Schools of the Future: Creating Better Learning Environments with Efficiency

July 10, 2019

1-3:30 PM

Agenda

- **Welcome and Introductions**
- **BBC K-12 Sector Update**
  - Brooke Holleman, U.S. Department of Energy
- **Creating Better Learning Environments with Zero Energy Schools**
  - Cathy Lin, Arlington Public Schools, VA
- **From E(fficiency) to Z(NE)**
  - Nik Kaestner, San Francisco Unified School District, CA
- **Making the Most of Building Automation Systems for Energy Management**
  - Zach Lammers, Anne Arundel County Public Schools, MD
- **Questions & Answers**

BBC K-12 Sector Update

Brooke Holleman, K-12 School Lead
U.S. Department of Energy

K-12 School Portfolio Snapshot

Energy Savings and Program Footprint Continue to Grow

Accomplishments	Total
Number of Partners	30
Approximate Number of Buildings	15,209
Approximate Number of Square Feet	238.5 M
Reported Savings	
Cumulative Energy Savings since 2011	3 TBTU
Cumulative Cost Savings	$25 M
Average Annual Energy Intensity Improvement Rate	2%

30 Partners, 4 Goal Achievers in 10 years

Better Buildings U.S. DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF ENERGY

Better Buildings K-12 Partner Results

Mt. Washington Elementary School

Partner: Bullitt County Public Schools, KY

32% Energy Savings; $28,000 Cost Savings

Warner Middle School Lighting and Controls

Partner: Xenia Community Schools, Xenia, OH

16% Energy Savings; $27,500 Cost Savings

Poudre High School Infrastructure Replacement

Partner: Poudre School District, CO

26% Energy Savings; $10,000 Cost Savings

betterbuildingssolutioncenter.energy.gov

Zero Energy Schools Accelerator

Launched by DOE in the fall of 2016 as a targeted, three-year effort to identify, develop, and share strategies to overcoming barriers to achieving ZE schools.

Implementing partners

State of Minnesota

State of California

State of Maryland

National partners

Key Resources

- Rural K-12 School Facility Workforce Development and Training Toolkit **NEW**
- Lighting Toolkit for K-12 Schools **NEW**
- Energy Efficiency & Renewable Energy Resources for Rural K-12 School Energy Managers and Educators **NEW**
- Street Lighting Acquisition Evaluation Tool
- Achieving Zero Energy: Advanced Energy Design Guide for K-12 School Buildings
- DOE State and Local Solutions Center
- DOE's STEM Rising Newsletter
- Better Buildings Workforce Guidelines
- Financing Navigator 2.0

Creating Better Learning Environments with Zero Energy Schools

Cathy Lin, Energy Manager & Stormwater Program Administrator, Arlington Public Schools

Arlington Public Schools

Creating Better Learning Environments with Zero Energy Schools

Cathy Lin, Energy Manager and Stormwater Program Administrator

July 10, 2019

Agenda

- Zero Energy Experience and Goals
- Learning In Zero Energy Schools
- Considerations and Lessons Learned

Zero Energy Experience

- Discovery Elementary School
  - Opened September 2015
  - Certified Zero Energy by International Living Future Institute
- Fleet Elementary School
  - Under construction
  - Zero energy target
  - Utilizes solar power purchase agreement (PPA)
- Reed Elementary School
  - In design
  - Zero energy target

Discovery Elementary

- Background
  - Neighborhood school
  - PreK – Grade 5 with 630 students
  - 97,588 GSF
  - Target EUI: 21.1 kBtu/sf
  - Actual EUI: 15.8 kBtu/sf
- Integrated Design
  - Siting, massing, building envelope
  - Equipment efficiency
  - LED lighting
  - Geothermal well field
  - Solar tubes and arrays
  - Commissioning, measurement, and verification

Zero Energy Goals

- Why Zero Energy
  - Create healthy buildings
  - Demonstrate commitment to environmental stewardship
  - Lower operating and maintenance cost
  - Reduce greenhouse gas emissions
- Arlington County Government
  - Green Building Policy, adopted 2008, revised 2019
  - Community Energy Plan (CEP), adopted 2013
- Arlington Public Schools
  - County guidelines and policies
  - Design specification identifies Energy Use Intensity (EUI) targets and zero energy goals

Learning In Zero Energy Schools

- Active Learning Environments
  - Bioretention gardens
  - National Wildlife Federation's Eco Schools USA Program
  - Solar lab
  - Student leadership forms Eco-Action team
  - Student led transportation tracking
- Energy Dashboard

Photo © Lincoln Barbour

Considerations and Lessons Learned

- Team Composition and Commitment
- Integrated Team Approach
- Highly Efficient Building Design
  - Building envelope
  - Geothermal heating and cooling
  - LED lighting
- Third Party Commissioning
- Measurement and Verification
- State Policies and Utility Rate Schedules
  - General Assembly net metering legislation
  - Local utility standby charges
  - Local utility interconnection rules

Thank You

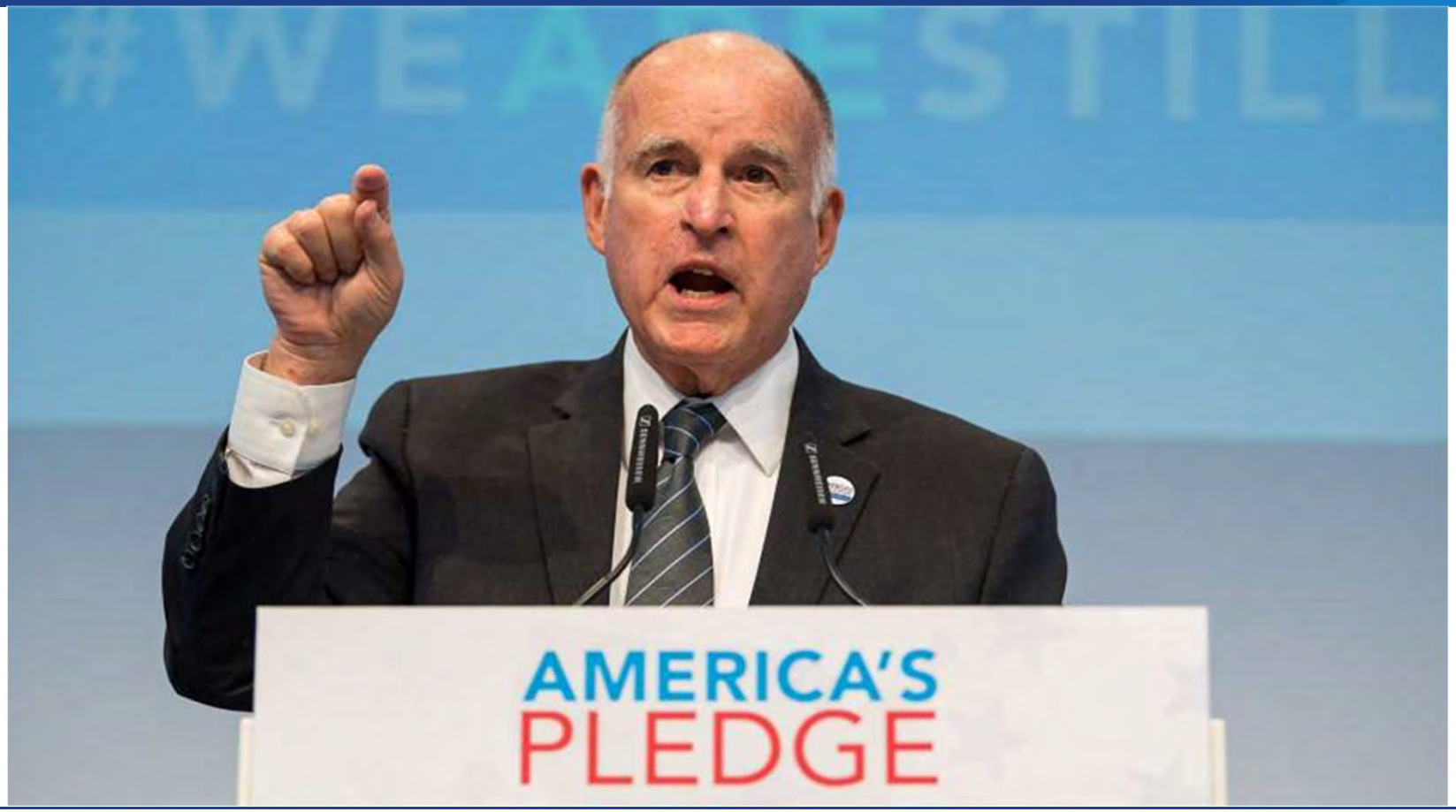
Aerial: AirPhotosLIVE

From E(fficiency) to Z(NE)

Nikolai Kaestner, Director of Sustainability
San Francisco Unified School District, CA

Our Students Want Action

Bold Leadership



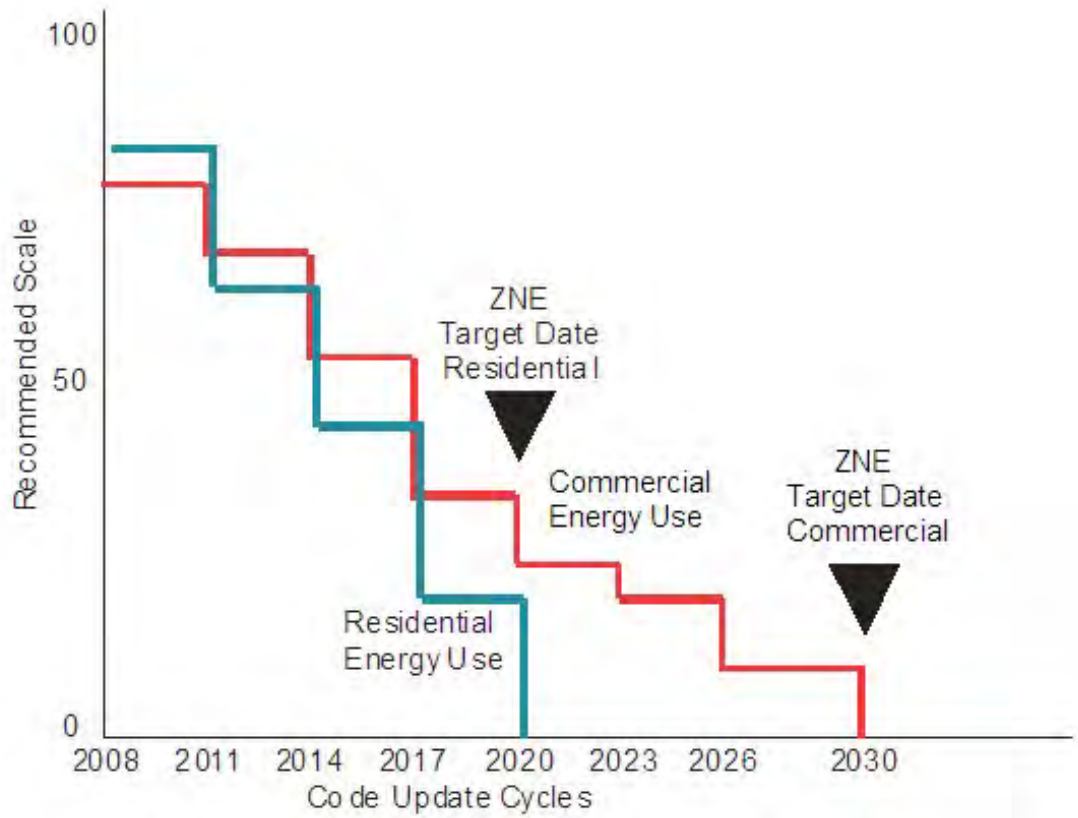
CA ZNE Building Goals

- *All new residential construction and all new commercial construction in California will be zero net energy by 2020 and 2030, respectively*
- *50% of existing commercial buildings will be retrofit to ZNE by 2030*
- *All new state buildings and major renovations shall be ZNE (2025)*
- *50% of existing state-owned building area by 2025 shall be ZNE*
- *IOUs shall launch and ramp a ZNE K-12 Schools and Community College Pilot Program in 2015-18*

DPR Construction San Diego Corporate Office , Chip Fox, DG&E, renovation

IBEW ZNE Center, San Leandro, renovation

Doable


100
50
0
Recommended Scale
ZNE
Target Date
Residential
Commercial
Energy Use
ZNE
Target Date
Commercial
Residential
Energy Use
2008
2011
2014
2017
2020
2023
2026
2030
Code Update Cycles

Our Schools

Part Deux

- *All new residential construction and all new commercial construction in California will be zero net energy by 2020 and 2030, respectively*
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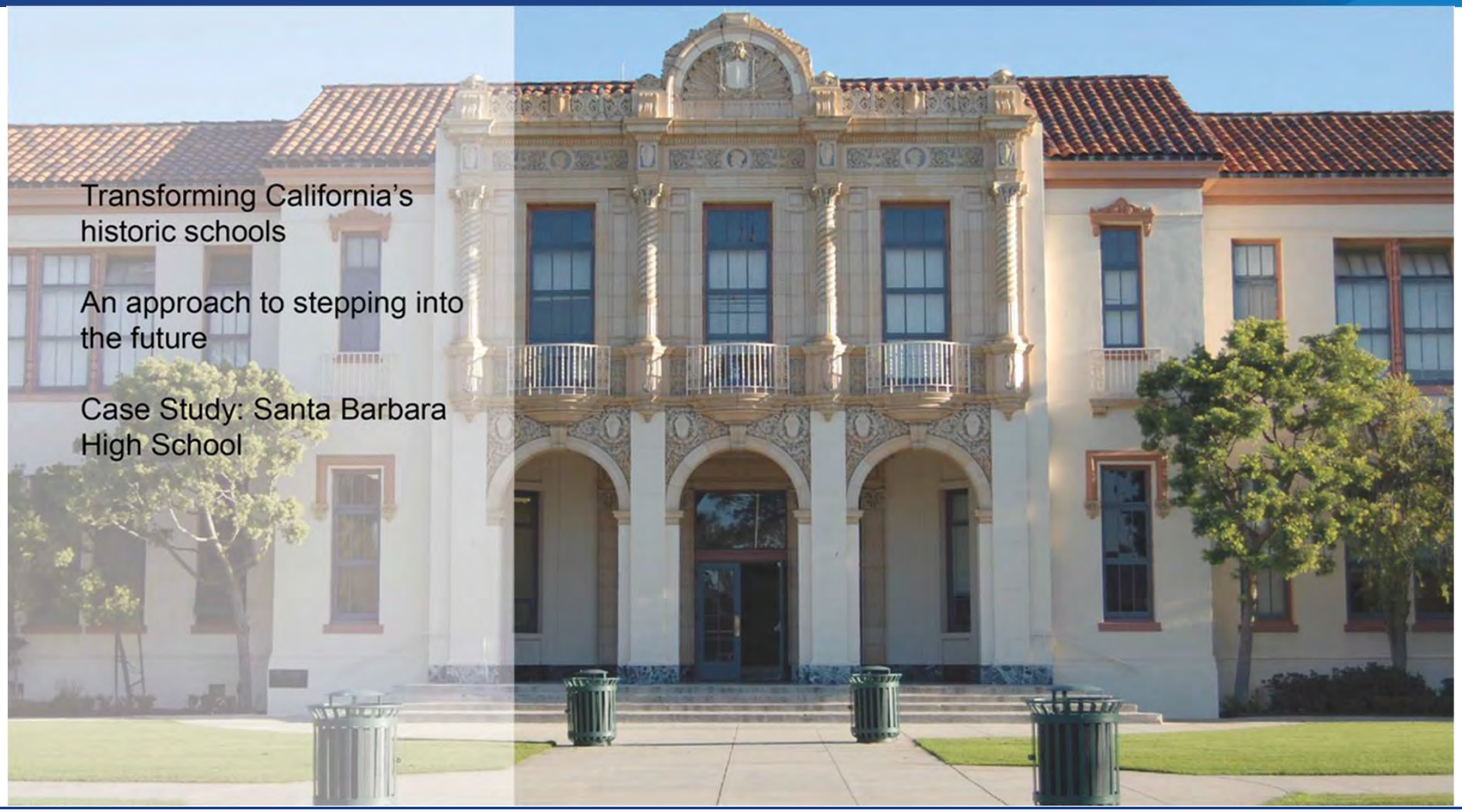
IBEW ZNE Center, San Leandro, renovation

OMG!

Doable???



Transforming California's historic schools

An approach to stepping into the future

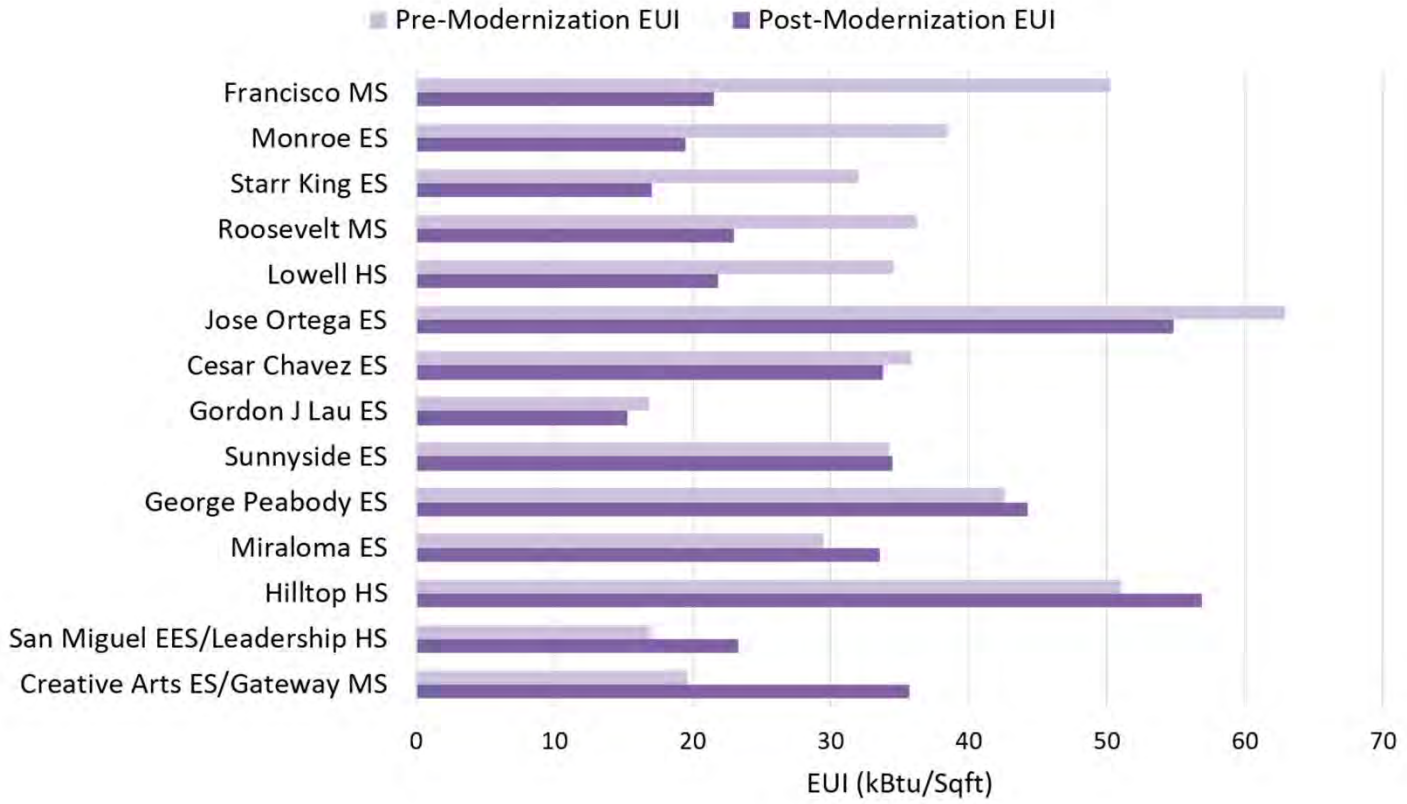
Case Study: Santa Barbara High School

EUI Goal

Table 29. Energy Intensity Values for Zero Energy Schools

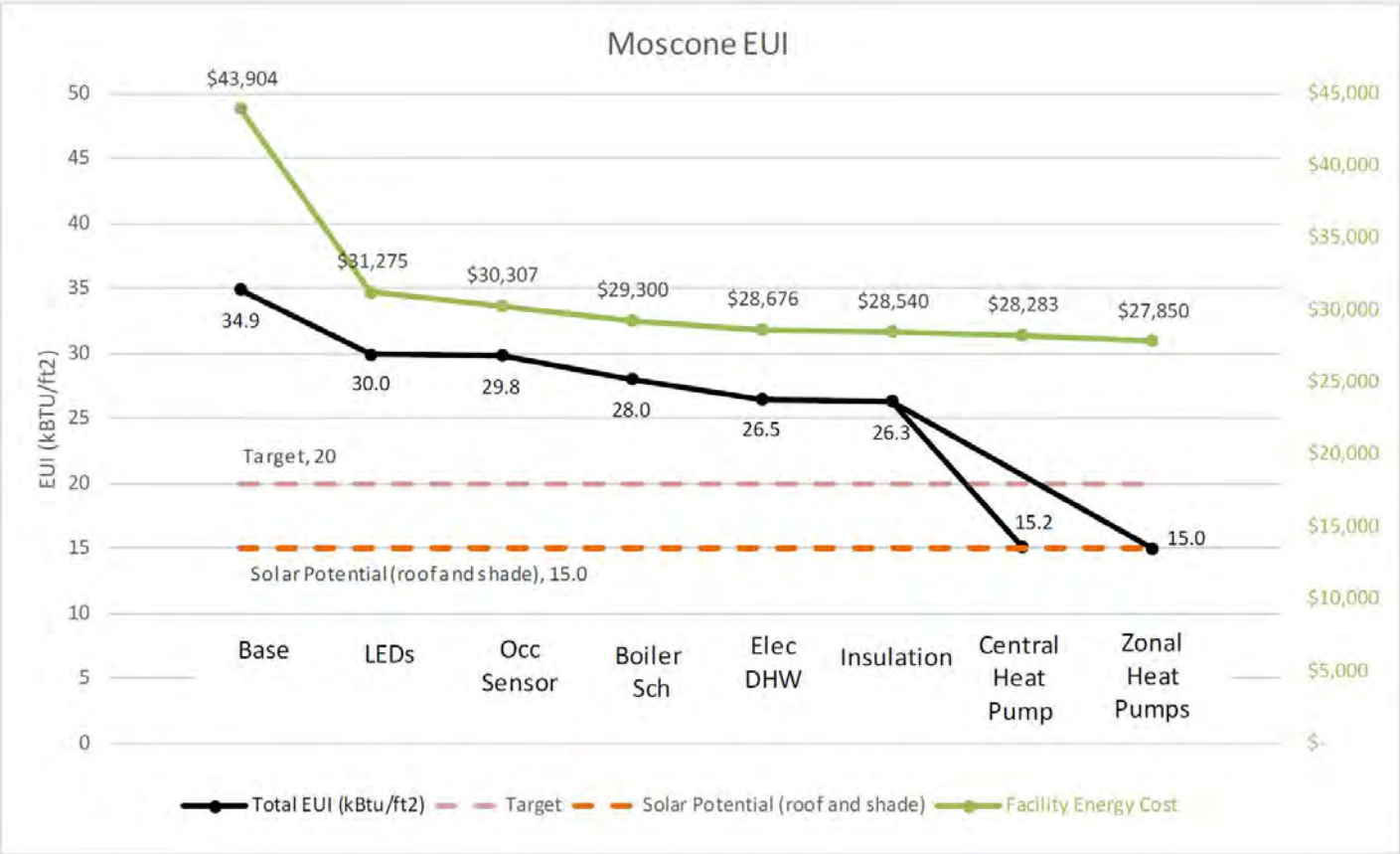
Climate Zone	Representative City	Primary School		Secondary School	
		Site Energy (kBtu/ft²·yr)	Source Energy (kBtu/ft²·yr)	Site Energy (kBtu/ft²·yr)	Source Energy (kBtu/ft²·yr)
1A	Miami, FL	25.9	76.4	23.1	68.5
2A	Houston, TX	24.3	71.1	21.7	63.5
2B	Phoenix, AZ	24.7	72.5	21.9	64.3
3A	Memphis, TN	23.8	69.0	21.2	61.6
3B	El Paso, TX	23.4	67.8	20.7	60.2
3C	San Francisco, CA	21.6	61.9	19.0	54.3
4A	Baltimore, MD	23.5	67.6	20.9	60.1
4B	Albuquerque, NM	21.1	66.6	21.4	58.8
4C	Salem, OR	21.4	64.2	17.7	56.4
5A	Chicago, IL	24.3	69.9	21.6	62.2
5B	Boise, ID	23.2	66.7	20.4	58.4
6A	Burlington, VT	24.5	70.1	21.6	61.9
6B	Helena, MT	23.5	66.9	20.5	58.4
7	Duluth, MN	25.9	74.1	22.8	65.1
8	Fairbanks, AL	28.7	82.5	25.0	71.5

There's Hope

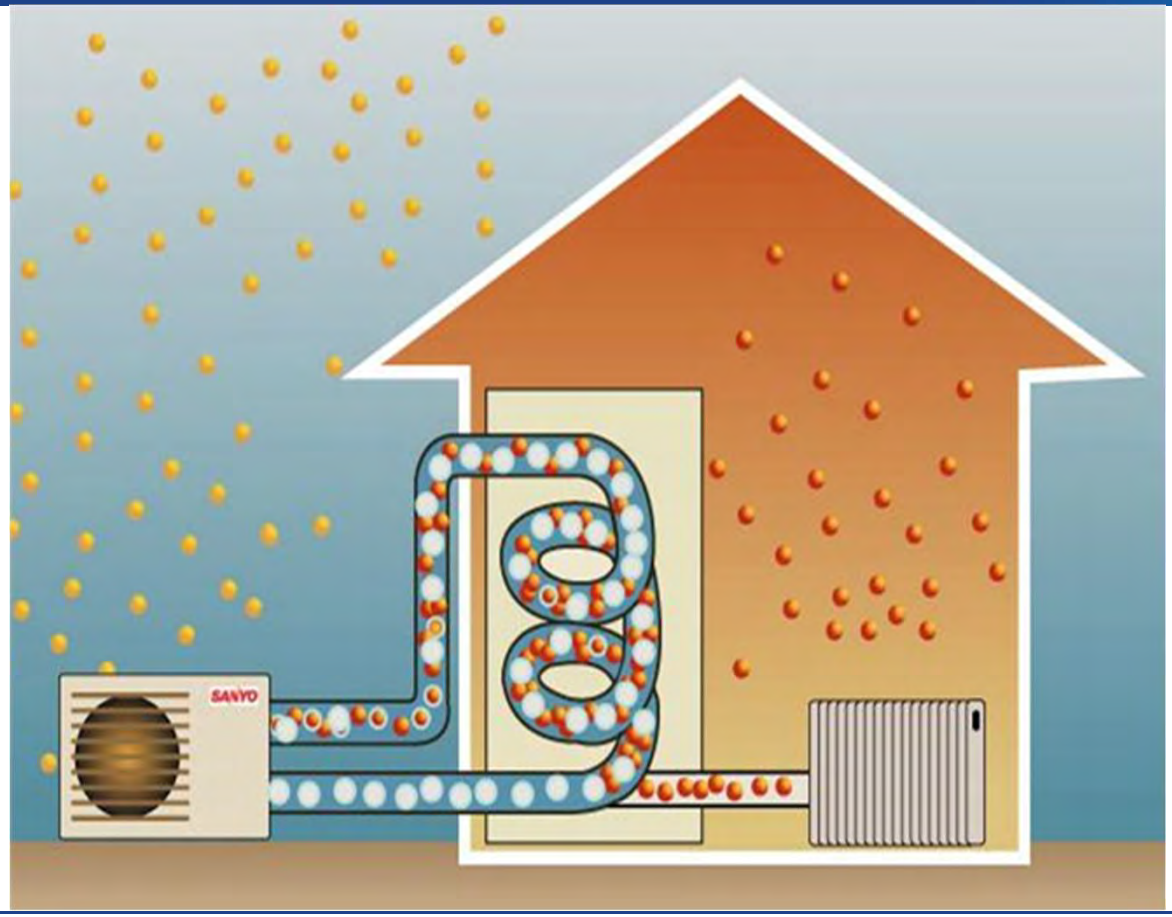

Pre-Modernization EUI
Post-Modernization EUI
Francisco MS
Monroe ES
Starr King ES
Roosevelt MS
Lowell HS
Jose Ortega ES
Cesar Chavez ES
Gordon J Lau ES
Sunnyside ES
George Peabody ES
Miraloma ES
Hilltop HS
San Miguel EES/Leadership HS
Creative Arts ES/Gateway MS
0
10
20
30
40
50
60
70
EUI (kBtu/Sqft)

What We're Working With…

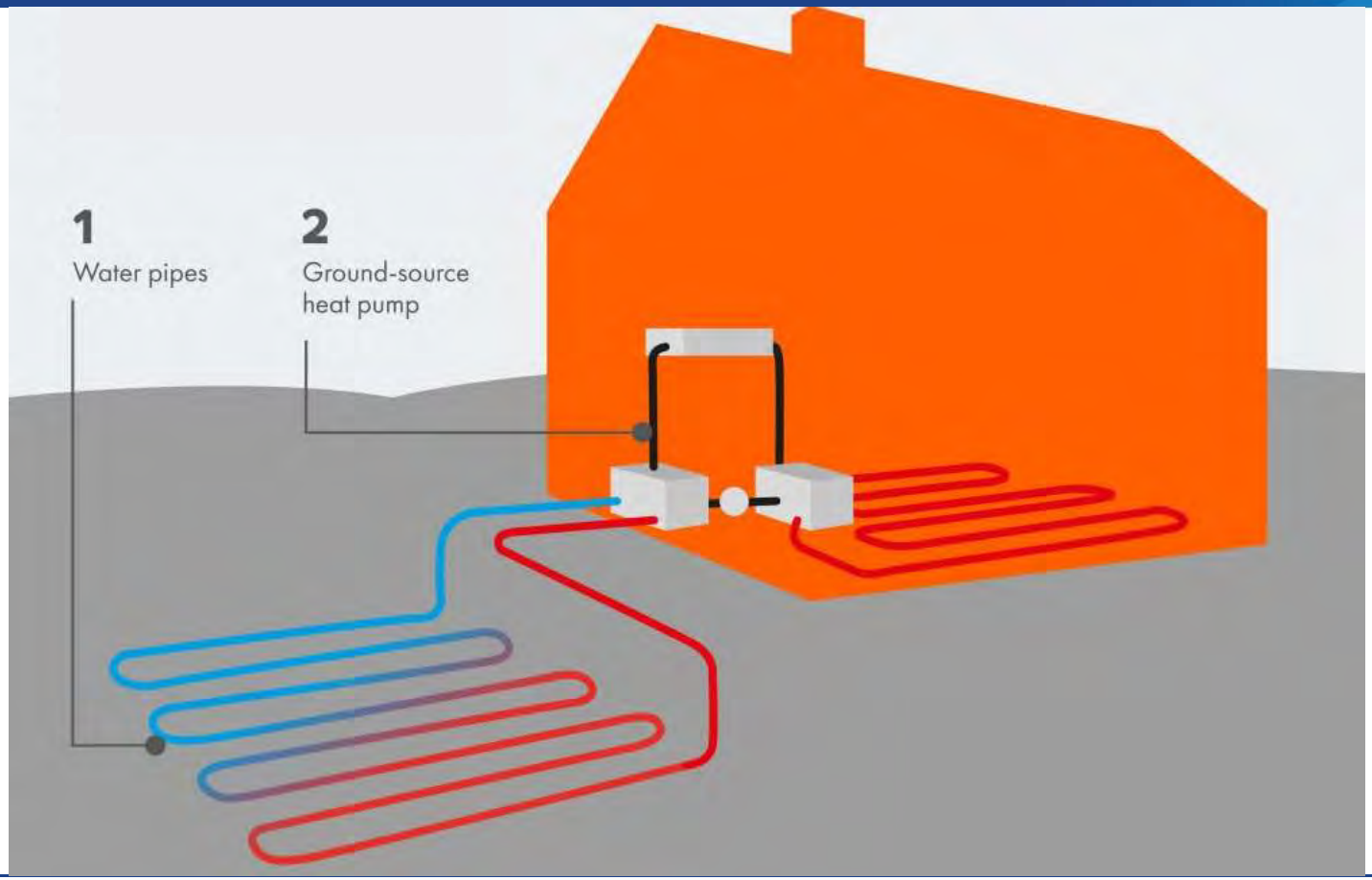
Efficiency: The Only Way



Amazing Heat Pumps



Ground as Heat Sink



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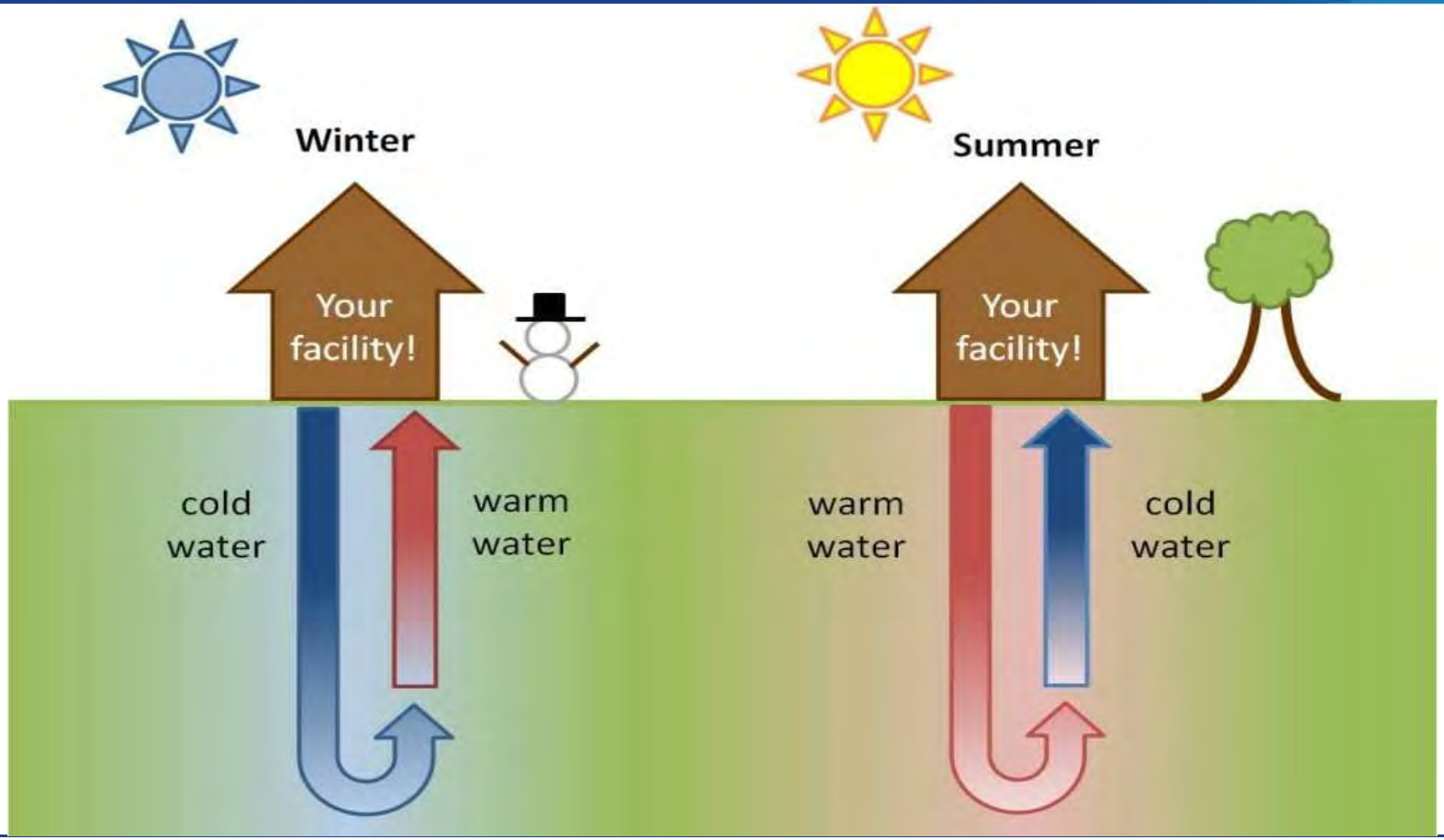
As Efficient as It Gets



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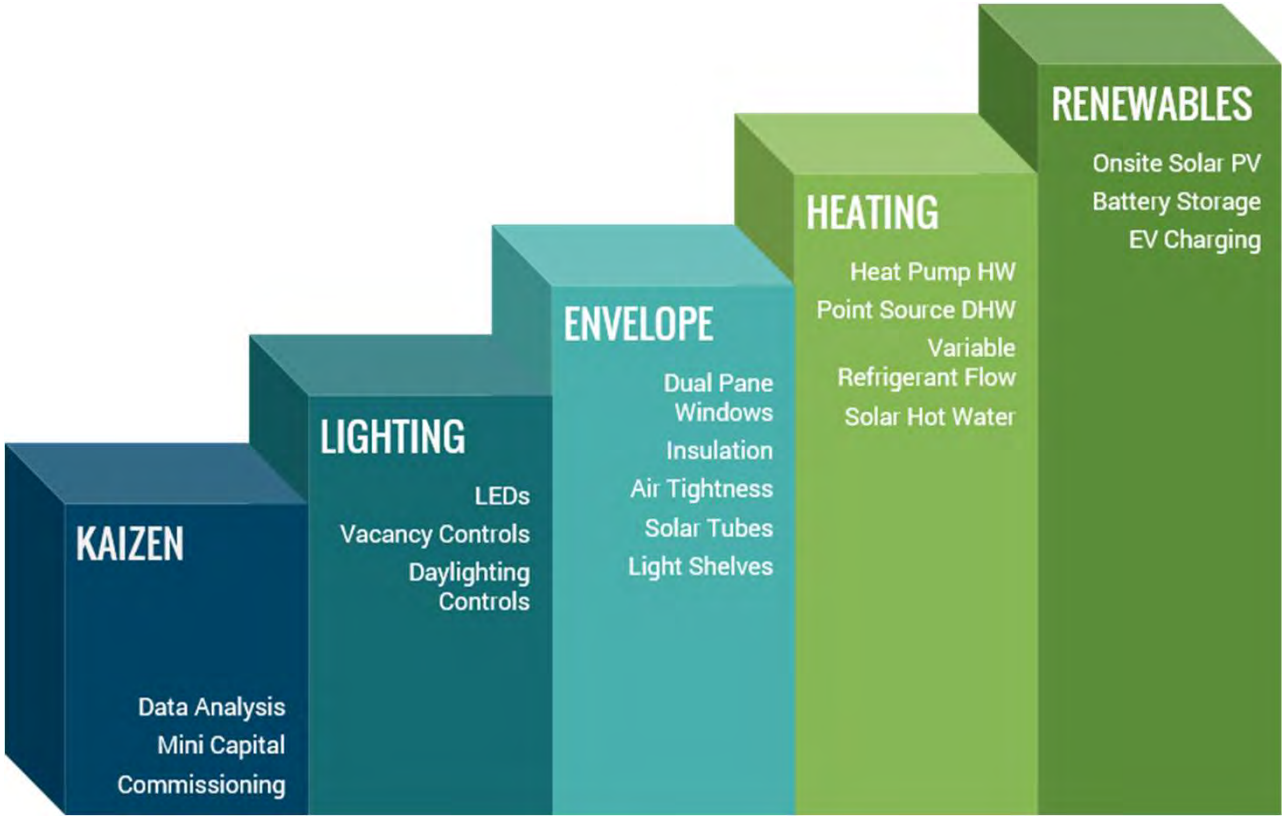
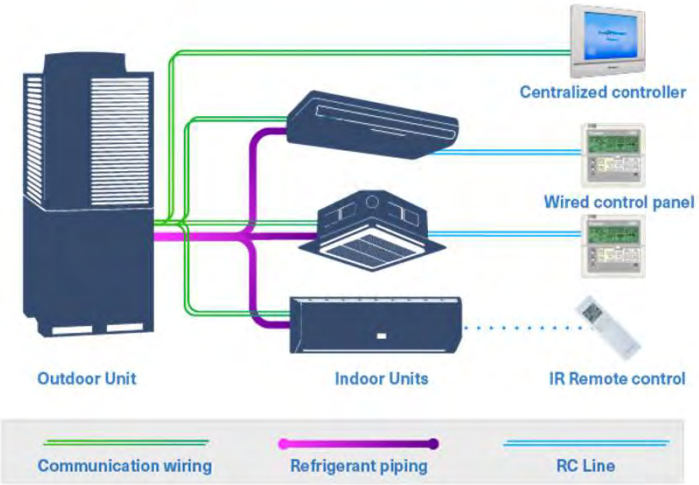
Labor Concerns

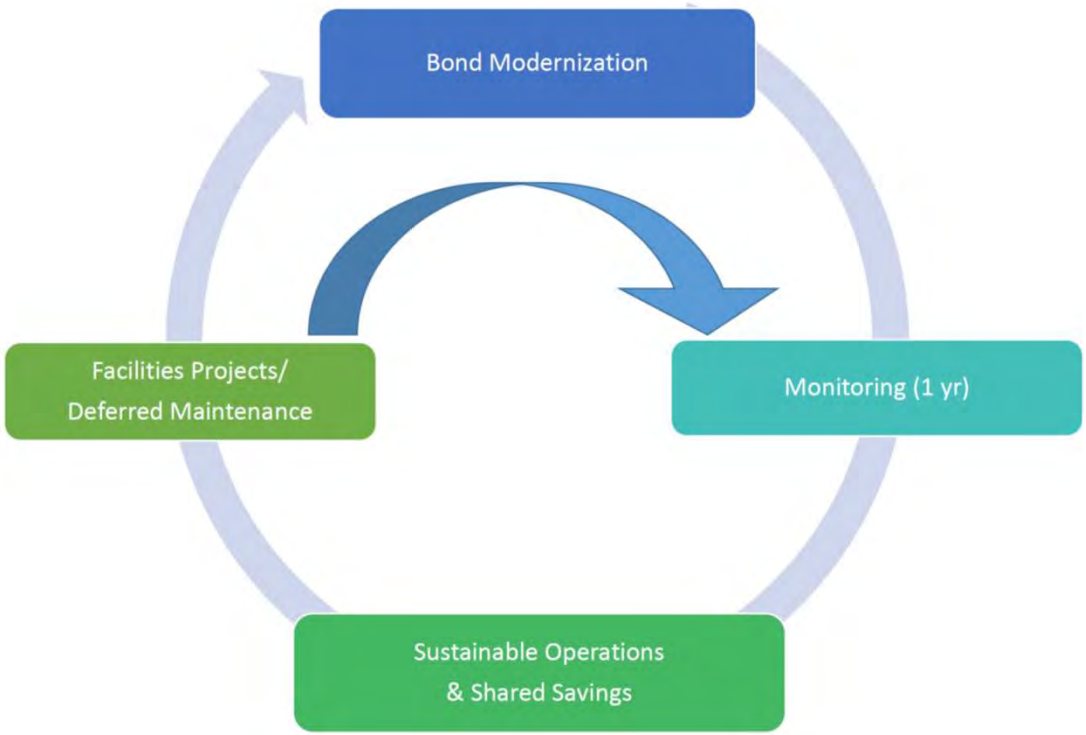


Make the Business Case

Minimize the Delta



Existing Opportunities



In Summary

PROS:

- Carbon Free Power
  → Fuel Switch
- Low Electric Rate
  → Minimal Cost
- Supportive Voters
  → Facility Bonds

CONS:

- No A/C
  → Electric Upgrades
- Low Electric Rate
  → No Solar
- No Demand Charges
  → No Batteries

SFUSD Building Strategy

NEW SCHOOLS

→ ZNE Ready

MODERNIZATION

→ System Replacements

RENEWABLES

→ In Due Time

Enshrined in Policy

Effective Immediately

- New buildings designed to ZNE
- New buildings pre-plumbed for rainwater harvesting

By 2020

- New fleet vehicles electric
- Buses fueled with renewable diesel
- Natural gas & water down 30%

By 2030

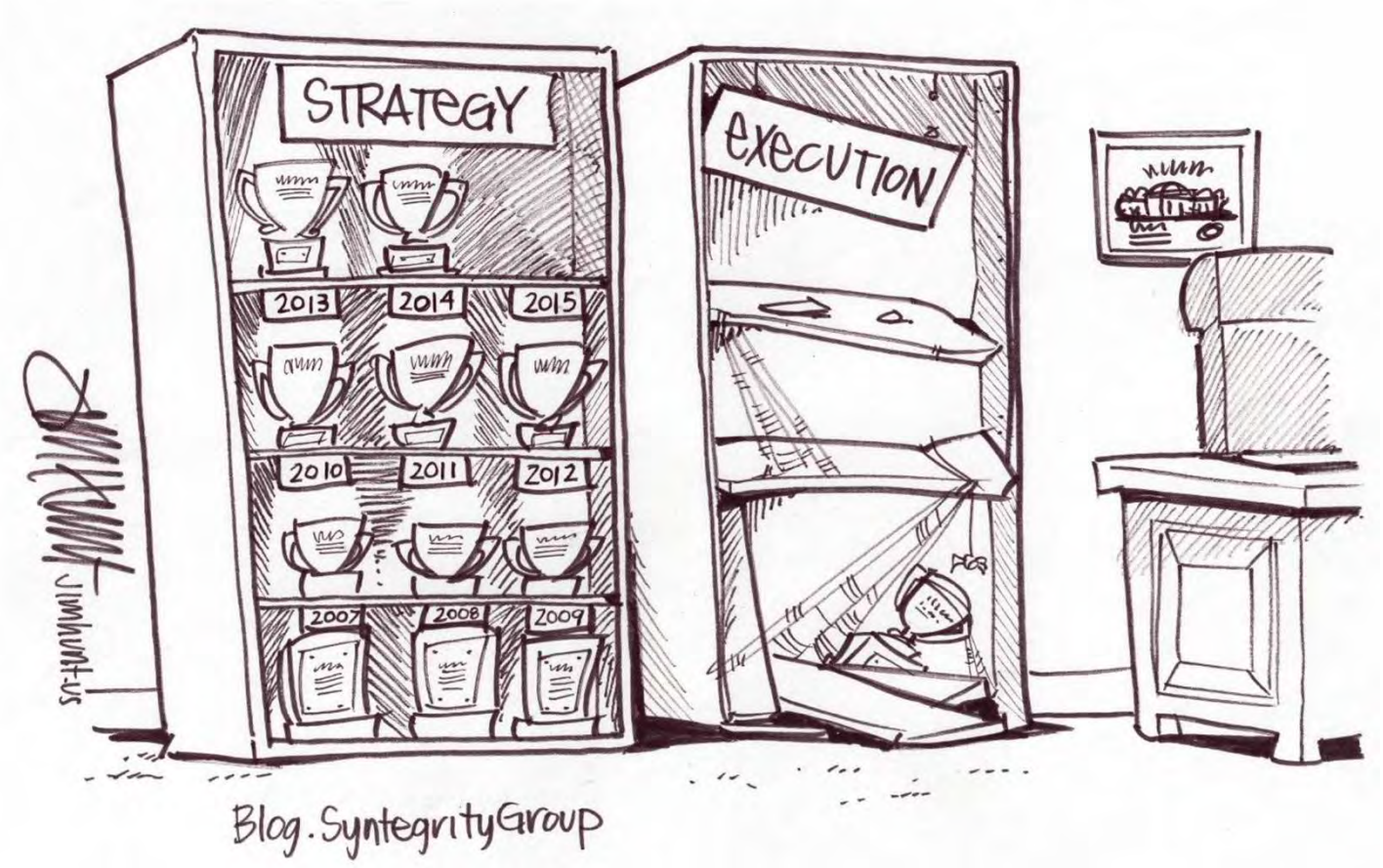
- All District vehicles emissions-free
- Natural gas & water down 50%

By 2040

- District to cover power needs on site
- Rainwater supplies 50% of water consumption

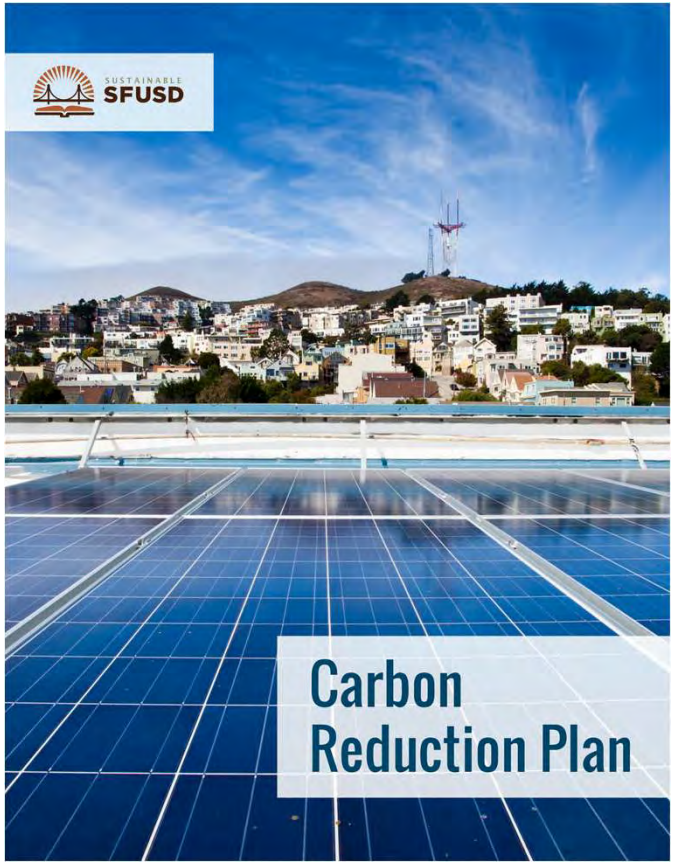
SUSTAINABILITY OFFICE SFUSD

All Done, Right?



Better Buildings U.S. DEPARTMENT OF ENERGY
U.S. DEPARTMENT OF ENERGY

Rules & Regulations



Overview

SFUSD PROJECT REQUIREMENTS

July 1, 2017

SUSTAINABLE SFUSD

STRATEGY

The District has many opportunities to improve the carbon footprint of its buildings:

BOND PROJECTS: voter-approved funding for new construction & major renovations provides the best opportunity for deep energy retrofits

MONITORING: post-occupancy commissioning and energy monitoring can identify opportunities to adjust operation to meet design intent

OPERATIONS & SHARED SAVINGS: preventative maintenance, energy and water monitoring, and engagement of users prevent rising energy and water usage as buildings age

FACILITIES PROJECTS: major repairs and deferred maintenance projects provide an opportunity to improve energy and water efficiency

These *SFUSD Owner's Project Requirements* were created to assist design teams in supporting the District's ambitious zero carbon goals. The following pages describe the process for incorporating ZNE-ready design into new buildings, bond modernizations, and facilities projects. In summary:

New Buildings will be designed to achieve an Energy Use Intensity (EUI) < 20 kBTU/sf/yr. SFUSD's preferred strategies for achieving such exemplary energy efficiency are outlined in the *ZNE Guidelines* at the end of this document. While the addition of renewable energy is generally outside the scope of new projects, solar readiness should be built into the building.

Bond Modernizations will focus on improvements to the lighting systems and building envelope as outlined in *ZNE Assessments* commissioned by the District for every project prior to the design phase. These assessments will also look for opportunities to improve heating and ventilation systems, but these items will generally be tackled in future bonds unless broken equipment necessitates earlier action.

Facilities Projects generally have limited scope and will support ZNE goals by upgrading building elements as they wear out. In each case, the *ZNE Guidelines* below and *District Design Standards + Guidelines* (DDSG) will inform the design and selection of materials and/or equipment for these projects.

Design Guidelines

ZNE GUIDELINES

Design teams working with SFUSD are asked to design buildings that are:

HEALTHY maximizing daylight and air quality and minimizing harmful pollutants.

BEAUTIFUL encouraging pride and engagement among families and the community.

EFFICIENT reducing energy use to a minimum to facilitate achievement of ZNE.

VALUABLE minimizing lifecycle costs and reducing maintenance as much as possible.

In order to achieve adequate levels of efficiency in San Francisco, design teams should consult the Department of Energy's (DOE) Technical Feasibility Study for Zero Energy K-12 Schools and follow the *ZNE Guidelines* below. While these guidelines are most easily implemented in new construction, they should also be utilized where applicable in bond modernization and facilities projects.

ENERGY: New buildings should be designed to achieve a modeled **Energy Use Intensity (EUI) of 15-20 kBTU/sf/yr**, a value that allows rooftop solar to offset yearly energy usage for a typical 2-3 story San Francisco school. Building systems should be **"designed for off"**, meaning that they will shut down without user intervention. **Solar analysis** during **Schematic Design (SD)** should confirm that rooftop solar potential will be adequate to cover modeled energy usage.

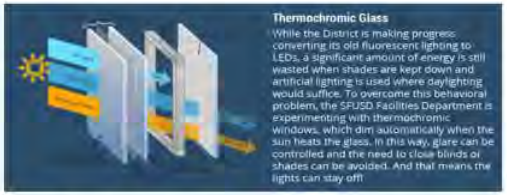
FORM: Buildings should be simple and compact, oriented to the sun, with a depth & layout that allows **daylight harvesting**, **natural ventilation**, **outside views**, and use of **thermal mass**.

MAINTENANCE: Every effort should be made to **facilitate maintenance access** to building systems (without ladders/lifts and without disturbing classes), materials should be chosen that are **easy to clean** and **inexpensive to maintain**, and design teams are encouraged to **expose** the **functional elements** of the building for students to see.

ENVELOPE: In order to minimize the heating load, wall, window, and door **insulation** levels should be **optimized** via building modeling to comply with the EUI target above. **Exterior insulation** should be specified **over cavity insulation** where possible. **Fiberglass batts** are **never allowed** due to poor thermal performance in the field. Moisture and air **control layers** should reside on the **warm side of exterior insulation** and architects should specify **airtight construction** practices. **Rain screens** are encouraged to enhance durability.

10

WINDOWS: Windows size and specifications should be tuned based on building **orientation**, with north and shaded, south-facing glass being largest and/or having higher **Solar Heat Gain Coefficients** (SHGC) than east or west-facing glass. **U-values** should be **less than 0.30** on all sides (including roof). Where budget allows, glare and heat control should be provided via **heat-responsive glass** and/or **exterior shading**. In addition, **interior shades** should always be provided.



Thermochromic Glass

While the District is making progress converting its old fluorescent lighting to LEDs, a significant amount of energy is still wasted when shades are kept down and artificial lighting is used where daylighting would suffice. To overcome this behavioral problem, the SFUSD Facilities Department is experimenting with thermochromic windows, which dim automatically when the sun heats the glass. In this way, glare can be controlled and the need to close blinds or shades can be avoided. And that means the lights can stay off!

LIGHTING: Whenever possible, buildings should utilize **natural light** to meet lighting needs. **Interior** lighting shall be **100% LED**, with **vacancy sensors** (not occupancy) and **daylighting controls per Title 24** (see the DDSG for guidance on shut-off delays). Classroom light levels of **35 foot-candles** are sufficient. **Skylights**, **sun tubes**, or **light wells** should be included in sufficient quantity to allow zero artificial lighting in **common areas** during daytime hours. **Exterior** lighting should incorporate **bi-level control** and astronomical **time clocks**.

HEATING: Space conditioning should be limited to **permanently occupied areas**; no conditioning is needed in foyers, hallways, restrooms, or closets. Heating shall be provided by **Variable Refrigerant Flow** (VRF) systems or high-efficiency **heat pumps**; NO FOSSIL FUEL-BASED HEATING (natural gas) IS ALLOWED. Space heating should be controlled **separately for each zone**, with set points of **66-72 °F** in **occupied** spaces. Occupied hours (should be aggressive **(M-F: 7am-6pm)**; the system should be off after hours and on weekends (w/the possibility of limited duration and zone-specific overrides).

COOLING/VENTILATION: Occupied spaces should rely on **natural ventilation** unless schools are located in close proximity to a major pollutant source (e.g. freeway, major arterial). If mechanical ventilation is required, schools should incorporate **dedicated outside air systems (DOAS)** designed to **ASHRAE 62.1** or **CEC T24** requirements in permanently occupied spaces, **demand-based (CO2)** controls in auditoriums, gyms, and cafeterias, and **MERV 13** final filters throughout. The **fresh air** should be delivered **low in the room** and originate from a shaded

11

Standards & Specs

SAN FRANCISCO UNIFIED SCHOOL DISTRICT

DISTRICT DESIGN STANDARDS + GUIDELINES

2016 PROPOSITION A BOND PROGRAM

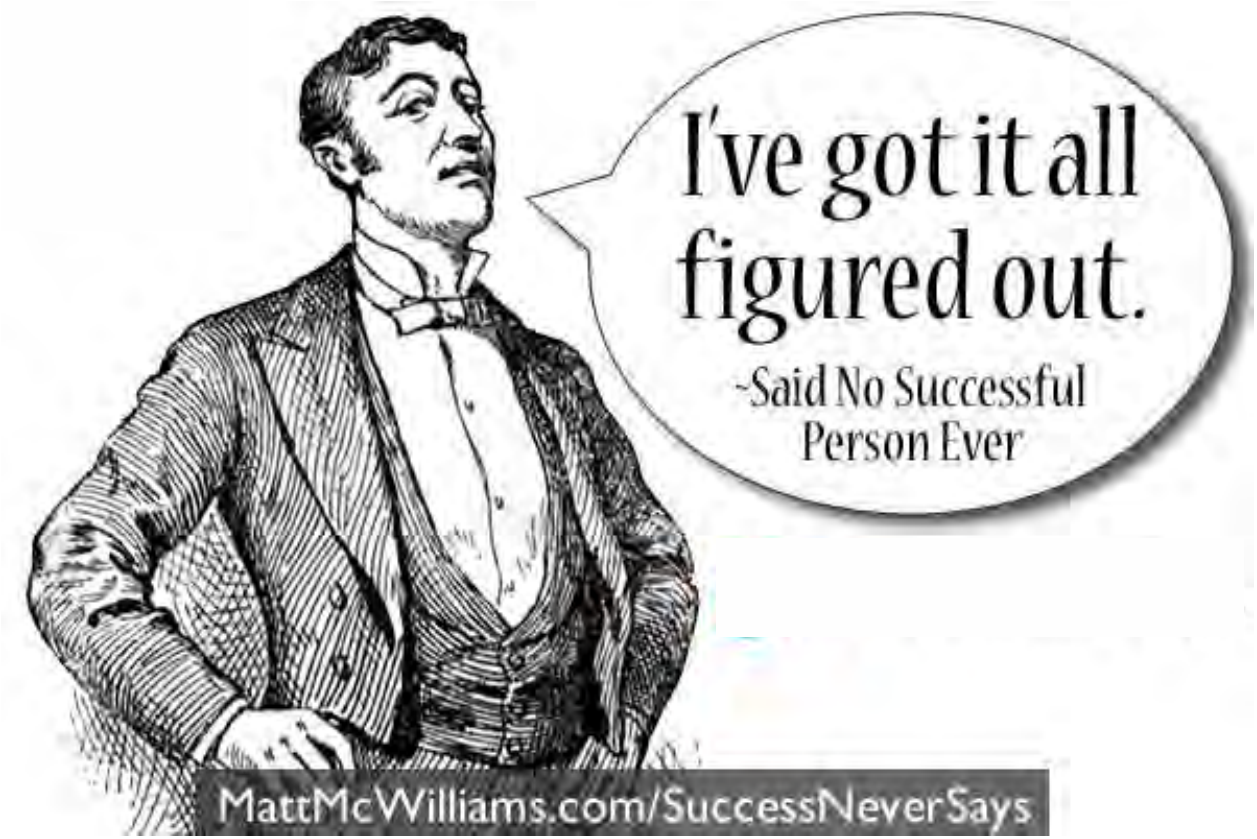
Assume Not & Verify

Get Help

"How could somebody have missed this?"
"Dam! I forgot my glasses."
"Have I registered for the **Design-Build** conference yet?"
"The lawyers are going to love this!"
"I don't recall seeing *that* in the plans?"
"Nobody said anything about a front door!"
"#*@$*&*!"

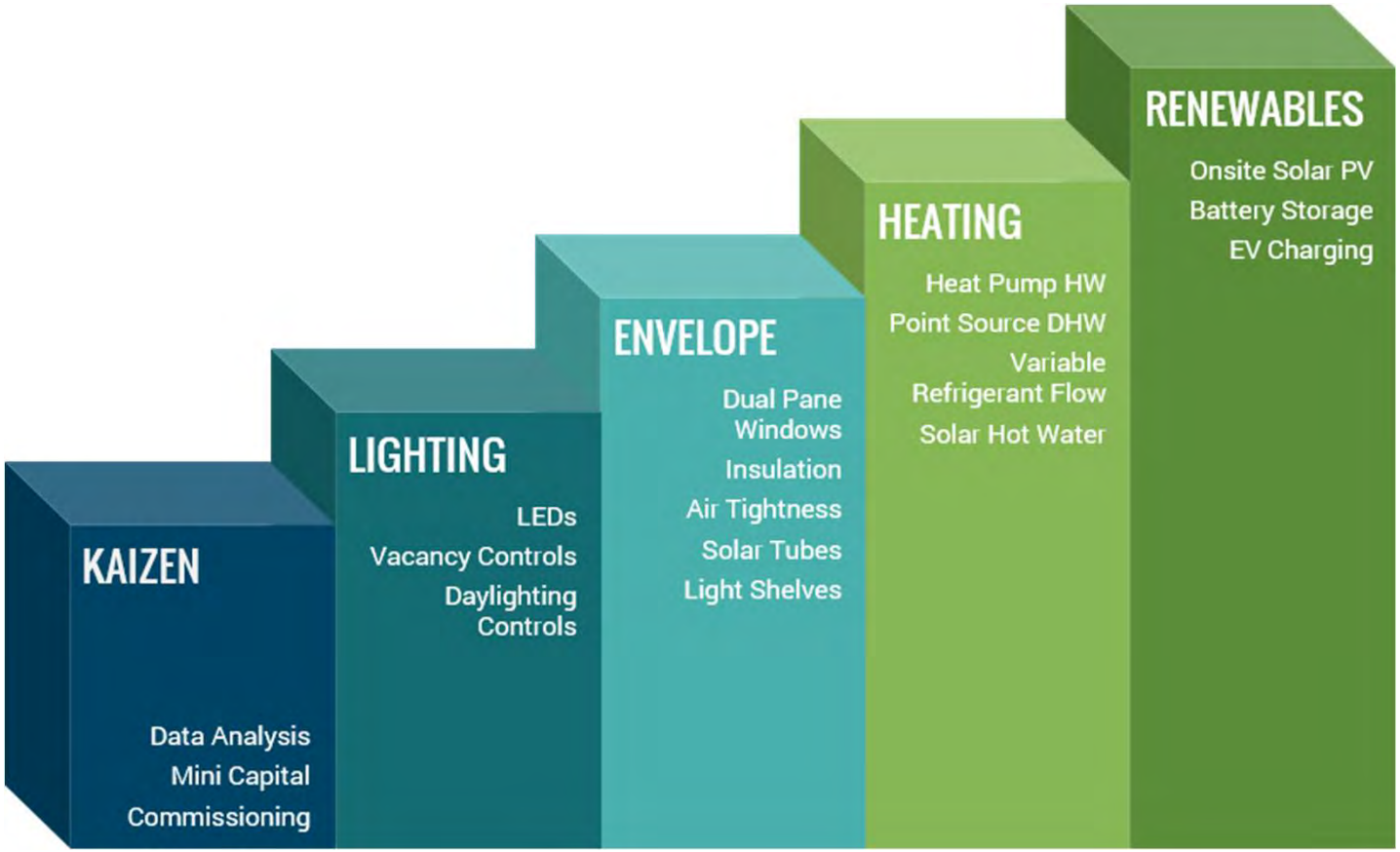
Smaller Projects

- LED Lighting
- Windows
- DHW Replacement
- Heating Controls/EMS
- Ventilation/VFD
- Pipe Insulation/Capping
- NO: New Gas Boilers

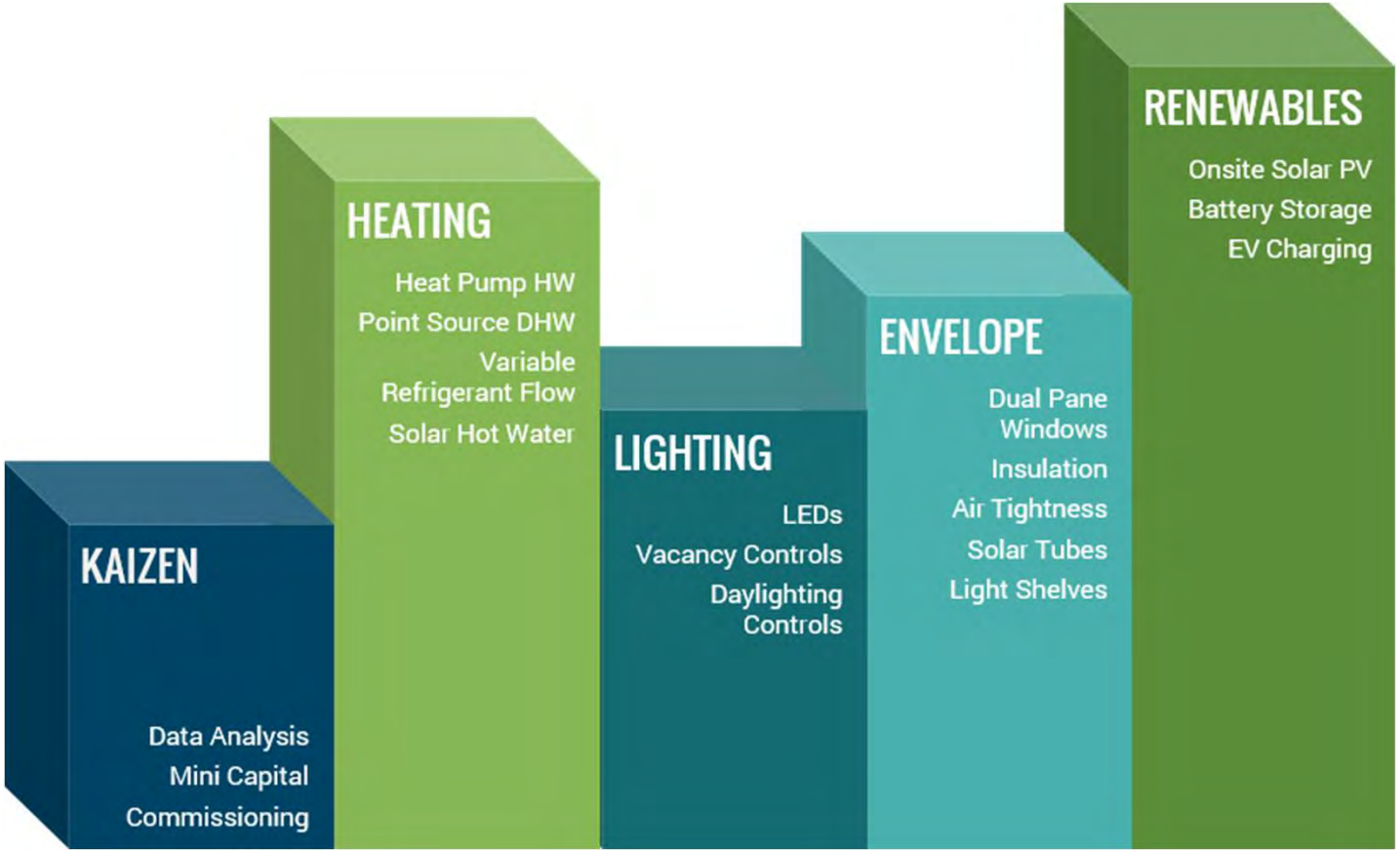

I've got it all figured out.
~Said No Successful Person Ever
MattMcWilliams.com/SuccessNeverSays

DO NOT
ENTER

ZNE Staircase

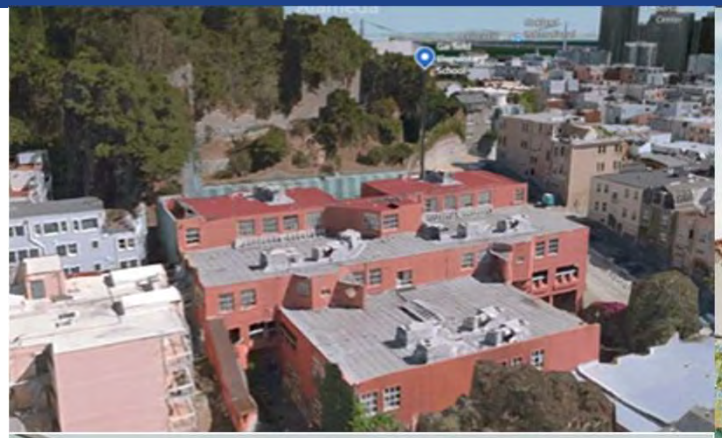


ZNE Adventure!



New ZNC Buildings

ZNC Retrofits



Making the Most of Building Automation Systems for Energy Management

Zach Lammers, Program Manager – Energy Conservation

Anne Arundel County Public Schools, MD

Anne Arundel County Public Schools

- Total Buildings: 125
- Student Population: 78,000 students
- Total Floor Area: 14 million square feet
- 99% Remotely Accessible – Web Based BAS
- 100% Air Conditioned

- Resources allocated in 2012-13 to create Energy Conservation Division
  - *We audit, track, advise, and implement energy conservation measures throughout the district*

Setup

- Energy Management: *How We Use It, When We use It, How we Buy It…*

- HVAC is primary source of energy consumption in K-12 buildings…
  - *Is **Expensive Equipment** running when it should be off?*
    - *Are they entering night heat / cool?*
    - *Are they running in occupied / unoccupied dehumidification too frequently?*
    - *Am I masking problems by thinking I have to run it all the time?*
  - *Are my **Controls** doing what they are supposed to be doing?*
  - *Do I need to run the **Whole Building** when only a fraction is used in the summer?*
    - *Can I shut down equipment an hour or two before typical end of day?*
    - *Night Survey – "What's running that shouldn't be?"*

- Leverage our Interval Meter and Building Automation Platforms to answer these fundamental Energy Management questions…

Common Challenges Faced

- Scale / Number of Facilities
- Diversity of Systems & Protocols
  - Historical Procurement led to multiple vendor-platforms
  - Legacy Systems with limited capability
- Increasing System Complexity
  - ATC sequence variation
    - Engineer-to-Engineer
    - Evolving Energy Code
- Multiple End Users
  - With Access and varying degrees of training…

Solutions

- Global Scheduling centrally managed for over 1,000 pieces of equipment
  - Supports after-hours and weekend activities
  - Supports other building and district level needs
    - Extreme Weather
    - Demand Response
- Implementing Standardized ATC Sequences
  - Proven sequence of operations
  - Easier to troubleshoot
  - Easier to scale
  - Ex: Chiller Plant Enable
- Leverage Custom Analytics, Reporting & Notifications
  - Weekly Runtime Reports, Override Reports
- Use Custom Querying & Dashboarding Capability
- Provide Visibility to Building Personnel

Solutions Continued…Global Schedules

Example Areas Impacted by Global Schedules…											
Global Schedule	**Admin**	**Classroom Area A**	**Classroom Area B**	**Classroom Area…**	**Kindergarten**	**Cafeteria**	**Kitchen**	**Gym**	**Media**	**Computer Lab**	**Comments**
Demand Response	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Temporarily Unoccupied	Demand Response temporarily overrides all schedules to load shed for Emergency DR scenarios…
24.7	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	Occupied All Day/Night	24.7 makes all units run occupied…
Code Red (no activities)	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	This unoccupies the building and overrides any previously entered special requests because Code Red means no after hours activities…
Code Blue (no activities)	Occupied 6am-4pm	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	This unoccupies the building except the Admin and overrides any previously entered special requests because Code Blue typically means no after hours activities…
Special Energy Requisitions	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	Occupied for Specific Interval	These are special requests like basketball games over a holiday break or after school activities in the summer that require certain areas to run while the rest of the school can remain in holiday mode…
Holidays	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	this unoccupies the building for holidays like spring break but still allows special requests like Church etc. to go on…
Holiday Admin	Occupied 6am-4pm	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	this unoccupies the building for holidays like Christmas break but keeps the admin area running on normal schedule…
Summer Fridays	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	Unoccupied Friday All Day/Night	this unoccupies the buildings on 6 out of 10 summer Fridays where this no admin or summer school use…and needs to be a higher priority than Summer hours
Summer Hrs	Occupied 6am-4pm	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	Unoccupied All Day/Night	this runs the admin and areas needed for summer class, parks n rec, etc. this schedule is unique to each school but is globally implemented…
2 Hr Early Schedule	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	Occupied 2 hours early	this can be used after a long weekend on extremely cold/hot nights to help each building reach temp by occupancy…
Election Day	Unoccupied	Unoccupied	Unoccupied	Unoccupied	Unoccupied	Occupied 5am-11pm	Unoccupied	Unoccupied	Unoccupied	Unoccupied	this unoccupies the building for holiday but permits the cafeteria to run which is where elections typically take place…

Solutions Continued…Standardized ATC Sequences

DIVISION 23 – HVAC DESIGN STANDARDS
SECTION 23 90 00 AUTOMATIC TEMPERATURE CONTROLS
ANNE ARUNDEL COUNTY PUBLIC SCHOOLS

THIS DOCUMENT IS A DESIGN STANDARD, NOT A SPECIFICATION

PART I – GENERAL

1.10 SECTION INCLUDES:

A. Design Considerations

B. Technical Considerations

C. General Requirements

D. Zones

E. Temperatures and Set Points

F. Schedules

G. Sequences

H. Graphics

I. Direct Digital Building System Components

1. Wiring, Conduits, and Panels
2. Control Dampers
3. Control Valves
4. Variable Frequency Drives (VFD)
5. Instrumentation and Control Devices

J. Training

1.20 DESIGN CONSIDERATIONS

A. Refer to section 23 00 00 – HVAC for GENERAL REQUIREMENTS, Code Information, and Standards Information.

1.30 TECHNICAL CONSIDERATIONS

A. LEED, IECC Compliance items planned for the project are to be discussed with AACPS before specifications are completed.

B. See "GENERAL REQUIREMENTS" in PART 2 of this section for addition design and technical considerations before developing the automatic temperature control system (ATC) for each project.

PART 2 – PRODUCTS

2.10 GENERAL RQUIREMENTS

A. The ATC system shall be a Direct Digital Control (DDC) system.

ATC SEQUENCES

GENERAL ITEMS (GI)

GI-1 General Notes for ATC System
GI-2 Auto-Occupied-Unoccupied Control

CENTRAL PLANT EQUPMENT (CPE)

CPE-1 Heating Water Plant Sequence
CPE-2 Chilled Water Plant Sequence-Air Cooled Chiller
CPE-3 Chilled Water Plant Sequence-Water Cooled Chiller
CPE-4 Chiller Room Ventilation and Refrigerant Control

TWO (2) PIPE SYSTEMS (TPS)

TPS-1 Fan Coil Unit-2 Pipe Chilled/Heating Water
TPS-2 Unit Ventilator-2 Pipe Chilled/Heating Water
TPS-3 Two Pipe System Isolation Valves

FOUR (4) PIPE SYSTEMS (FPS)

FPS-1 Fan Coil Unit-4 Pipe Heating Water and Chilled Water
FPS-2 Unit Ventilator-4 Pipe Heating Water and Chilled Water

AIR HANDLING UNITS (AHU)

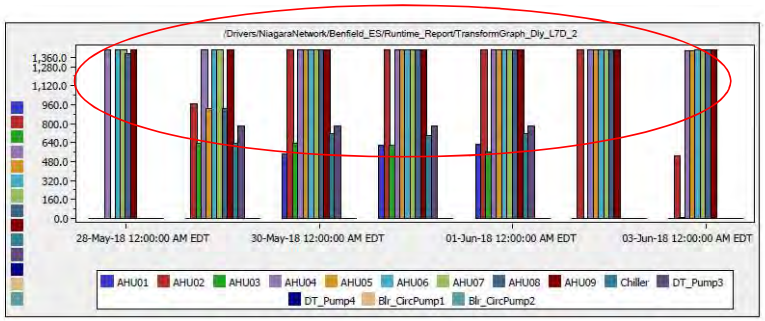
AHU-1 Air Handling Unit – Single Zone VAV
AHU-2 Air Handling Unit – VAV with SF and RF
AHU-3 Rooftop Energy Recovery Unit-2 Pipe Chilled/Heating Water and DX Cooling
AHU-4 Energy Recovery Unit-4 Pipe Heating Water and Chilled Water
AHU-5 Kitchen Hood Exhaust System with make-up Air Unit

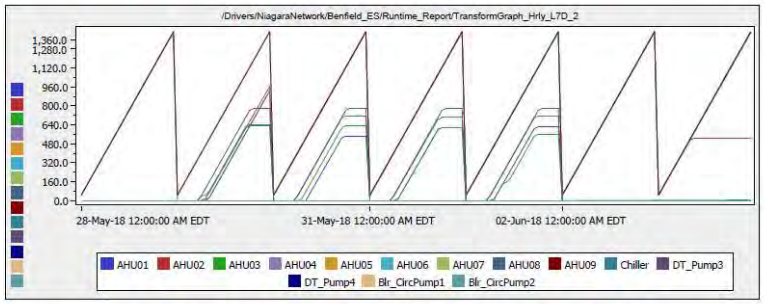
GEOTHERMAL SYSTEM (GEO)

GEO-1 Geothermal Heat Pump Loop Pumping System-Basic
GEO-2 Geothermal Heat Pump Loop Pumping System with Closed Circuit Fluid Cooler Assistance
GEO-3 Heat Pump Unit Connected to Geothermal Heat Pump Loop Piping

Solutions Continued…Weekly Runtime Report

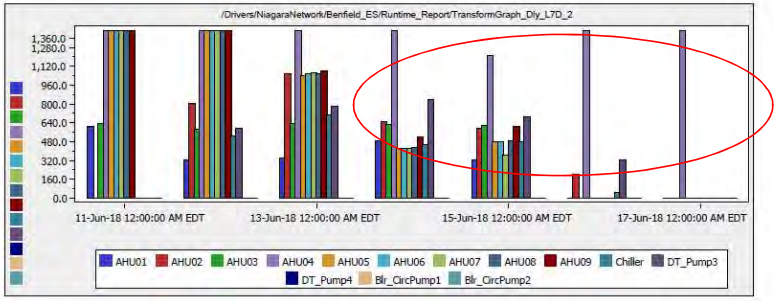
Before

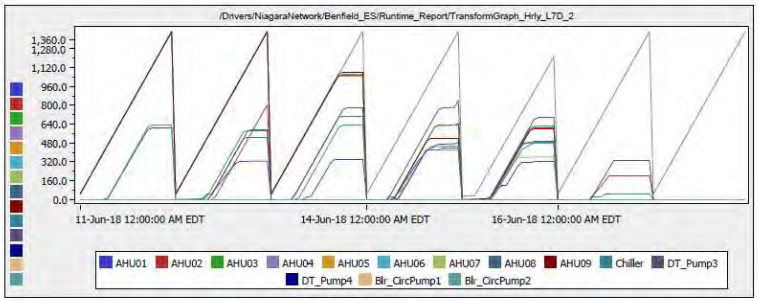




timestamp	AHU01	AHU02	AHU03	AHU04	AHU05	AHU06	AHU07	AHU08	AHU09	Chiller	DT_Pump3	DT_Pump4	Blr_CircPump	Blr_CircPump
28-May-18 12:00:00 AM	0.0	0.0	0.0	1425.9	0.0	1425.9	1425.9	1391.7	1425.9	0.0	0.0	0.0	0.0	0.0
29-May-18 12:00:00 AM	0.0	964.8	630.2	1425.9	928.6	1425.9	1425.9	927.8	1425.9	638.0	778.2	0.0	0.0	0.0
30-May-18 12:00:00 AM	545.9	1425.8	630.3	1425.8	1425.8	1425.8	1425.8	1425.8	1425.8	715.7	777.9	0.0	0.0	0.0
31-May-18 12:00:00 AM	615.5	1425.9	617.3	1425.9	1425.9	1425.9	1425.9	1425.9	1425.9	701.5	777.9	0.0	0.0	0.0
01-Jun-18 12:00:00 AM E	623.4	1425.8	560.8	1425.8	1425.8	1425.8	1425.8	1425.8	1425.8	715.7	777.9	0.0	0.0	0.0
02-Jun-18 12:00:00 AM E	0.0	1425.9	0.0	1425.9	1425.9	1425.9	1425.9	1425.9	1425.9	0.0	0.0	0.0	0.0	0.0
03-Jun-18 12:00:00 AM E	0.0	528.7	5.2	1415.0	1415.0	1425.9	1425.9	1425.9	1425.9	0.0	0.0	0.0	0.0	0.0

After





timestamp	AHU01	AHU02	AHU03	AHU04	AHU05	AHU06	AHU07	AHU08	AHU09	Chiller	DT_Pump3	DT_Pump4	Blr_CircPump	Blr_CircPump
11-Jun-18 12:00:00 AM	608.3	0.0	630.1	1425.9	1425.9	1425.9	1425.9	1425.9	1425.9	0.0	0.0	0.0	0.0	0.0
12-Jun-18 12:00:00 AM	326.0	803.9	585.6	1425.8	1425.8	1425.8	1425.8	1425.8	1425.8	530.4	592.5	0.0	0.0	0.0
13-Jun-18 12:00:00 AM	340.2	1060.8	630.2	1425.8	1043.8	1056.3	1065.2	1057.7	1081.3	708.5	778.2	0.0	0.0	0.0
14-Jun-18 12:00:00 AM	484.7	646.5	629.8	1425.9	420.1	419.8	420.2	433.0	517.4	455.1	841.3	0.0	0.0	0.0
15-Jun-18 12:00:00 AM	322.6	596.5	621.0	1213.2	480.2	480.0	362.9	491.6	606.3	483.3	694.4	0.0	0.0	0.0
16-Jun-18 12:00:00 AM	0.0	203.9	0.0	1425.9	0.0	0.0	0.0	0.0	0.0	49.9	328.2	0.0	0.0	0.0
17-Jun-18 12:00:00 AM	0.0	0.0	0.0	1425.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Better Buildings U.S. DEPARTMENT OF ENERGY
U.S. DEPARTMENT OF ENERGY

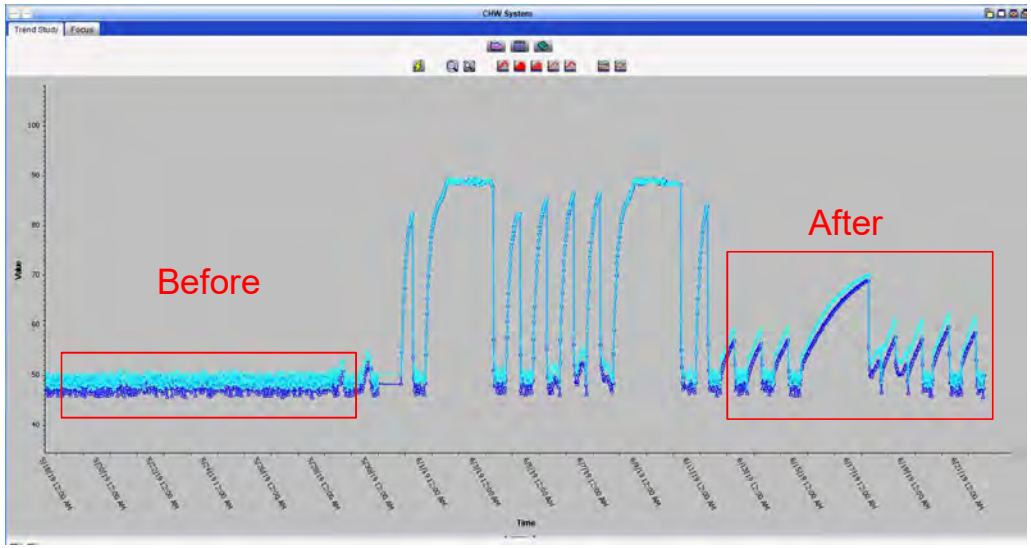
Solutions Cont'd…Weekly Override Report

Weekly report automatically emailed by BAS to outlook which has a macro to filter and sort…

	A	B	C	D	F	G
1	BrooklynParkMS_Overrides					
2	slot:/Services/ReportService/BrooklynParkMS_Overrides					
3	22-Feb-18 9:38 AM EST					
4						
5	Device Name	Point Name	To String	Priority Level	Point Value	Point Destination
25	AHU3S	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/AHUs/AHU3S/OCC$2dC
26	AHU5C_Lobby	OCC-C	Occpd {overridden}	8	Occpd	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/AHUs/AHU5C_Lobby/OCC$2dC
27	AHU8C_Auditorium	OCC-C	Occpd {overridden}	8	Occpd	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/AHUs/AHU8C_Auditorium/OCC$2dC
28	SC_UVent15_ScienceLecture_237	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/UVs/SC_UVs/SC_UVent15_ScienceLecture_237/OCC$2dC
29	SC_UVent25_ClassRM_340	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/UVs/SC$20UVs/SC_UVent25_ClassRM_340/OCC$2dC
30	SC_UVent37_ClassRM_339	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/UVs/SC$20UVs/SC_UVent37_ClassRM_339/OCC$2dC
31	SC_UVent38_TeachersPlanningRM_337	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/UVs/SC$20UVs/SC_UVent38_TeachersPlanningRM_337/OCC$2dC
32	SC_UVent4_Clothing	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC11/points/UVs/SC_UVs/SC_UVent4_Clothing/OCC$2dC
33	SC_UVent42_TeachersPlanningRM_328	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/UVs/SC$20UVs/SC_UVent42_TeachersPlanningRM_328/OCC$2dC
34	SC_UVent68_ScienceLab_302	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/UVs/SC$20UVs/SC_UVent68_ScienceLab_302/OCC$2dC
35	SC_UVent7_Tech\AudioLab	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC11/points/UVs/SC_UVs/SC_UVent7_Tech$5cAudioLab/OCC$2dC
36	SC_UVent70_ScienceLab_302	OCC-C	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/UVs/SC$20UVs/SC_UVent70_ScienceLab_302/OCC$2dC
40	SAHUVAV_1S5_PrincipalOffice	OccCmd	Occpd {overridden}	8	Occpd	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU1S_VAVs/SAHUVAV_1S5_PrincipalOffice/OccCmd
41	SAHUVAV_7S10_ResourceCenter_213	OccCmd	Occ {overridden}	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S10_ResourceCenter_213/OccCmd
42	SAHUVAV_7S11_MediaCenter	OccCmd	Occ {overridden}	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S11_MediaCenter/OccCmd
43	SAHUVAV_7S14_MediaCenter	OccCmd	Occ {overridden}	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S14_MediaCenter/OccCmd
44	SAHUVAV_7S15_MediaCenter	OccCmd	Occ {overridden}	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S15_MediaCenter/OccCmd
45	SAHUVAV_7S16_ComputerRM_230	OccCmd	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S16_ComputerRM_230/OccCmd
46	SAHUVAV_7S17_InstructionRM_224	OccCmd	Unocc {down,stale,overri	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S17_InstructionRM_224/OccCmd
47	SAHUVAV_7S18_VolRM_228	OccCmd	Occ {overridden}	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S18_VolRM_228/OccCmd
48	SAHUVAV_7S22_CareerServices	OccCmd	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/VAVs/AHU7S_VAVs/SAHUVAV_7S22_CareerServices/OccCmd
49	SAHUVAV_7S23_Office	OccCmd	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/VAVs/AHU7S_VAVs/SAHUVAV_7S23_Office/OccCmd
50	SAHUVAV_7S26_Speech	OccCmd	Unocc {overridden}	8	Unocc	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC13/points/VAVs/AHU7S_VAVs/SAHUVAV_7S26_Speech/OccCmd
51	SAHUVAV_7S4_ChoralMusic120	OccCmd	Occ {overridden}	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC11/points/VAVs/AHU7S_VAVs/SAHUVAV_7S4_ChoralMusic120/OccCmd
52	SAHUVAV_7S6_TeacherPlanning3_129	OccCmd	Occ {fault,down,overridd	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC11/points/VAVs/AHU7S_VAVs/SAHUVAV_7S6_TeacherPlanning3_129/OccCmd
53	SAHUVAV_7S9_RenzulliRM_212	OccCmd	Occ {overridden}	8	Occ	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/VAVs/AHU7S_VAVs/SAHUVAV_7S9_RenzulliRM_212/OccCmd
69	CHHS_DX1_SC	SUM-WIN	Winter {overridden}	8	Winter	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC11/points/HTG_CLG/CHHS_DX1_SC/SUM$2dWIN
79	CCUnitV49_RecRM_2014	UnocHtg	70.0 °F {overridden}	8	70.0 °F	slot:/Drivers/NiagaraNetwork/BrooklynParkMS/AACPS_BrooklynPkMS_NC12/points/UVs/CC_UVs/CCUnitV49_RecRM_2014/UnocHtg
452						
453						
454						
455						

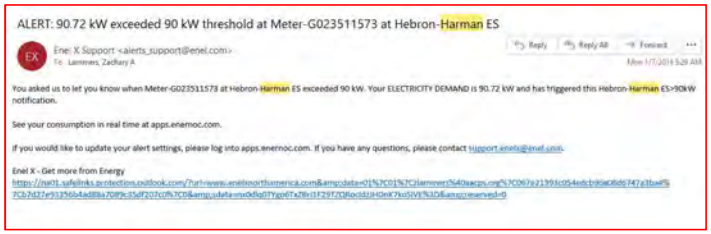
Solutions Cont'd…Weekly Trend Summary Review

Weekly review of pre-configured BAS trend studies commonly reveal overrides or programming errors that lead to excessive runtime or plant cycling...



Solutions Continued…Night Baseload Alerts

Night Baseload Notification


ALERT: 90.72 kW exceeded 90 kW threshold at Meter-G023511573 at Hebron-Harman ES

Enel X Support <alerts_support@enel.com>
To: Lammers, Zackary A

Reply | Reply All | Forward

Mon 1/7/2019 5:29 AM

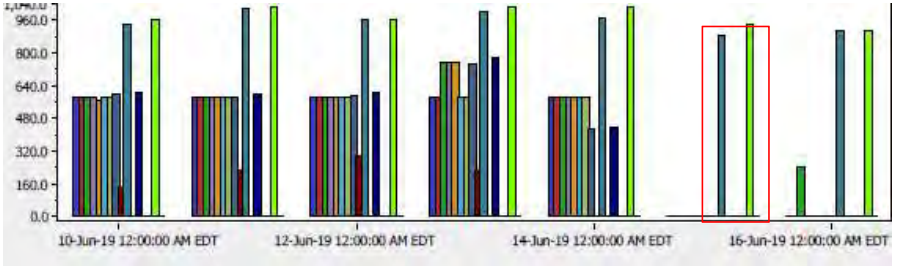
You asked us to let you know when Meter-G023511573 at Hebron-Harman ES exceeded 90 kW. Your ELECTRICITY DEMAND is 90.72 kW and has triggered this Hebron-Harman ES>90kW notification.

See your consumption in real time at apps.enernoc.com.

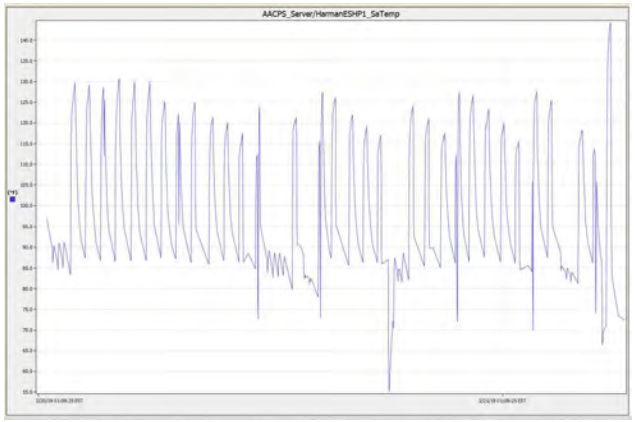
If you would like to update your alert settings, please log into apps.enernoc.com. If you have any questions, please contact support.enels@enel.com.

Enel X - Get more from Energy

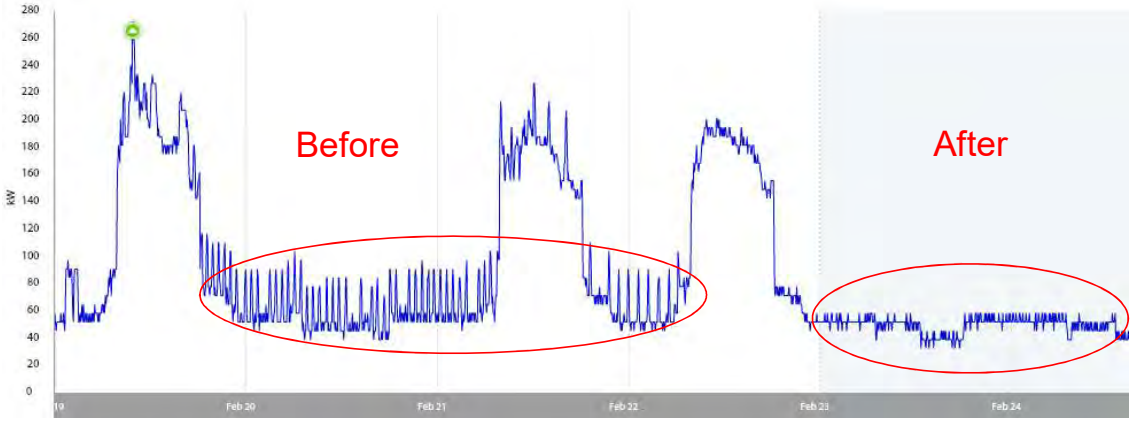
BAS Runtime Chart



Equipment DAT Trend

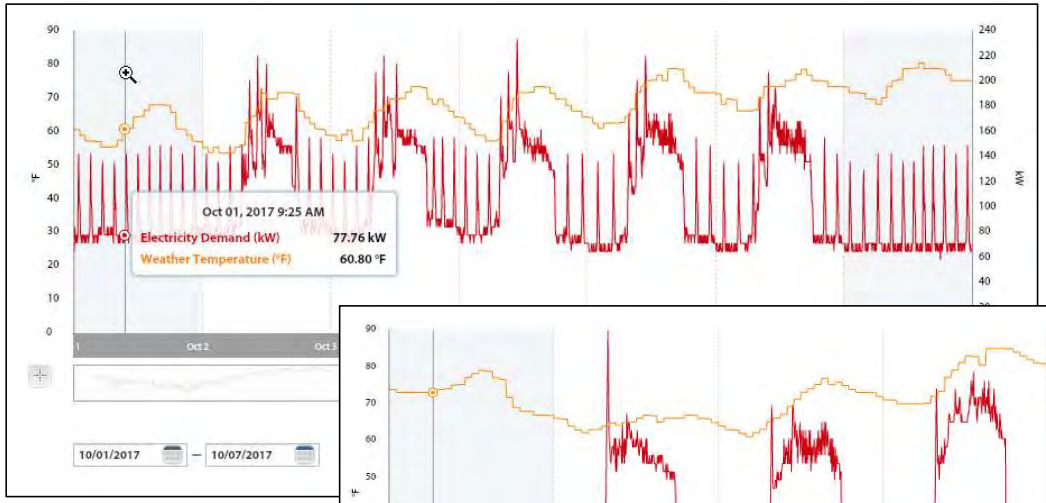


Demand Trend



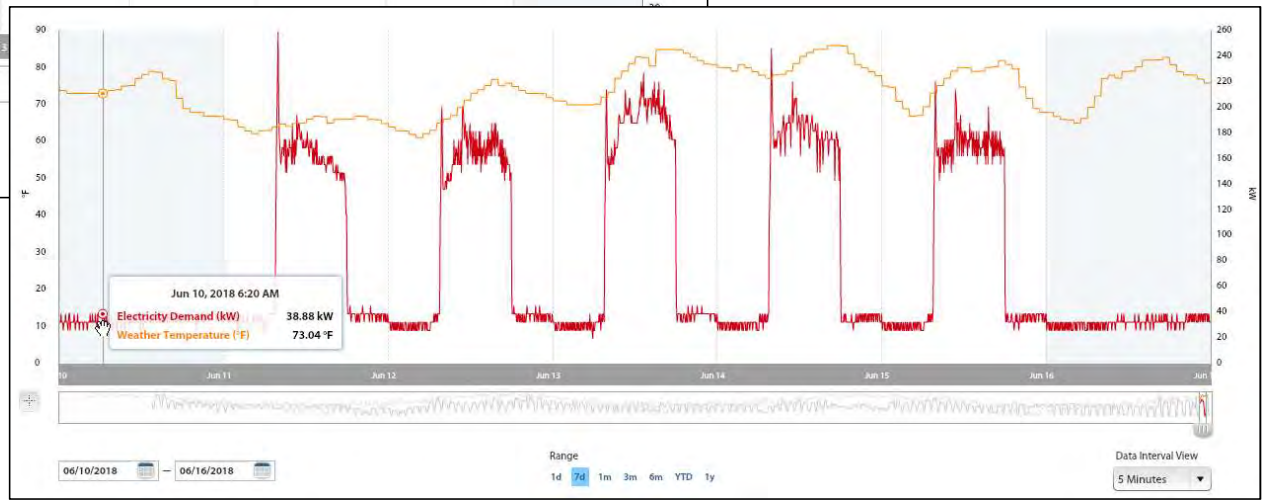
Solutions Cont'd…Sequence Improvements

Several buildings were not programmed to require building occupancy in addition to OAT enable setpoint…thus night operation and cycling…



Before

After



Chiller Plant Enable Tabulated Results Thus Far…

Measure Title	Building Name	Measure Type	Equipment Type	Status	Estimated / Measured Savings
Chiller Plant Enable Logic	Annapolis ES - Metasys	Control	Cooling Systems (Chillers)	Implemented	$10,000
Chiller Plant Enable Logic	Brock Bridge ES – Tridium overlay of EBI-310	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Brooklyn Park MS – Tridium Overlay of JCI	Control	Cooling Systems (Chillers)	Implemented	$15,000
Chiller Plant Enable Logic	Crofton ES – Tridium (previously Metasys)	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Davidsonville ES – Tridium (previously Metasys)	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Eastport ES – Metasys	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Four Seasons – Tridium (previously Circon)	Control	Cooling Systems (Chillers)	Implemented	$4,000
Chiller Plant Enable Logic	Georgetown East ES - Tridium	Control	Cooling Systems (Chillers)	Implemented	$2,420
Chiller Plant Enable Logic	Glen Burnie HS - Tridium	Control	Cooling Systems (Chillers)	Implemented	$15,000
Chiller Plant Enable Logic	Glendale ES - Metasys	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Lindale MS – EBI-410	Control	Cooling Systems (Chillers)	Implemented	$10,000
Chiller Plant Enable Logic	MacArthur MS - Tridium	Control	Cooling Systems (Chillers)	Implemented	$10,000
Chiller Plant Enable Logic	Marley MS - Tridium	Control	Cooling Systems (Chillers)	Implemented	$10,000
Chiller Plant Enable Logic	Meade MS – Tridium overlay of JCI	Control	Cooling Systems (Chillers)	Implemented	$10,000
Chiller Plant Enable Logic	Nantucket ES – Transition from Circon to Tridium	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Oak Hill ES – Tridium	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Rolling Knolls ES – Tridium	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Severn River Magothy – Tridium (EBI-310 previously)	Control	Cooling Systems (Chillers)	Implemented	$10,000
Chiller Plant Enable Logic	Severna Park MS - Metasys	Control	Cooling Systems (Chillers)	Implemented	$10,000
Chiller Plant Enable Logic	Southern HS – Tridium	Control	Cooling Systems (Chillers)	Implemented	$17,649
Chiller Plant Enable Logic	Traceys ES - Tridium (Previously Honeywell)	Control	Cooling Systems (Chillers)	Implemented	$5,000
Chiller Plant Enable Logic	Arundel HS – Metasys JCI Lon	Control	Cooling Systems (Chillers)	In Progress	$15,000
Chiller Plant Enable Logic	North County HS – Legacy Honeywell	Control	Cooling Systems (Chillers)	In Progress	$15,000
Chiller Plant Enable Logic	Sunset ES – Tridium overlay of EBI-310	Control	Cooling Systems (Chillers)	In Progress	$5,000
Chiller Plant Enable Logic	Van Bokkelen – EBI-410	Control	Cooling Systems (Chillers)	In Progress	$5,000
				Projected Energy Savings -->	$209,069

Continuing Effort & Goals

- Currently
  - Leveraging BAS platforms to execute fundamental energy management practices and find additional efficiency opportunities
  - Retroactively implementing standardized ATC sequences where appropriate
    - Ex: Chiller Plant Enable, HW Plant Enable, OSS, etc.
  - Using real-time electric data in combination with BAS data to support M&V and business case
- Goals
  - Migrating each school to centralized platform
  - Increasing the number of facilities with real-time energy information
    - 2/5 of facilities have it
    - all HS's & MS's, some ES's
  - Integrate Lighting Control
    - Currently non-networked standalone systems managed at schools

Questions & Answers

U.S. DEPARTMENT OF ENERGY

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Thank You

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