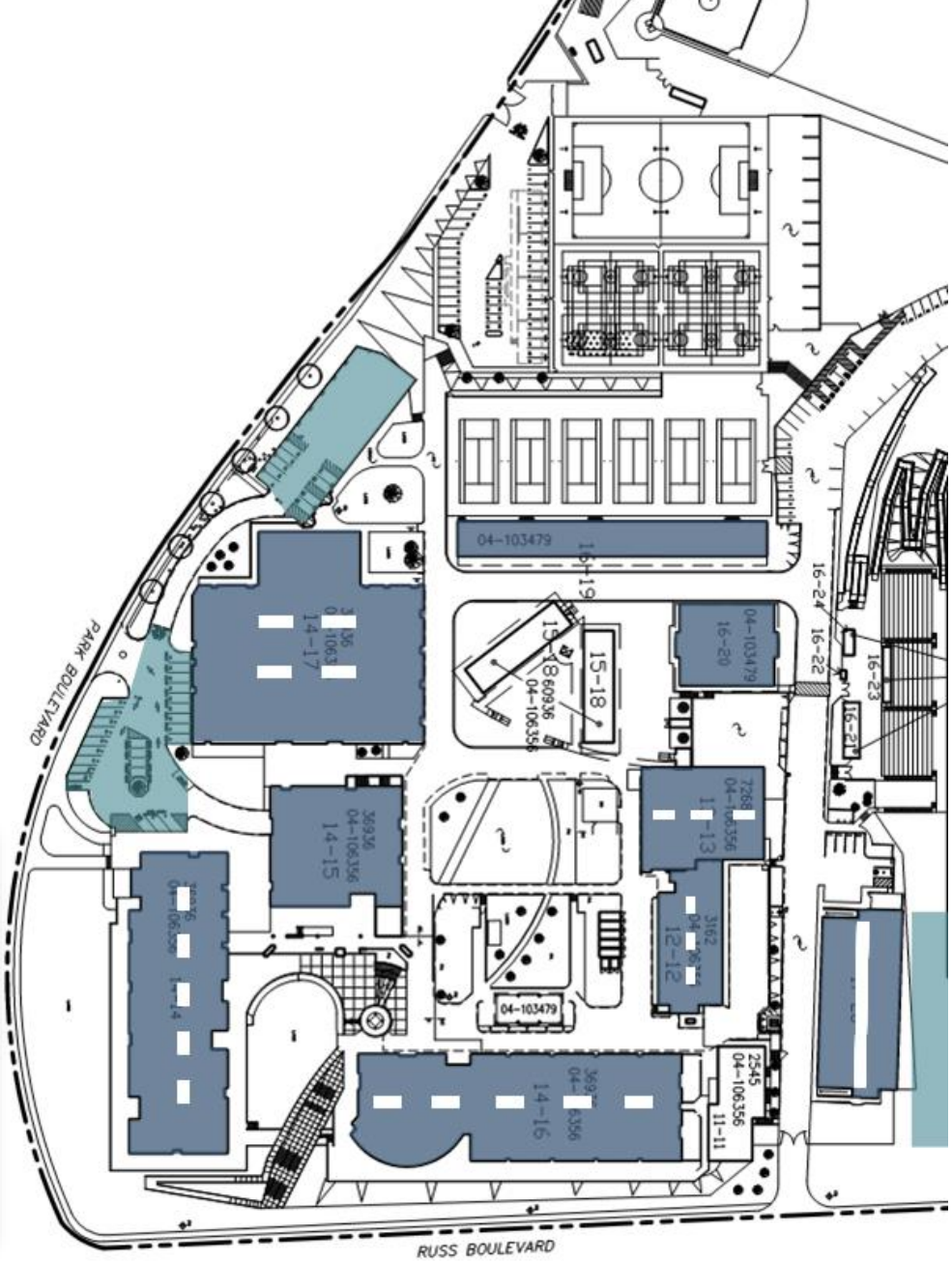
THIS GOAL IS ACHIEVABLE BY UTILIZING SELECT DESIGN STRATEGIES I

IF ALL DESIGN STRATEGIES DEVELOPED BY THE AEDIS-INTEGRAL TEAM ARE IMPLEMENTED TO ACHIEVE CAMPUS LOW ENERGY POTENTIAL:

EUI = 23 KBTU/SF/YEAR



Resource: CEBECS



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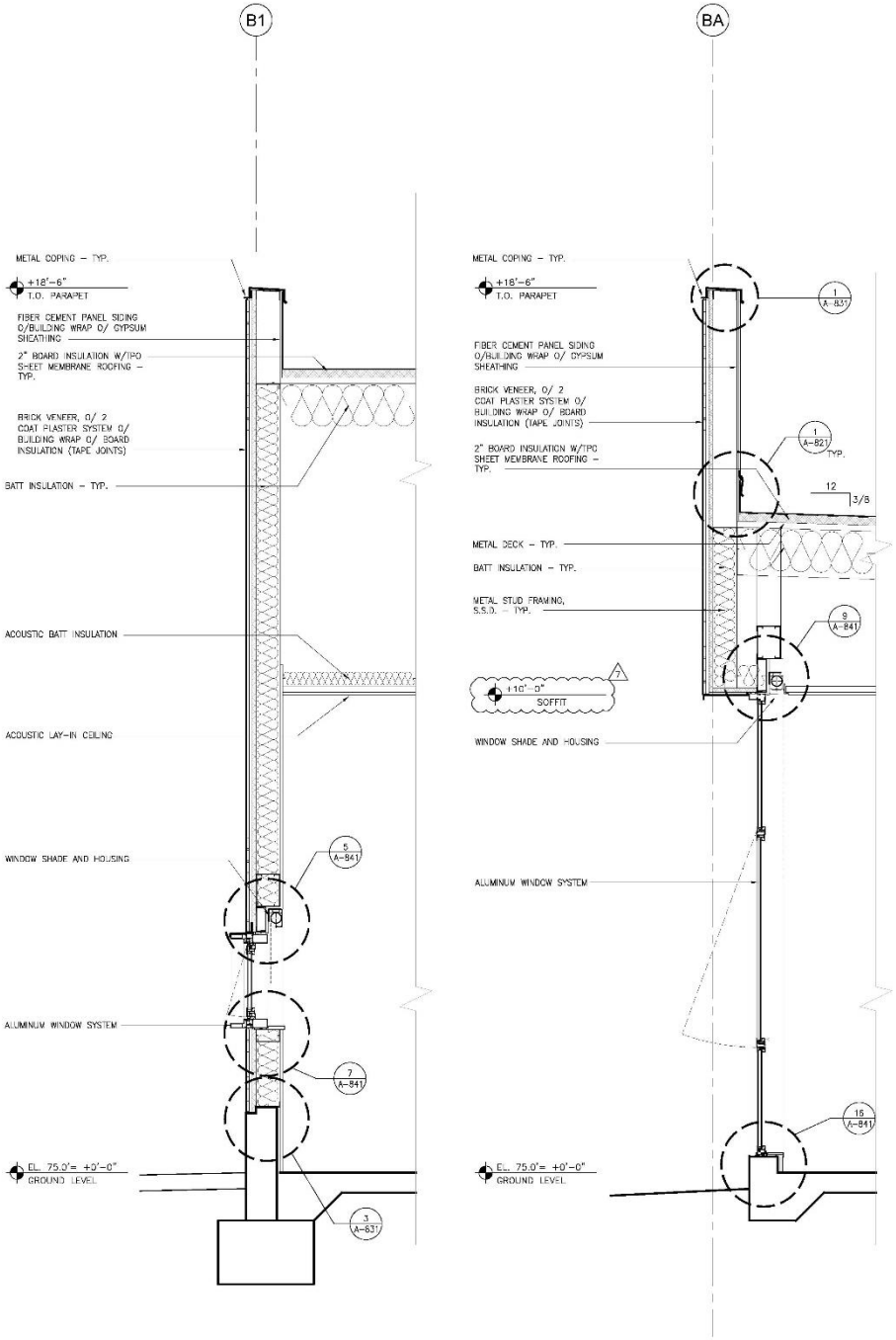
Zero-Net Energy in California Schools – A Case Study and more

LeyVa Middle School ZNE+E Administration Building (2012)

nbi new buildings institute


envelope



Wall Assembly and Roof Assembly

- **WALL R 12.5**

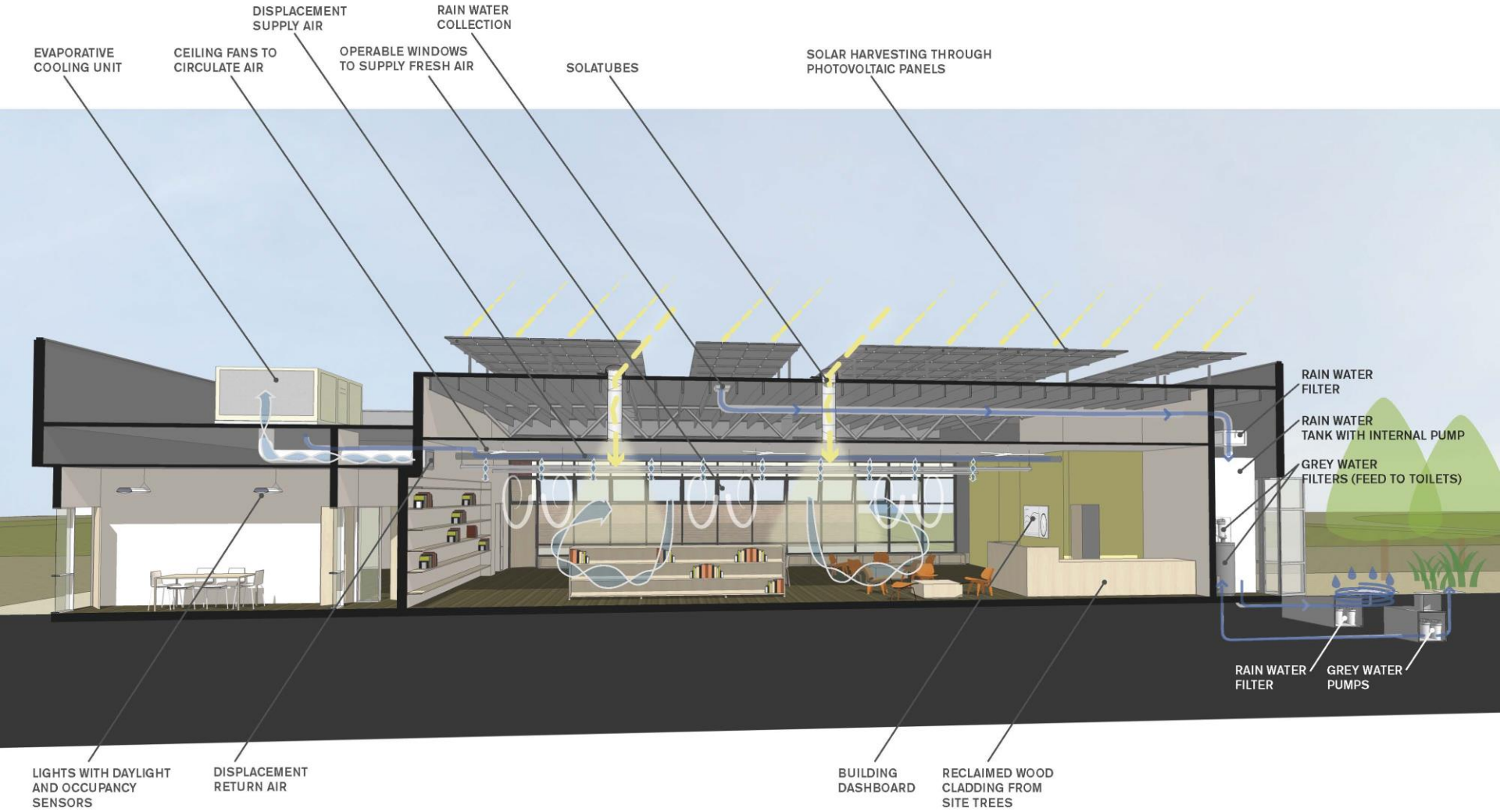
- ¾" Brick Veneer
- ¾" Exterior Plaster
- ½" Rigid plus ½" shear board/ 1" Rigid
- 6" metal studs at 24" oc with R19

- *Could go 1" more of rigid to R 17*

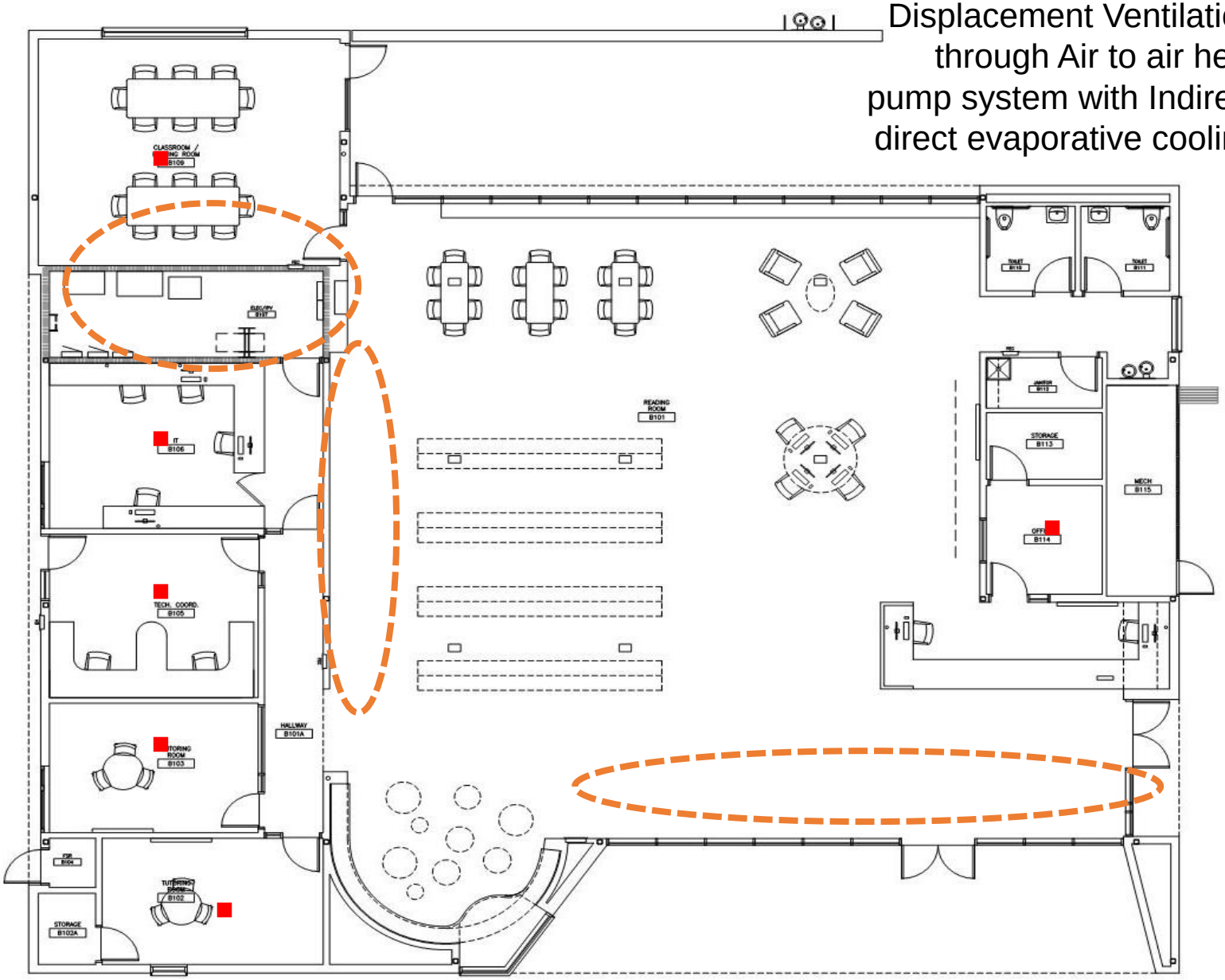
- **ROOF – R 27**

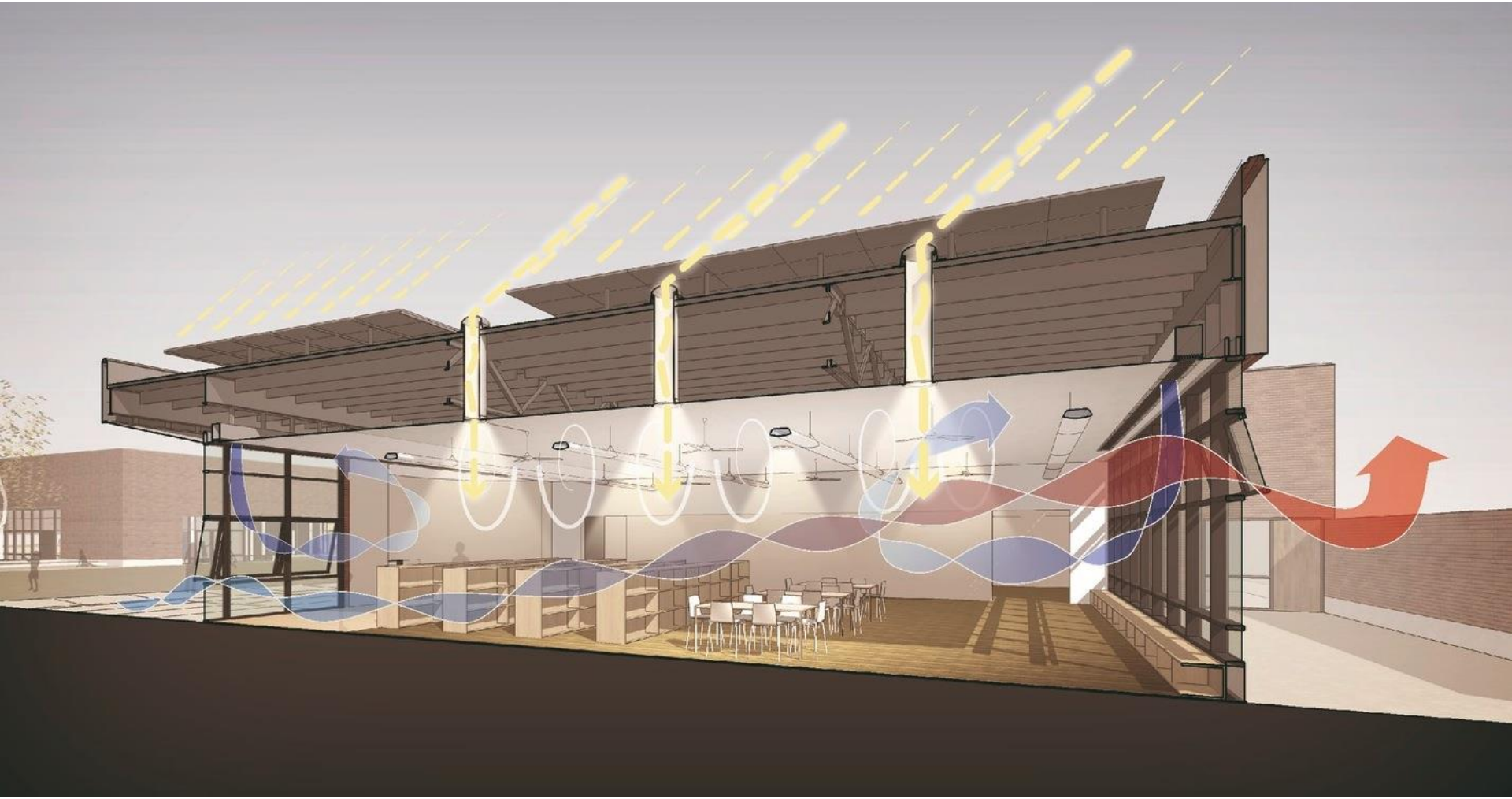
- TPO Roofing
- 2" rigid
- 1-1/2" metal decking
- R-40 insulation

- Change in assembly - Wood would have been R20 with same assembly (vs R12.5)

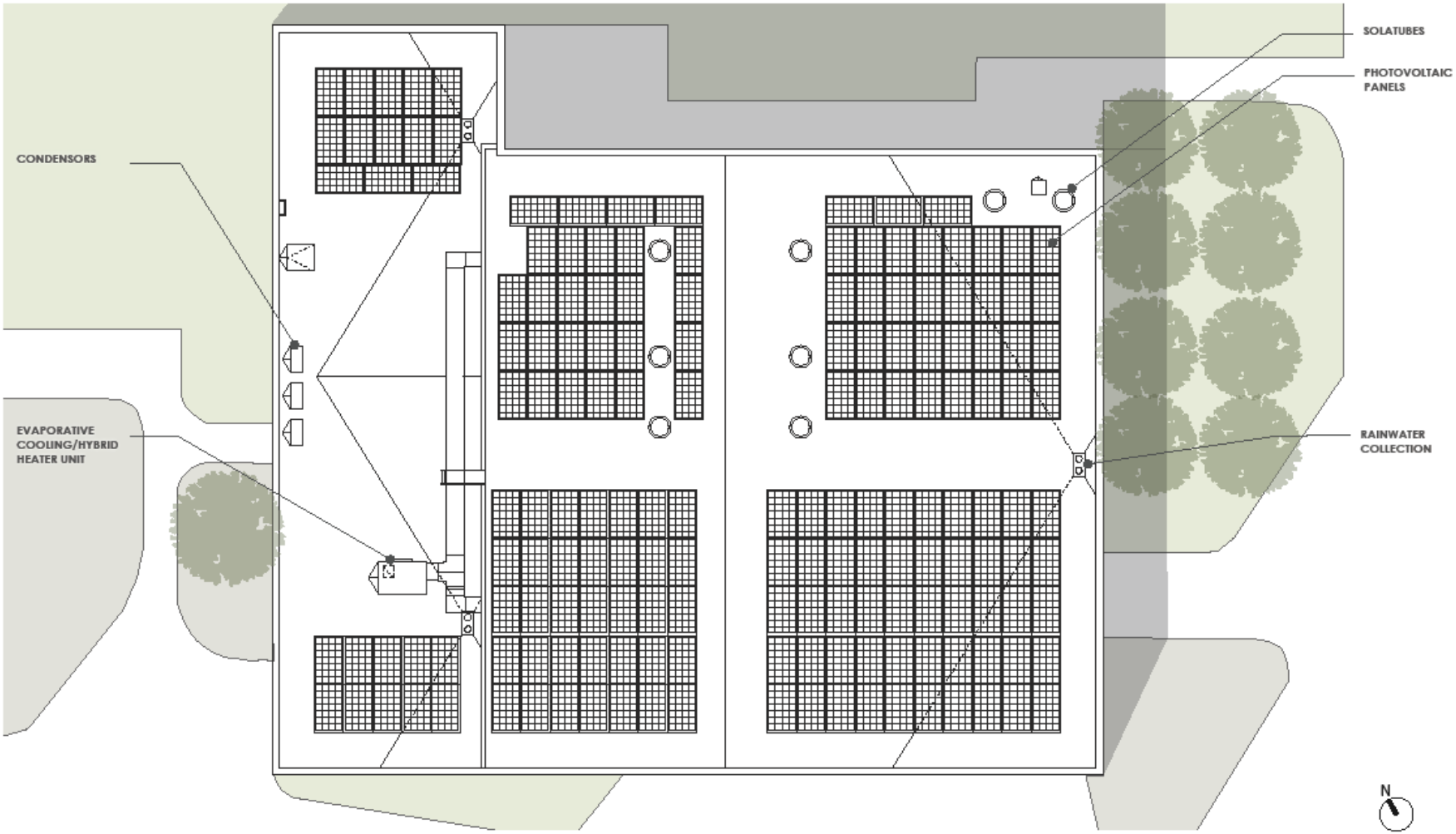

EVAPORATIVE COOLING UNIT
CEILING FANS TO CIRCULATE AIR
DISPLACEMENT SUPPLY AIR
OPERABLE WINDOWS TO SUPPLY FRESH AIR
RAIN WATER COLLECTION
SOLATUBES
SOLAR HARVESTING THROUGH PHOTOVOLTAIC PANELS
RAIN WATER FILTER
RAIN WATER TANK WITH INTERNAL PUMP
GREY WATER FILTERS (FEED TO TOILETS)
RAIN WATER FILTER
GREY WATER PUMPS
LIGHTS WITH DAYLIGHT AND OCCUPANCY SENSORS
DISPLACEMENT RETURN AIR
BUILDING DASHBOARD
RECLAIMED WOOD CLADDING FROM SITE TREES

Displacement Ventilation through Air to air heat pump system with Indirect direct evaporative cooling





Maximized panels on roof area
170 panels @ 250 w/panel – 40 kw sized 15% over
Flat panels vs tilted resulted in a 13% reduction - required for city planning requirement



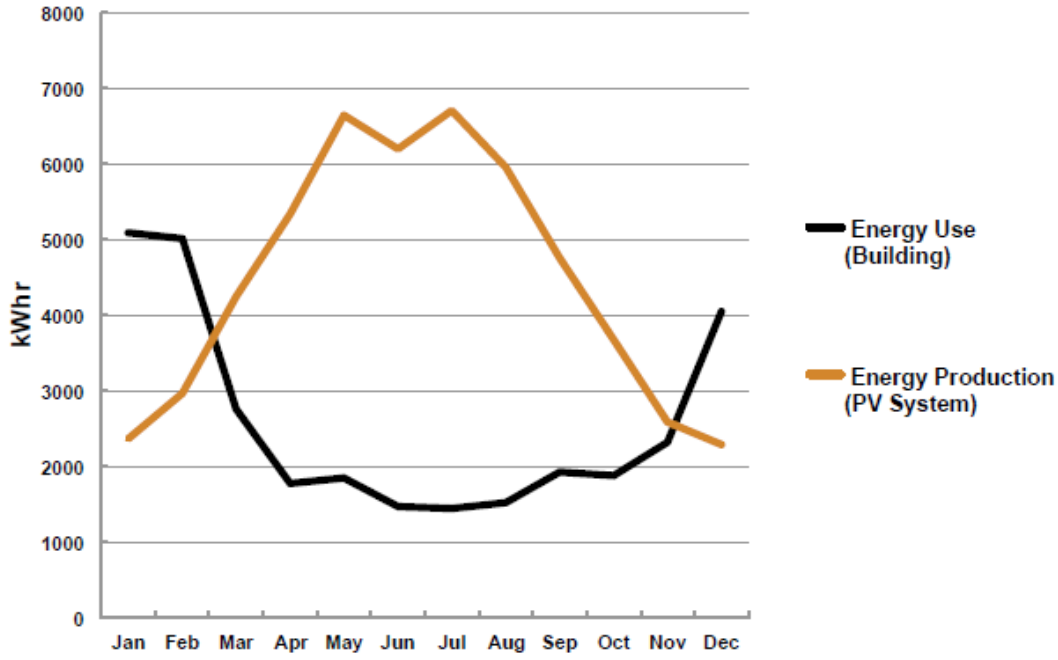
SACRED HEART LIBRARY
ROOF PLAN

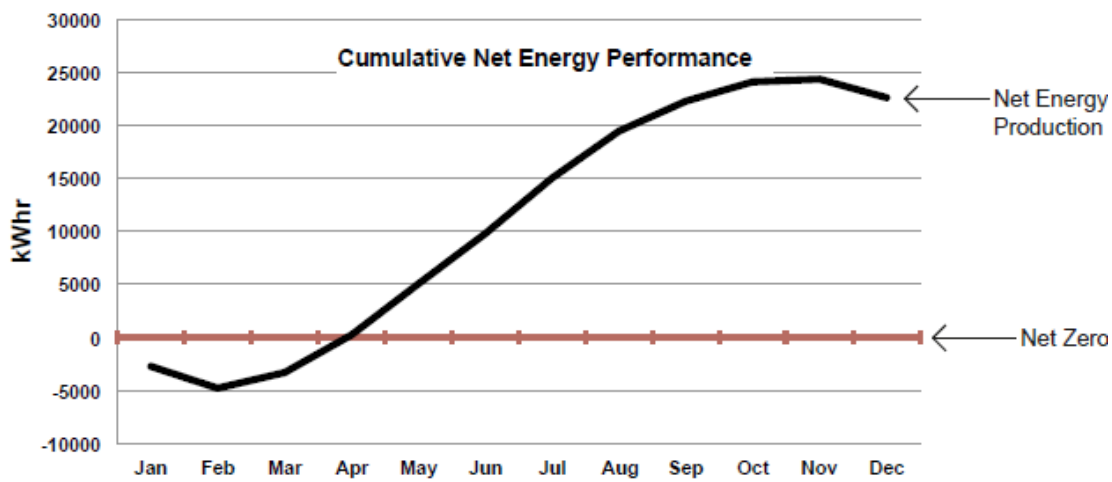
WRNSSTUDIO
March 27, 2013


LIVING BUILDING CHALLENGE℠
Stir the pot.
Infuse with inspiration and poetry.
Embrace the psychology of the end gam
Lead the market forward.
Create models for the future.
Achieve the Living Building Challenge℠

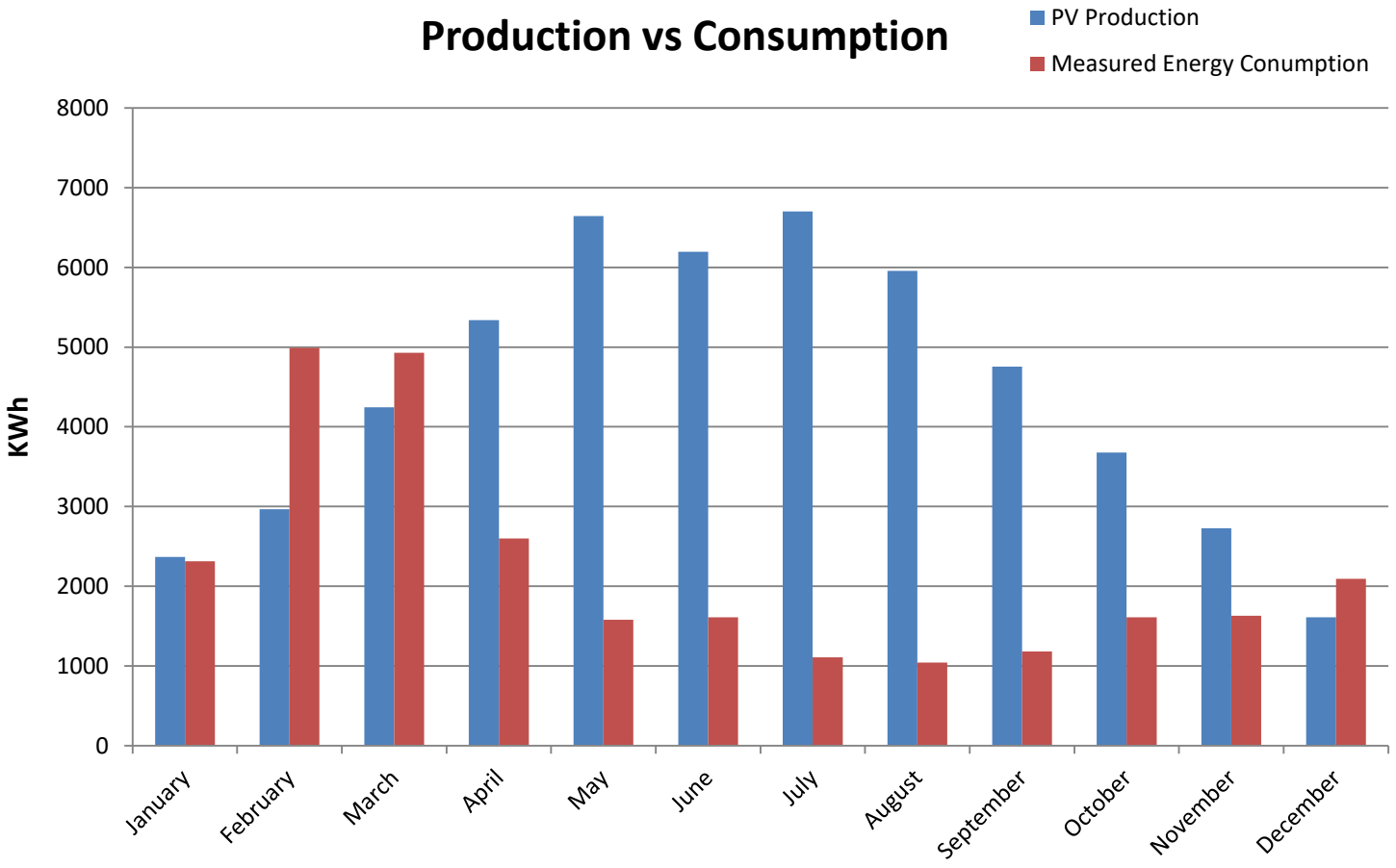
Stevens Library at Sacred Heart Schools

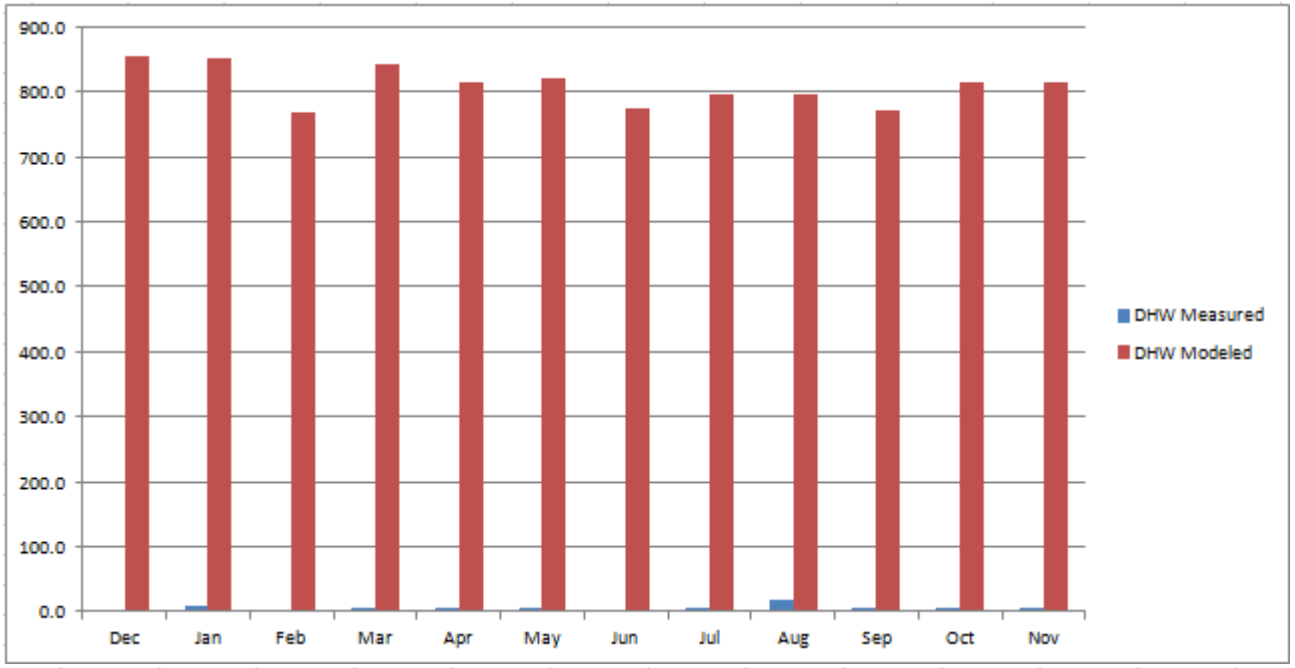
Solar Photovoltaic System Performance





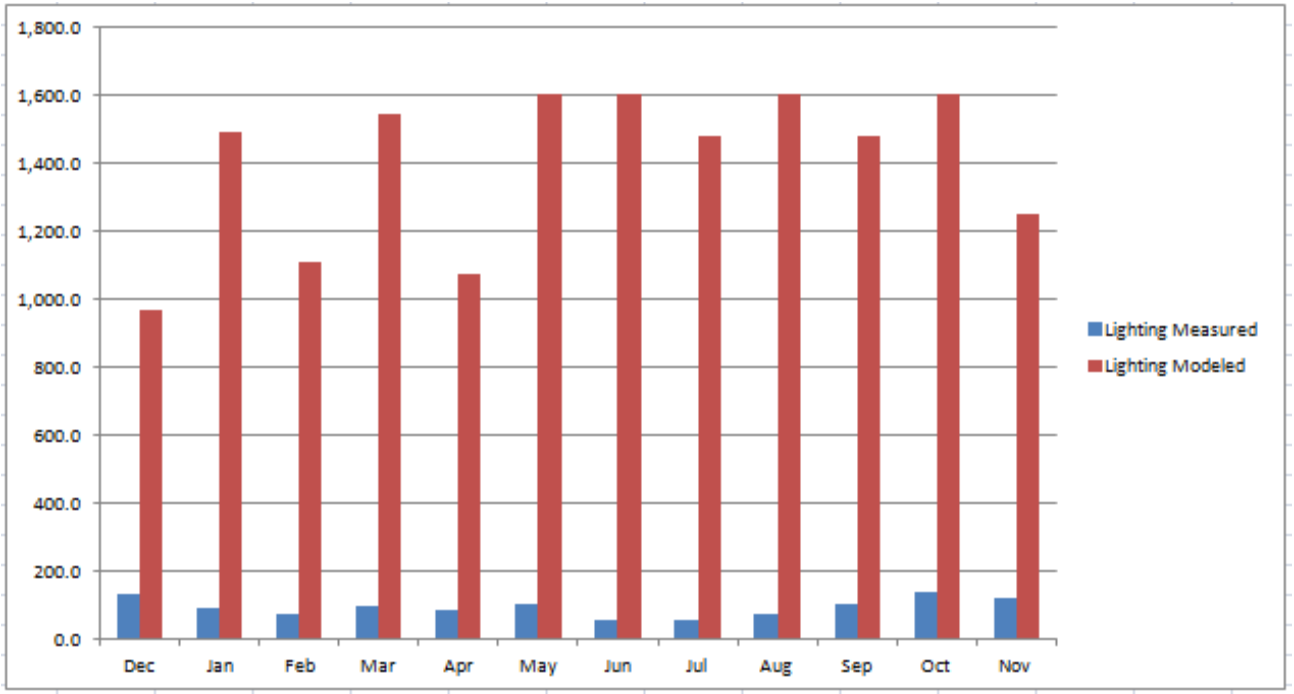
PV predicted at 50832 kWh
PV measured 56,811kWh
x





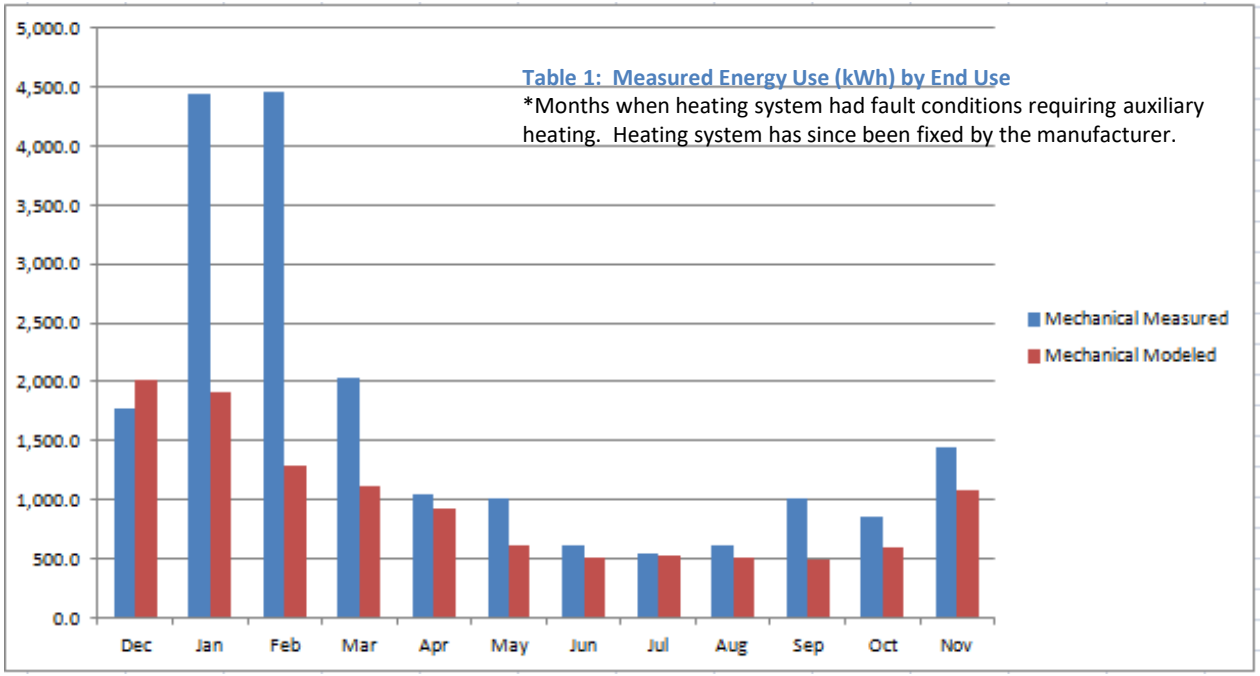
DHW

	Measurec	Modeled
Dec	2.5	856.0
Jan	7.9	853.0
Feb	3.3	768.0
Mar	5.0	842.0
Apr	6.8	815.0
May	7.4	820.0
Jun	1.4	775.0
Jul	5.4	795.0
Aug	17.9	797.0
Sep	7.4	771.0
Oct	6.4	815.0
Nov	5.5	816



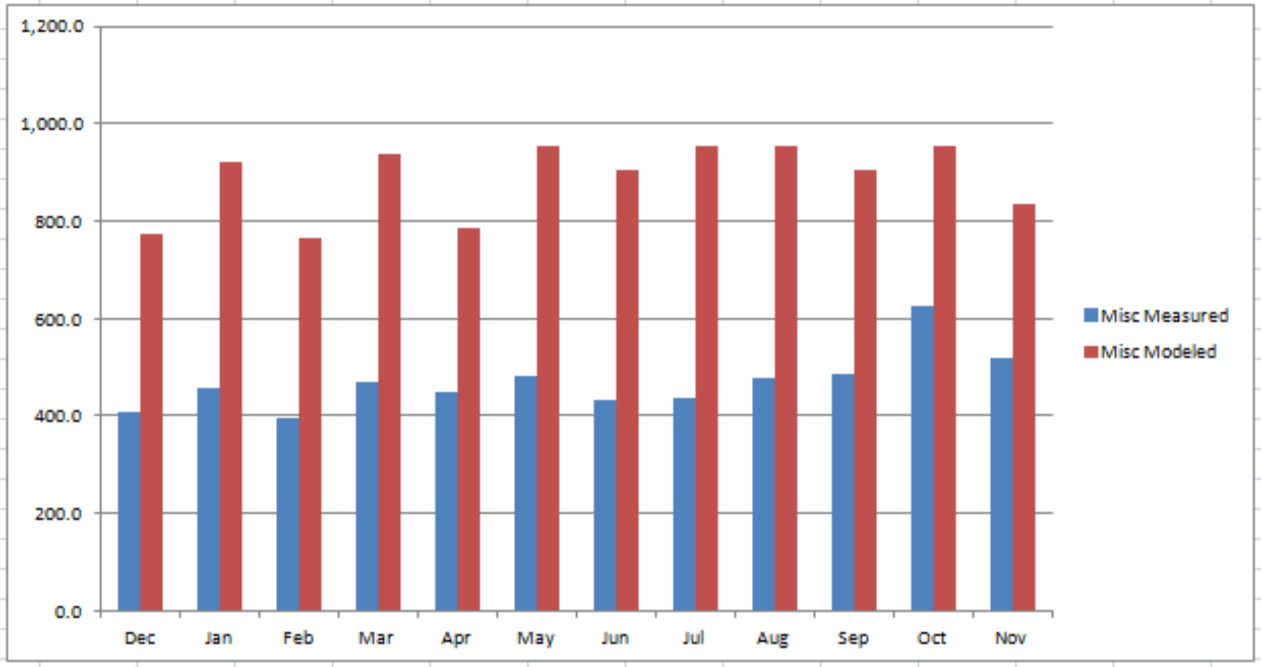
Lighting

	Lighting	
	Measurec	Modeled
Dec	129.9	969.0
Jan	86.6	1,488.0
Feb	71.5	1,109.0
Mar	94.0	1,546.0
Apr	81.2	1,073.0
May	103.9	1,604.0
Jun	53.9	1,604.0
Jul	54.2	1,477.0
Aug	73.6	1,604.0
Sep	103.0	1,477.0
Oct	135.3	1,604.0
Nov	120	1246



Mechanical

	Mechanical	
	Measured	Modeled
Dec	1,773.9	2018
Jan	4,442.5	1,914.0
Feb	4,457.6	1,283.0
Mar	2,032.1	1,115.0
Apr	1,040.7	928.0
May	1,018.2	617.0
Jun	616.1	506.0
Jul	547.3	527.0
Aug	609.1	520.0
Sep	1,013.8	499.0
Oct	863.3	601.0
Nov	1446.5	1086



Misc

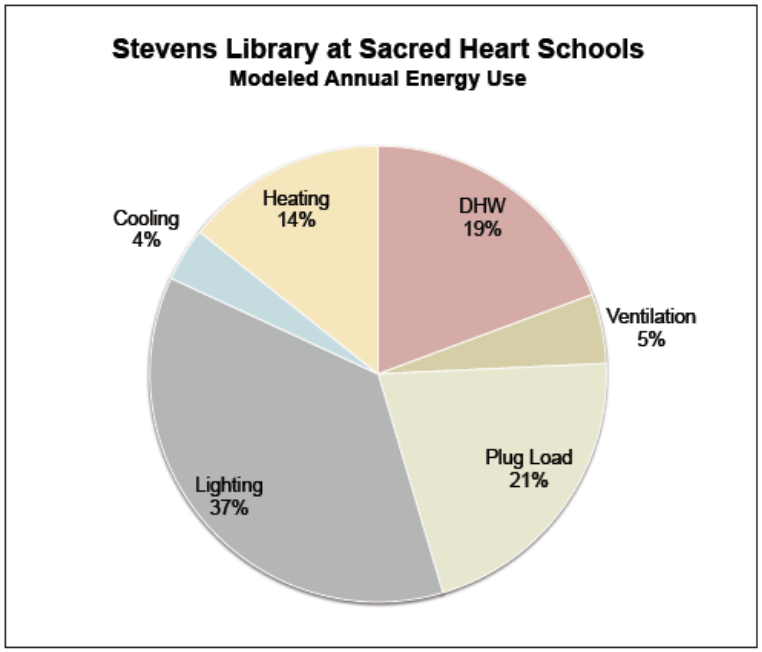
	Measured	Modeled
Dec	407.3	772.0
Jan	455.7	922.0
Feb	396.3	765.0
Mar	469.3	938.0
Apr	450.7	786.0
May	481.4	955.0
Jun	434.4	903.0
Jul	435.1	955.0
Aug	479.2	955.0
Sep	486.5	903.0
Oct	626.0	955.0
Nov	519.63	836

highs & lows

Better tracking
Constant communication

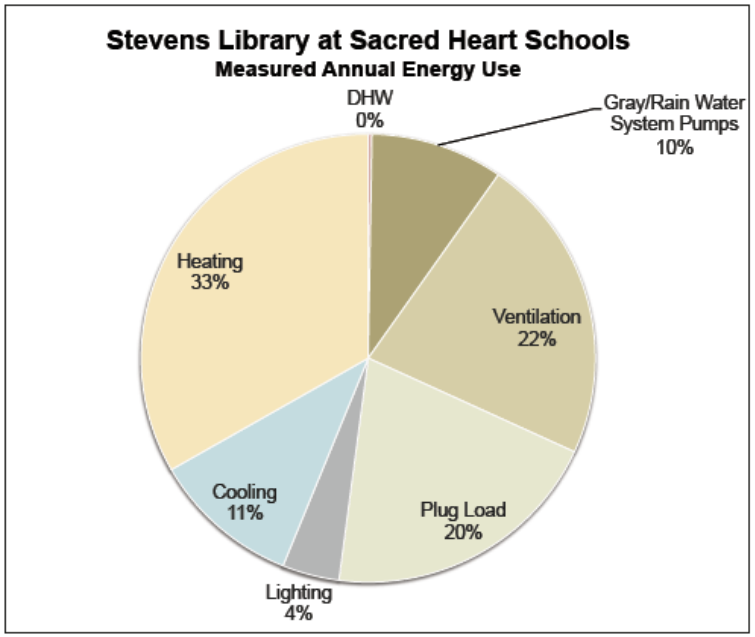
lighting

Daylight modeling and People modeling



Modeled Energy Use

50 MWhr per Year
Modeled EUI = 27.0



Measured Energy Use

31.1 MWhr per Year
Actual EUI = 16.9

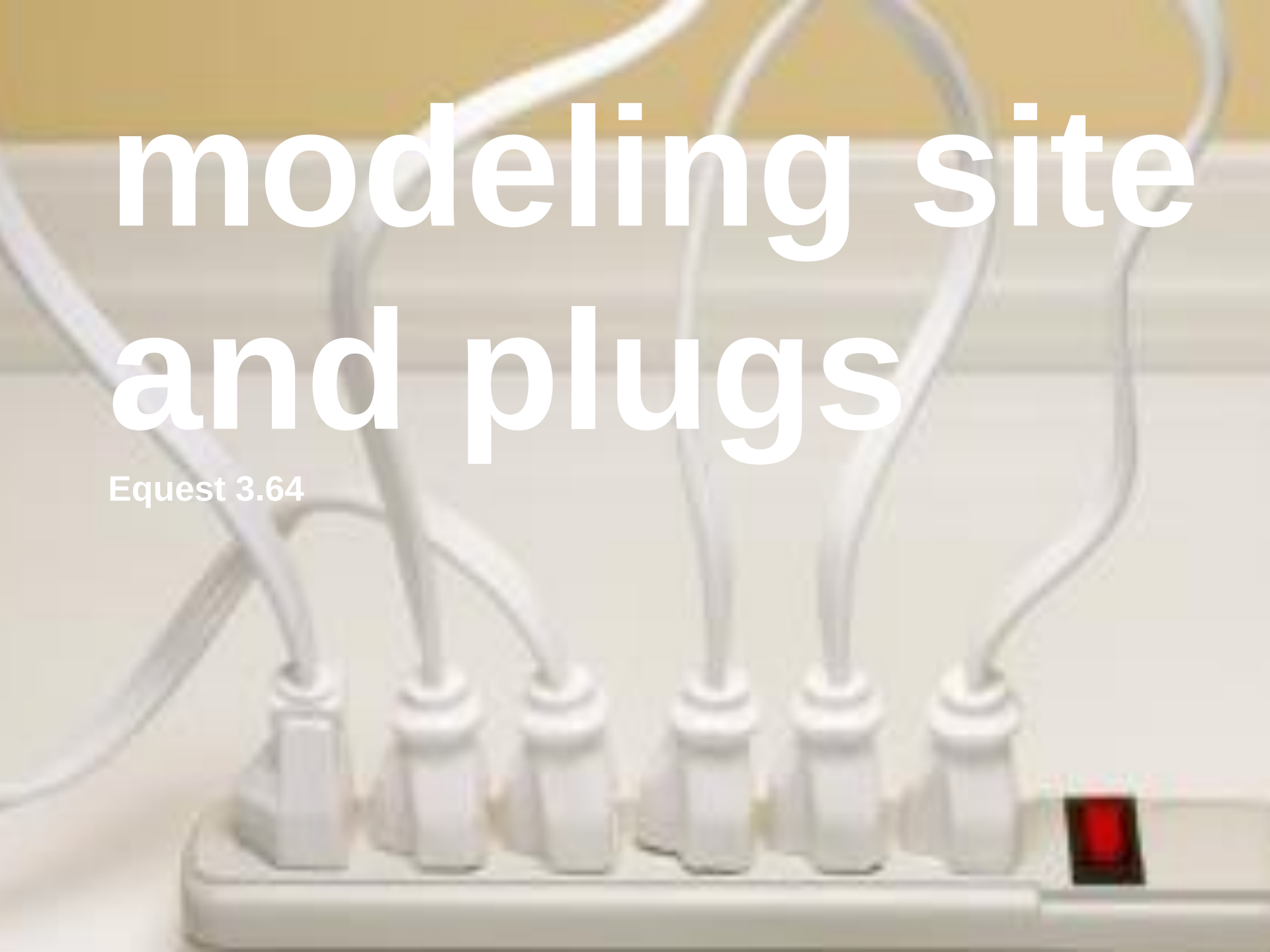
37 % predicted

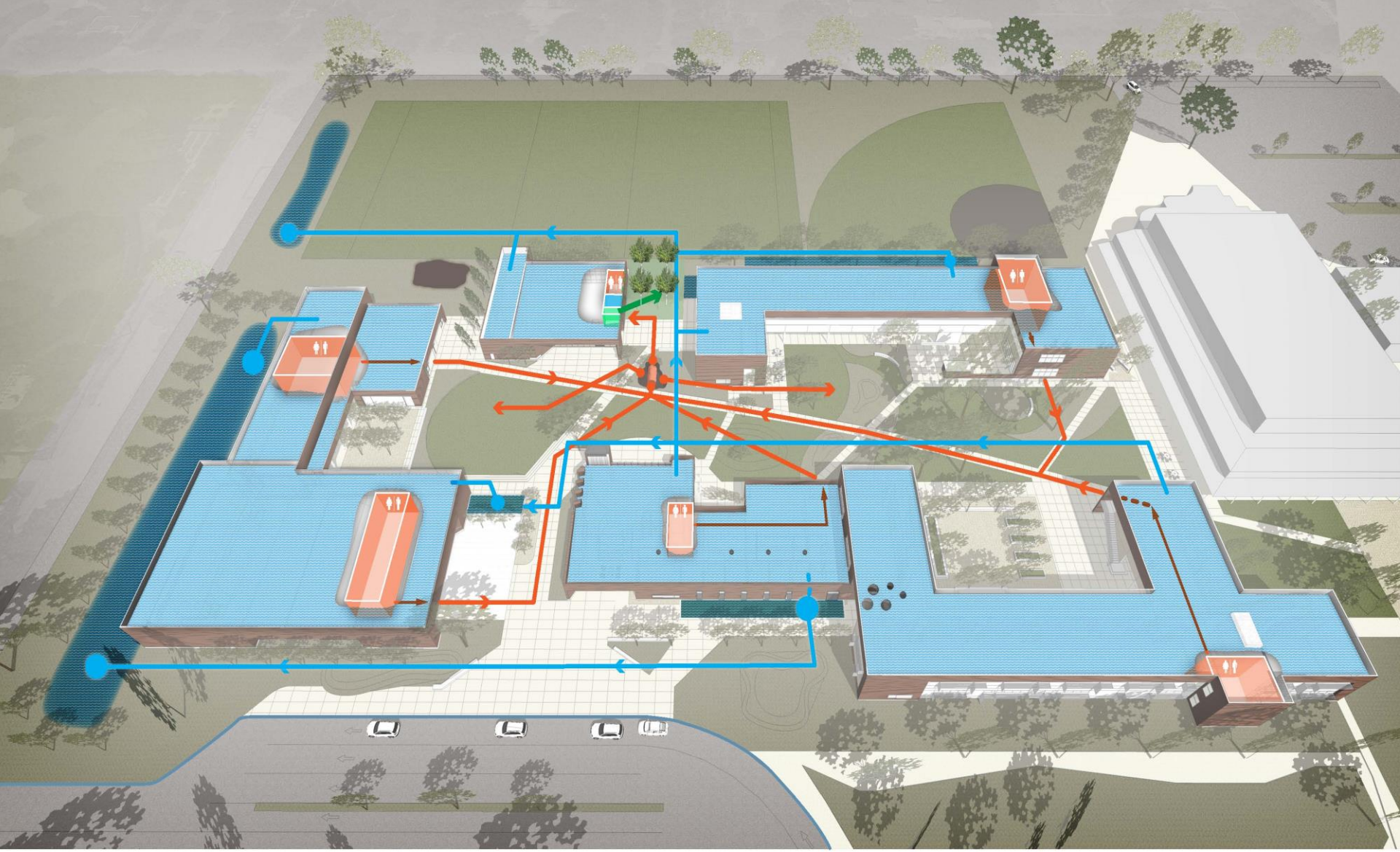
4% actual

Approximately 8000 kWh difference

modeling site and plugs

Equest 3.64





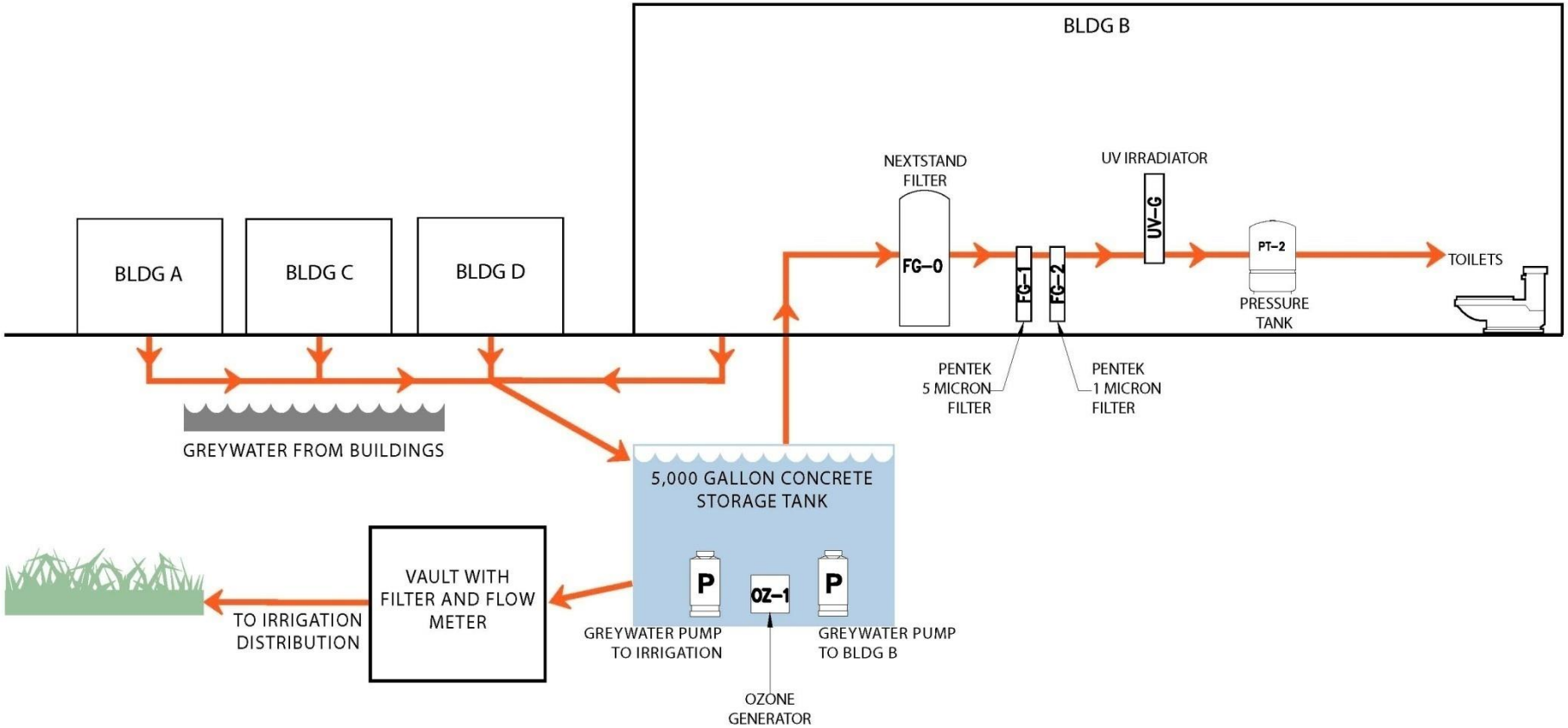
SACRED HEART SCHOOLS

ATHERTON, CA

LOWER & MIDDLE SCHOOLS

STORMWATER, RAINWATER, GREYWATER COMPOSITE DIAGRAM

WRNS STUDIO LLP

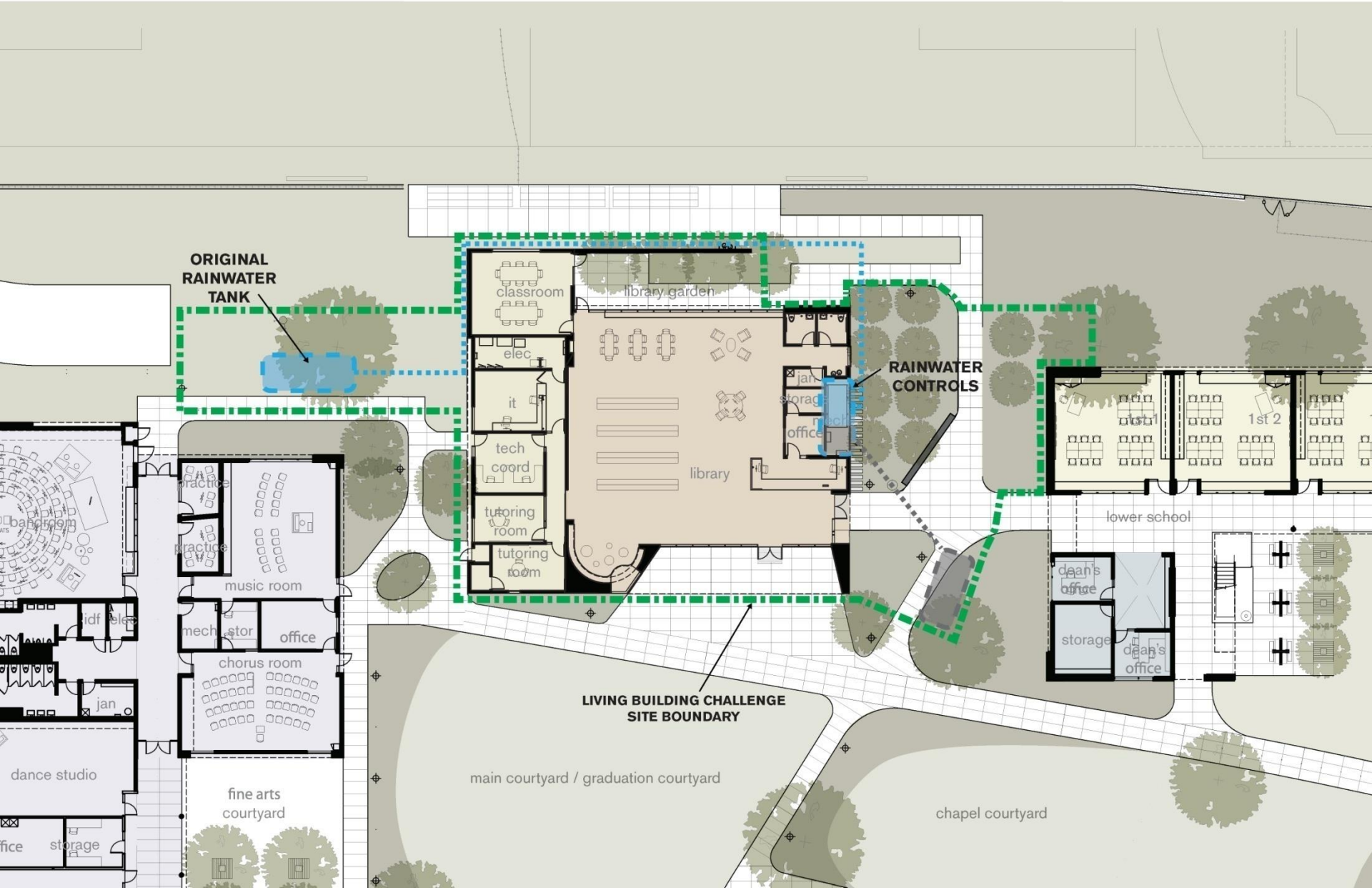


SACRED HEART SCHOOLS

ATHERTON, CA

LOWER & MIDDLE SCHOOLS

WRNS STUDIO LLP

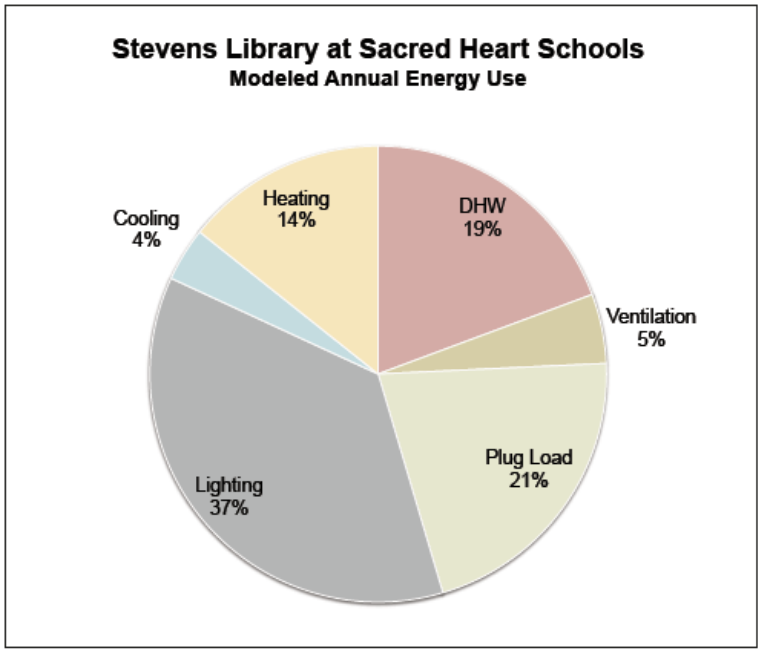

ORIGINAL RAINWATER TANK
classroom
library garden
elec
it
tech coord
tutoring room
tutoring room
library
jan storage
tech
office
RAINWATER CONTROLS
1st 1
1st 2
lower school
dean's office
storage
dean's office
practice
practice
music room
mech
stor
office
chorus room
jan
dance studio
fine arts courtyard
storage
LIVING BUILDING CHALLENGE SITE BOUNDARY
main courtyard / graduation courtyard
chapel courtyard


classroom
library garden
elec
it
tech coord
tutoring room
tutoring room
library
jan
storage
tech
office
RAINWATER TANK
GREYWATER FILTERS
1st 1
1st 2
lower school
dean's office
storage
dean's office
GREYWATER TANK
practice
practice
music room
mech
stor
office
chorus room
jan
dance studio
fine arts courtyard
storage
LIVING BUILDING CHALLENGE SITE BOUNDARY
main courtyard / graduation courtyard
chapel courtyard

Greywater added approximately 3000 kWh to the actual metering data – not originally expected

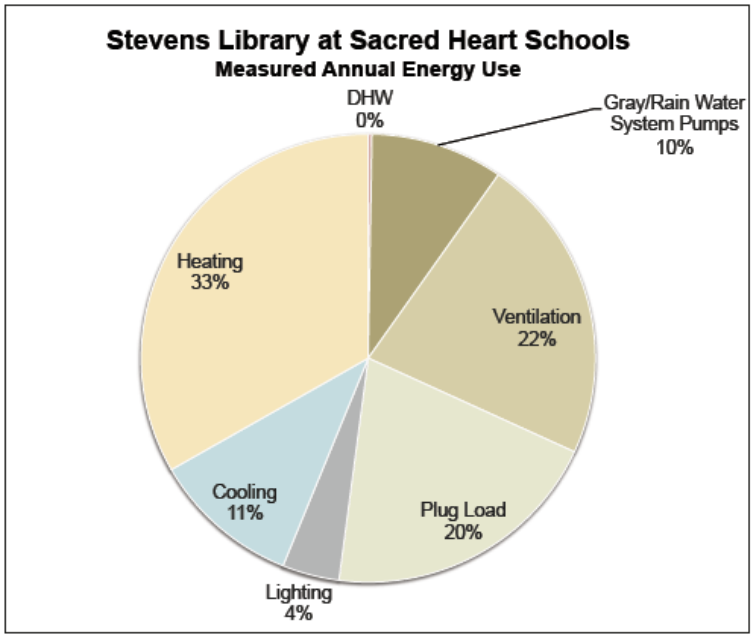
EUI of 16.1 or 13.2 if not including greywater

	Fans	Heating	Cooling	Lighting	DHW	Gray/Rain Water System	Misc/Plug	Total Use	PV Generation
1/13	952	3030	229	135	7	116	623	5092	2367
2/13	937	2984	226	133	7	114	613	5014	2966
3/13	486	778	459	143	7	269	618	2760	4246
4/13	580	86	313	100	7	228	463	1777	5337
5/13	603	90	326	104	7	237	481	1848	6645
6/13	365	54	197	54	1	364	434	1469	6198
7/13	324	48	175	54	5	401	435	1442	6703
8/13	361	54	195	74	18	340	479	1521	5956
9/13	600	89	324	103	7	316	486	1925	4756
10/13	514	76	278	137	6	237	633	1881	3678
11/13	408	653	386	120	6	225	519	2317	2589
12/13	757	2409	182	107	6	92	495	4048	2289
2013 Total	6887	10351	3290	1264	84	2939	6279	31094	53730



Modeled Energy Use

50 MWhr per Year
Modeled EUI = 27.0

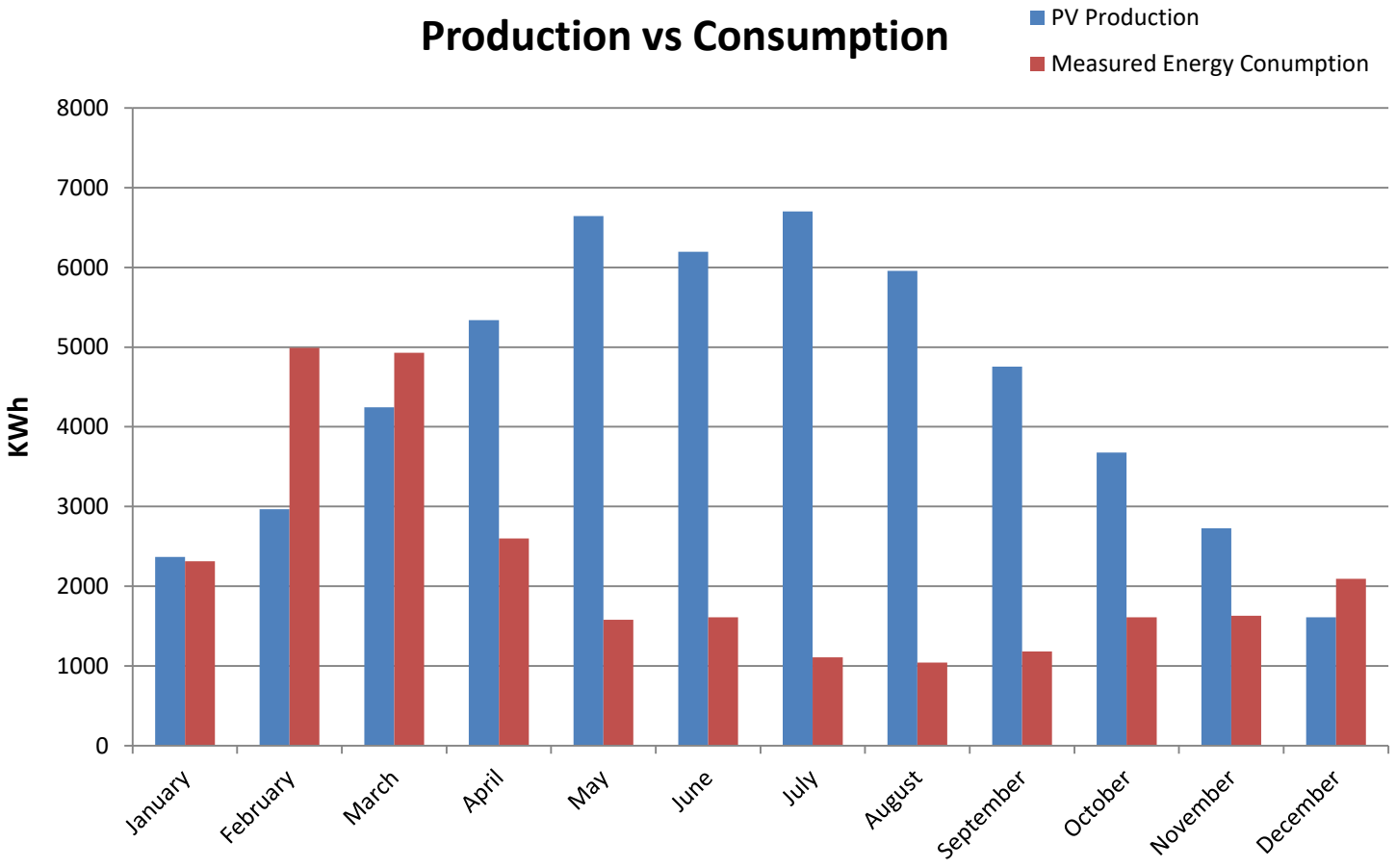


Measured Energy Use

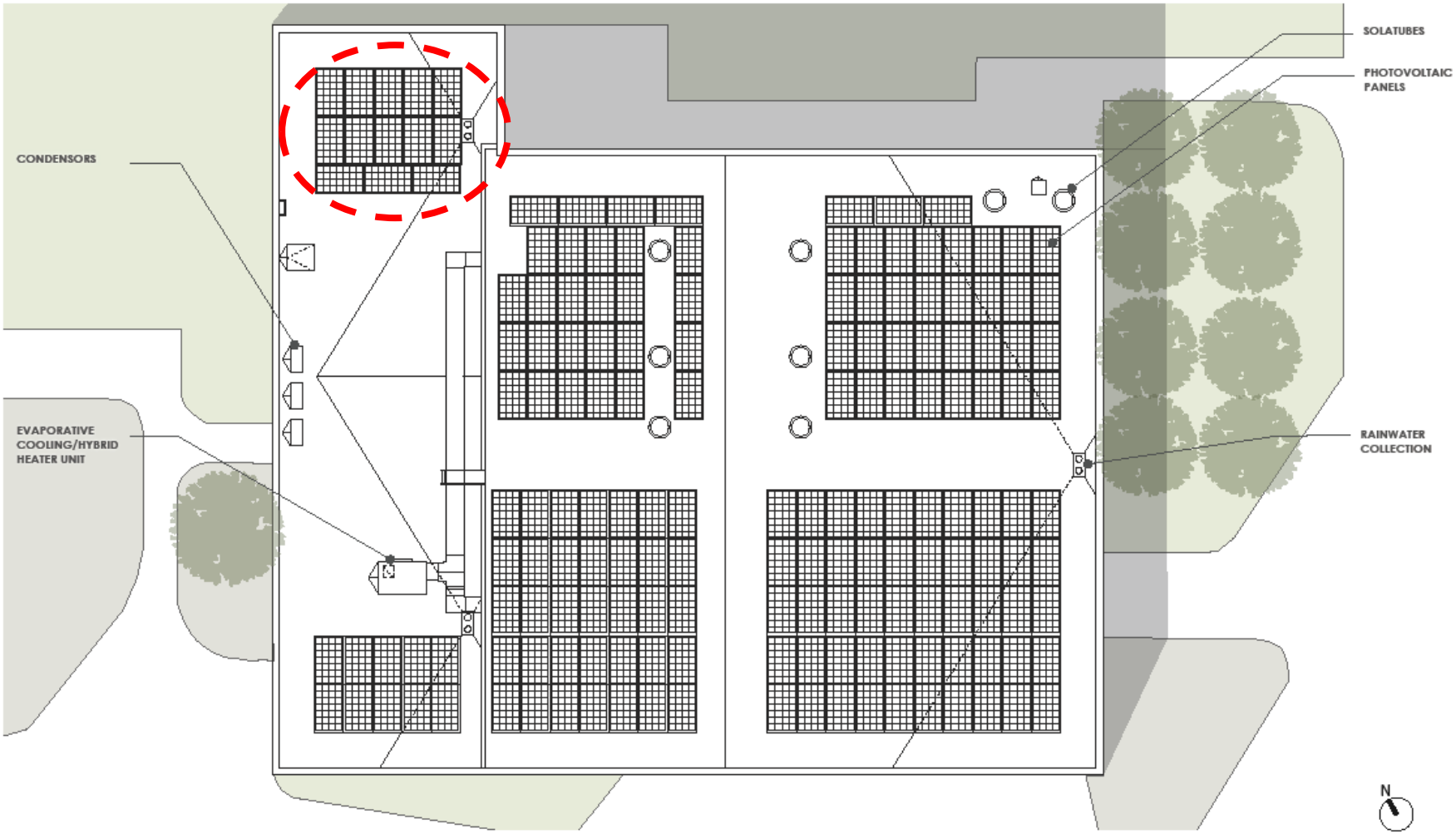
31.1 MWhr per Year
Actual EUI = 16.9


how much

PV predicted at 50832 kWh
PV measured 56811kWh
Demand measured 24394 kWh



170 panels @ 250 w/panel – 40 kw sized 15% over covers graywater system, 4,408 kwh



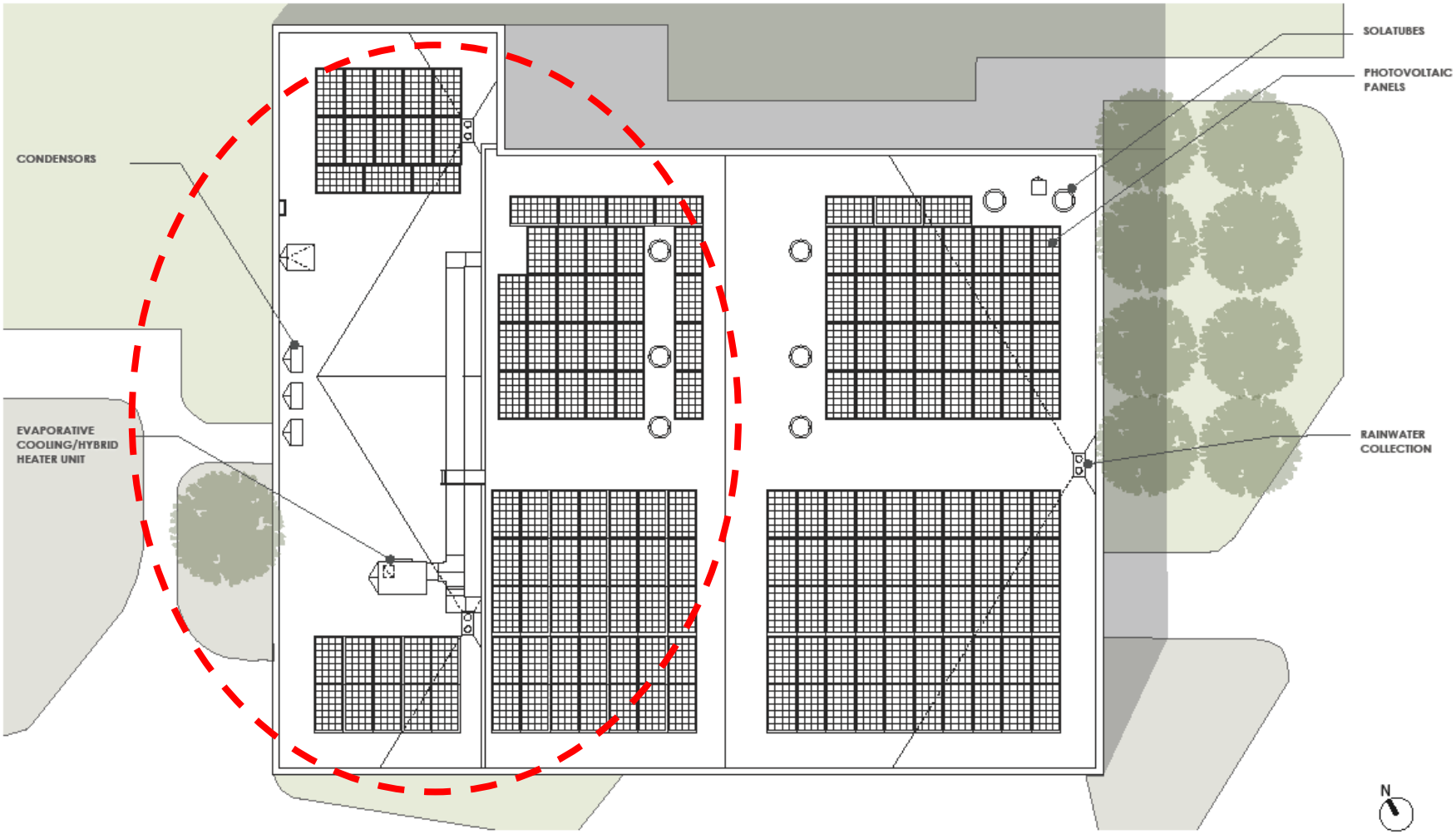
SACRED HEART LIBRARY

ROOF PLAN

WRNSSTUDIO

March 27, 2013

Too much?



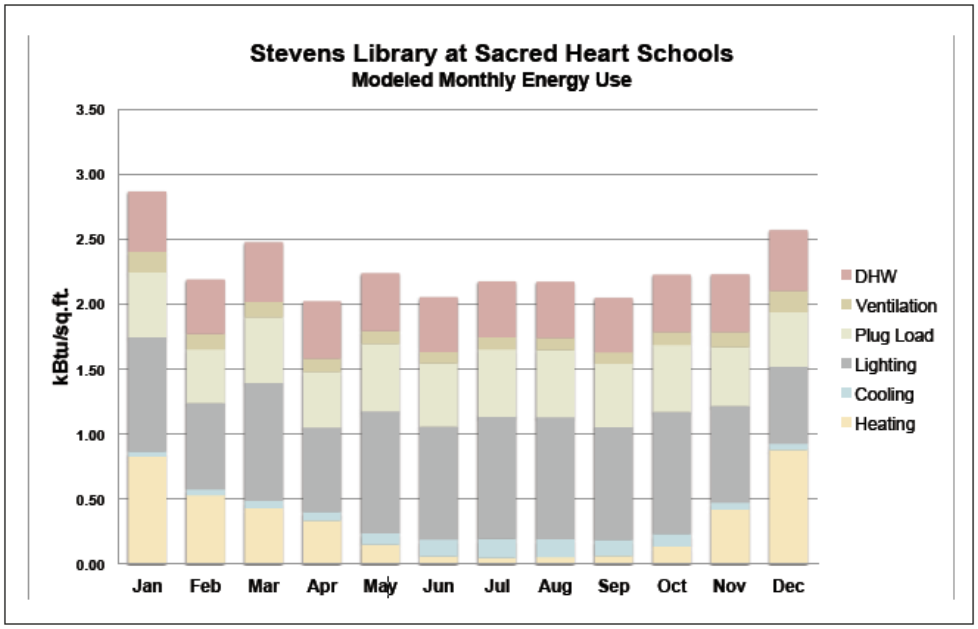
SACRED HEART LIBRARY

ROOF PLAN

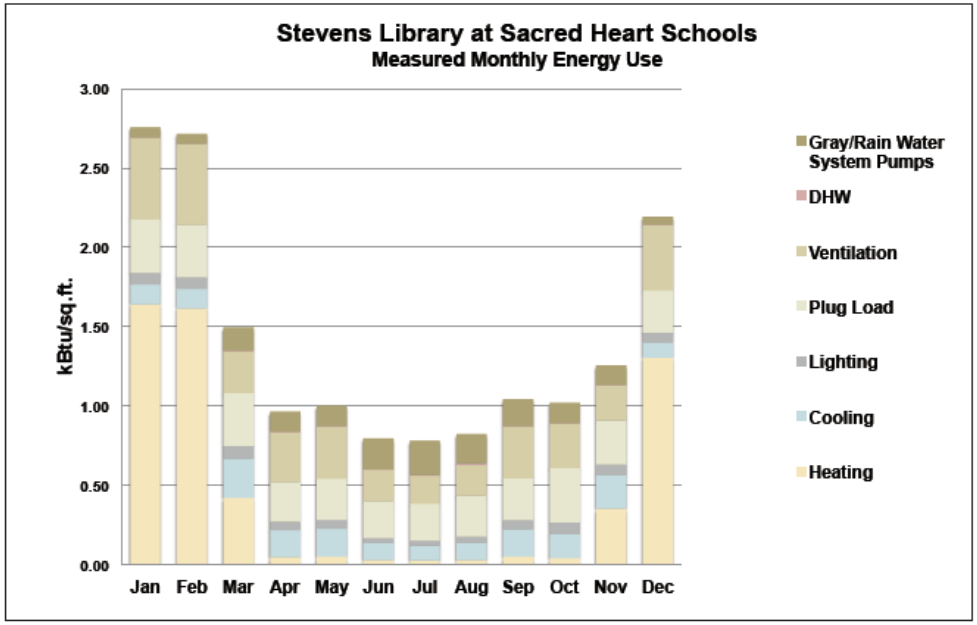
WRNSSTUDIO

March 27, 2013

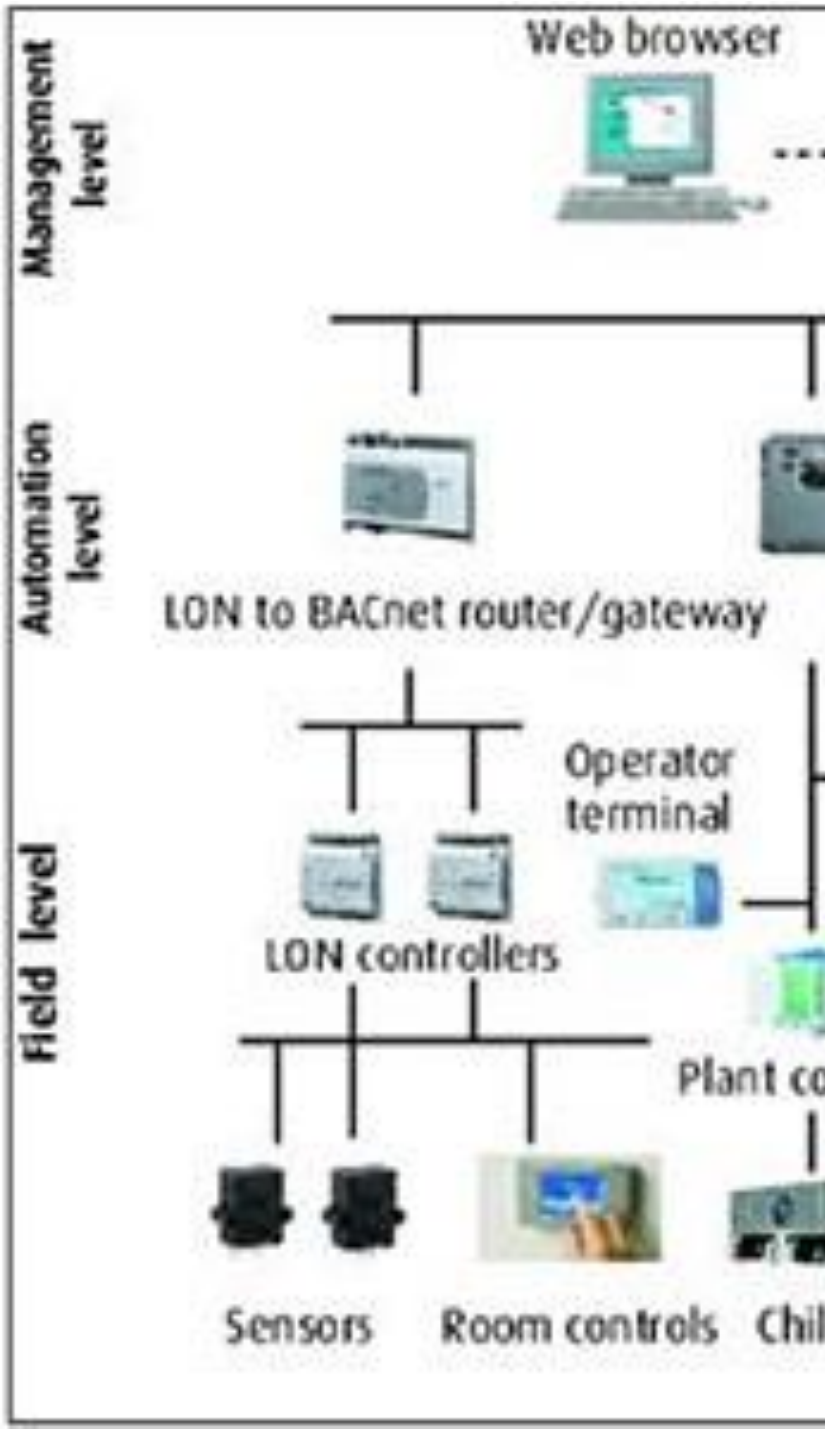

Too Good?



Energy Use – Actual Measurement and Comparison to Modeling Results

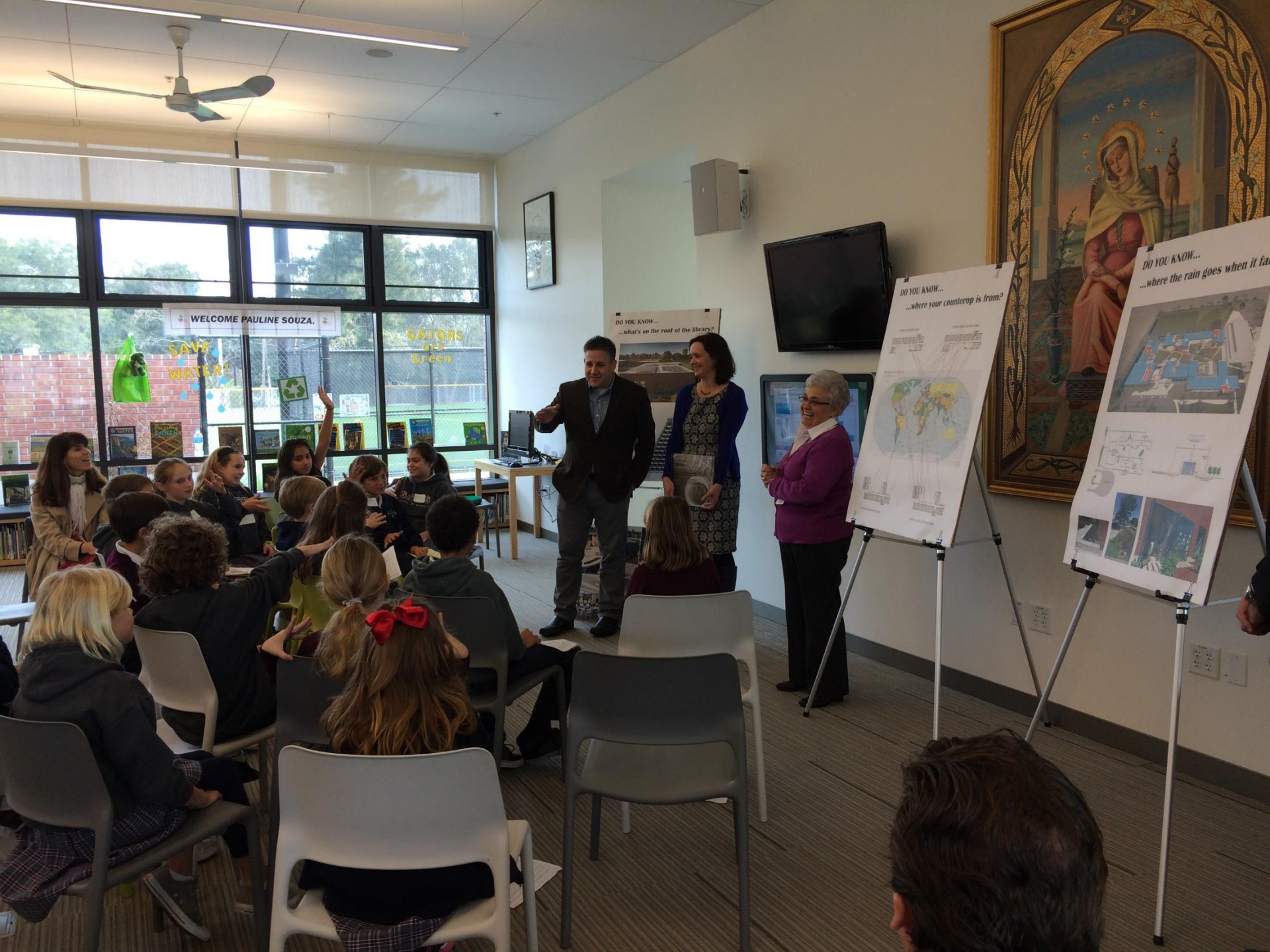


BMS Controls


Management level
Web browser
Automation level
LON to BACnet router/gateway
Field level
Operator terminal
LON controllers
Plant co
Sensors
Room controls
Chil


people


highs


WELCOME PAULINE SOUZA.
SAVE WATER!
GATORS are Green
DO YOU KNOW...
...what's on the roof of the library?
DO YOU KNOW...
...where your counterop is from?
DO YOU KNOW...
...where the rain goes when it fa


DO YOU KNOW...
DO YOU KNOW...
DO YOU KNOW...
EXIT

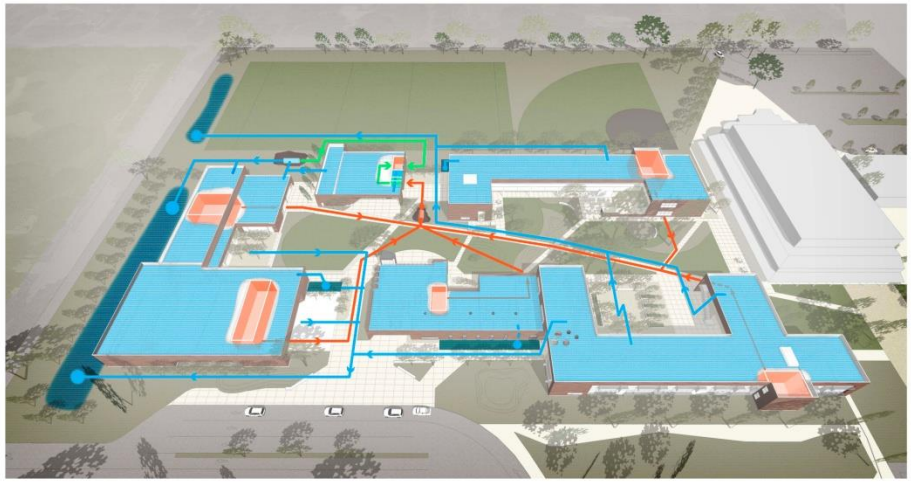

WELCOME PAULINE SOUZA.
SAVE WATER!
GATORS are Green
WATER
Our Living EARTH
green
Energy for the Future
Water for Everyone
LAND

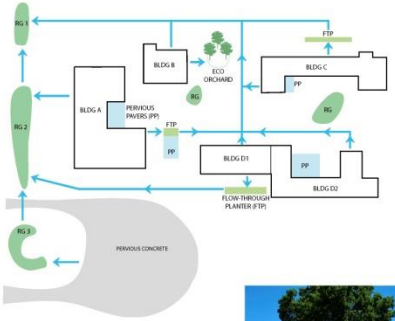

GRAYWATER
RAINWATER

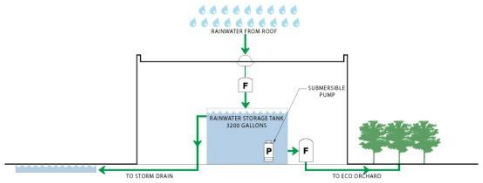

KNOW...
e the rain goes when it falls?
DO YOU KNOW...
re your counterop is from?
SHEKER PAVILION

DO YOU KNOW...

...where the rain goes when it falls?

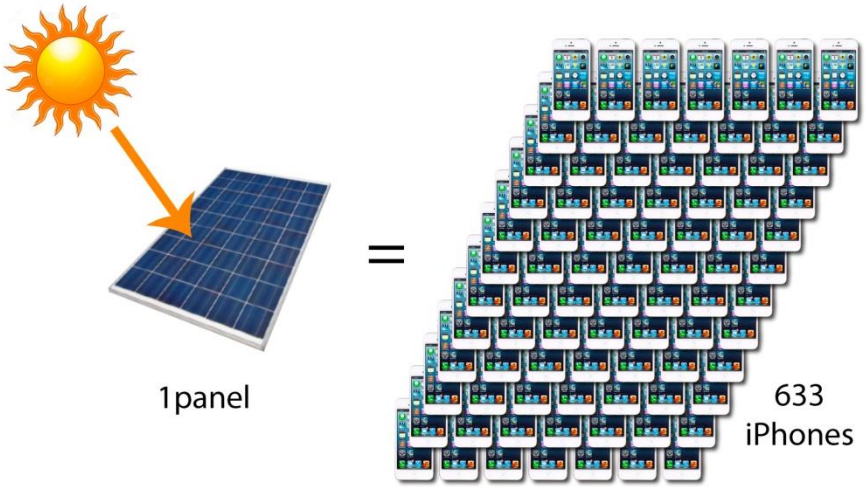






DO YOU KNOW...

...what's on the roof of the library?



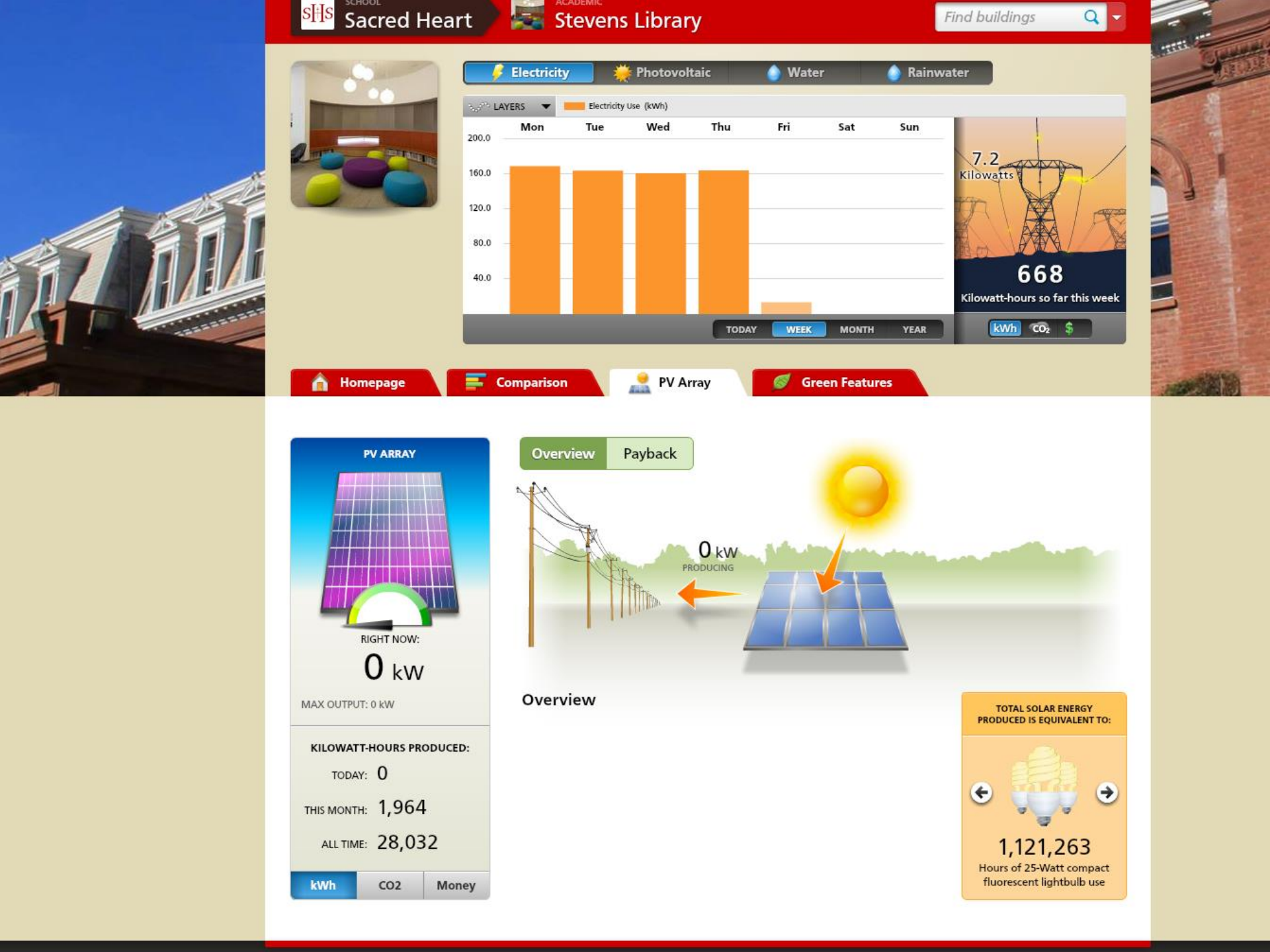

OU KNOW...
what's on the roof of the library?
1panel
633
iPhones
VISITOR
Use Our Natural Resources to Conserve Energy
Panels and Daylighting
and Evaporative Cooling
and for Watering the Grass
Irrigation System
In Ground Water Tanks
ghting Sensor


DO YOU KNOW...
...where the rain goes wh


DO YOU KNOW...
...where your counterop is from?
LOWER SCHOOL FIRST FLOOR
LOWER SCHOOL SECOND FLOOR


EXIT


EXIT


SCHOOL
Sacred Heart
ACADEMIC
Stevens Library
Find buildings
Electricity
Photovoltaic
Water
Rainwater
LAYERS
Electricity Use (kWh)
Mon
Tue
Wed
Thu
Fri
Sat
Sun
200.0
160.0
120.0
80.0
40.0
TODAY
WEEK
MONTH
YEAR
7.2
Kilowatts
668
Kilowatt-hours so far this week
kWh
CO2
$
Homepage
Comparison
PV Array
Green Features
PV ARRAY
RIGHT NOW:
0 kW
MAX OUTPUT: 0 kW
KILOWATT-HOURS PRODUCED:
TODAY: 0
THIS MONTH: 1,964
ALL TIME: 28,032
kWh
CO2
Money
Overview
Payback
0 kW
PRODUCING
Overview
TOTAL SOLAR ENERGY PRODUCED IS EQUIVALENT TO:
1,121,263
Hours of 25-Watt compact fluorescent lightbulb use

SCHOOL
Sacred Heart

ACADEMIC
Stevens Library

Find buildings

Electricity | Photovoltaic | Water | Rainwater

LAYERS | PV Output Power (kWh)

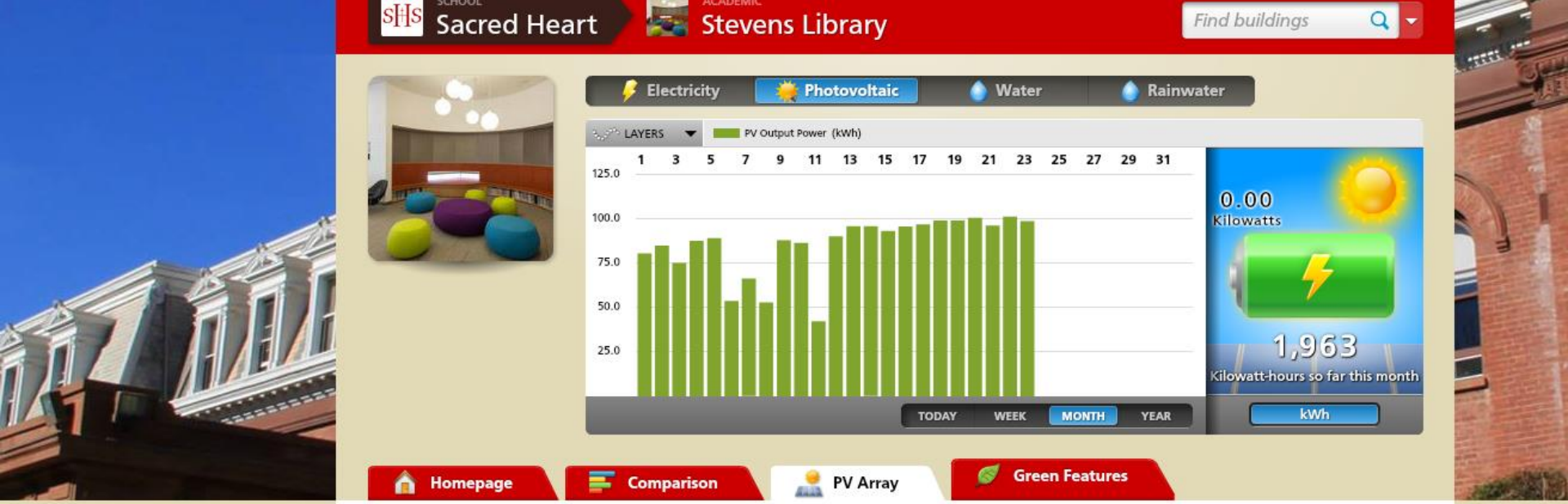
0.00
Kilowatts

1,963
Kilowatt-hours so far this month

TODAY | WEEK | MONTH | YEAR

kWh

Homepage | Comparison | PV Array | Green Features



PV ARRAY

RIGHT NOW:

0 kW

MAX OUTPUT: 0 kW

KILOWATT-HOURS PRODUCED:

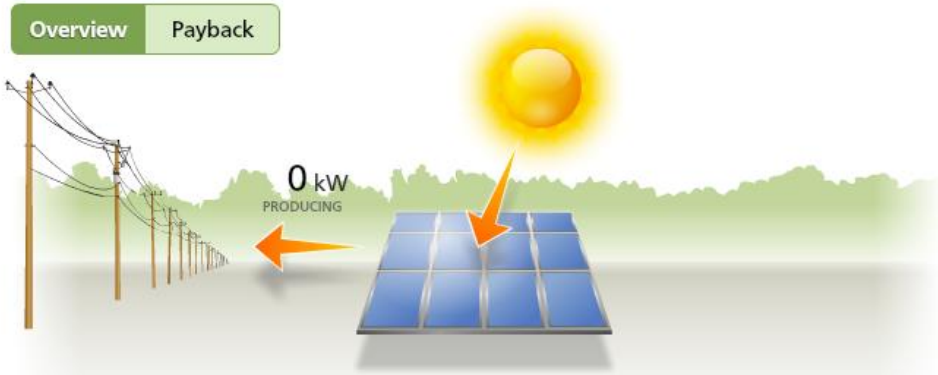
TODAY: 0

THIS MONTH: 1,964

ALL TIME: 28,031

kWh | CO2 | Money

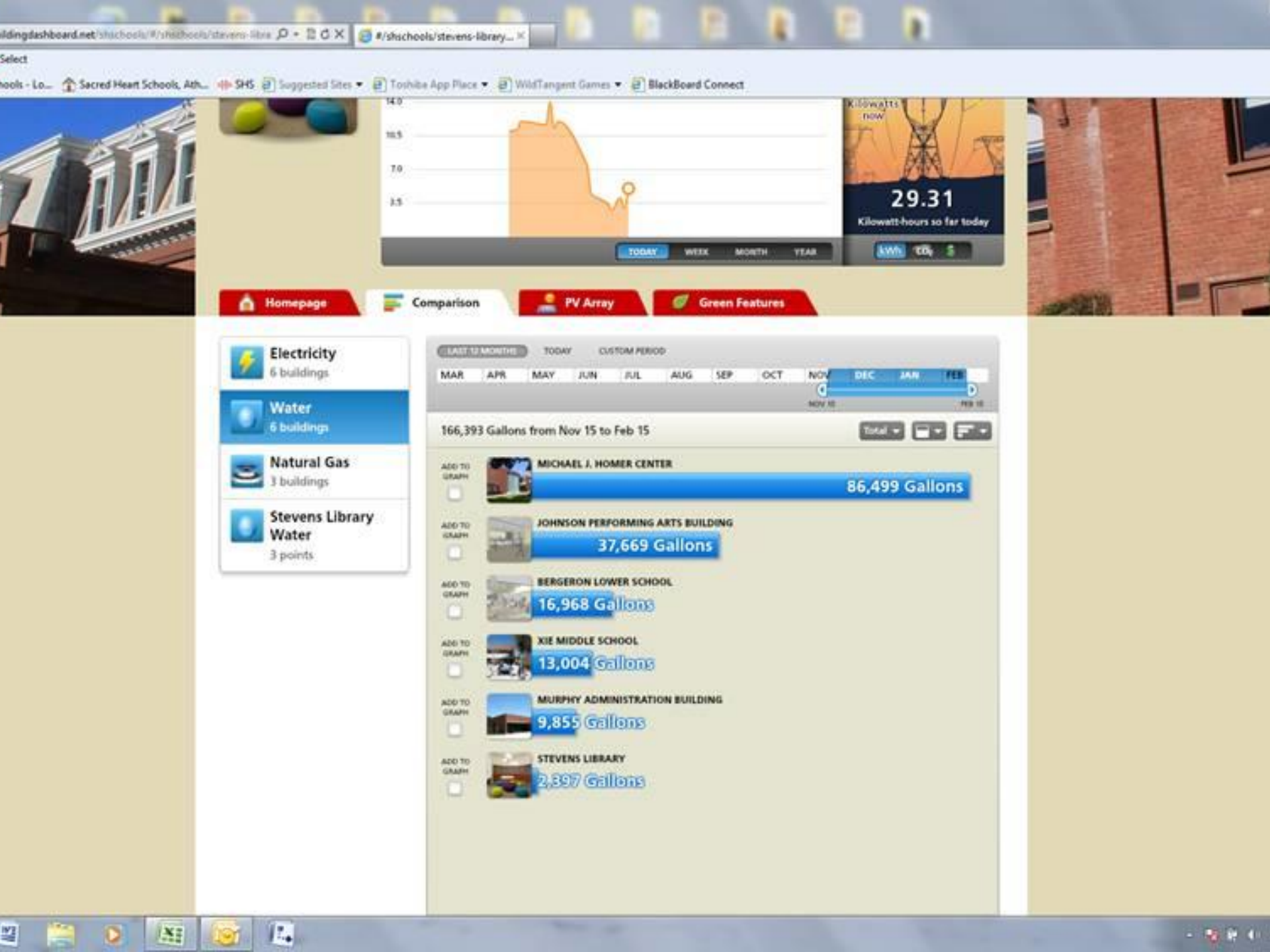
Overview | Payback



Overview

TOTAL SOLAR ENERGY PRODUCED IS EQUIVALENT TO:

1,121,248
Hours of 25-Watt compact fluorescent lightbulb use


#/shschools/stevens-library...
Select
Sacred Heart Schools, Ath...
SHS
Suggested Sites
Toshiba App Place
WildTangent Games
BlackBoard Connect
14.0
10.5
7.0
3.5
TODAY
WEEK
MONTH
YEAR
Kilowatts now
29.31
Kilowatt-hours so far today
kWh
Homepage
Comparison
PV Array
Green Features
Electricity
6 buildings
Water
6 buildings
Natural Gas
3 buildings
Stevens Library Water
3 points
LAST 12 MONTHS
TODAY
CUSTOM PERIOD
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
166,393 Gallons from Nov 15 to Feb 15
Total
ADD TO GRAPH
MICHAEL J. HOMER CENTER
86,499 Gallons
JOHNSON PERFORMING ARTS BUILDING
37,669 Gallons
BERGERON LOWER SCHOOL
16,968 Gallons
XIE MIDDLE SCHOOL
13,004 Gallons
MURPHY ADMINISTRATION BUILDING
9,855 Gallons
STEVENS LIBRARY
2,397 Gallons

Stevens Library - Building D...

line v2 Vision 7.0

buildingdashboard

Connect

SCHOOL
Sacred Heart

ACADEMIC
Stevens Library

Find buildings

Electricity | Photovoltaic | Water | Rainwater

LAYERS

Total Water Use (Mix Of City Water, Gray Water, And Well Water) (Gallons)

3.3
gal/hr

15.13
Gallons so far

TODAY | WEEK | MONTH | YEAR

gal

Homepage | Comparison | PV Array | Green Features

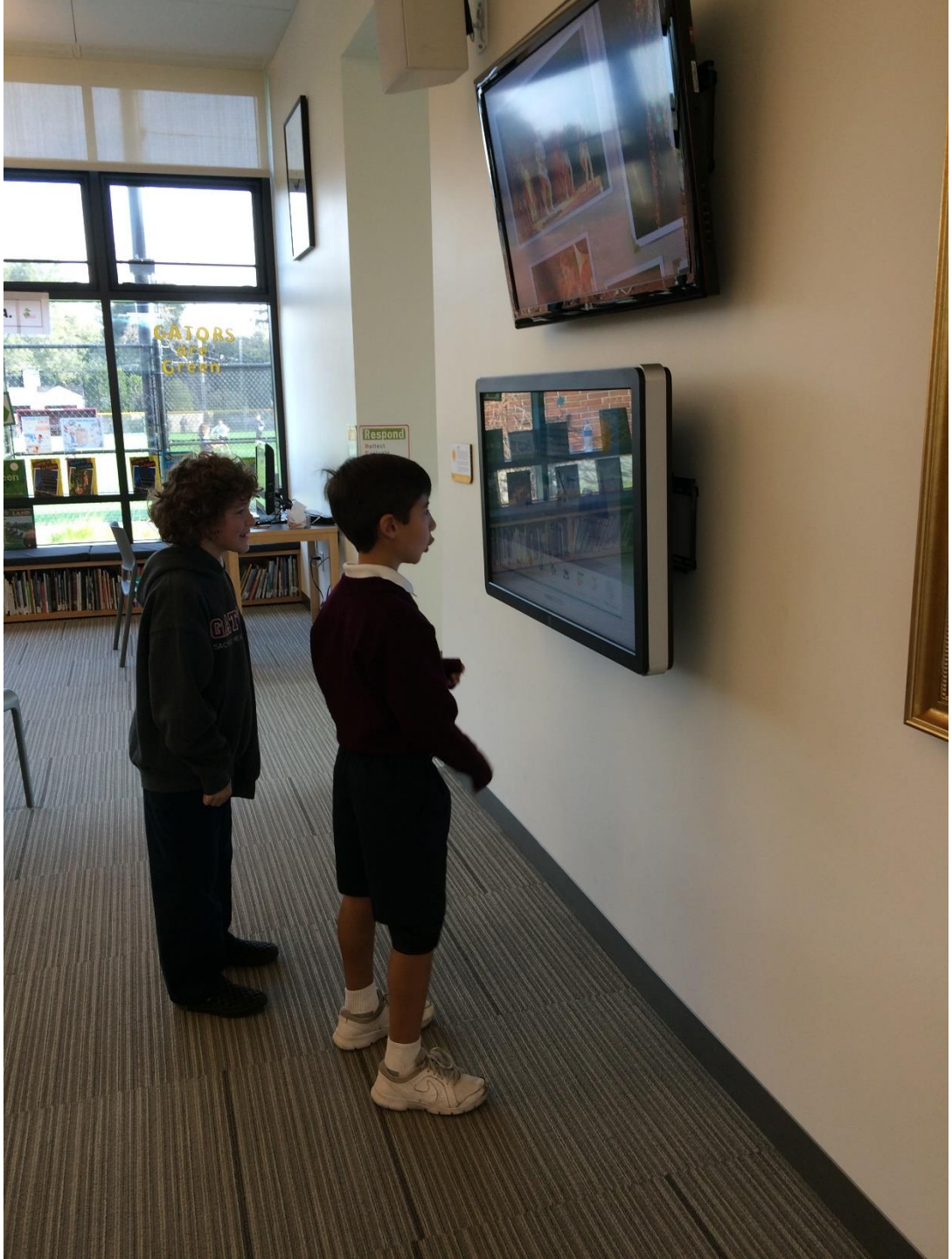
Commit to Conserve

TOTAL COMMITMENTS: 0

Tweets

SHSAtherton 11:49 AM Jun 28

Thanks for making the 2012-2013 school year a success!


GATORS
Respond


PROUD to be GREEN.

Momentum moving forward

SHS Stevens Library
Sacred Heart Schools

6300 sf library;83,000 sf school; 6 acre site
Independent School
LOW construction budget - y2009
LOW - Moderate fees- y2009
LOW interest in driving sustainability through project
FAST paced Design and Construction (9 mo. design; 14 mo. build)

Pursued Net Zero Water
LEED Platinum targeted
Net Zero Energy Certified through ILFI

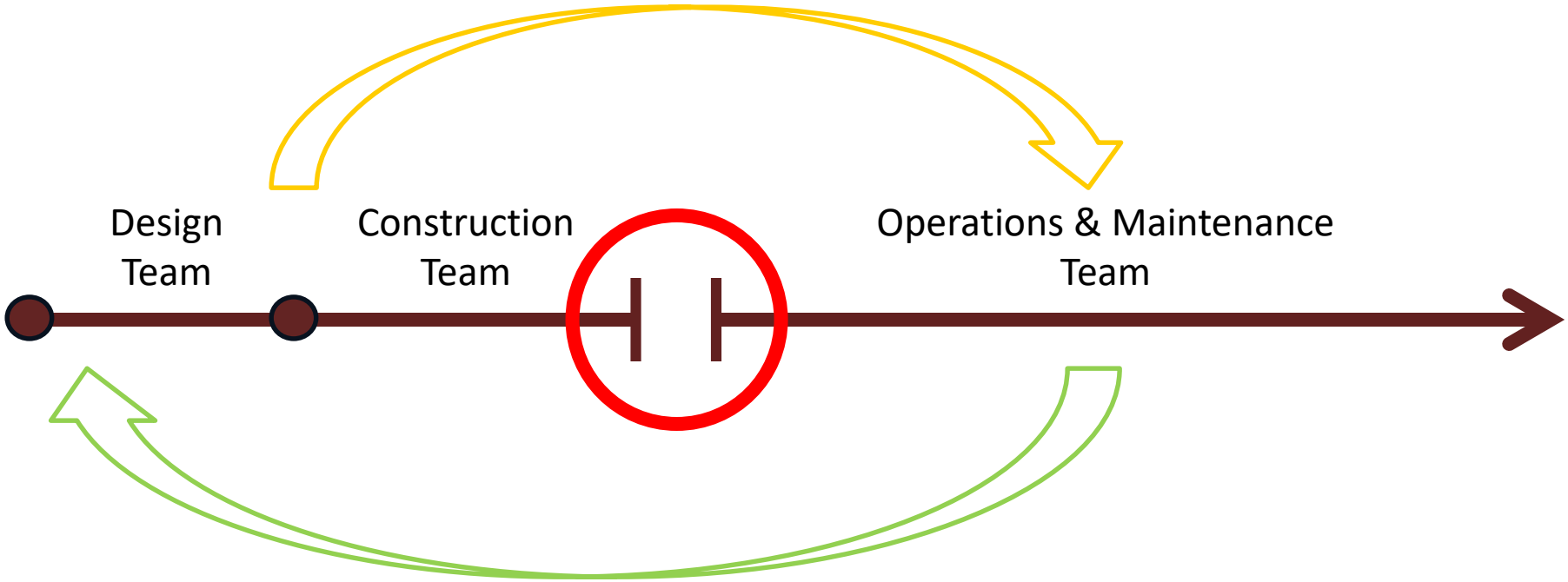
Designing to the ZNE Target Part 2: Design for Operations

2:00 - 2:30 p.m.

Defining the elements that need to be put into a building in order to enable ZNE operation

Designing to the ZNE Target
Part 2: Design for Operations

Integrating operations team into the design process



Designing to the ZNE Target Part 2: Design for Operations

Developing a ZNE operations framework:

- Select technologies appropriate to operators and occupants
- Provide tools and resources
- Develop facilities operations plans

Designing to the ZNE Target Part 2: Design for Operations

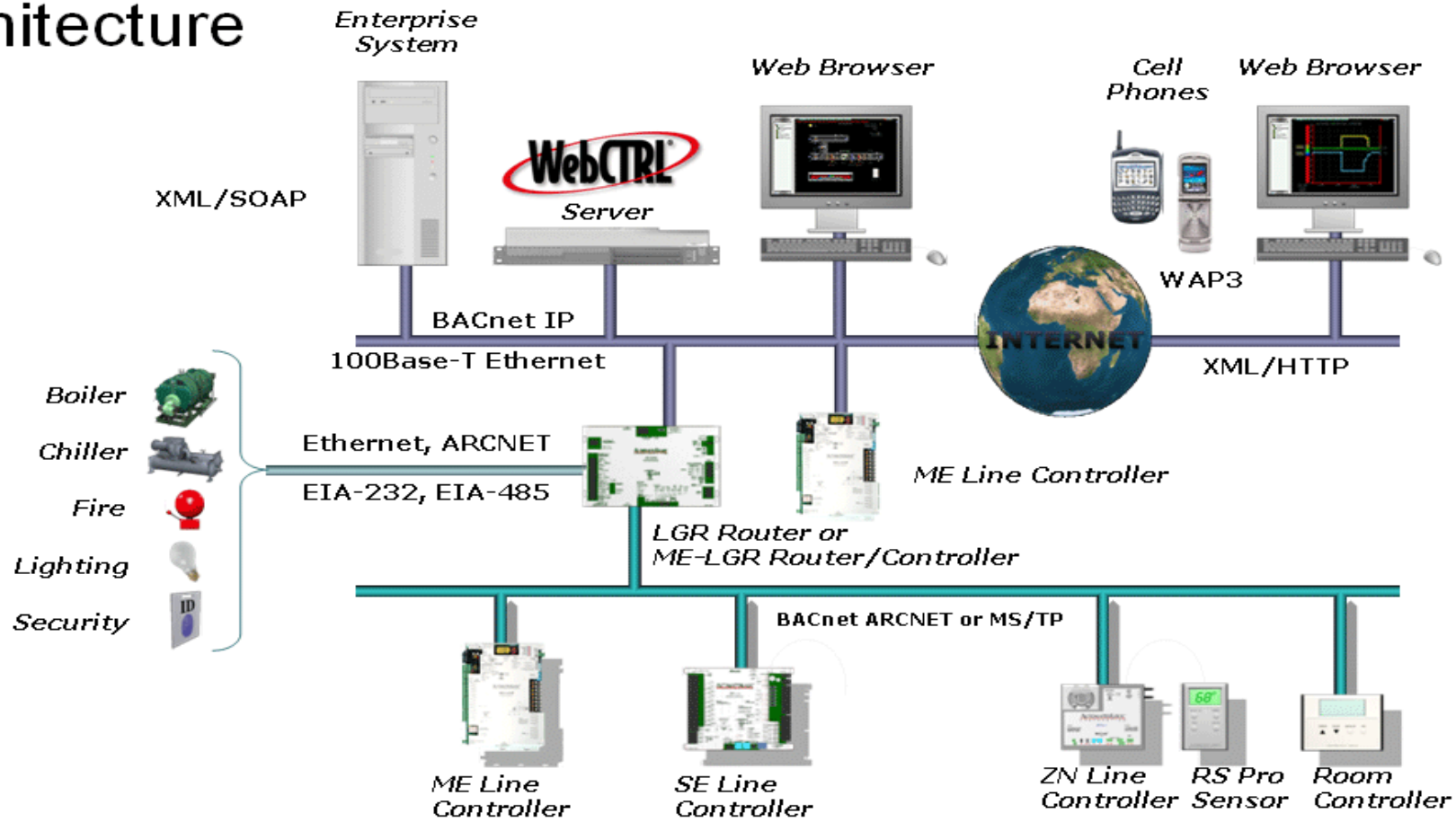
KEY TOPICS

- Building automation and controls integration
- Integrating operations into the design process
- Developing a ZNE operations framework: technologies, tools and facilities operations planning

Designing to the ZNE Target Part 2: Design for Operations

ZNE design strategies: Building automation and controls, and controls integration

Architecture



Designing to the ZNE Target Part 2: Design for Operations

Building automation and controls integration

Many decisions to make:

- System type
- Points controlled
- Integration between systems
- Simplicity vs complexity

Despite all the choices…

Just make it work.

Designing to the ZNE Target Part 2: Design for Operations

Building automation and controls integration

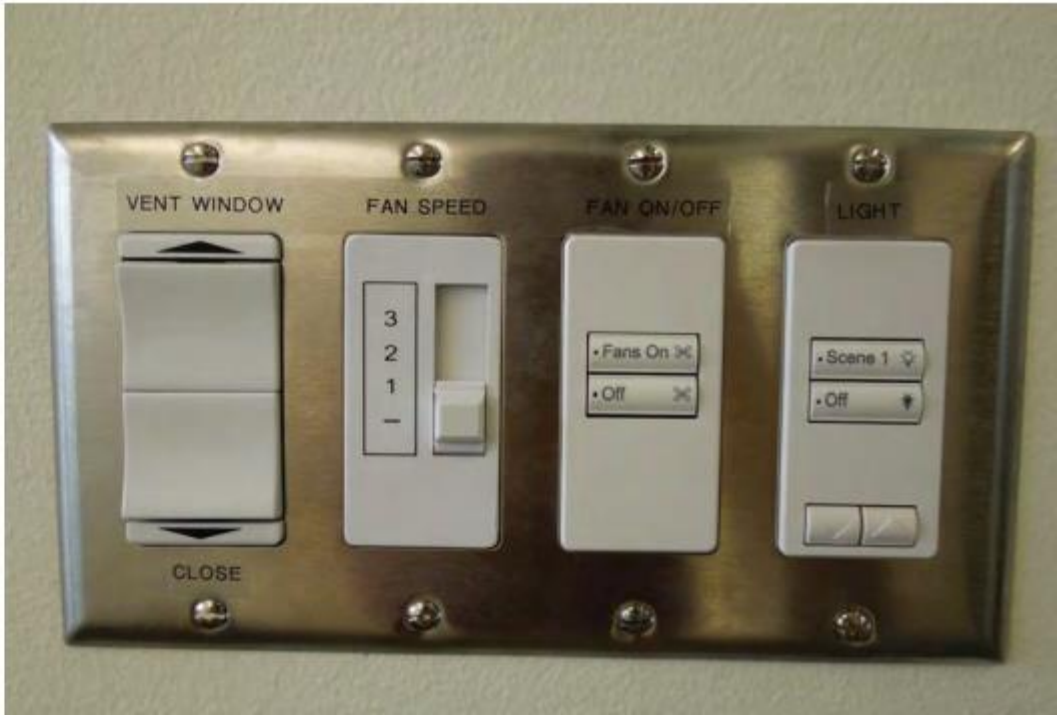
Making It All Work Together: Key Points

- Plan for Measurement and Verification
- Beware of Value Engineering!
- Controls considered from design through operation
  - **Controls Integrator** contracted 1 year post occupancy
- Design controls for real-world use
  - Keep the **Operators** and **Occupants** in mind


EMERGENCY

Controls

- User-friendly/intuitive
- Over-rides contribute to the confusion
- Consistent - across an institution if possible
- Organized



http://energytrust.org/library/forms/Synergy_Human_Impact_Net_Zero_Presentation.pdf

Designing to the ZNE Target Part 2: Design for Operation

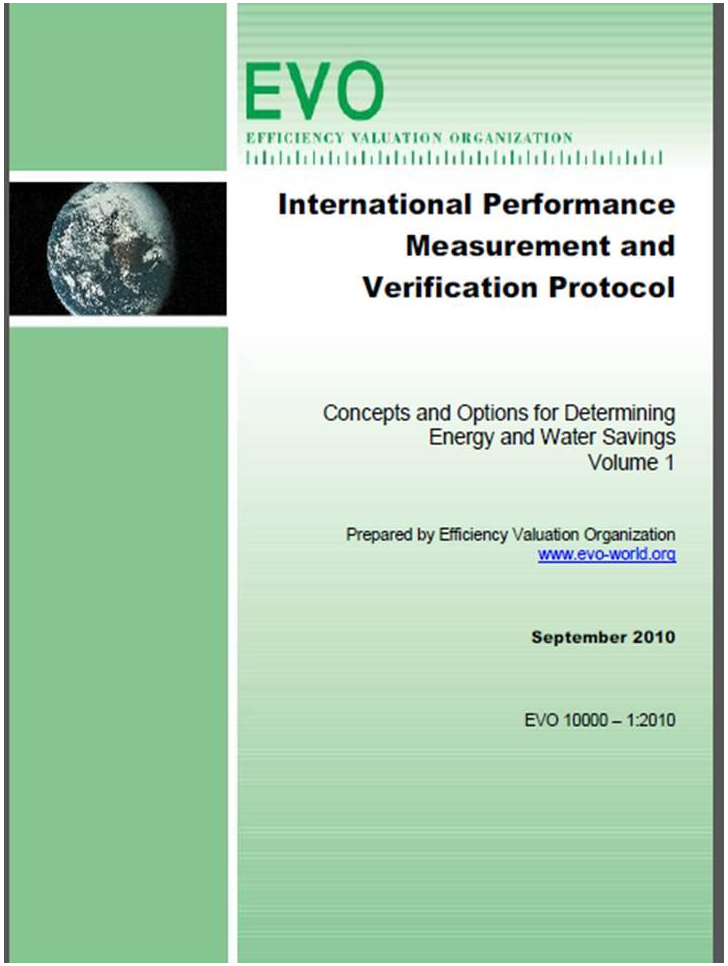
You can't improve what you don't measure

Measurement and verification of building performance

- Standardized Protocol: IPMVP

Design for Measurability

- Submetering & Electrical Circuits
- Controls: Data Trending
- Make sure you can *use* measured data to improve performance!

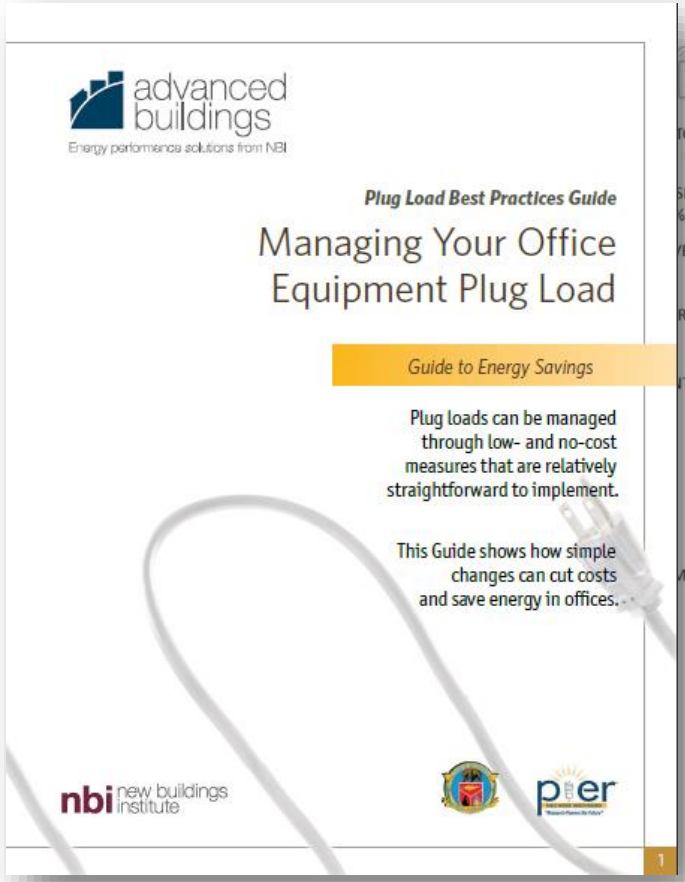


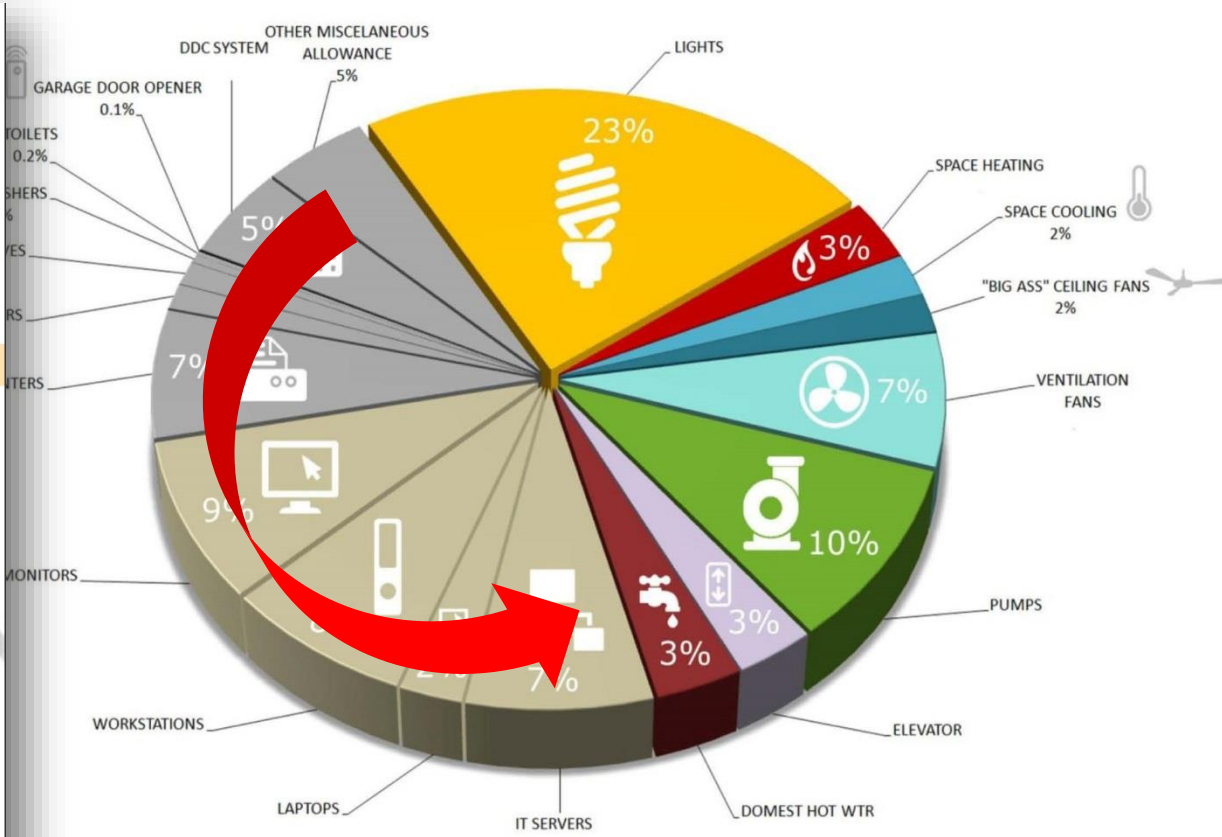
zero net energy

Image credit: EVO

Designing to the ZNE Target
Part 1: Design for performance

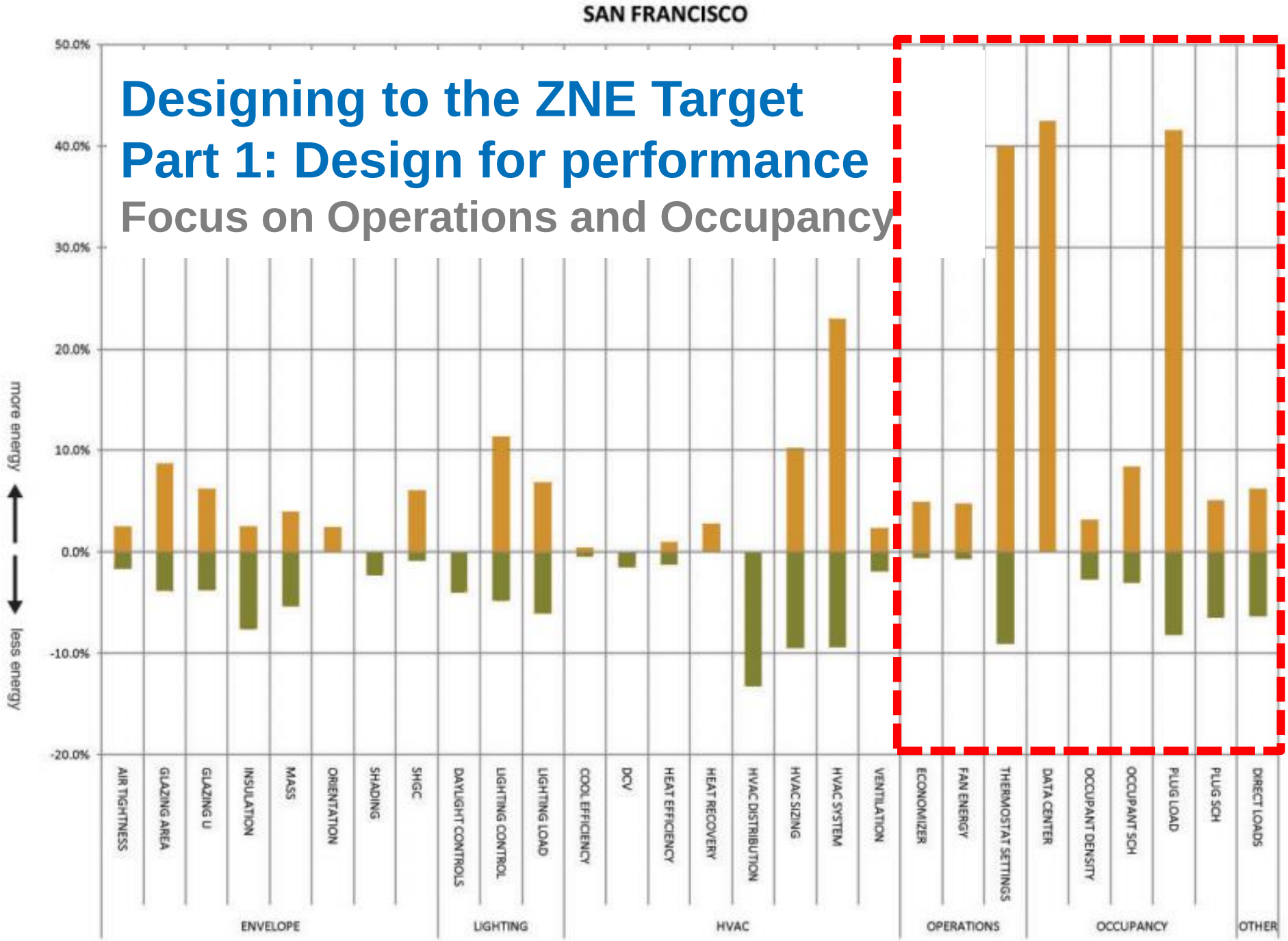
Plug load performance – selecting energy efficient plug load equipment





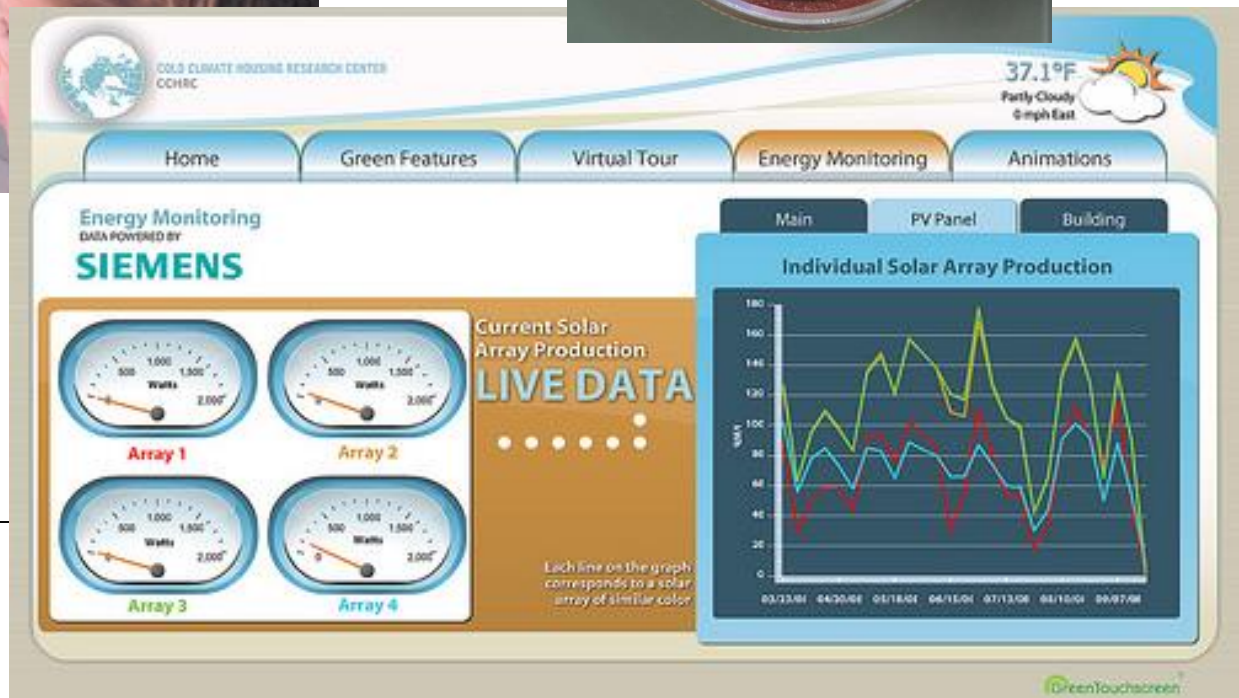
Courtesy of PAE Consulting Engineers

Designing to the ZNE Target
Part 1: Design for performance
Focus on Operations and Occupancy



http://newbuildings.org/sites/default/files/SensitivityAnalysisReport.pdf

Operator & Occupant Engagement



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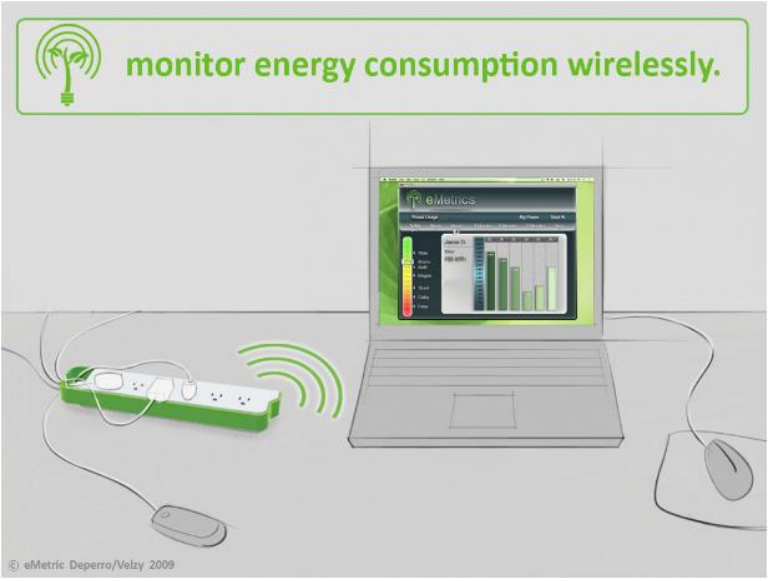
Operator & Occupant Engagement



eMetric by Jason Deperro

Designing to the ZNE Target
Part 2: Design for Operations

Questions & Answers

Break

2:30 – 2:45 p.m.

Building to the ZNE Design

2:45- 3:15 p.m.

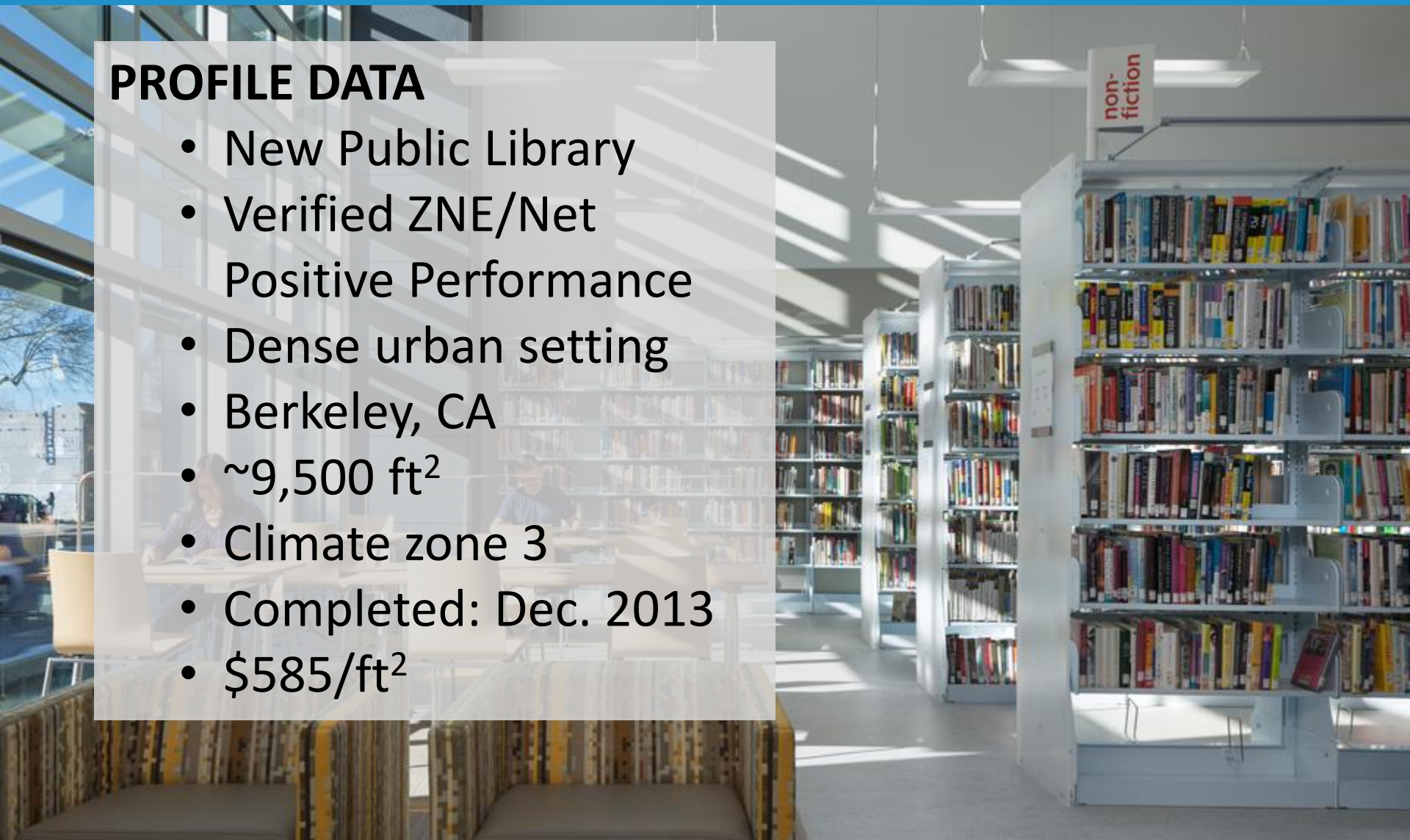
Ensuring that a ZNE design becomes a ZNE building, from selecting contractors, construction and commissioning, to fine-tuning

Building to the ZNE Design

KEY TOPICS

- Construction delivery methods
- Integrating ZNE strategies and technologies into the school facility
- ZNE commissioning: ensuring ZNE performance
- Beginning M&V, controls integration and setting up systems for successful operations

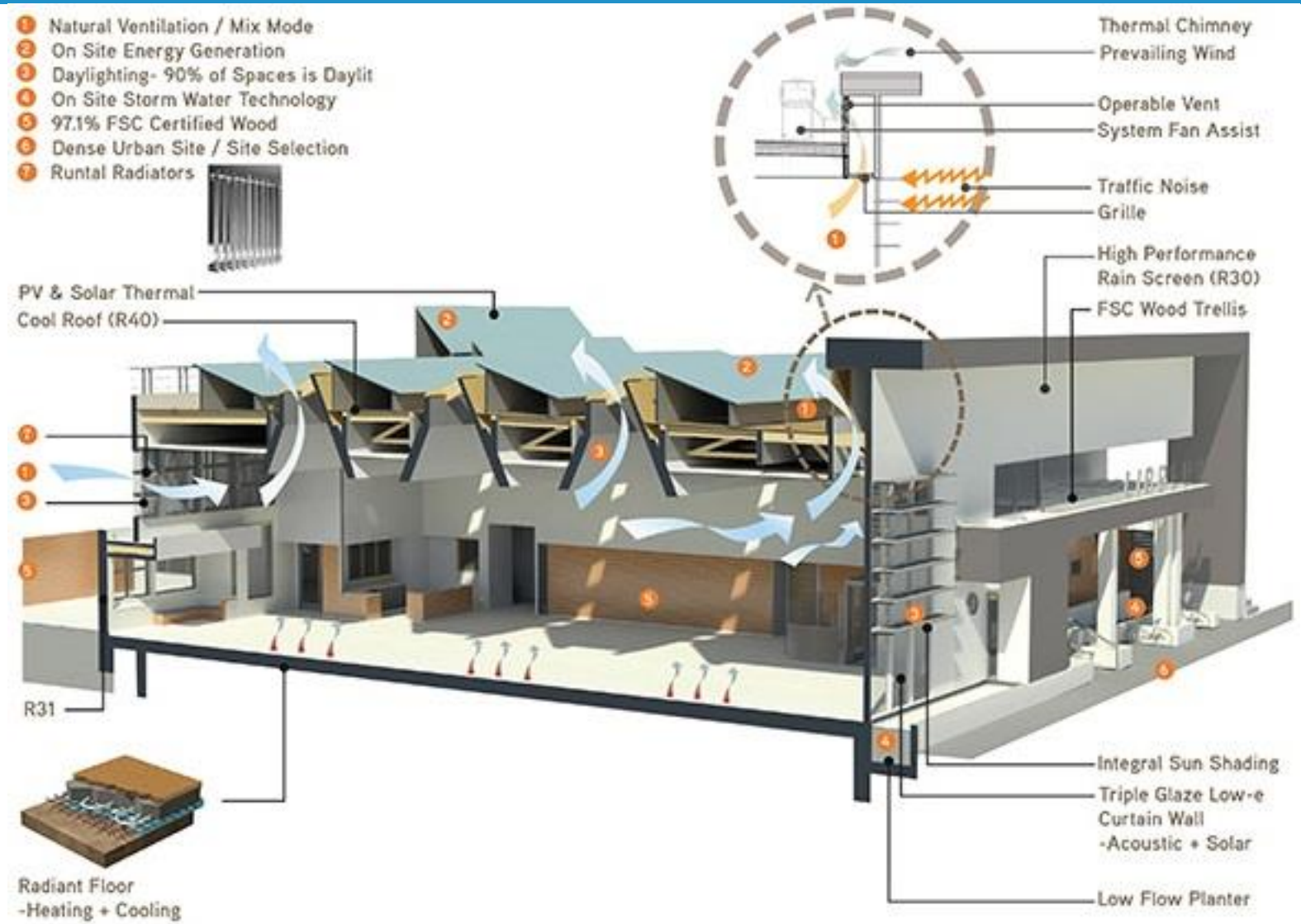
West Berkeley Public Library



PROFILE DATA

- New Public Library
- Verified ZNE/Net Positive Performance
- Dense urban setting
- Berkeley, CA
- ~9,500 ft^2
- Climate zone 3
- Completed: Dec. 2013
- \$585/ft^2

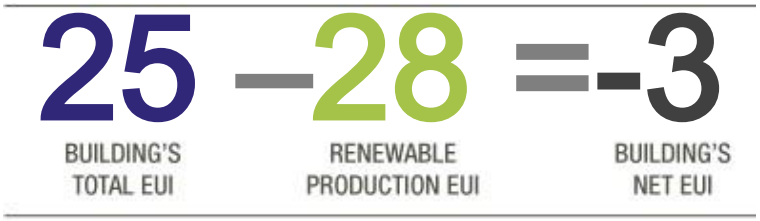
West Berkeley Public Library

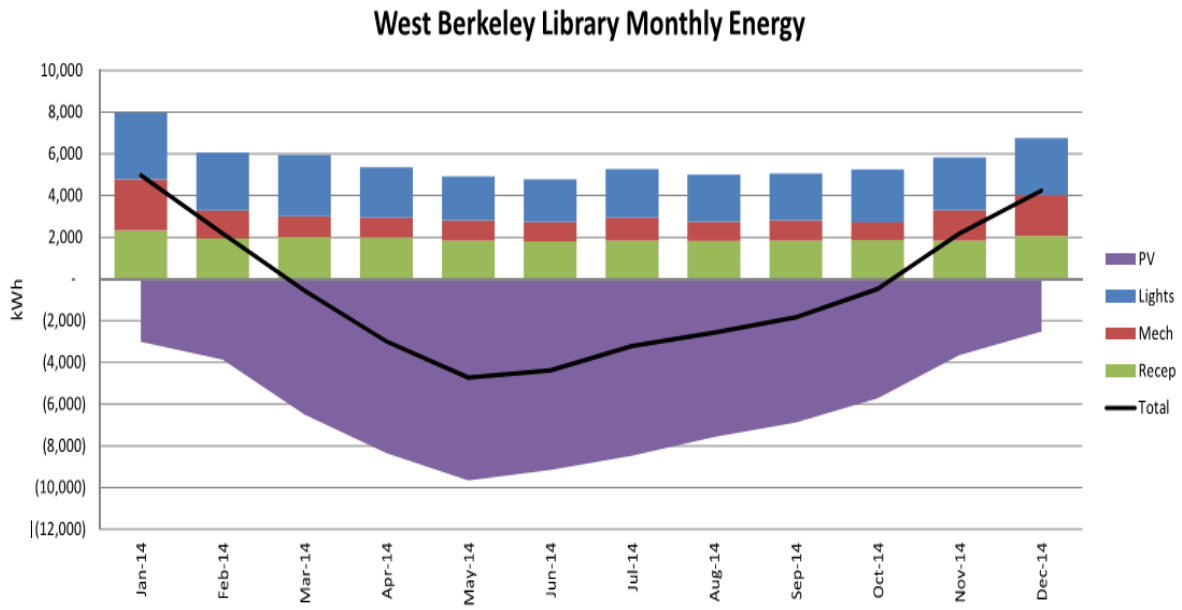


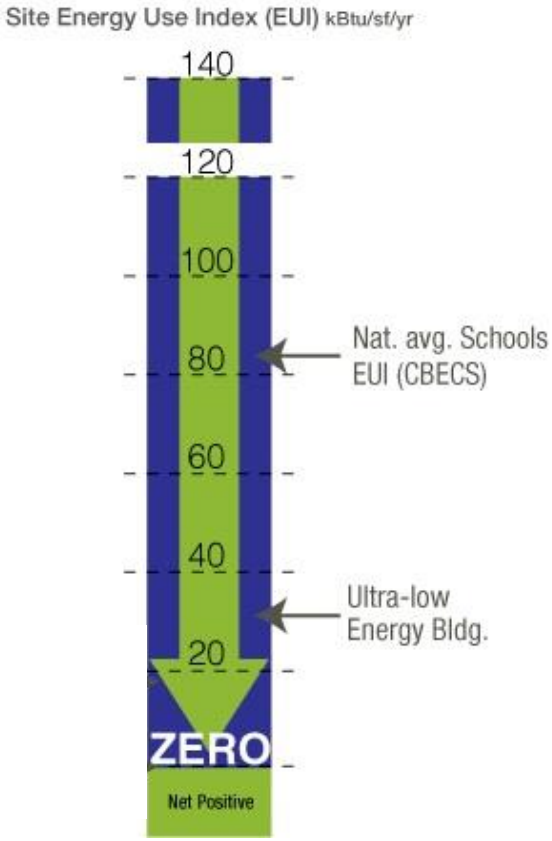
West Berkeley Public Library

METRICS

- Over 50% savings beyond Title 24
- Net Positive







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CHALLENGES & LESSONS LEARNED

Skylights:

- Operable skylight controls were difficult to get to communicate with building management system (BMS)
- Value engineering exercise had removed integral blinds- added back during construction

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CHALLENGES & LESSONS LEARNED

Daylighting:

- Operable skylight controls were difficult to communicate with building management system Value engineering exercise had removed integral blinds- added back during construction
- Skylight blinds have solar cell - self powered and automatic

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CHALLENGES & LESSONS LEARNED

Natural Ventilation:

- Interior of chimney has to be lined with acoustic board
- Provide for access to service and maintain
- CFD studies were worth it. Minimal comfort issues – most addressed during commissioning

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KEY LESSONS

- Extensive Bioclimatic Studies & Energy Modeling are Critical
- Anticipate Changes in Technology – be ZNE Aware
- Design & Define Performance Criteria for Design/Build Systems –PV/ Solar
- Commissioning – Data, Performance, Metrics – Stay the Course.

Building to the ZNE Design

Construction delivery methods:

- Design – Bid – Build
- Design – Build
- Guaranteed Maximum Price
- Integrated Project Delivery
- Energy Savings Performance Contract (ESPC)

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Design–bid–build

Owner **contracts** with **separate entities for both the design and construction** of a project.

There are three main sequential phases to the design–bid–build delivery method:

- The design phase
- The bidding (or tender) phase
- The construction phase

Design–build

Design and construction services are **contracted by a single entity** known as the design–builder or design–build contractor.

Guaranteed Maximum Price

Also known as GMP, Not-To-Exceed Price

A cost-type contract or **open-book contract costs incurred plus a fixed fee subject to a ceiling price**.

The **contractor is responsible for cost overruns**, unless the GMP has been increased via formal change order as a result of added scope by client

Integrated Project Delivery (IPD)

Collaborative alliance of people, systems, business structures and practices into a process that harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.

Eight main sequential phases to the integrated project delivery method:

- conceptualization phase [expanded programming]
- criteria design phase [expanded schematic design]
- detailed design phase [expanded design development]
- implementation documents phase [construction documents]
- agency review phase
- buyout phase
- construction phase
- closeout phase
- facilities management

Integrated Project Delivery (IPD)

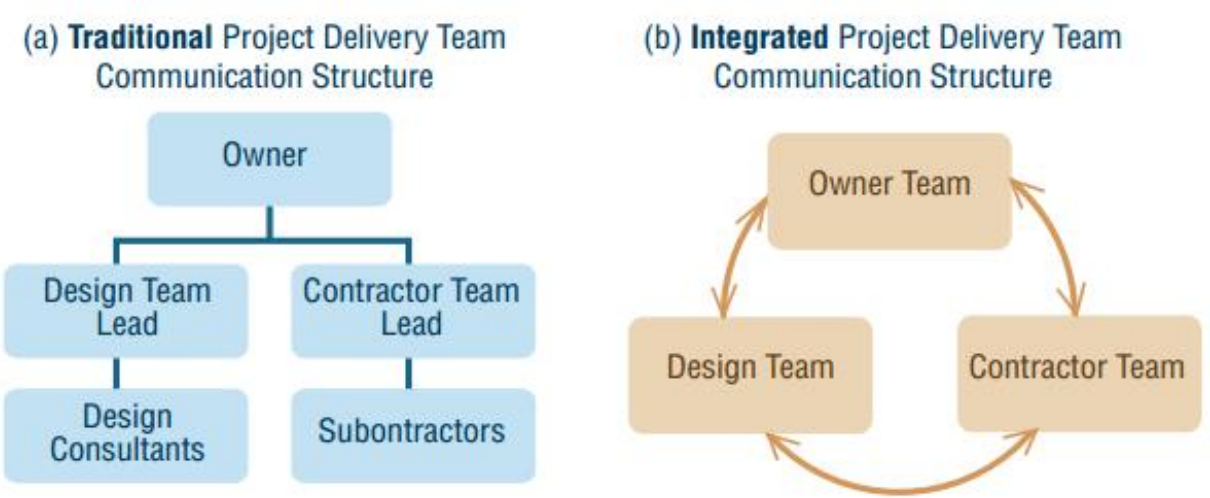
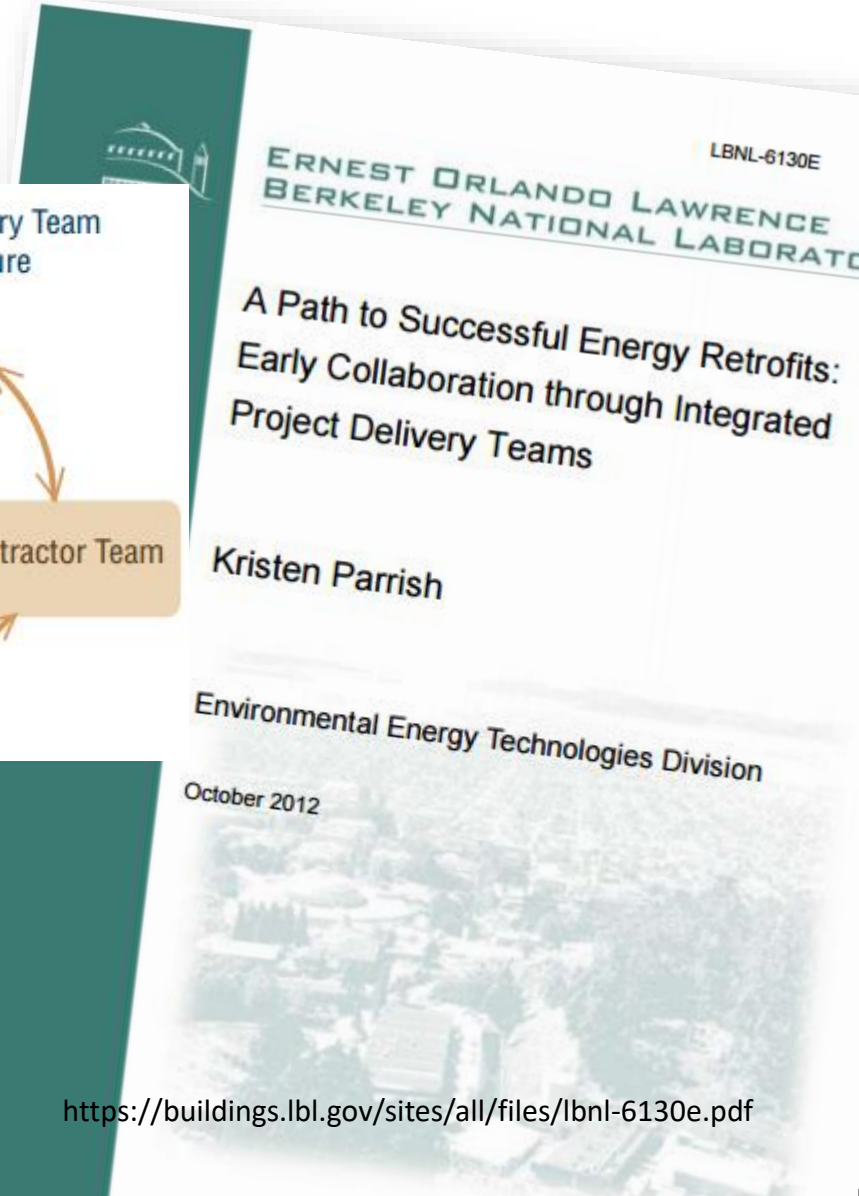


Figure 2: Traditional vs. Integrated Project Team Structure



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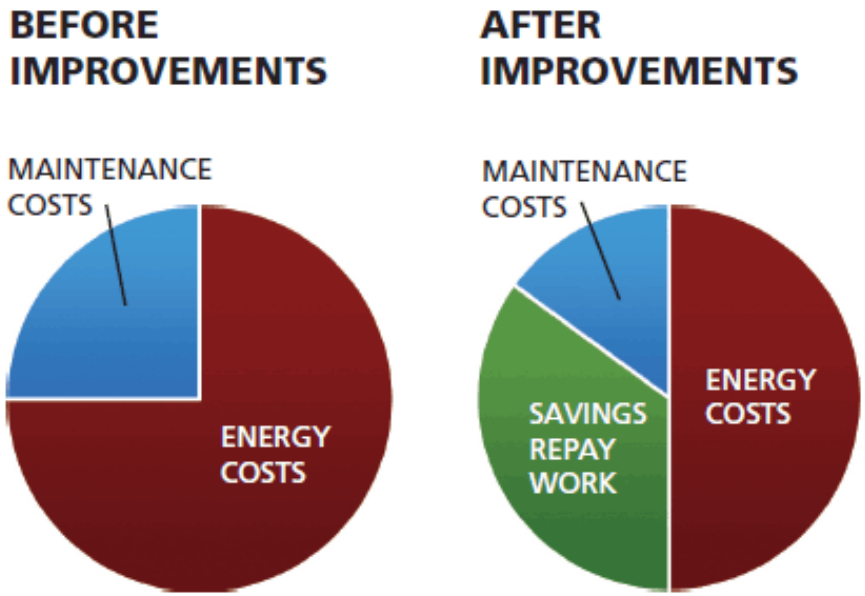
https://buildings.lbl.gov/sites/all/files/lbnl-6130e.pdf

Energy Savings Performance Contract (ESPC)

- Energy savings performance contracts (ESPCs): Procure energy savings / facility improvements with no up-front capital costs
- An ESPC is a partnership between an owner and an energy service company (ESCO)

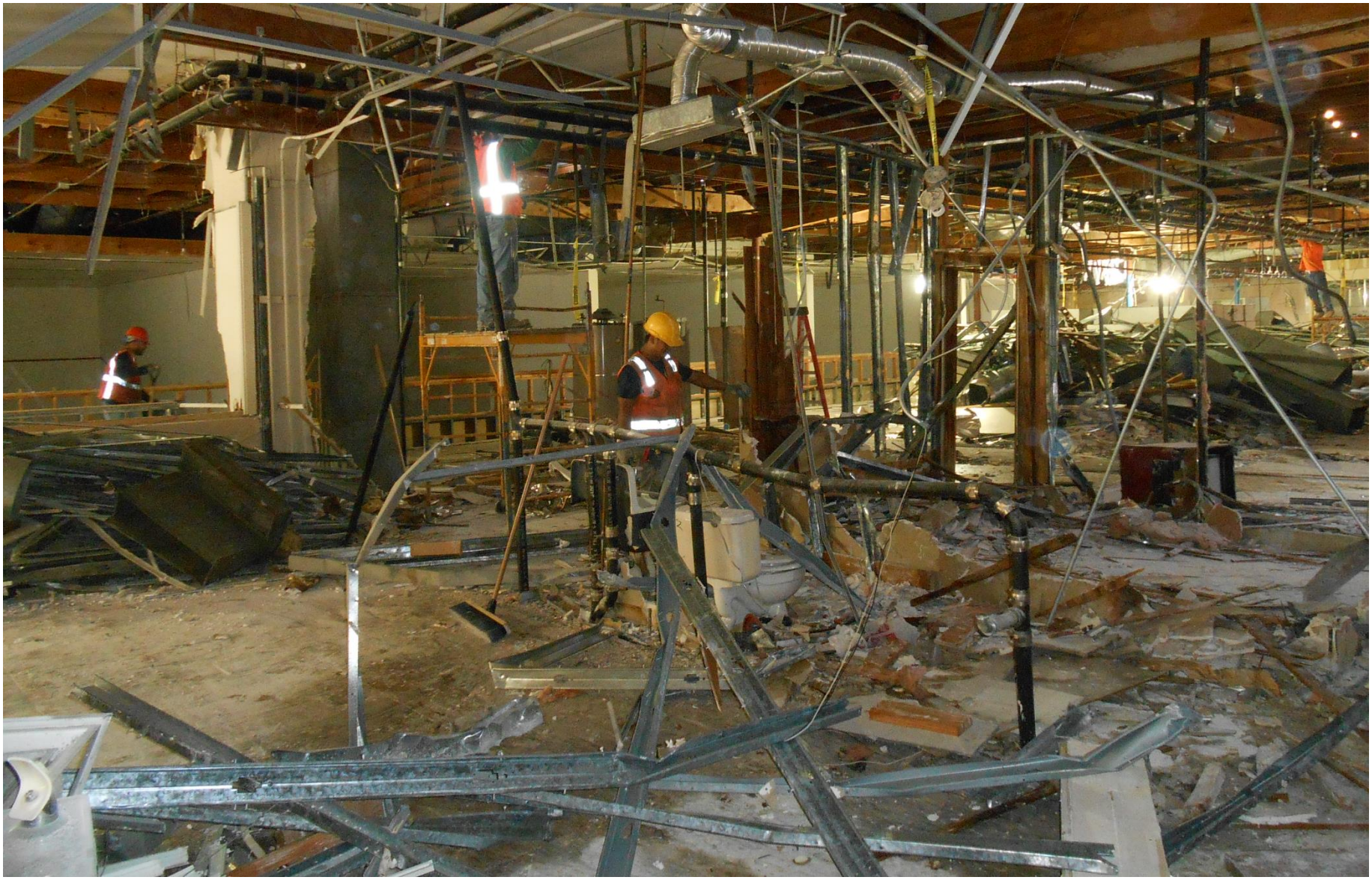


Building to the ZNE Target

Integrating ZNE strategies and technologies into the school facility:

- Insulation
- Glazing
- Lighting and Daylighting
- HVAC
- Controls

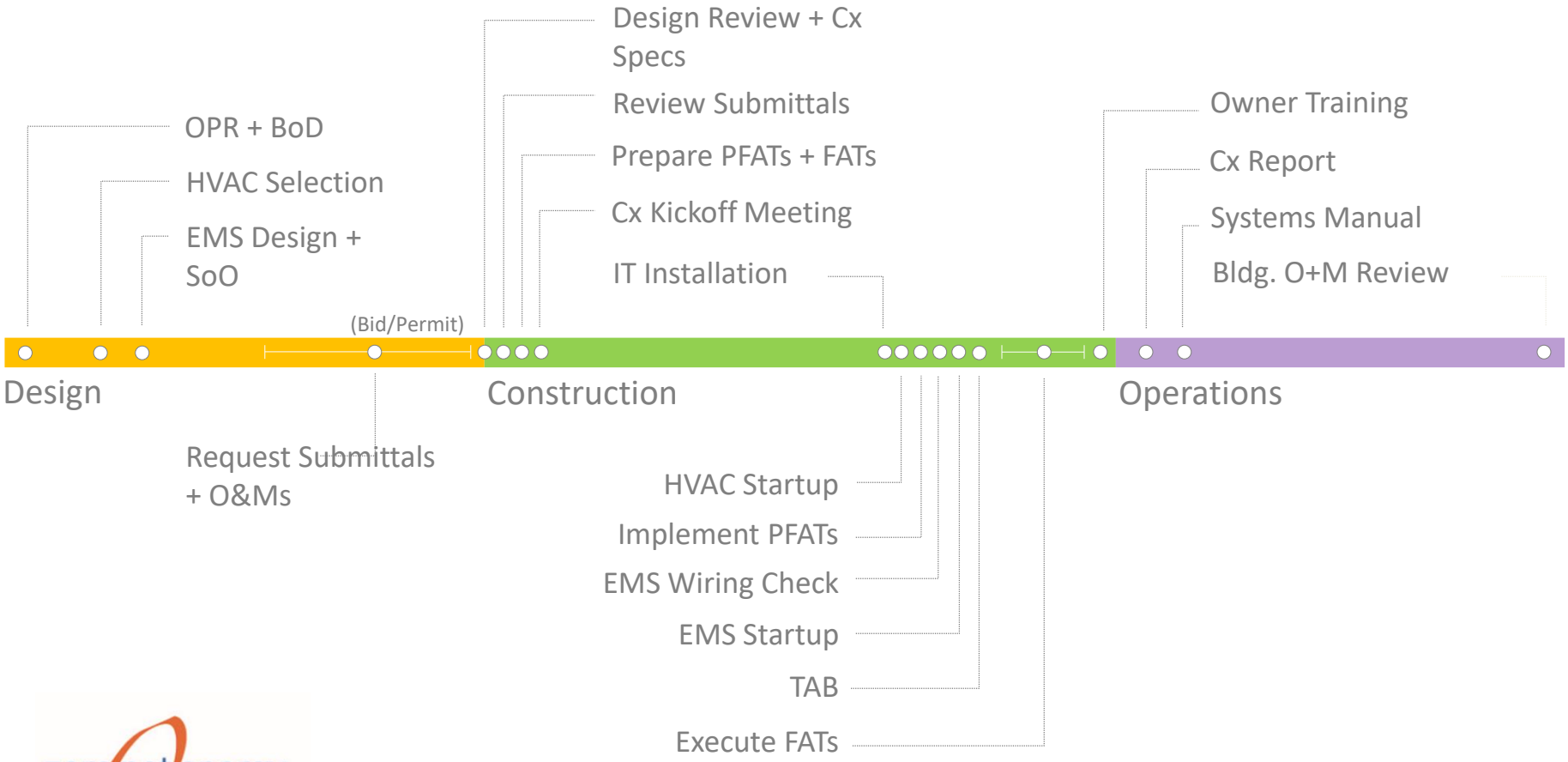
Building to the ZNE Target



Building to the ZNE Target

Building to the ZNE Target

ZNE commissioning: ensuring ZNE performance

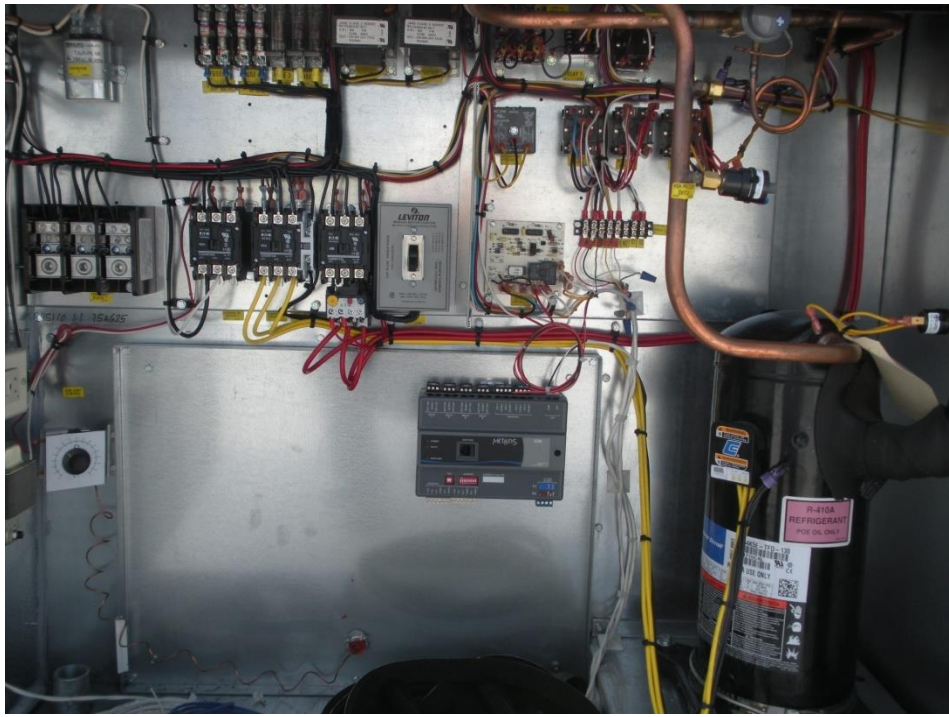


Who is involved in Commissioning?

- Architect
- MEP Engineer
- Commissioning Authority
- Owner/PM
- General Contractor
- MEP Contractor
- TAB Contractor
- Controls Contractor

ZNE Commissioning

Begin the commissioning process early during the design process and execute additional activities after systems performance verification is completed.



ZNE Commissioning

Implement Commissioning Activities:

1. Conduct commission Design Review of the Owner's Project Requirements (OPR), Basis of Design (BOD), and design documents
2. Review contractor submittals concurrently with A/E reviews
3. Develop a systems operations manual
4. Verify that training requirements for operations personnel and building occupants are completed.
5. Review building operation within 10 months of substantial completion with O&M staff and occupants.

Building to the ZNE Design

Questions & Answers

Operating to the ZNE Design

3:15 - 3:45 p.m.

Operating to the ZNE Target:
Taking ZNE Design to ZNE Reality

Operating to the ZNE Target: Taking ZNE Design to ZNE Reality

KEY TOPICS:

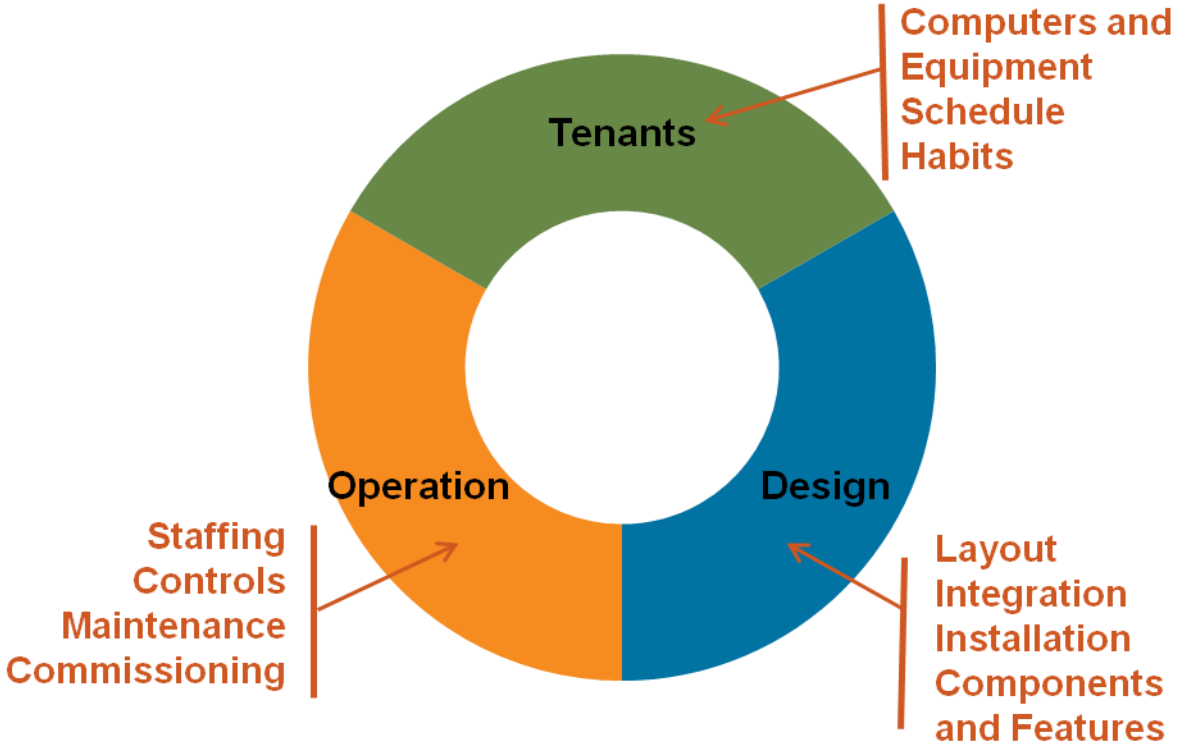
- Bridging from design to operations: Integrating the design team into ongoing operations
- Operator training and occupant engagement
- Purchasing equipment: A focus on minimizing plug loads
- Monitoring and diagnostics
- Maintenance and ongoing commissioning: ensuring persistence in performance

Operational Strategies: End of Construction

Features that can be delivered/required in the construction contract/process

- Acceptance Testing (incl., economizers, controls, feedback systems etc)
- Infiltration Testing/Air Barrier Commissioning
- Metering/Meterability
- Equipment Fault Detection and Diagnostics (FDD) Capabilities
- Operations/User Manual
- Updated OPR
- Operations guide
- Maintenance schedule
- As-Built Drawings

Building Operation: Post Construction



Operating to the ZNE Target: Taking ZNE Design to ZNE Reality

Initiation and Training to start building operation on the right track:

- Owner Orientation
- Operator Training
- Metering and Feedback Plan
- Equipment Purchase Standards for Fit-out
- Occupant Training
- Maintenance Plan

Operating to the ZNE Target: Taking ZNE Design to ZNE Reality

Maintaining long-term building operation:

- Resource Conservation Manager
- Tenant engagement
- Plug Load Management
- Retro Commissioning Plan
- Performance Data Review
- Equipment purchase guidelines
- On-going operator training/support
- Disclosure
- Operator feedback
- Tenant feedback
- Public feedback

ZNE Exercise:

Turn to your neighbor and discuss: *What are the most important elements for operations going forward?*

Existing ZNE & Ultra-Low Energy Case Studies

- CPUC Case Study Briefs & NBI ZNE Case Studies
  http://newbuildings.org/case-studies-zne-projects
- PG&E Case Studies
  http://energydesignresources.com/resources/publications/case-studies/case-studies-zne-non-residential-buildings.aspx
- NBI Registry
  http://newbuildings.org/share
- Getting to Zero Database
  http://newbuildings.org/getting-to-zero-buildings-database

Zero Net Energy Project Profile
Small Office Retrofit

Photos: ARCHITECTS hannah gabriel wells

OVERVIEW

Site Details

Building Size: 4,500 SF
Location: San Diego, California
Construction Type: Retrofit
Construction Year: 1955, 2009
Building Type: Small Office
CA Climate Zone: 7

Measured Energy Stats

13 - 22 = -9

BUILDING'S TOTAL EUI | RENEWABLE PRODUCTION EUI | BUILDING'S NET EUI

Site Energy Use Index (EUI) kBtu/SF/year

The Energy Equation: **the building energy use** *minus* **the renewables production** *equals* **the net energy of the building**. Buildings may be 'Getting to Zero' and have a net EUI

BACON STREET OFFICES

The Bacon Street Office project is a 4,500 SF retrofit of a single-story, 1950's-era auto repair shop into a high performance office for the firm ARCHITECTS hannah gabriel wells. Through creative design strategies, renewable energy generation and with support from local utilities, including the Savings by Design program, the project has achieved zero net energy goals. In fact, this project is so energy efficient it returns power to the grid.

Planning & Design Approach

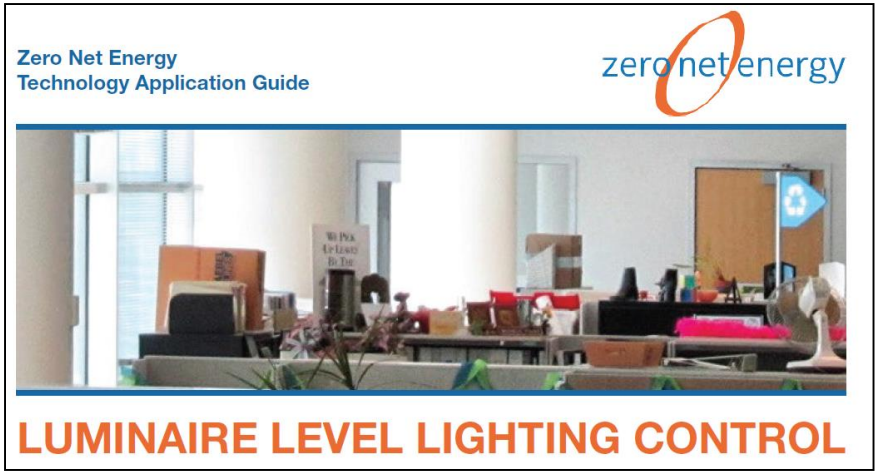
The project demonstrates the difference between typical projects and ZNE projects. The following steps were critical to success:

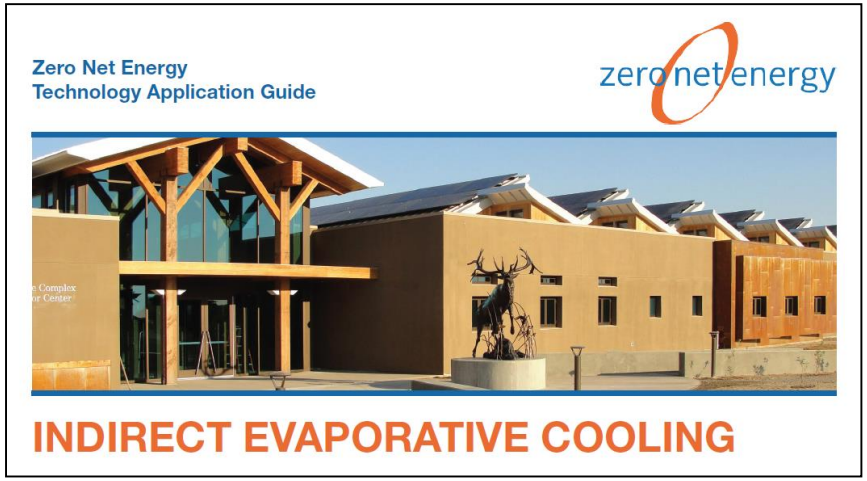
- Start early and use an integrated design process
- Outline goals and benefits
- Structure fees to provide more research and design iterations
- Stay flexible and inclusive with the design process

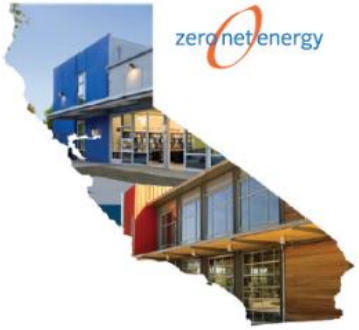
Energy Efficiency Strategies and Features

Daylighting: A wall of windows along the public street side of the building provides daylight and views of a new landscaped parking court with native vegetation and canopy trees. This light is balanced with toplighting from diffuse skylights at the back of the space. Illuminating walls, ceilings and balancing

ZNE Technology Application Guides

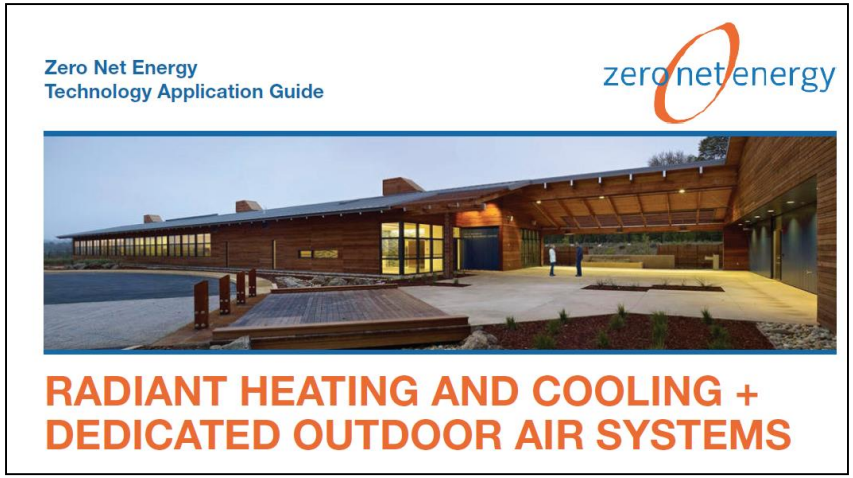






energy upgrade® CALIFORNIA

SxD SavingsByDesign



http://newbuildings.org/zero-energy

5 GREAT NEW TOOLS FOR ZNE BUILDINGS

1 ZNE Message Platform

Key messages for target audiences on the what and why of ZNE.

2 "Intro to ZNE" Presentation

Customizable powerpoint presentation provides an overview of California's goals and policies for ZNE, key strategies, and case study examples.

3 ZNE Companion Guide/Fact Sheets

Collection of FAQs, resources, design strategies, and key messages for designers, commercial building owners, policymakers, and decisionmakers of schools and public buildings.

4 Case Studies: ZNE & Ultra-Low Energy Buildings

Read about ZNE and ultra-low energy building examples, including design strategies, costs, and lessons learned.

5 ZNE Action Bulletin

Sign up for our quarterly e-newsletter for updates on ZNE news, events, trainings, case studies, planning, policy, and research. To sign up, or to get more info about the toolkit, email heather@newbuilding.org.

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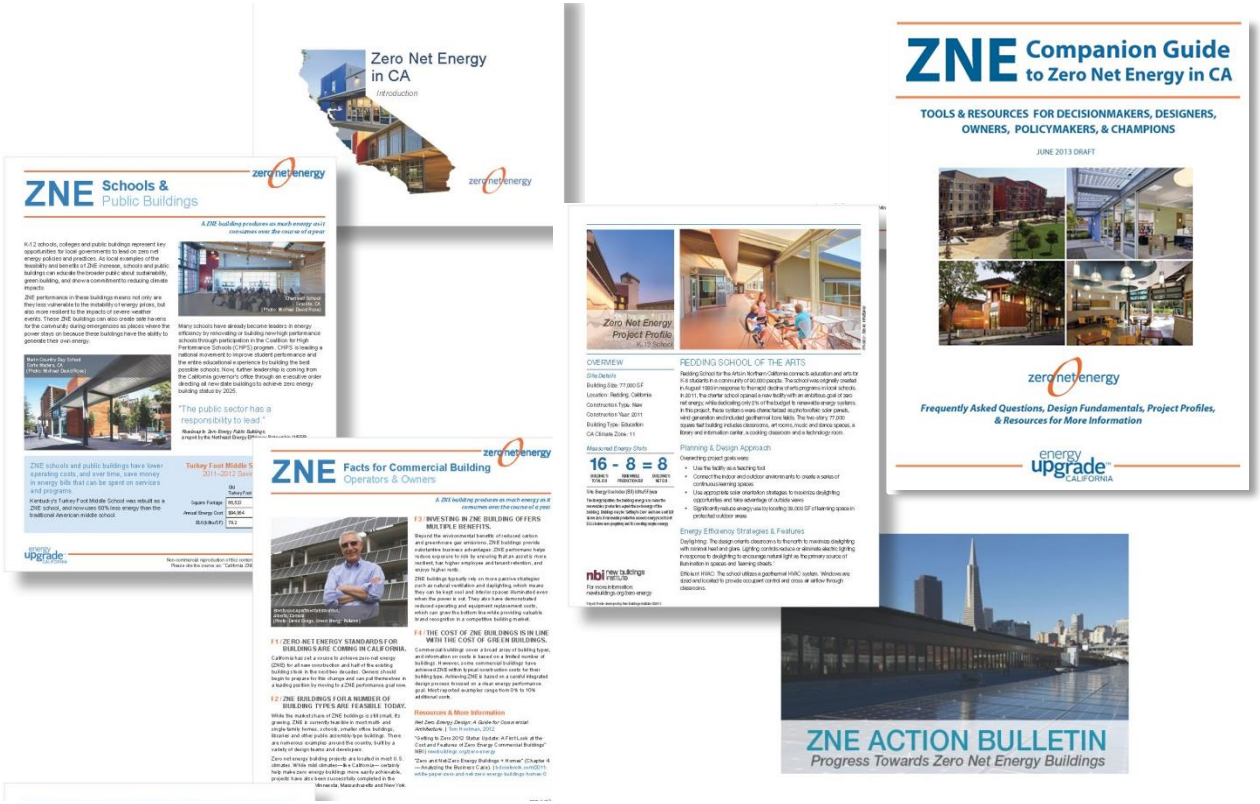
ZNE Communications Toolkit



www.newbuildings.org/zne-communications-toolkit

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George V. Leyva Middle School Administration Building

"The business case for making the building net zero energy is that it will not just lower our energy bill, but it also will allow us to put those savings straight back to the top line of our operations budget for maintaining programs for kids." – Assistant Superintendent Kathy Gomez

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Closing Discussion

3:45 - 4:00

Share your Feedback

+ / △

Take the Feedback Survey:

www.surveymonkey.com/r/ZNESchoolsTraining12

Prop 39 ZNE School Retrofit Workshops

Thank you!

For more information, contact:

Ralph DiNola, Ralph@newbuildings.org
Heather Flint Chatto, heather@newbuildings.org

zero net energy