



EE + RE + ZE: Zero Energy Buildings for Schools

Wednesday, May 17,
2017

2:00—3:15 pm

Panelists

- Dr. Erin Russo, Principal, Discovery Elementary School
- Christos Chrysiliou AIA, CCM, LEED BD+C, Director of Architectural & Engineering Services, LAUSD
- Joe Da Silva, PhD, AIA, RI School Building Authority
- Crystal McDonald, US DOE

Occupant/Owner Experience, Learning Opportunities

Dr. Erin Russo

Principal

Discovery Elementary School



ARLINGTON PUBLIC SCHOOLS
DISCOVERY ELEMENTARY
EXPLORERS



Better Buildings Summit

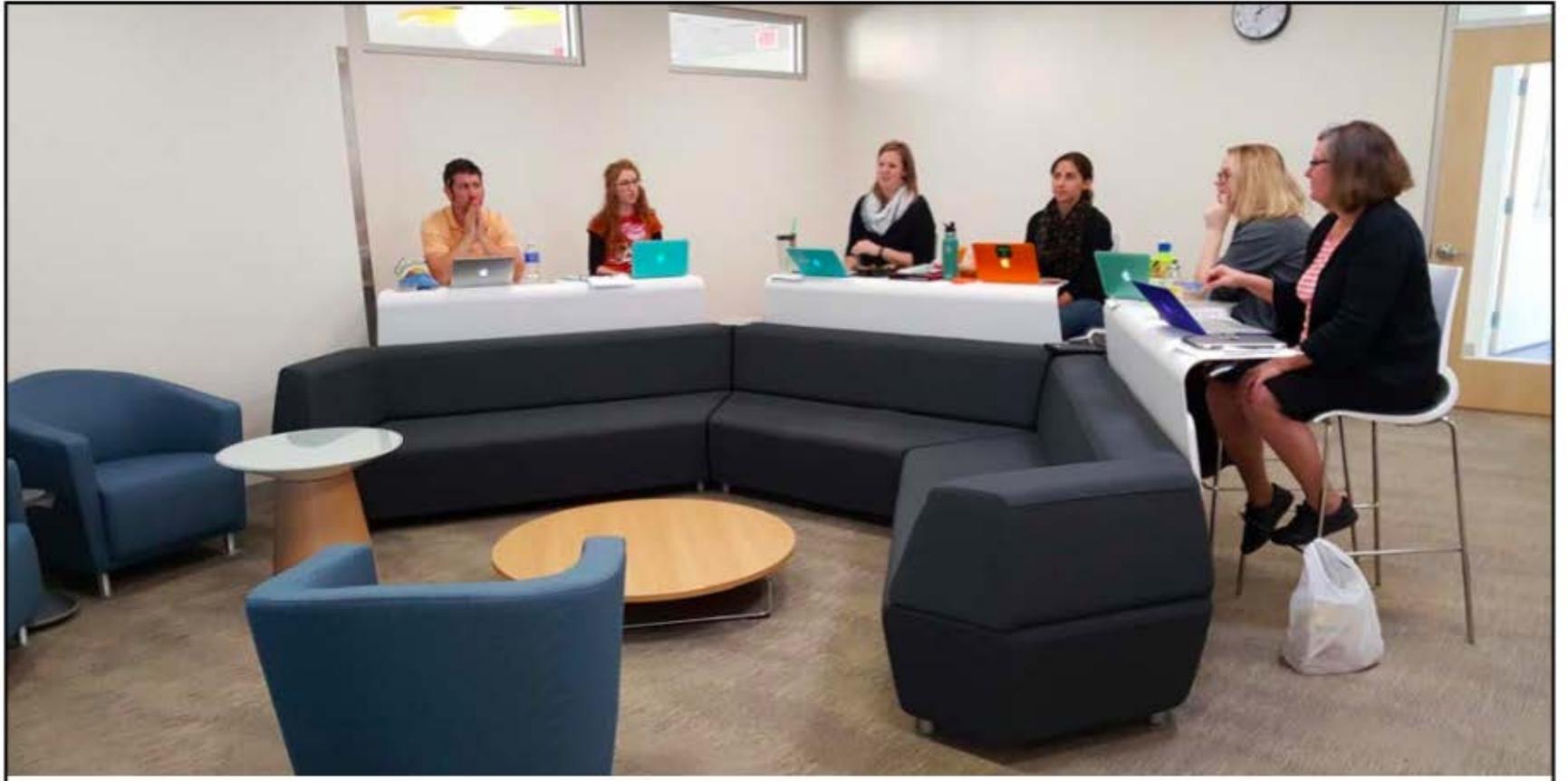
Dr. Erin Russo



Limitless Possibilities



When Collaboration Becomes The Norm



Expanding The Notion of Team



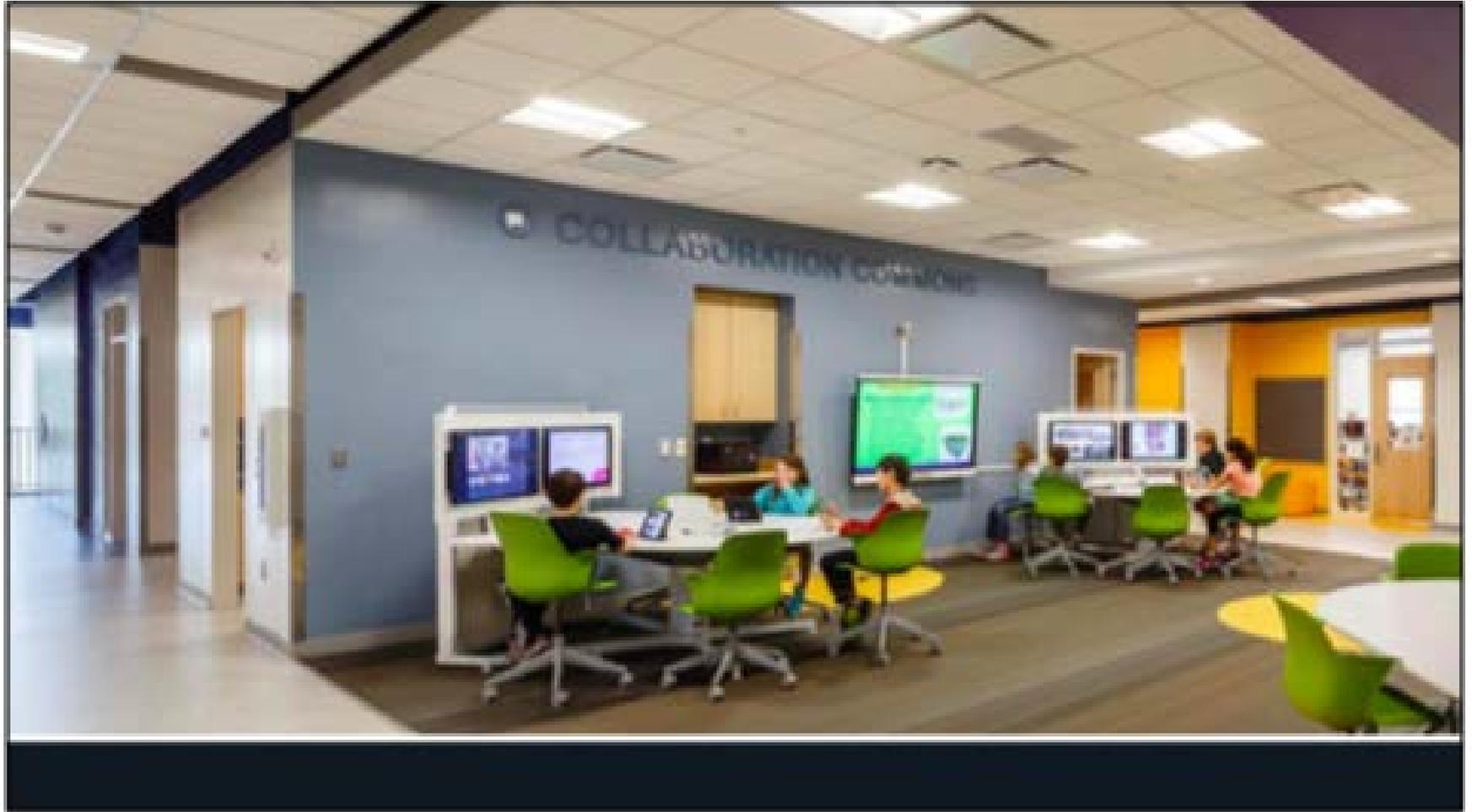
A walk down the hallway breaks down the idea of "my isolated room"



Not 5 third grade classrooms, but 5 third grade teachers teaching all



Collaboration becomes the norm because design has stripped us of isolation









John Re
@HeyJRDiscovery

Following

human graph on bike walk to school day - Ms
Cs 2nd grade @DiscoveryESPTA
@DiscoveryAPS @ATPcommutes
@MissCoulouris



Sylvia
@SylviaKinder

Following

Natural light, atrium windows are Awesome to
•• students @RussoErin @vmdoarchitects
@PhilipDonovan





Authentic learning



DISCOVERY ELEMENTARY
ECO-ACTION

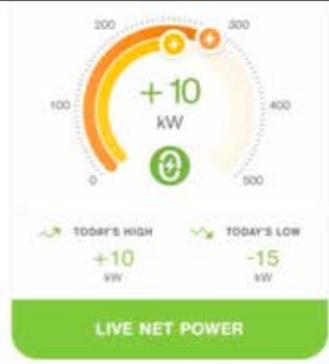
WE WILL DO OUR BEST
TO MAKE OUR EARTH
HEALTHIER & TO MAKE
OUR SCHOOL
A BETTER PLACE



Authentic learning



Weighing trash | Food donations | Cardboard challenge | Tour guides



Powerful, purposeful learning



Axis, orbit, equator, math, science, history and the Pantheon!

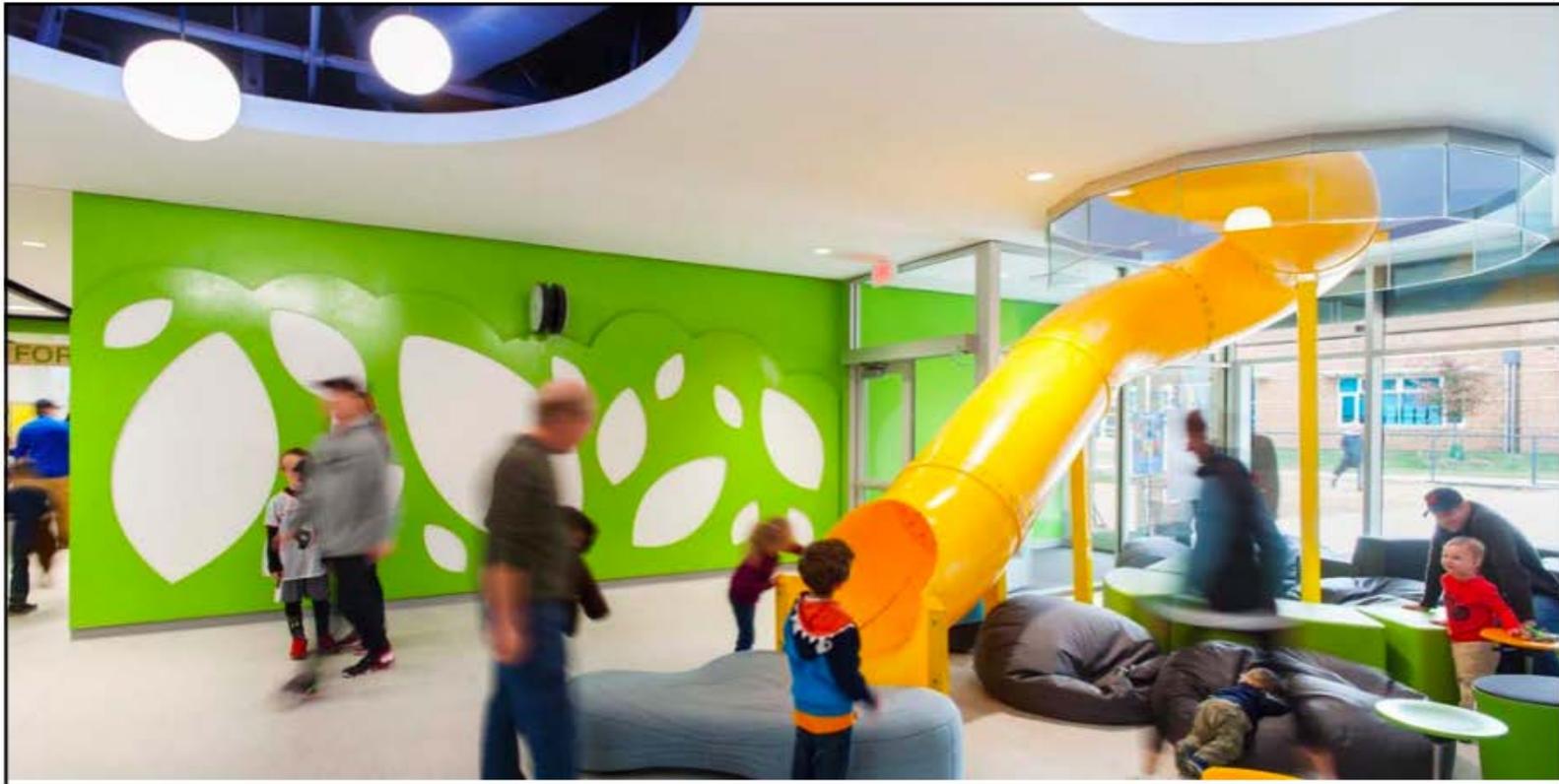


This is their school | Student ownership of their learning

GALAXY VOYAGERS

- Mrs. Zarkowsky
- Levi A
- Peter Matthews
- Brady Uary
- Nathan Reiser
- Aspena Ch...





The Place To Be at 3:41



Limitless Possibilities

District-wide Commitment and Approach

Christos Chrysiliou AIA, CCM, LEED BD+C
Director of Architectural & Engineering Services
Los Angeles Unified School District



Los Angeles Unified School District
M&O Branch – Sustainability Initiatives Unit

LAUSD's Road to Zero Net Energy

Christos Chrysiliou, AIA, CCM, LEED AP BD+C

Director of Architecture and Engineering Services



May 17, 2017



AGENDA



ABOUT LAUSD



OUR COMMITMENT



THE ROAD AHEAD



THE JOURNEY

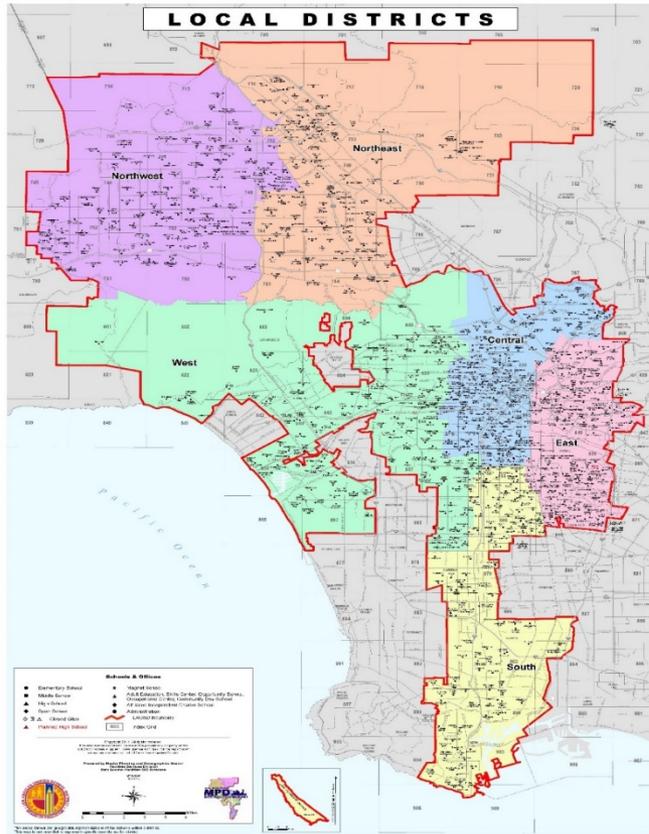


THE DESTINATION



ABOUT LAUSD

ABOUT LAUSD



664,774 students (K-12)

60,171 employees

720 square miles of site boundaries

6,657 acres of land

25,076 structures

33,000 classrooms

1,200 schools and centers

LAUSD Sustainability Initiatives

Source: achieve.lauds.net (Fingertip Facts)
laschools.org/new-site/fingertip-facts/



ABOUT LAUSD

Water Stewardship



Energy Conservation



Campus Ecology



Awareness & Outreach



Sustainability Initiatives Unit

Focus Areas

High Performance Schools



Emerging Technologies



LAUSD Sustainability Initiatives



ABOUT LAUSD

VIDEO



<http://learninggreen.laschools.org>



ABOUT LAUSD



OUR COMMITMENT



THE ROAD AHEAD



THE JOURNEY



THE DESTINATION



OUR COMMITMENT

MISSION AND GOALS

Mission

LAUSD's Sustainability Initiatives mission is to **be the most sustainable school district in the nation** by developing and implementing programs that support energy efficiency, water conservation, and educational and awareness programs.

Goals

- 20% Energy Intensity Reduction by 2024
- 20% Water Consumption Reduction by 2024
- Support High Performance Design
- Support Education and Awareness Programs
- Support Campus Ecology Programs
- Identify, Evaluate and Implement Emerging Technologies

www.learninggreen.laschools.org



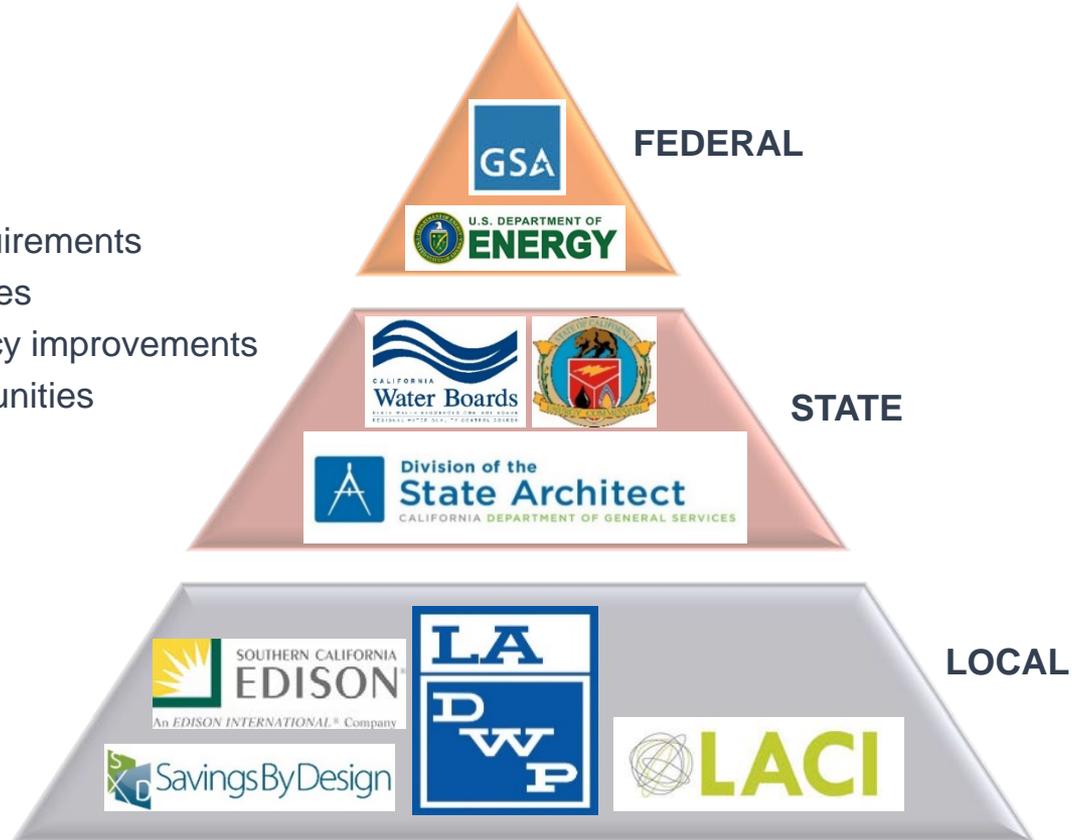
LAUSD Sustainability Initiatives

EXTERNAL PARTNERSHIPS



OUR COMMITMENT

- Guidelines
- Consultation
- Regulatory requirements
- New technologies
- Energy efficiency improvements
- Funding opportunities



LAUSD Sustainability Initiatives

INTERNAL COLLABORATION



OUR COMMITMENT



LAUSD Sustainability Initiatives

PLANNING & IMPLEMENTATION STRATEGY



OUR COMMITMENT

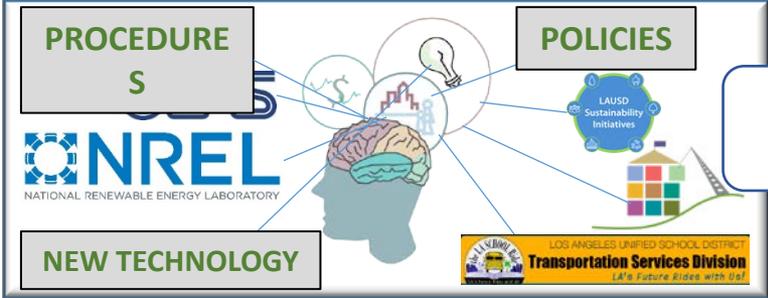
Conceive





1

Research & Develop



2

Collaborate



3

Implement

- Photovoltaic Systems
- On Site Energy Storage
- Interior/Exterior Lighting Upgrade (LED)
- Interior Lighting Controls
- Window Glazing
- HVAC System Upgrade
- HVAC System Upgrade
- Plumbing Fixture Upgrade
- High Performance Schools Certification
- Campus Ecology
- Smart Irrigation

4

LAUSD Sustainability Initiatives



ABOUT LAUSD



OUR COMMITMENT



THE ROAD AHEAD



THE JOURNEY



THE DESTINATION



THE ROAD AHEAD



ROAD TO ZNE LAND

ZNE UP AHEAD

Benchmarking	1/4
Utility Data Analysis	1 1/4
Design & Construction Strategies	2 1/4
Energy/Water Efficiency Measures	3 1/4
Essential Programs to ZNE	4 1/4

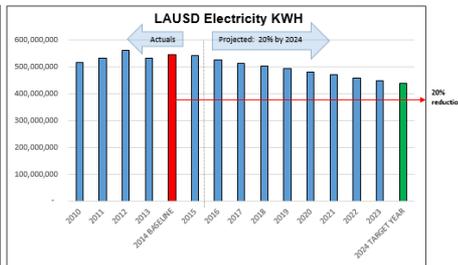
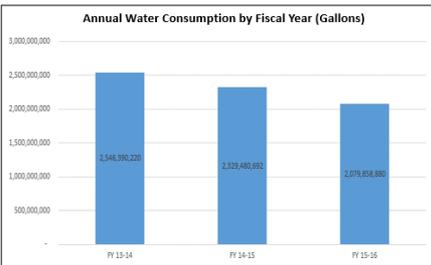
EXIT TO ZNE LAND



THE ROAD AHEAD

NAVIGATIONAL STRATEGIES

UTILITY DATA ANALYSIS



EFFICIENCY MEASURES

ENERGY EFFICIENCY MEASURES

- Lighting**
 - Interior Fixtures - Retrofit or Replacement, w/ Dimmable Ballasts
 - Exterior Fixtures - Retrofit or Replacement
 - Review Interior Lights for Daylight control and dimming.
- HVAC**
 - Air Handler & Package Units - Repair, Modify or Replace
 - Pumps, Economizers and VFDs - Repair, Replace or New
 - Adjust temperature set points
 - Revise equipment operating schedules
- Controls**
 - Energy Management Systems - HVAC
 - Chiller control upgrades
 - Occupancy & Daylight sensor - Repair, Replace or New
 - Lighting controls - interior & exterior lighting
- Plumbing**
 - Domestic Water Heaters - Repair, Modify or Replace
 - Consider Condensing or Tankless Water Heaters
 - Adjust temperature set points



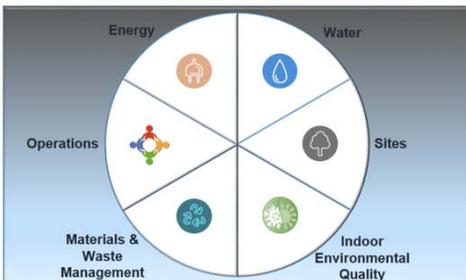
WATER EFFICIENCY MEASURES

- Outdoor Systems**
 - Drought-tolerant landscaping
 - Smart irrigation
 - Stormwater Management
- Controls**
 - Smart irrigation
- Plumbing**
 - Low flow plumbing equipment and fixtures



DESIGN / PROGRAM STRATEGIES

DESIGN & CONSTRUCTION



PROGRAM STRATEGIES



ESSENTIAL PROGRAMS TO ZNE

- High Performance Schools Certification
- Campus Ecology
- Photovoltaic Systems
- On Site Energy Storage
- Interior/Exterior Lighting Upgrade (LED)
- Interior Lighting Controls
- Window Glazing
- HVAC System Upgrade
- Plumbing Fixture Upgrade
- Smart Irrigation



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THE JOURNEY

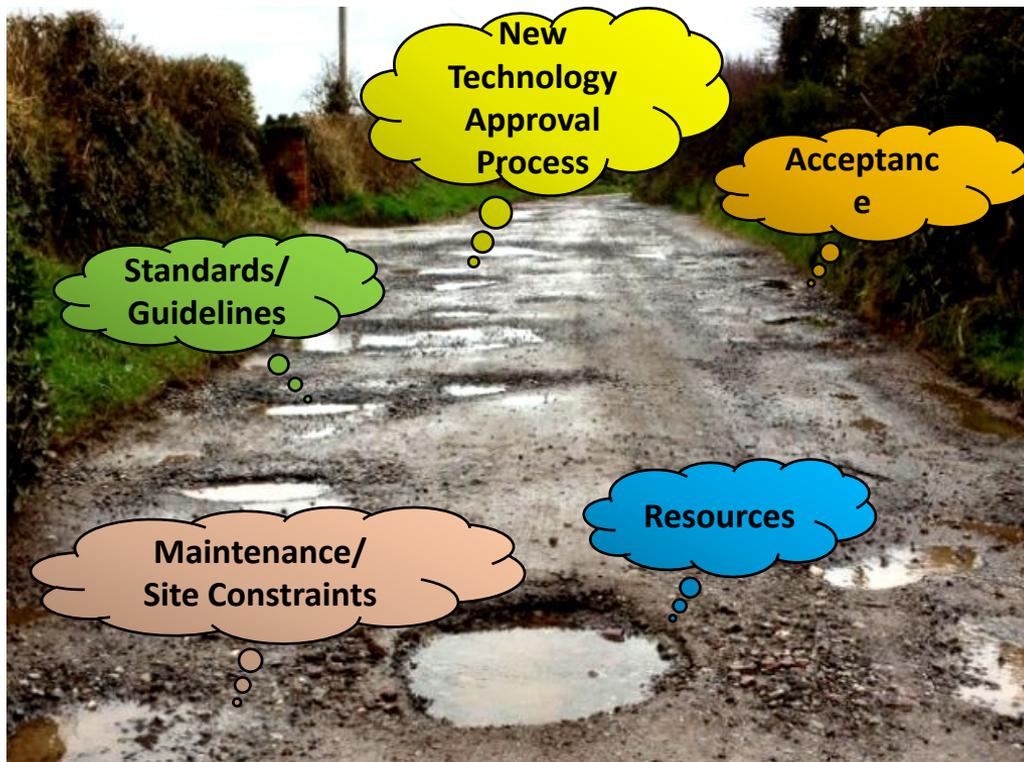


THE DESTINATION



THE JOURNEY

EXISTING CONDITIONS/CHALLENGES





THE JOURNEY



Siting

Photovoltaic Panels

Recycled Water System

ZNE COMPONENTS



Abundant Natural Lighting



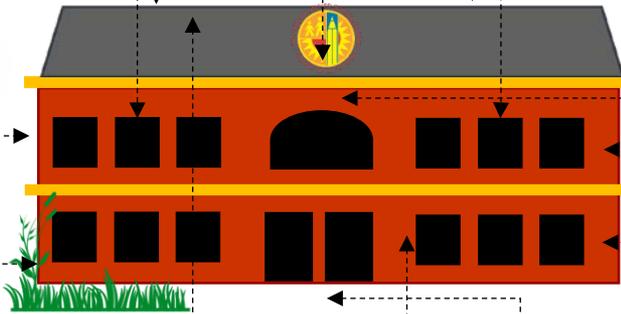
EMS System



Drought Tolerant Landscaping



Local and Central Temperature Control



Boiler Plant Upgrade



Overhangs & fins to control heat gain and glare



Low flow plumbing & fixtures



Daylight & Occupancy Sensors



LOW VOC Paints & Materials



Energy Star Rated Equipment



Low Power HVAC Equipment Upgrade



Geothermal Heat Exchange System



LED Lighting



THE JOURNEY

SOLVING THE PUZZLE





THE JOURNEY

LESSONS LEARNED



- **Engage**
 - Involvement of stakeholders in the design process
 - Engaging and leveraging partnerships
 - Incorporating site location's characteristics into design
- **Connect**
 - Behavioral transformation through shared sustainable practices
 - Integrating core High Performance design elements to sustainable systems
 - Effective use of High Performance features as teaching tools
- **Support**
 - Ongoing focus on sustainable building performance



ABOUT LAUSD



OUR COMMITMENT



THE ROAD AHEAD



THE JOURNEY



THE DESTINATION

MOVING TOWARDS ZNE



THE DESTINATION

**Photovoltaic Array-
Canoga Park HS**



Recycled Water System



**School Garden –
Fair ES**



- **Solar Program** - Generated capacity of 21.5 Million KWh enough to power 3,500 homes for a year.
- **Lighting/Controls Efficiency Program**– Replaced over 67,000 fixtures
- **Plumbing Fixture Retrofit Program (Low flow)** – Replaced 3,600 plumbing fixtures
- **High Performance Schools** – Certified 120 CHPS Projects – 6 LEED projects
- **School Gardens** – Over 600 schools with gardens
- **Prop 39** – \$120M invested in Energy Efficiency
- **LADWP MOU** – \$46M to be invested in Energy & Water Conservation
- **Prop 84 & DROPS** – \$6M To be invested in Water Conservation

LAUSD Sustainability Initiatives

SHOWCASE: SANTEE EDUCATION COMPLEX



THE DESTINATION



- High school facility in Central L.A.
- 1,940 students and 145 staff
- 338,079 sq. ft. of classrooms, library, gymnasium, office, auditorium building, athletic fields, and competition-size pool.
- One of the highest energy-consuming facilities in LAUSD.



**AWARENESS &
CONSERVATION**



**ENERGY
EFFICIENCY**



**RENEWABLE
ENERGY**



**ZERO NET
ENERGY**

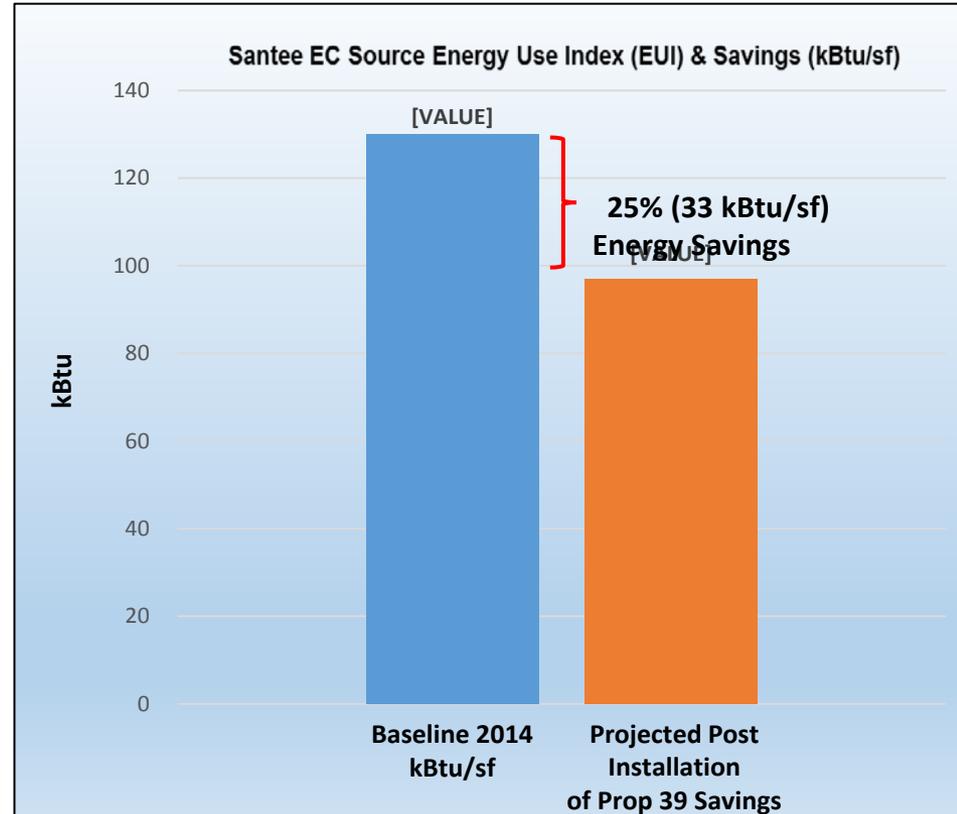


THE DESTINATION

ENERGY EFFICIENCY MEASURES



Prop 39 Savings Measures	Project Cost	Annual Expected Savings			
		Energy Cost	KwH	Therms	kBtu
Lighting upgrades and occupancy sensors installation	\$1,074,490	\$32,261	249,500		851,294
Exterior lighting upgrades	\$138,064	\$28,477	220,244		751,473
Energy management system upgrade	\$462,622	\$73,280	365,000		1,245,380
Domestic hot water pump set points and schedule	\$4,103	\$598	3,924		13,389
Hot boiler upgrade	\$445,564	\$3,588		4,839	483,900
Domestic hot water heater upgrade	\$200,720	\$822		1,109	110,900
Chiller VFD installation	\$129,707	\$3,594	27,796		94,840
Domestic hot water pumps VFD installation	\$107,350	\$387	2,990		10,202
Total	\$2,562,620	\$143,007	869,454		3,561,377
Total kBtu per sq. ft.					10.53
Source Energy Savings kBtu/ sq. ft.					33.08



Goal: 25% EUI reduction from 130 kBtu/sf (2014) to below 97 kBtu/sf by June 2017

* Santee EC = 338,079 sq. ft.



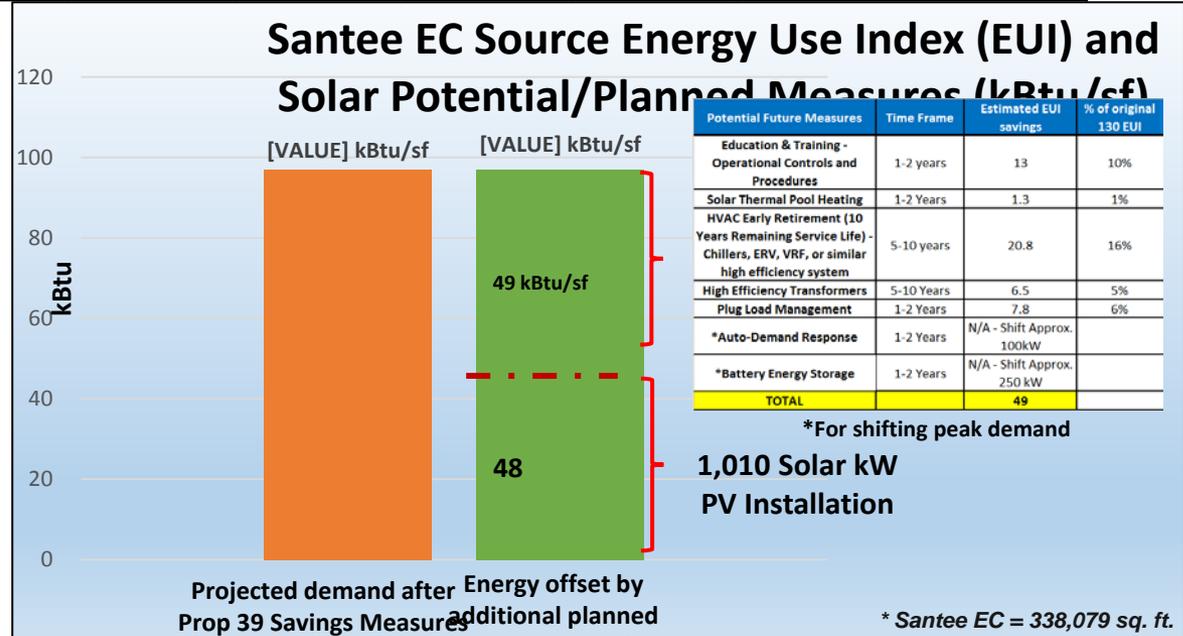
ZERO NET ENERGY



Energy Efficiency Measures	Project Cost	Annual Expected Savings					Required to reach ZNE
		Energy Cost	kWh	Source kBtu	Site kBtu	Source kBtu/sf	
Additional Planned Measures	\$2,600,000	\$216,645	1,546,235	16,565,871	5,275,755	49	Education and Training Mechanical Systems Upgrade Electrical Systems Upgrade
Solar Panel Installation	\$2,120,551	\$212,355	1,514,680	5,168,087	5,168,087	48	1,010 Solar kW
Total	\$4,720,551	\$429,000	3,060,915			97 kBtu/sf	



To reach ZNE, Santee EC will need 1,010 Solar kW of PV installation, along with additional energy efficiency measures.





THE DESTINATION

AWARDS & RECOGNITION

- **2016 Green Ribbon District Sustainability National Award** (US. Department of Education)
- **2016 Green Ribbon District Sustainability Award** (CA Department of Education)
- **2016/2017 LADWP Water Stewardship Award**
- **Green Ribbon School - Dorsey HS 2015**
- **Green Ribbon Gold Level - Westchester Environmental Science Magnet and Porter MS**



LAUSD Sustainability Initiatives



THE DESTINATION

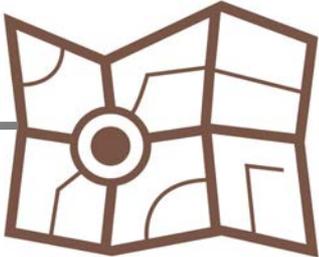
CALL TO ACTION



Begin by having a better understanding of your facility.



FACILITY SYSTEMS AND CONSERVATION AWARENESS



LOCATION AND SITE RESOURCES



CONSUMPTION PATTERNS AND BENCHMARKING



THE DESTINATION



DESTINATION

Resilience

Influence



**"Be the change you wish to see in the world."
- Mahatma Gandhi**

Transformation

Impact



THANK YOU!

A photograph of a vertical garden. Several clear plastic bottles have been repurposed as planters, hanging from a wooden surface. They contain various green plants and small white flowers. The background is a wooden wall.

Learning Green

LAUSD Sustainability Initiatives

Questions?

Website: learninggreen.laschools.org

Contact us by email: learninggreen@lausd.net

Telephone: (213) 241-1000

Policy Drivers for Sustainable Education Facilities

Joe Da Silva, PhD, AIA

Facilities Director

Rhode Island School Building Authority

“What the best and wisest parent wants for his child, that must we want for all the children of the community. Anything less is unlovely, and left unchecked, destroys our democracy.” *John Dewey*



Lead by Example: State Level ZNE



255 Westminster St
Providence, RI 02903

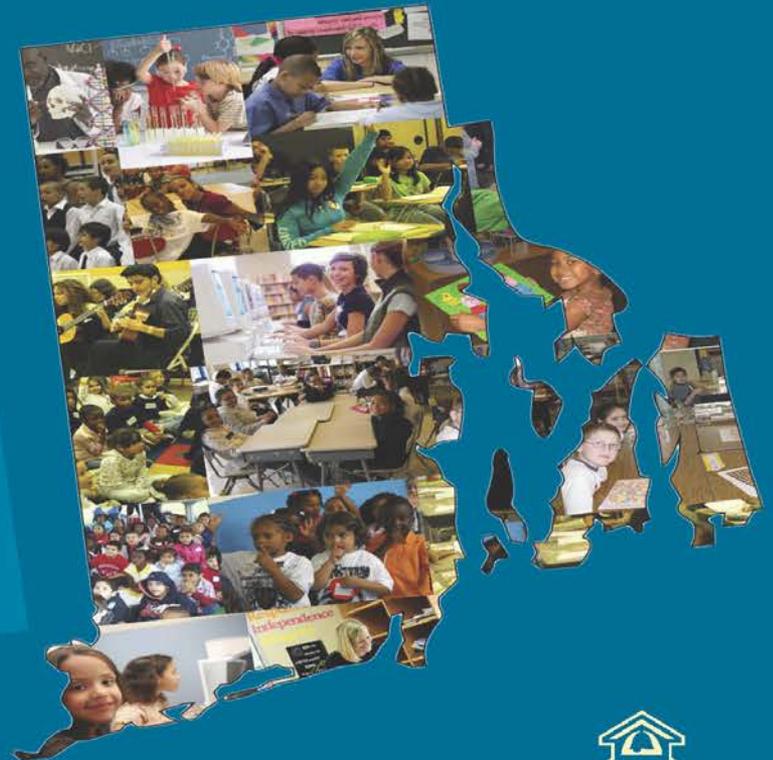
(401) 222-4600

Voice/TTY:
(800) 645-6575

Relay RI:
(800) 745-5555

WWW.RIDE.RI.GOV

Joseph da Silva, PhD, AIA.



RI School Building Authority

Rhode Island Department of Elementary and Secondary Education



Agenda

1. Keep the Main Thing, the Main Thing

- ZNE & Health
- ZNE & Cognition

2. Measure + Exposure

3. What, Why, & How

4. RI NRG Schoolhouse Assessment

- Action Plan
- Findings
- Conservation Measures



Keep Main Thing the Main Thing



Schoolhouses: *Teaching & Learning*

Schoolhouses are important to ensure that all students: **Achieve** at the high levels needed to lead fulfilling and productive lives; **Succeed** in Academics and Employment Settings; and **Contribute** to Democratic Society.



Schoolhouses have an effect on students ability to learn and teachers ability to teach. Quality buildings that are **thermally, acoustically, and visually comfortable** provide important benefits to students, educators, administrators, and the public.

Schoolhouse's can Shape How Students:

- Move
- Work
- Learn
- Interact
- Engage
- Transverse
- Communicate
- Identify
- Feel

“We shape our *schools* and afterwards our *schools* shape us” *Winston Churchill*



Schoolhouses Speak to Students

**Not in words, but in
Colors, Shapes, Textures, & Physical Climate:**

**Delightful vs. Confusing
Wondrous vs. Depressing
Welcoming vs. Hostile
Inspiring vs. Fearful**

**Open vs. Closed
Bright vs. Dark
Dry vs. Damp
Clean vs. Dirty
Fresh vs. Moldy**



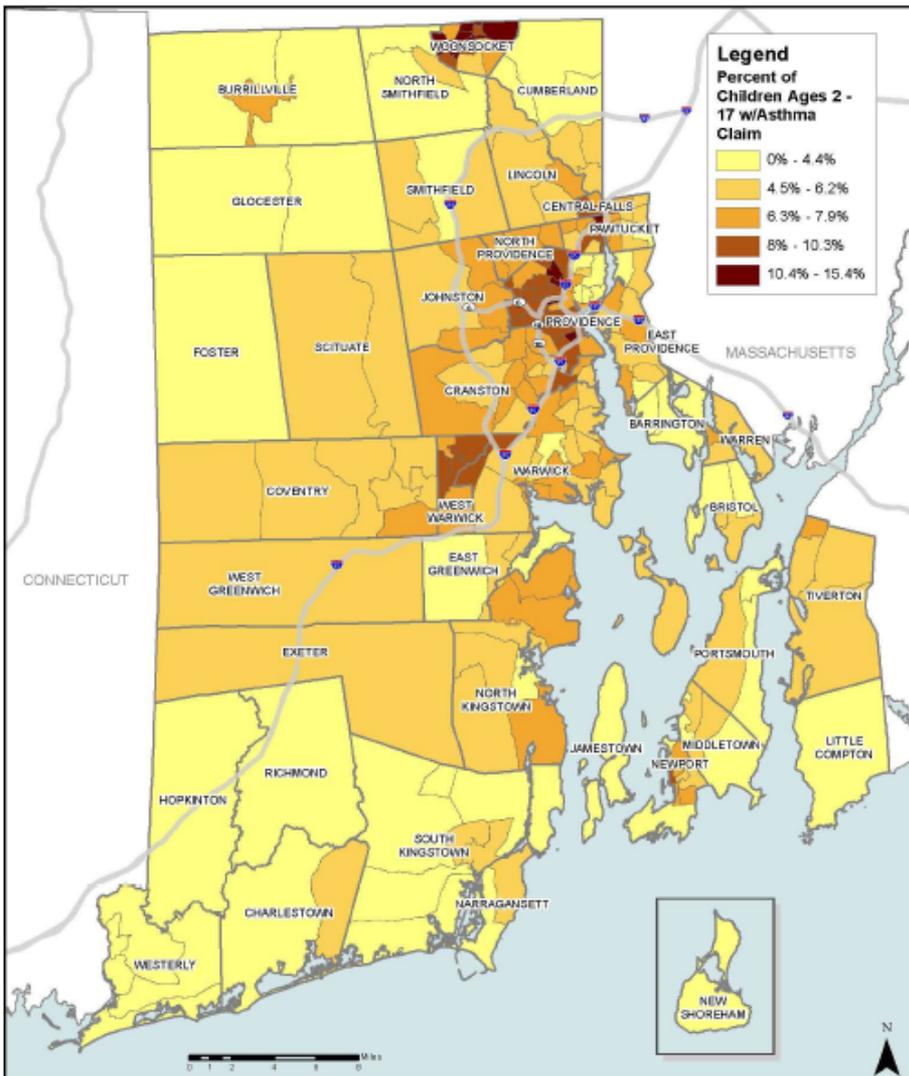
Schoolhouses & Absenteeism



Energy & Health



Percent of Children Ages 2-17 with an Asthma Claim*, 2010-2012, Three-Year Average



Who Has Asthma?

- 1 in 10 in RI have asthma
- Asthma is the most common chronic disease in children
- RI childhood asthma rates are 40% higher than national averages
- There are significant health disparities for asthma

* Asthma diagnosis in diagnosis fields 1-6 (UHC) or 1-4 (BCBSRI and NHPRI) on any claims form, ICD-9-CM 493.xx

Asthma Triggers & Energy



Common asthma triggers impacting schools :

- Pests (cockroaches, mice, rats)- **Doors, Openings**
- Mold (**leaking roofs, pipes, no ventilation**)
- Dust mites (**clutter, HVAC systems, carpets**)
- Particulate matter (**exhaust, pollution, Filters**)
- Chemical cleaners or scented products (**ventilation**)
- Extreme temperatures, air quality alert days, (**Heating**)
- Allergens (**latex, pollen, Filters**)
- Infection (**Ventilation**)

Schoolhouses & Retention

Adequate and Equitable facilities are a necessary part of a thorough and efficient education system



Measure & Expose



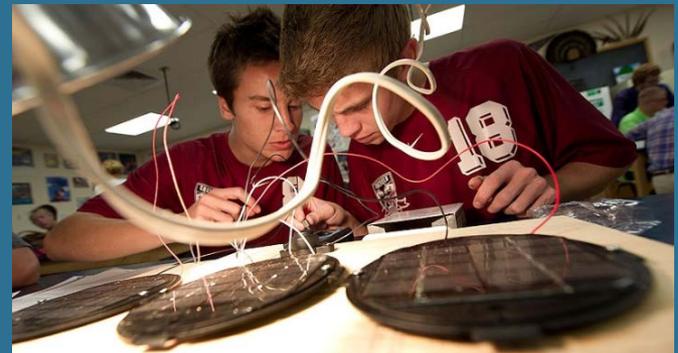
What We Did

- Surveyed 307 Schools
- 24.435 million ft²
- Derived Utility Cost Data from UCOA Data
- Benchmarked Energy Use for each school
- Assessed the Condition of Energy Consuming Equipment
- Identified Energy Conservation Measures
- Defined Action Plans to Achieve Net Zero Energy for Each School
- Identified Funding Sources & Execution Strategies



Why We Did This

- Student & Staff Health
- Significantly Reduce Energy \$
- Net Zero Energy Schools
- Avoid Energy Volatility \$
- Reduce O&M Costs
- Improve Cognitive Performance
- Improve Student Learning
- Create Living Laboratories
- Demonstrate Institutional Values
- Preserve & Current Staff & Academic Programs



Opportunities...Opportunities...Opportunities

How Did We Do It

- Entered Conditions Data into Handheld
- Energy Engineers Filtered UCOA Utility Data
- Utility Consumption Derived from Cost Data based on Assumptions
- Calculated EUI & \$/ft² for each School
- Identified Energy Conservation Measures
- Defined Action Plans to Achieve Net Zero Energy
- Estimated Costs, Savings & simple payback period
- Utilized Potential Contractors
- Solicited Incentives & Funding Sources



RI Energy Schoolhouse Assessment

Key information analyzed for 300 plus schools:

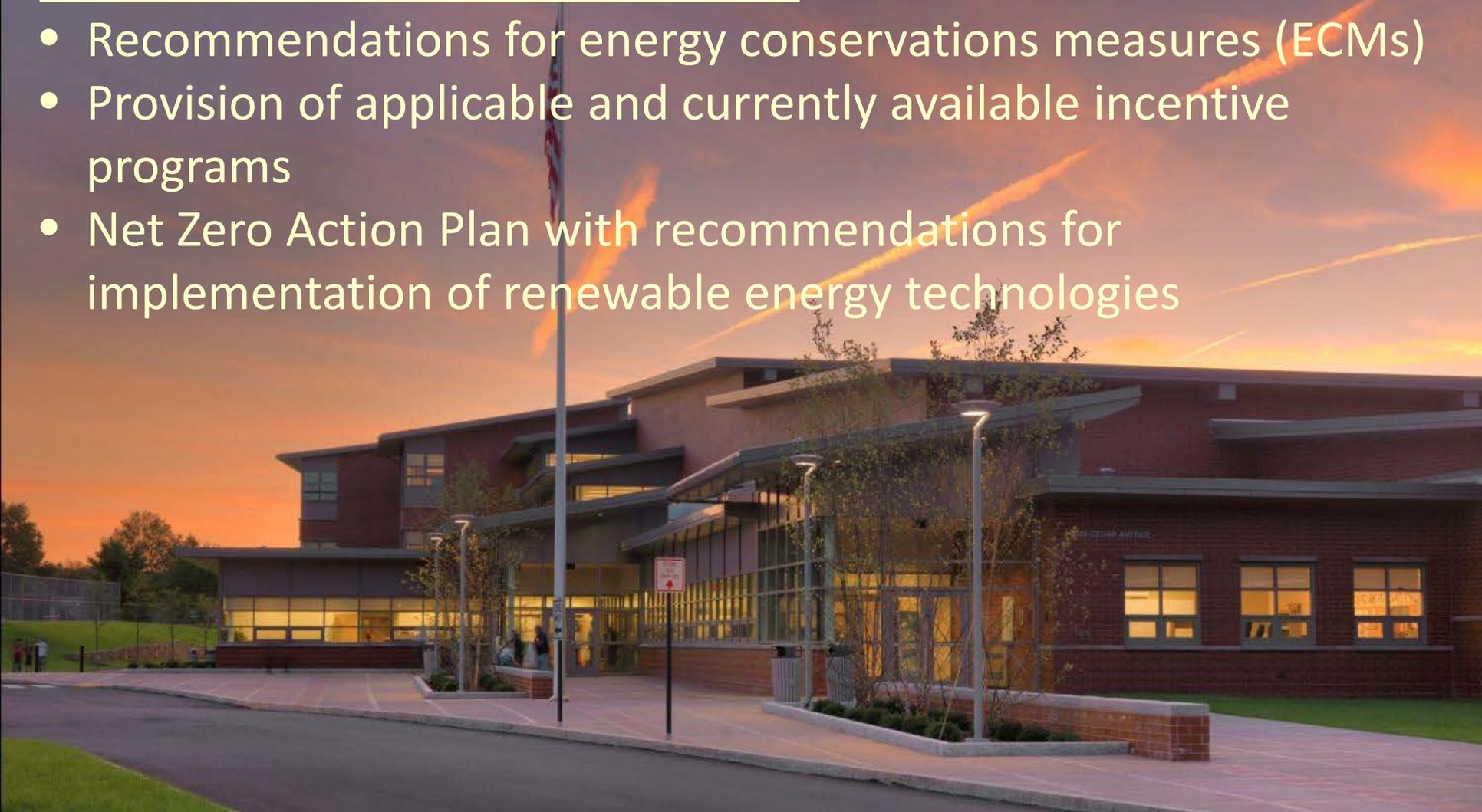
- Stated energy cost assumptions
- RIDE uniform chart of accounts (available data)
- Key utility cost and consumption benchmarks from 2011 - 2014
- Energy use index – determination of each school's Energy Use Index (BTU/FT²/year)
- Peer comparison – comparison of each school's EUI to the RIDE average
- Evaluation of the energy efficiency of existing systems



Energy Schoolhouse Assessment (cont'd)

Key results for each school include:

- Recommendations for energy conservations measures (ECMs)
- Provision of applicable and currently available incentive programs
- Net Zero Action Plan with recommendations for implementation of renewable energy technologies



Zero Net Energy Action Plan

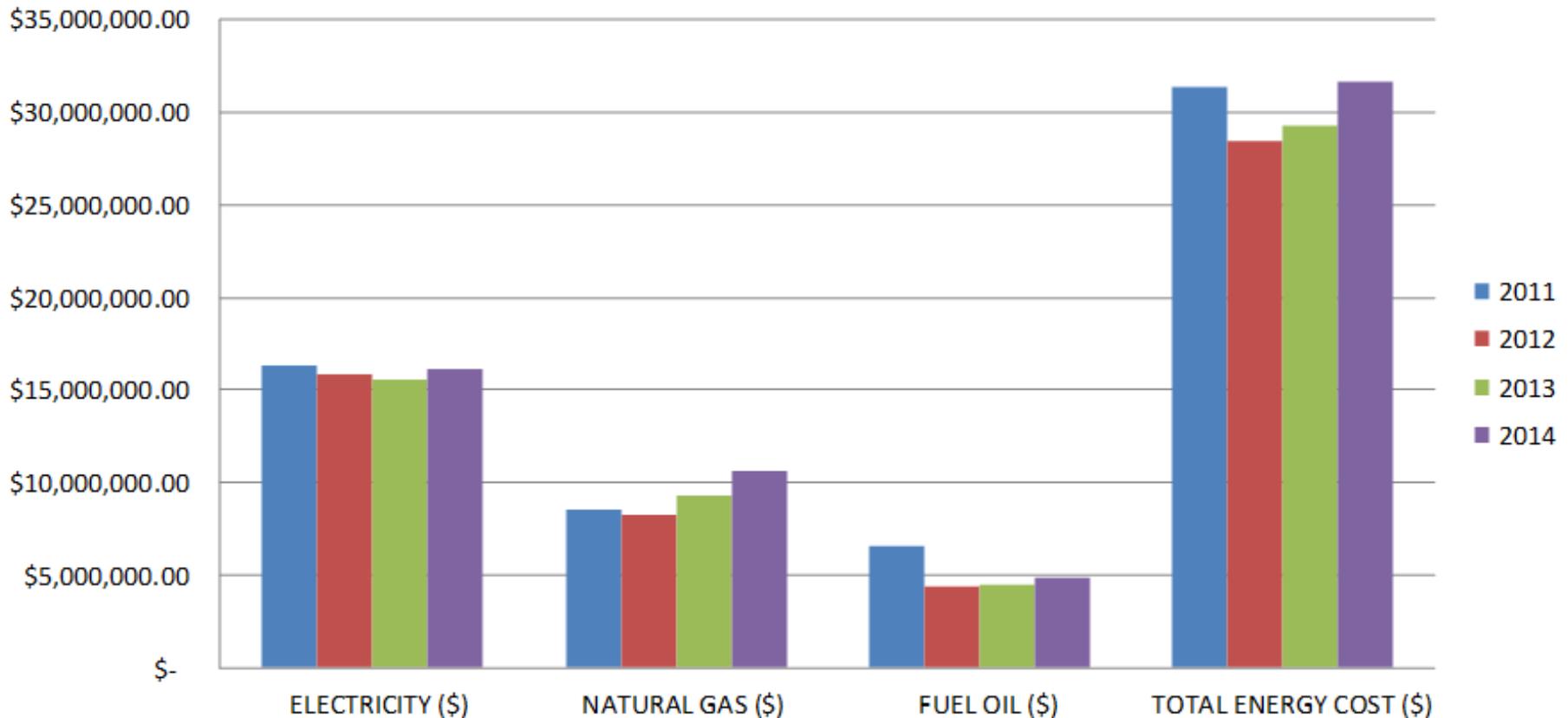
- Express Core Values by Example
- Integrate with Master Plans
- Energy Efficiency / Optimization Projects
 - LED Lights
 - Building Automation Systems
 - Energy Recovery Ventilation (ERVs)
- Installation of Solar Photovoltaics
- Migrate to Ground Source Heat Pumps
- Public Private Partnerships
- Reduce Utilities Cost to Zero
- Curriculum Integration of Net Zero



Findings

- Rhode Island 4th highest AVG. Electric Rate in US 18.69 cents/kWh
- Avg. EUI 45.2 -60.7 vs. US Avg. 58.2
- Energy Costs \$33.6 Million
- Avg. Age of School 62 Years +/- 30
- Avg. School Energy Cost \$1.48/ft²

RI PUBLIC SCHOOLS ENERGY COST PROFILE





NATIONAL COUNCIL ON SCHOOL FACILITIES

States Advancing Effective K-12 Policy, Planning, and Practice

State Maintenance & Operations of Plant FY 2011–2013 (in 2014\$)

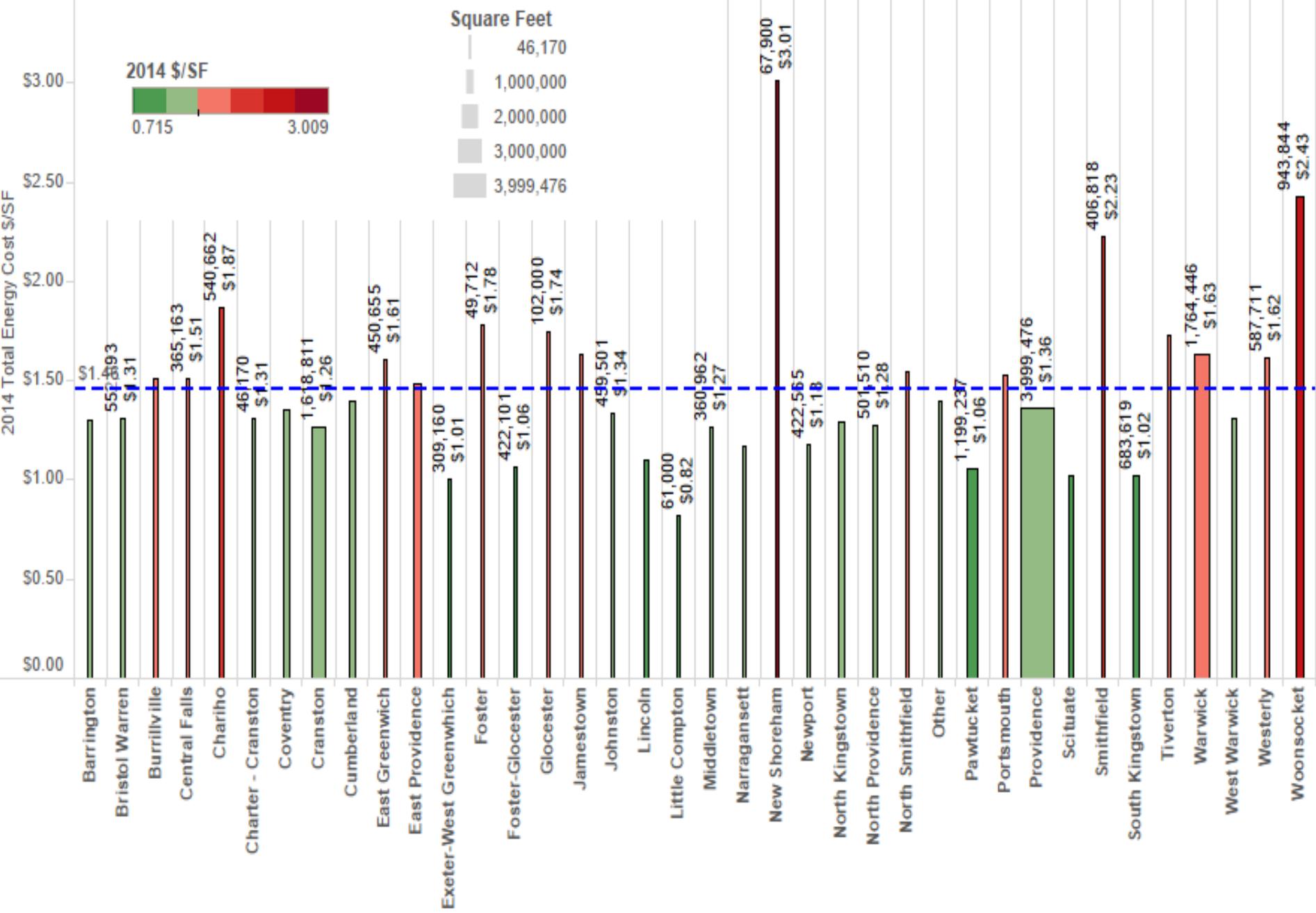
Annual Average	\$167 M
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	ELECTRICITY (\$)	NATURAL GAS (\$)	FUEL OIL (\$)	TOTAL ENERGY COST (\$)
2011	\$17,434,845.96	\$9,104,285.94	\$7,118,687.76	\$33,657,819.66
2012	\$15,833,735.46	\$8,282,212.55	\$4,347,688.61	\$28,463,636.62
2013	\$15,575,733.04	\$9,283,844.69	\$4,475,885.61	\$29,335,463.34
2014	\$16,118,947.03	\$10,668,684.41	\$4,900,188.61	\$31,687,820.05

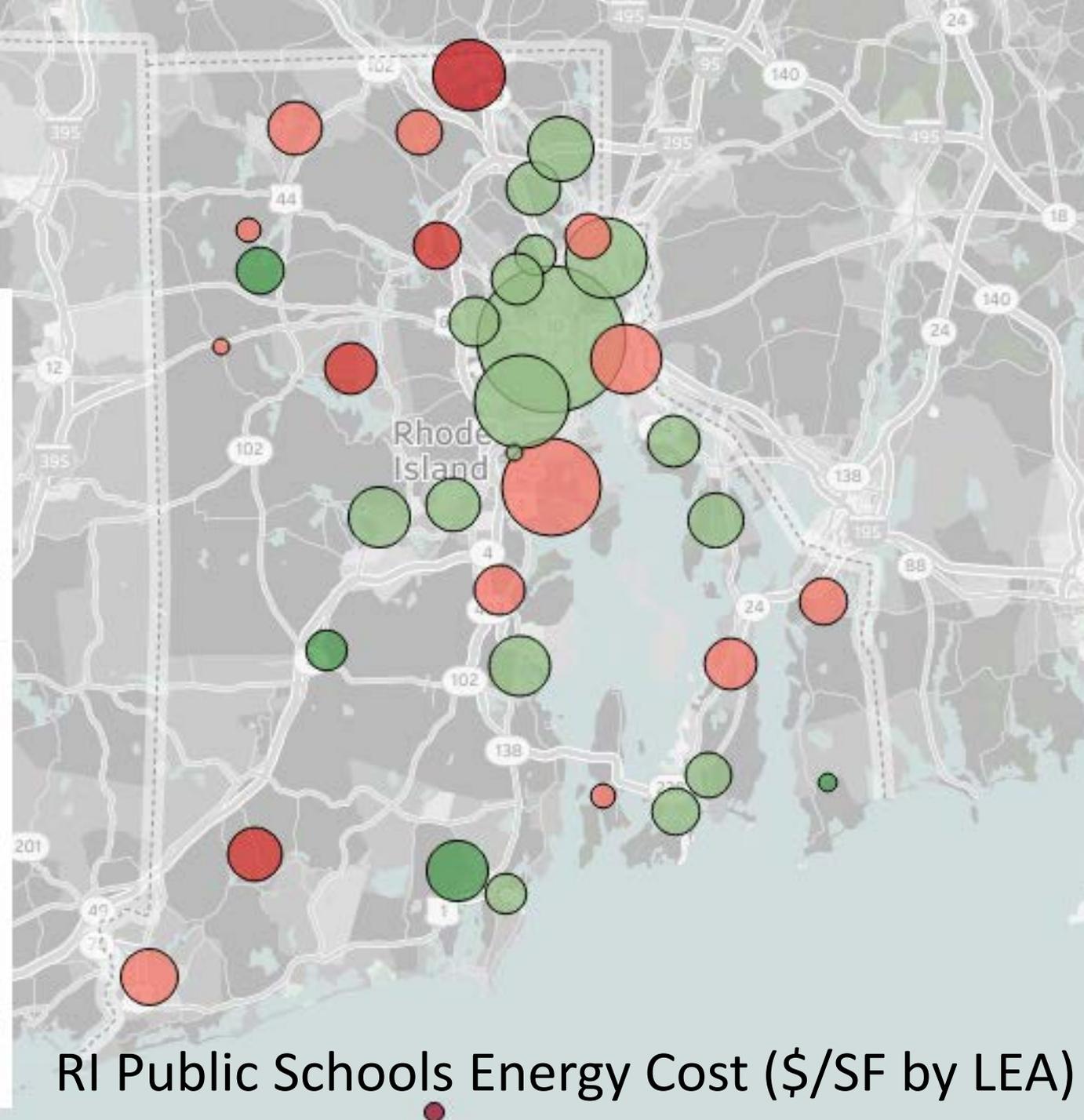
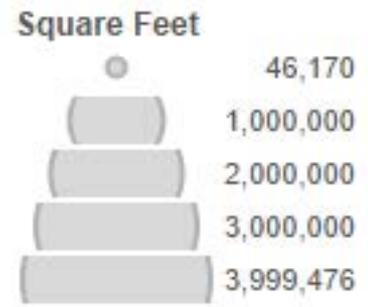
operating budgets on “Maintenance and Operation of Plant,” which includes cleaning, routine and preventive maintenance, minor repairs, utilities, and school security. During this period, Rhode Island school districts spent 8.2% of their total operating funds on maintenance and operations.

2014 Energy Cost/\$F by District

RI Public Schools Energy Consumption Findings



Total Annual Energy Cost per SF by District



RI Public Schools Energy Cost (\$/SF by LEA)

Energy Conservation Projects

LED Lighting Retrofits:

- Reduce Lighting Electricity by 30%
- Takes Advantage of Existing Lighting Controls
- Optimizes the use of natural daylight

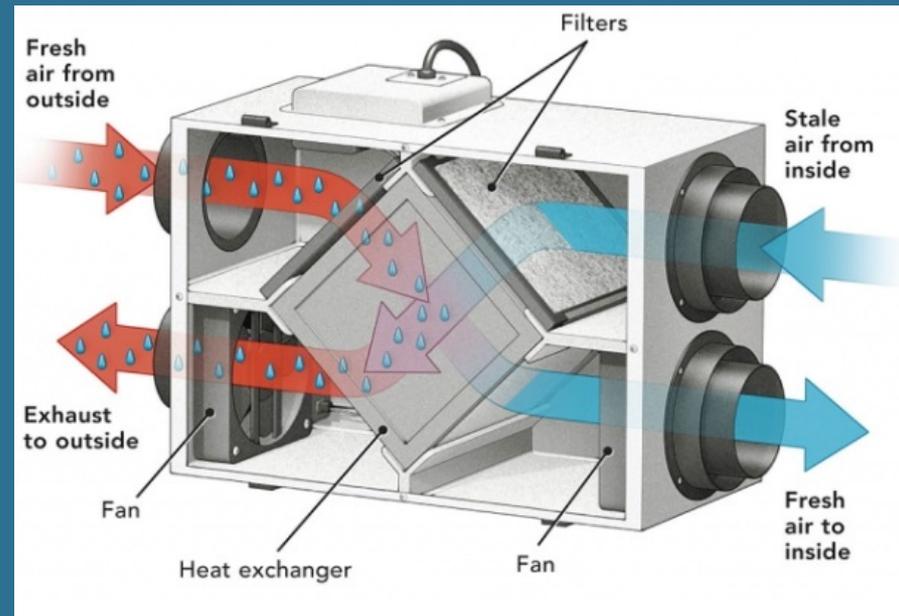
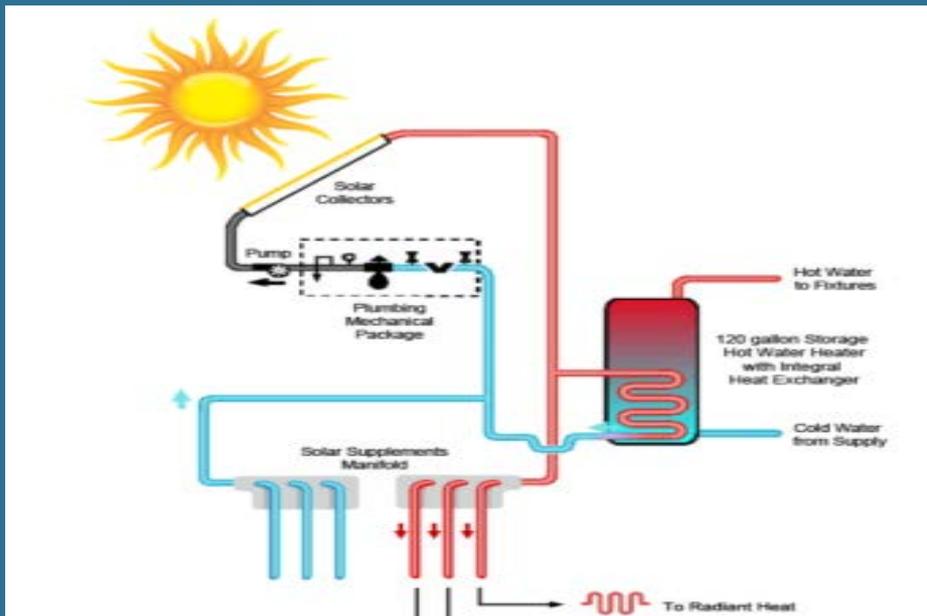
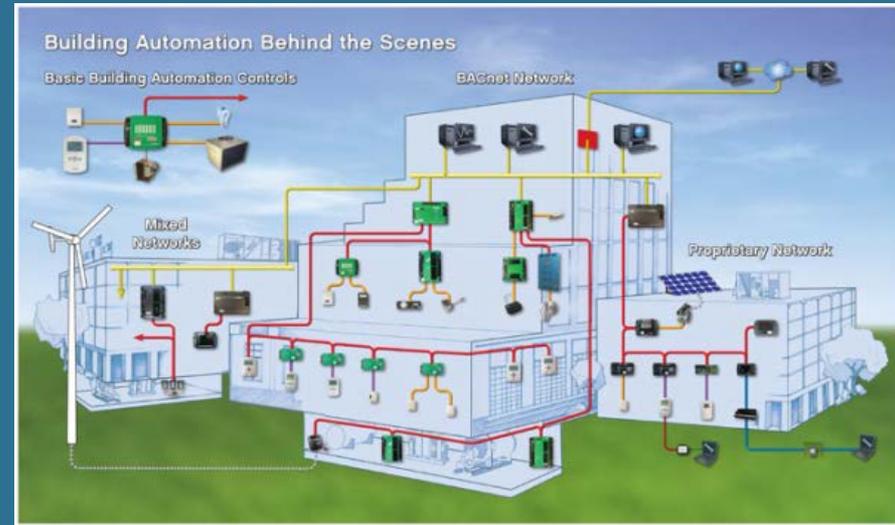
Building Automation:

- Reduces heating energy by up to 10%
- Turns unnecessary equipment off
- Turns thermostats down when unoccupied
- Allows scheduling for vacations and holidays
- Reduces associated electrical energy by 5%



Next Gen - Energy Conservation Measures

- Broader Benefits
- Better for Student Learning
- Longer Pay Back Periods
- Building Automation Systems
- Energy Recovery Ventilation
- LED Lighting Retrofit
- Solar Assisted Domestic Hot Water



Total Need PV Solar Needed

- Enough to generate 106 million +/- kWh/year
- App. 70-80 Megawatts of PV arrays
- Approximate Cost \$300 Million (before incentives)
- Annual Savings – App. \$15.9 Million/Year



Steps Toward 0_{net}

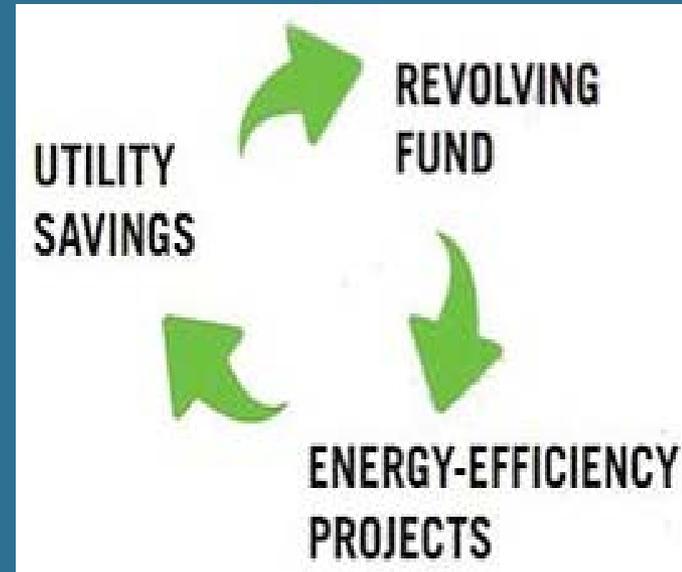
- ASHRAE Level 2 & 3 Audits
- Bundle ECMs
 - Building Automation System
 - Energy Recovery Ventilation
 - LED Lighting Retrofits
- Bundle Net Zero Energy Measures
 - Solar Assisted Domestic Hot Water Heaters
 - Geothermal Heat Pumps
 - Solar PV

Funding 0_{net} Energy

RIIF- Established a revolving loan fund

LEAs Borrow from fund to implement Net Zero Action Plan

Derived savings repay the loan fund



$$C (EE + RE) = ZNE$$

Conservative Use of Energy

Operation
Culture

“School
as a tool”



NRG
Efficiency

Renewables NRG

Thank You!!



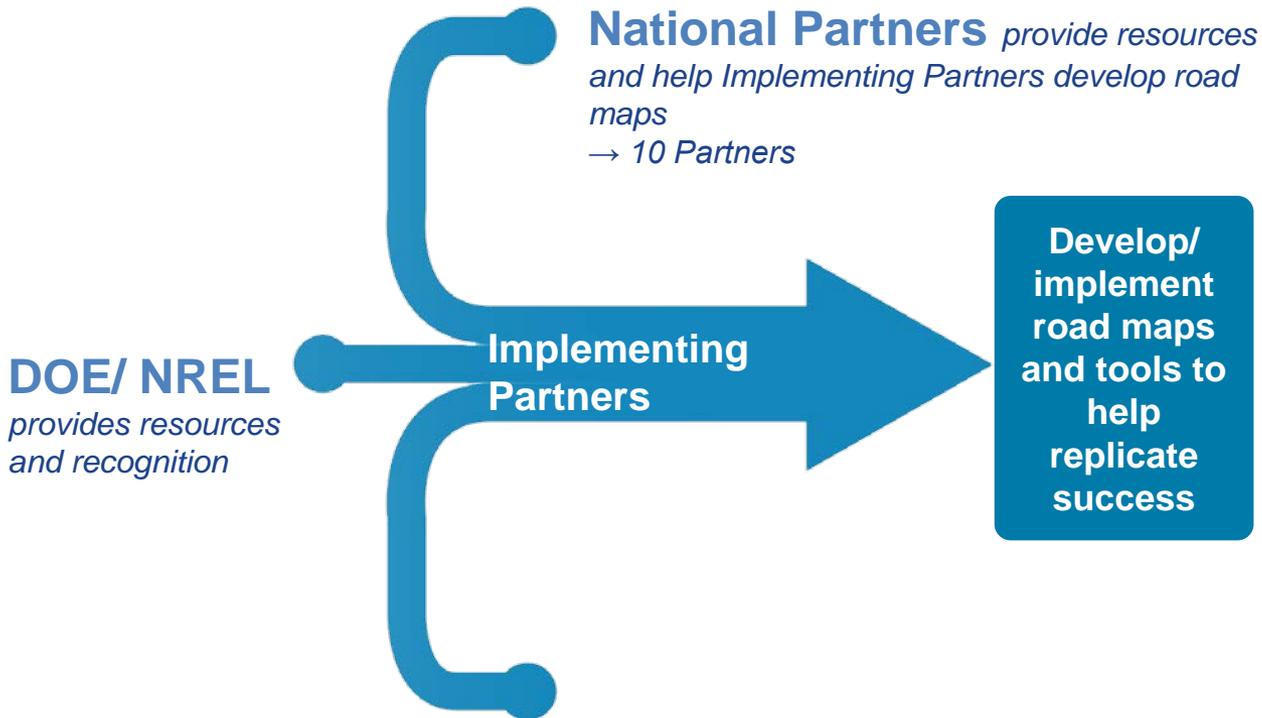
Joseph da Silva, PhD, AIA
Department of Education
RI School Building Authority
(401) 222-4294
Joseph.dasilva@ride.ri.gov
Website: www.ride.ri.gov/sba



Zero Energy Schools Accelerator

Vision

K-12 school buildings provide healthy, dynamic learning environments and resilient community assets that have zero to minimal energy costs.



BBC K-12 School District Partners



- Alachua County Public Schools
- Albuquerque Public Schools
- Anne Arundel County Public Schools
- Aurora Public Schools
- Bullitt County School District
- Camas School District
- Douglas County School District
- Dysart Unified School District No. 89
- Evergreen School District
- Fairfax County Public Schools
- Fort Atkinson School District
- Garnet Valley School District
- Hillsboro School District
- Houston Independent School District
- Huntsville City School District
- Indian River Central School District
- Indianapolis Public Schools
- Kansas City Public Schools
- Los Angeles Unified School District
- Manchester School District
- Mesa County Valley School District 51
- Parkway School District
- Portland School District
- Poudre School District
- River Trails School District 26
- Tulsa Public Schools
- Xenia Community Schools

Thank You

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