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
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
What is a classroom?
human graph on bike walk to school day - Ms Cs 2nd grade @DiscoveryESPTA @DiscoveryAPS @ATPcommutes @MissCoulouris

Natural light, atrium windows are Awesome to students @RussoErin @vmdoarchitects @PhilipDonovan
WE WILL DO OUR BEST TO MAKE OUR EARTH HEALTHIER & TO MAKE OUR SCHOOL A BETTER PLACE
Axis, orbit, equator, math, science, history and the Pantheon!
This is their school | Student ownership of their learning
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
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

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

Emerging Technologies

Focus Areas

Awareness & Outreach

High Performance Schools

Energy Conservation

Campus Ecology

Water Stewardship

Emerging Technologies

LAUSD Sustainability Initiatives

ABOUT LAUSD

Focus Areas
LAUSD Sustainability Initiatives

http://learninggreen.laschools.org
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
LAUSD Sustainability Initiatives

EXTERNAL PARTNERSHIPS

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

OUR COMMITMENT

LAUSD Sustainability Initiatives
LAUSD Sustainability Initiatives

**PLANNING & IMPLEMENTATION STRATEGY**

1. **Conceive**
   - Photovoltaic Systems
   - On Site Energy Storage
   - Interior/Exterior Lighting Upgrade (LED)
   - Interior Lighting Controls
   - Window Glazing
   - HVAC System Upgrade

2. **Research & Develop**
   - HVAC System Upgrade
   - Plumbing Fixture Upgrade
   - High Performance Schools Certification
   - Campus Ecology
   - Smart Irrigation

3. **Collaborate**
4. **Implement**

**OUR COMMITMENT**
**LAUSD Sustainability Initiatives**

**ROAD TO ZNE LAND**

### THE ROAD AHEAD

<table>
<thead>
<tr>
<th>Stage</th>
<th>Mileage</th>
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<tbody>
<tr>
<td>Benchmarking</td>
<td>¼</td>
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<tr>
<td>Utility Data Analysis</td>
<td>1 ¼</td>
</tr>
<tr>
<td>Design &amp; Construction Strategies</td>
<td>2 ¼</td>
</tr>
<tr>
<td>Energy/Water Efficiency Measures</td>
<td>3 ¼</td>
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<tr>
<td>Essential Programs to ZNE</td>
<td>4 ¼</td>
</tr>
</tbody>
</table>

**EXIT TO ZNE LAND**

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LAUSD Sustainability Initiatives
NAVIGATIONAL STRATEGIES

UTILITY DATA ANALYSIS

ENERGY EFFICIENCY MEASURES
- Lighting
  - Outdoor fixtures: Retrofit or replacement of incandescent with LED
- HVAC
- Controls
- Plumbing

WATER EFFICIENCY MEASURES
- Agriculture
- Smart irrigation
- Electronic Management

DESIGN / PROGRAM STRATEGIES

PROGRAM STRATEGIES
- Solar
- High Efficiency HVAC
- User Controls
- Operational Performance
- Lighting
- Building Envelope Energy Consumption

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
EXISTING CONDITIONS/CHALLENGES

CAUTION UP AHEAD

- Standards/Guidelines
- New Technology Approval Process
- Acceptance
- Resources
- Maintenance/Site Constraints
ZNE COMPONENTS

- Low flow plumbing & fixtures
- Recycled Water System
- Photovoltaic Panels
- EMS System
- Abundant Natural Lighting
- Local and Central Temperature Control
- Drought Tolerant Landscaping
- Boiler Plant Upgrade
- Overhangs & fins to control heat gain and glare
- Daylight & Occupancy Sensors
- Low flow plumbing & fixtures
- Low Power HVAC Equipment Upgrade
- Energy Star Rated Equipment
- Geothermal Heat Exchange System
- LED Lighting
- LOW VOC Paints & Materials
- THE JOURNEY

Low Power HVAC Equipment Upgrade

Overhangs & fins to control heat gain and glare

Daylight & Occupancy Sensors
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
LAUSD Sustainability Initiatives

• **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

MOVING TOWARDS ZNE

- Photovoltaic Array - Canoga Park HS
- Recycled Water System
- School Garden – Fair ES

THE DESTINATION
SHOWCASE: SANTEE EDUCATION COMPLEX

- 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
**Energy Efficiency Measures**

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

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

Total kBtu per sq. ft. 10.53

Source Energy Savings kBtu/ sq. ft. 33.08

Baseline 2014 kBtu/sf

Projected Post Installation of Prop 39 Savings

25% (33 kBtu/sf) Energy Savings

*Santee EC = 338,079 sq. ft.*
To reach ZNE, Santee EC will need 1,010 Solar kW of PV installation, along with additional energy efficiency measures.
• 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
Begin by having a better understanding of your facility.
“Be the change you wish to see in the world.”
- Mahatma Gandhi
THANK YOU!

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

Joseph da Silva, PhD, AIA.

RI School Building Authority
Rhode Island Department of Elementary and Secondary Education
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 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
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
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
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)
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 & $/ft^2 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
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
Key results for each school include:

- Recommendations for energy conservation 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
## State Maintenance & Operations of Plant


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

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.
RI Public Schools Energy Consumption Findings

2014 Energy Cost/SF by District

Square Feet
- 46,170
- 1,000,000
- 2,000,000
- 3,000,000
- 3,999,476

2014 $/SF
- 0.715
- 3.009

Total Energy Cost/SF

Barrington $1.493
Bristol $1.331
Burrlilville $1.813
Charlton $1.515
Charter - Cranston $1.970
Cohasset $1.268
Cumberland $1.611
East Greenwich $1.347
East Providence $1.826
Exeter $1.010
Foster $1.782
Glocester $1.068
James Chases $1.742
Johnston $1.343
Lincoln $1.227
Little Compton $1.273
Middletown $1.068
Narragansett $1.180
New Shoreham $1.180
Newport $1.200
North Kingston $1.130
North Providence $1.190
North Smithfield $1.360
Other $1.065
Pawtucket $1.027
Portsmouth $1.230
Providence $1.360
Smithfield $1.027
South Kingston $1.630
Tiverton $1.630
Warwick $1.630
West Warwick $1.630
Westerly $1.630
Woonsocket $2.430
Total Annual Energy Cost per SF by District

Annual $/SF
0.715 3.009

Square Feet
46,170
1,000,000
2,000,000
3,000,000
3,999,476

2016 Household Income (median)
0 to 35,600
35,600 to 46,700
46,700 to 59,300
59,300 to 78,300
78,300 to 501,000

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\textsubscript{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\textsubscript{net} Energy

RIIF- Established a revolving loan fund
LEAs Borrow from fund to implement Net Zero Action Plant
Derived savings repay the loan fund
C (EE + RE) = ZNE

Conservative Use of Energy

Operation
Culture

"School as a tool"

Renewables NRG

NRG Efficiency
Thank You!!

Joseph da Silva, PhD, AIA
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Joseph.dasilva@ride.ri.gov
Website: www.ride.ri.gov/sba
**Vision**
K-12 school buildings provide healthy, dynamic learning environments and resilient community assets that have zero to minimal energy costs.

**National Partners** provide resources and help Implementing Partners develop road maps → 10 Partners

**DOE/ NREL** provides resources and recognition

Develop/implement road maps and tools to help replicate success
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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