VanDusen Botanical Gardens Visitor Centre, Vancouver, BC | Credit: Nic Lehoux

Metropolitan Washington Regional Schools Roundtable on Energy

Reilly Loveland
Project Manager | New Buildings Institute

November 27, 2018

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Linking Energy Benchmarking and Strategic Planning to Co-benefits

Why Zero Energy Schools?

- The next evolution in sustainable, high performance buildings
- Cost avoidance from utility bills to classroom
- Create comfortable and productive environment for teachers and students
- Provide hands-on, tangible learning opportunities for 21st century skills
- Make schools and communities stronger, resilient and energy independent

Hood River School District Science Building | Hood River, OR
Photo Courtesy of Opsis Architecture

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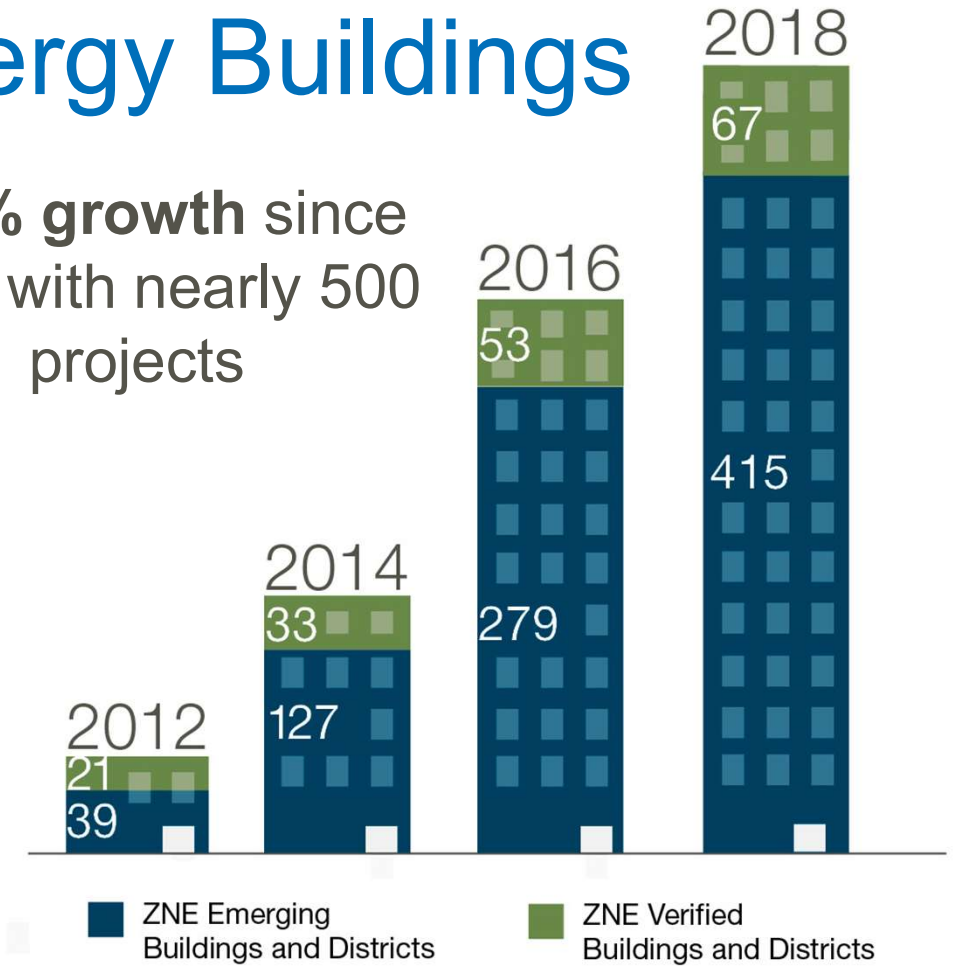
2018 List of Zero Energy Buildings

700% growth since 2012 with nearly 500 projects



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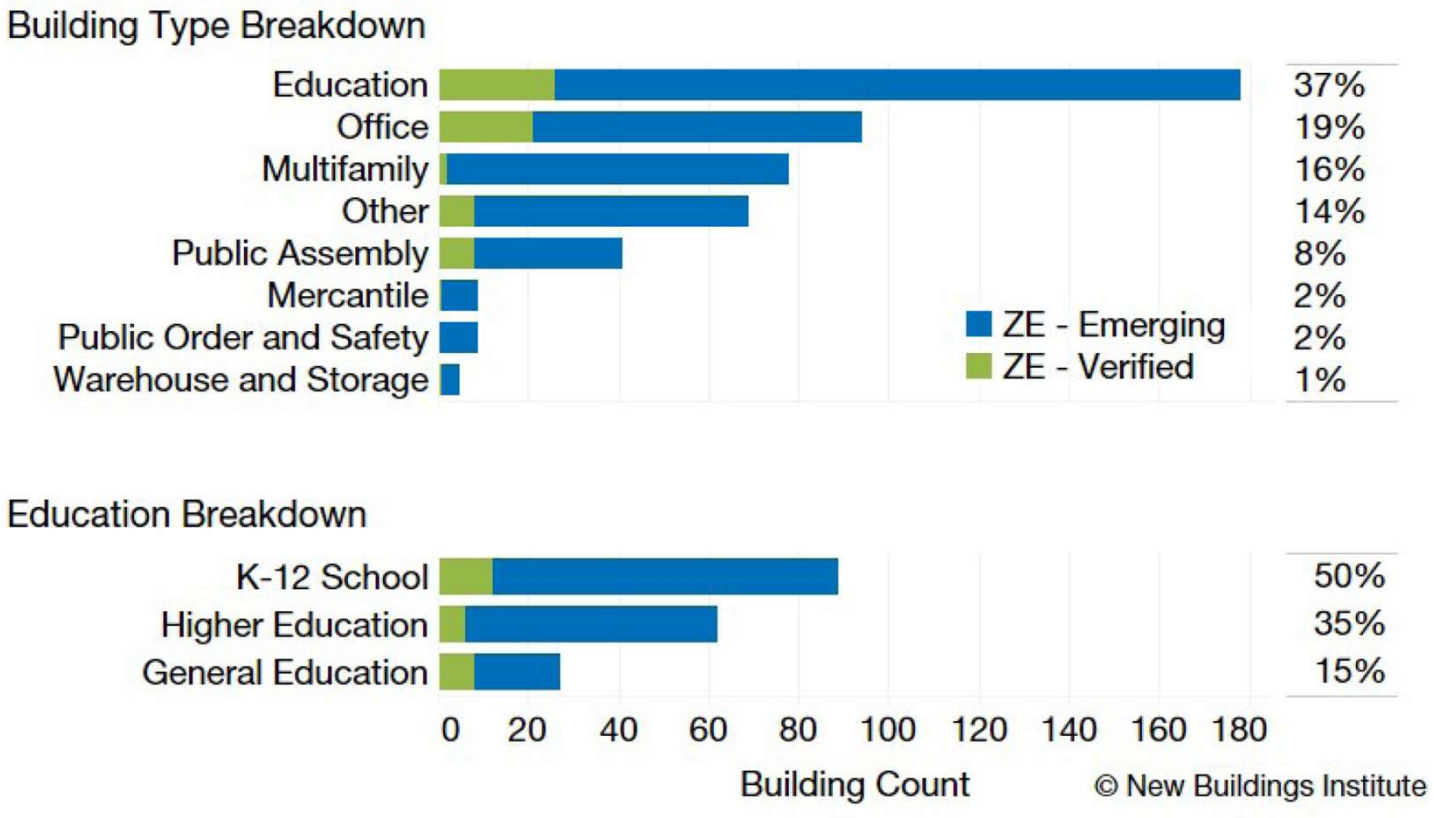
Schools are Leading in Zero Energy



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Process to Achieve Zero Energy

Kathleen Grimm School, PS 62 | New York, NY
Photo Courtesy: James Ewing

- Get stakeholder support
- Make a commitment
- Set energy targets
- Integrate targets into policies and contracts
- Use an integrated design process
- Design/construct to target
- Optimize operations
- Measure and verify

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Getting to Zero Energy in Schools

Redding School for the Arts | Redding, CA
Photo Courtesy: TRILOGY Architecture

While ZE is a realistic end game, the path to sustainable, zero net energy schools is a process that will take time to accomplish.

School districts can start now with benchmarking, energy targets, policies, plans and practices on the path to zero.

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Benefits of High Performance Schools

- Occupants in ventilated spaces with low CO2 and low volatile organic compounds (VOCs) had improved scores in crisis response, information usage, and strategy ranging from 100 to 300%.[1]
- Students in daylit environments showed a 20-26% improvement on test scores compared to traditionally lit environments[2].
- Students with operable windows progressed 7-8% faster than those without operable windows[2].
- Students with the most daylighting performed 7-18% better in math and reading than those without[2].
- Students exposed to daylight attended school 3.2 to 3.810 more days per year[3]

Discovery Elementary School | Arlington, VA
Photo Courtesy of VMDO Architects

1. Bakó-Biró, Zs., Kochhar, N., Clements-Croome, D.J., Awbi, H.B. & Williams, M. (2007, January). Ventilation Rates in Schools and Learning Performance. https://www.researchgate.net/publication
2. Heshong Mahone Group. (1999, August 20). Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance. http://h-m-g.com/downloads/Daylighting/schoolc.pdf
3. Healthy Schools Network, Inc. (2012) Daylighting. http://www.healthyschools.org/downloads/Daylighting.pdf

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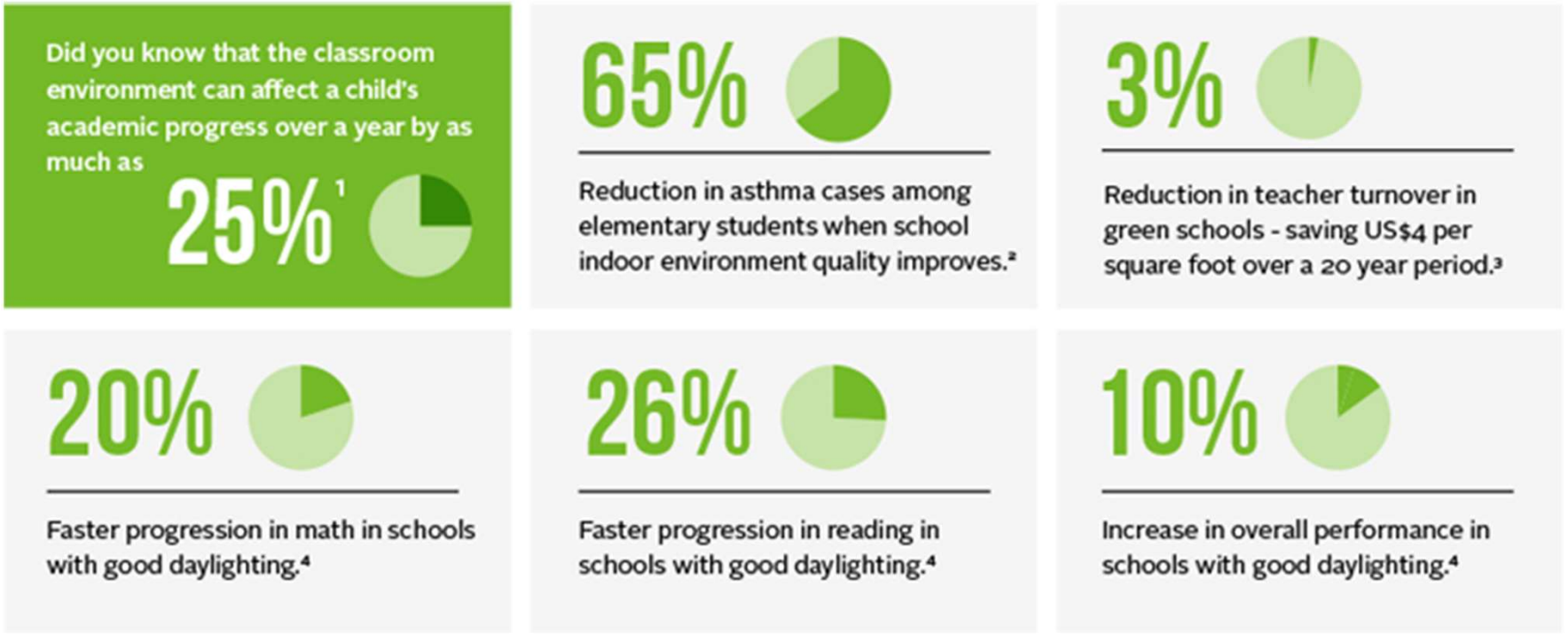
High Performance Schools Fast Facts!



Source: World GBC

1. Barett, P., Zhang, Y., Moffat, J., & Kobbacy, K. (2012, October 03). A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning.
2. Meng, Y., Babey, S. H., & Wolstein, J. (2012). Asthma-Related School Absenteeism and School Concentration of Low-Income Students in California.
3. Katz, G. (2006). Greening America's Schools: Costs and Benefits.
4. Heschong Mahone Group. (1999). Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance.

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School buildings as a tool to enhance student learning

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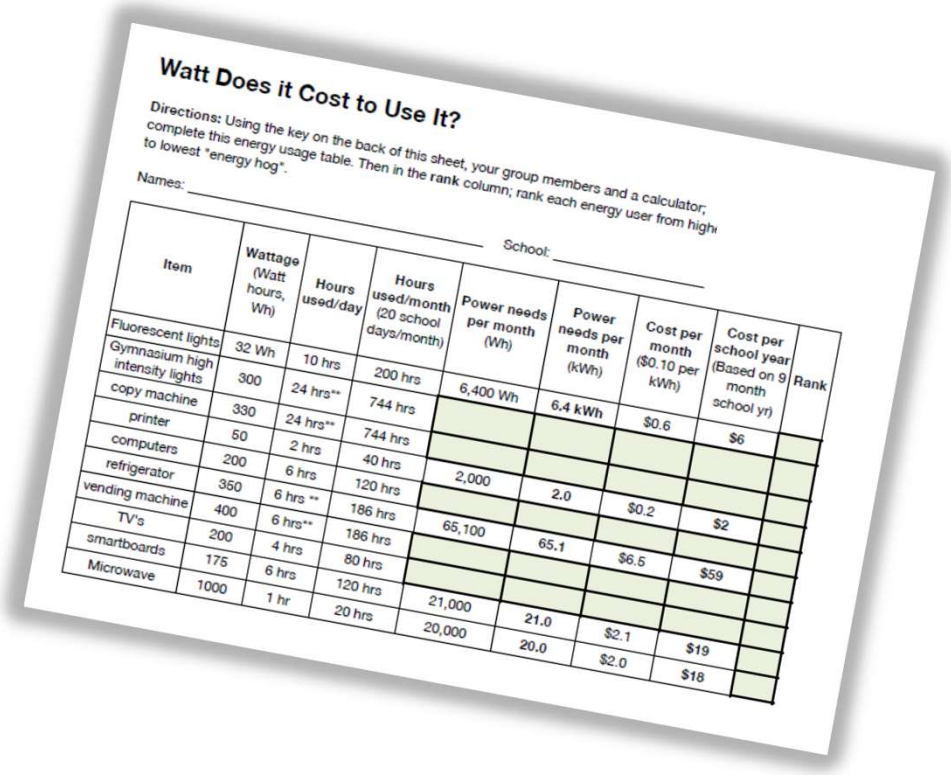
Use the Building as an Opportunity for Education

- **Hands on learning** opportunities increase **student performance** and **lesson retention**.
- **Use daily building operations as educational opportunities**.
- Adapts students to a knowledge-based **technologically advanced society**.
- Students grasp **21st century skills** like teamwork, research gathering, time management, information synthesizing, independence and utilizing high tech tools.
- Schools house **the next generation of environmental leaders**.



Watt Does it Cost to Use It?

Directions: Using the key on the back of this sheet, your group members and a calculator; complete this energy usage table. Then in the rank column; rank each energy user from high to lowest "energy hog".

Names: _____ School: _____

Item	Wattage (Watt hours, Wh)	Hours used/day	Hours used/month (20 school days/month)	Power needs per month (Wh)	Power needs per month (kWh)	Cost per month ($0.10 per kWh)	Cost per school year (Based on 9 month school yr)	Rank
Fluorescent lights	32 Wh	10 hrs	200 hrs	6,400 Wh	6.4 kWh	$0.6	$6	
Gymnasium high intensity lights	300	24 hrs**	744 hrs					
copy machine	330	24 hrs**	744 hrs					
printer	50	2 hrs	40 hrs	2,000	2.0	$0.2	$2	
computers	200	6 hrs	120 hrs					
refrigerator	360	6 hrs **	186 hrs	65,100	65.1	$6.5	$59	
vending machine	400	6 hrs**	186 hrs					
TV's	200	4 hrs	80 hrs					
smartboards	175	6 hrs	120 hrs	21,000	21.0	$2.1	$19	
Microwave	1000	1 hr	20 hrs	20,000	20.0	$2.0	$18	

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ZE Supports Next Generation Science Standards & Skills

- **Analyzing and Interpreting Data**
  - Engineering Design and Human Impacts
  - Energy
- **Influence of Science, Engineering, and Technology on Society and the Natural World**
  - Engineering Design
- **ESS3.C: Human Impacts on Earth Systems**
  - Human Impacts
- **Science Addresses Questions About the Natural and Material World**
  - Human Impacts
- **Constructing Explanations and Designing Solutions**
  - Energy
- **Engaging in Argument from Evidence**
  - Energy
- **ETS1.B: Developing Possible Solutions**
  - Energy

… among others!

Los Angeles USD Student Performing Energy Audit
Photo Courtesy of LAUSD

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Fayette County Schools E=USE^2 Program

E=USE^2 Sustainability Audit Patrol

*Please keep completed copies in your binder.

Auditor(s):

Patrol date-

Classroom	Lights	Computer, monitors, printers, projectors	Personal Appliances (lamps, heaters, minifridge, desk lamps..)	Recycling Bins Utilized	Doors Closed	Windows Closed	Air Fresheners (candles, plug-in…)	Totals ✓	Totals X

Non-classroom	Lights	Computer, monitors, printers, projectors	Personal Appliances (lamps, heaters, minifridge, desk lamps…)	Recycling Bins Utilized	Doors Closed	Windows Closed	Air Fresheners (candles, plug-in…)	✓	X

Record Key
✓= Green Superstar ☺
X = Needs Improvement ☹

Don't forget to total up your tally!

Total ✓:

Total X:

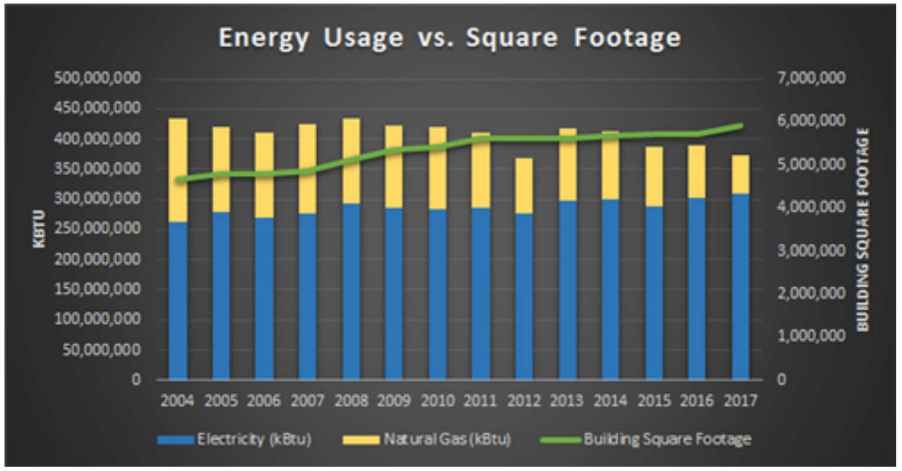
Green Dashboard Data **This Month:** _____**kWh** **Last Month:** _____**kWh**
http://buildingdashboard.net/fayettecountyps/#/FayetteCountyPS

Plug-Load Worksheet

Belkin Conserve Insight

Fill in all green cells — Find this Excel Spreadsheet in Teacher's Corner on www.Sustainability.FCPS.net

Device Measured	Quantity in Use	Typical Hours per Day Device is in Use (Estimate)	Average Watts Measured when Device is Being Used (i.e. Lamp turned on, phone charging, coffee pot brewing, etc.)	Average Watts Measured when Device is Not Being Used (i.e. phantom loads like a microwave or coffee pot not being used.) NOTE: If object is on all day like a mini-fridge, enter "0".	Monthly kilowatt-hours (kWh) for All Devices	Yearly kilowatt-hours (kWh)	Annual Cost per Device	Total Cost for All Devices in Room	Tons of CO2 Emitted Annually	Pounds of Coal Burned Annually
(Name of object)	*(How many plugged in?)*	*(How many hours is the device **actually used** [turned on] per day?)*	*(After leaving object plugged in Insight watt-meter for 20 seconds while turned on, about how many Watts does the object use?) **Lightning Bolt***	*(After leaving object plugged in Insight watt-meter while turned off, about how many Watts does the object use?) **Lightning Bolt***		*(For this calculation, we assume device is only in use 10 months of the year)*	*(Average electricity cost: $0.10 per kWh)*			
EXAMPLE: Mini-fridge	1	24	80.0	0.0	57.6	576.0	$57.60	$57.60	0.4032	426.816
EXAMPLE: Computer	8	8	150.0	20.0	364.8	3648.0	$45.60	$364.80	2.5536	2703.17



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The Winning Pitch for Efficiency

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Names: _____ School: _____

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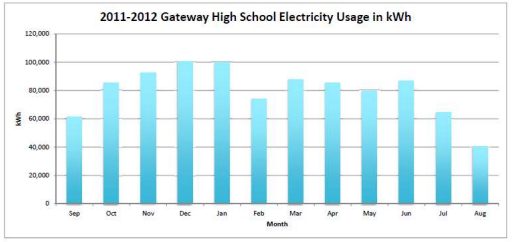
Gateway High School Energy Usage

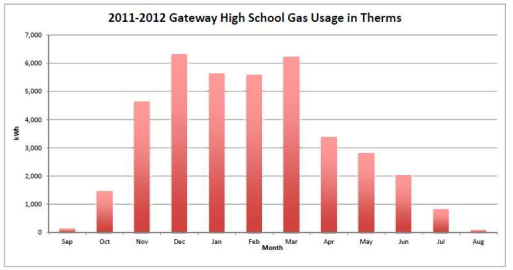
School Year Electricity Usage in kWh

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
kWh	61,500	85,200	92,700	100,500	99,900	74,100	87,900	85,500	79,500	87,000	64,500	40,500	958,800



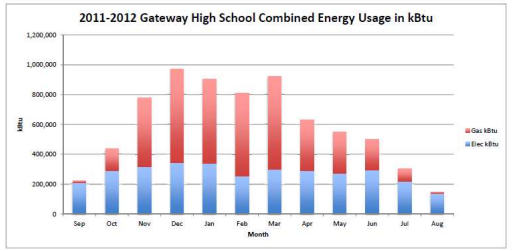
School Year Gas Usage in Therms

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Therms	124	1,452	4,634	6,305	5,638	5,579	6,222	3,385	2,807	2,025	825	73	39,069



School Year Total Combined Energy Usage in kBtu

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Totals
Elec kBtu	209,838	290,702	316,292	342,906	340,659	252,829	299,915	291,726	271,254	296,844	220,074	138,186	3,271,426
Gas kBtu	12,400	145,200	463,400	630,500	563,800	557,900	622,200	338,500	280,700	202,500	62,500	7,300	3,906,900
Total kBtu	222,238	435,902	779,692	973,406	904,659	810,729	922,115	630,226	551,954	499,344	302,574	145,486	7,178,326



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Garden Grove School District Retrofit

Location: Garden Grove, CA

Construction Type: Retrofit

Schools: Ralston Intermediate & Santiago High School

Building Size: Ralston: 6,200 SF
Santiago HS: 8,069 SF

Building Completed: 2018

Energy Target: Zero Net Energy

Predicted EUI: 24.7 kBtu/sf/yr

GGUSD is a large, low income school district in California. It ranks among the lowest 20% of districts in terms of household income and top 20% test scores. Their culture of frugality means they have consistently invested in students over facilities.

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Photo Courtesy of Garden Grove School District.

Garden Grove School District Retrofit

Technologies:

- LED Lighting Upgrade
- Lighting & HVAC Controls
- Tubular skylights and daylighting
- High Efficiency HVAC
- Energy Star Appliances
- Energy Dashboard
- 38 kW Photovoltaic Array (proposed)

The Santiago project will serve as a hub for the school's environmental student groups where students use energy data as a hands-on STEM learning opportunity to drive school design decisions.

Lighting Replacements Before and After. Photo Courtesy of Garden Grove School District.

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Thank you!

Reilly Loveland

Project Manager

reilly@newbuildings.org

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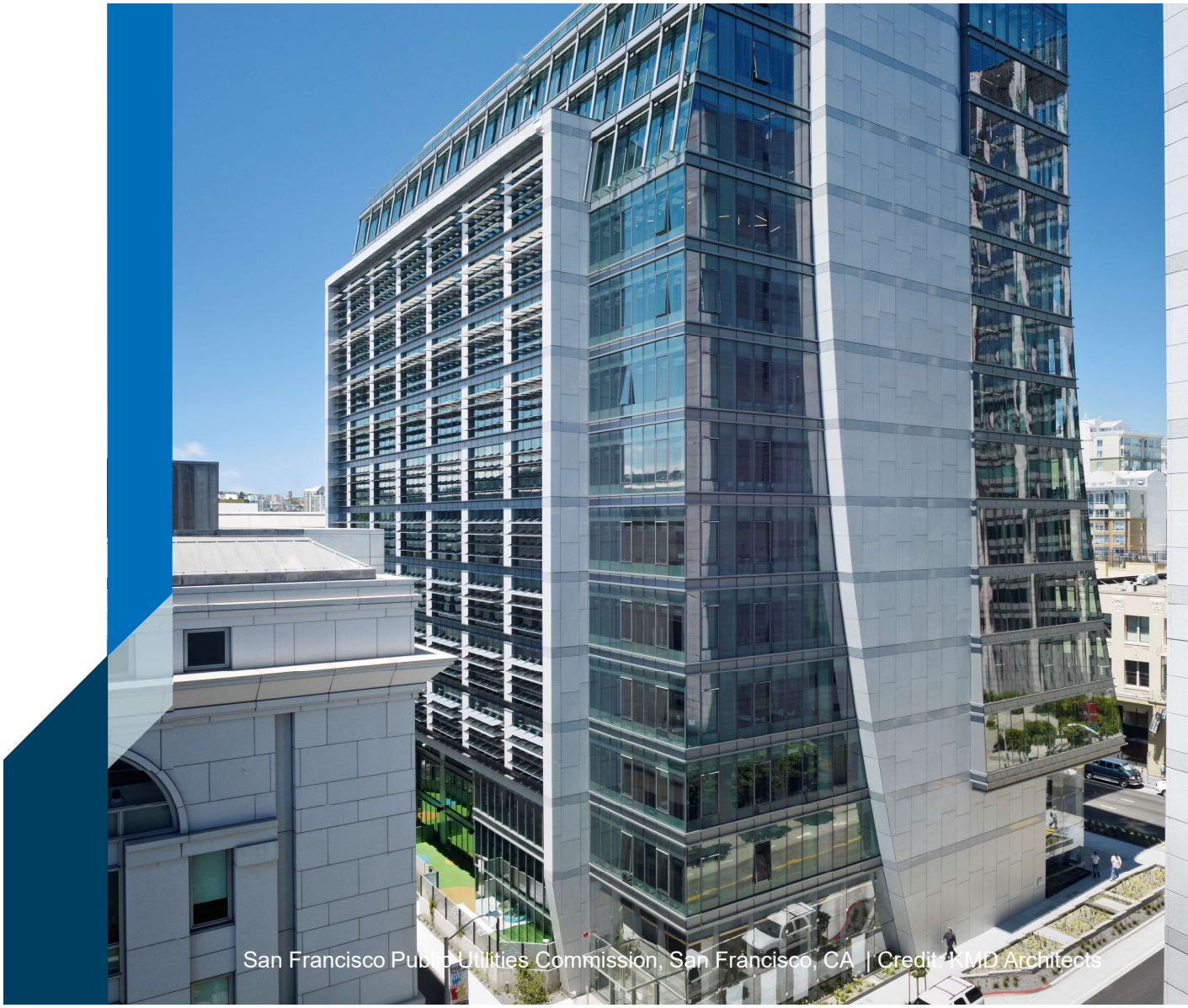

San Francisco Public Utilities Commission, San Francisco, CA | Credit: KMD Architects