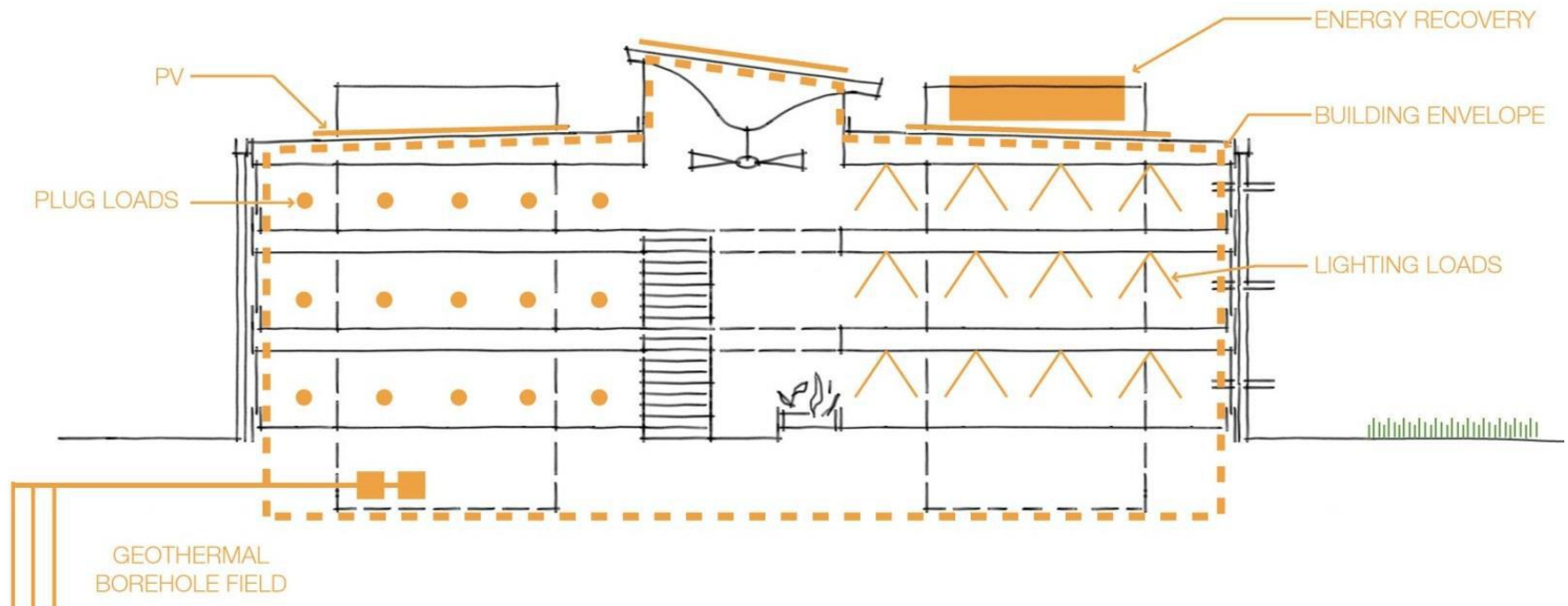


Net Zero Energy Schools

What, Why and How



Banff, Alberta - May 18, 2017

Presenters



Rob Winstead

Principal, Stantec



Cam Munro

Specification and
Standards Manager,
Alberta Infrastructure

Learning Objectives

In this session we will answer the following questions about Net-Zero Schools.

1 What is a Net Zero Energy School?

A discussion of NZE definitions, projects, and programs, with a particular focus on NZE Schools.

2 Why are Net-Zero Energy Schools important?

Discussion of global trends – social, economic, climatic, etc. – that are driving the need for NZE buildings, including schools.

3 How do you deliver a Net-Zero Energy School?

Review of 12 steps, in order of priority, to deliver a NZE school.

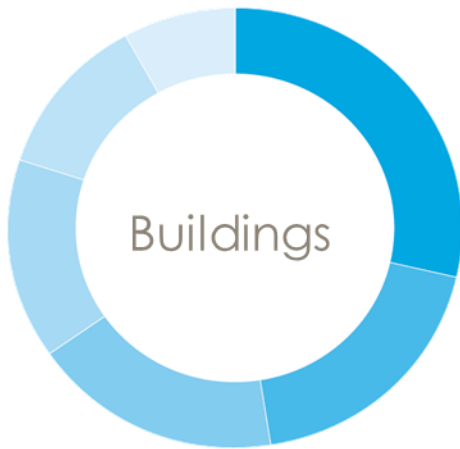
4 What else besides energy?

Discussion of considerations beyond energy – water, health, resilience, etc.

5 What about learning?

Discussion of how these sustainability strategies can be used to support contemporary learning.

Who is Stantec?



- Commercial
- Education & Institutional
- Healthcare
- Industrial Buildings
- Science & Technology
- Airports & Aviation



- Oil & Gas
- Mining
- Power



- Community Development
- Roadways
- Water
- Bridges
- Transit & Rail

Who is Stantec?



3000+

Buildings Group
Professionals



500+

Dedicated to the
Education Studio



450+

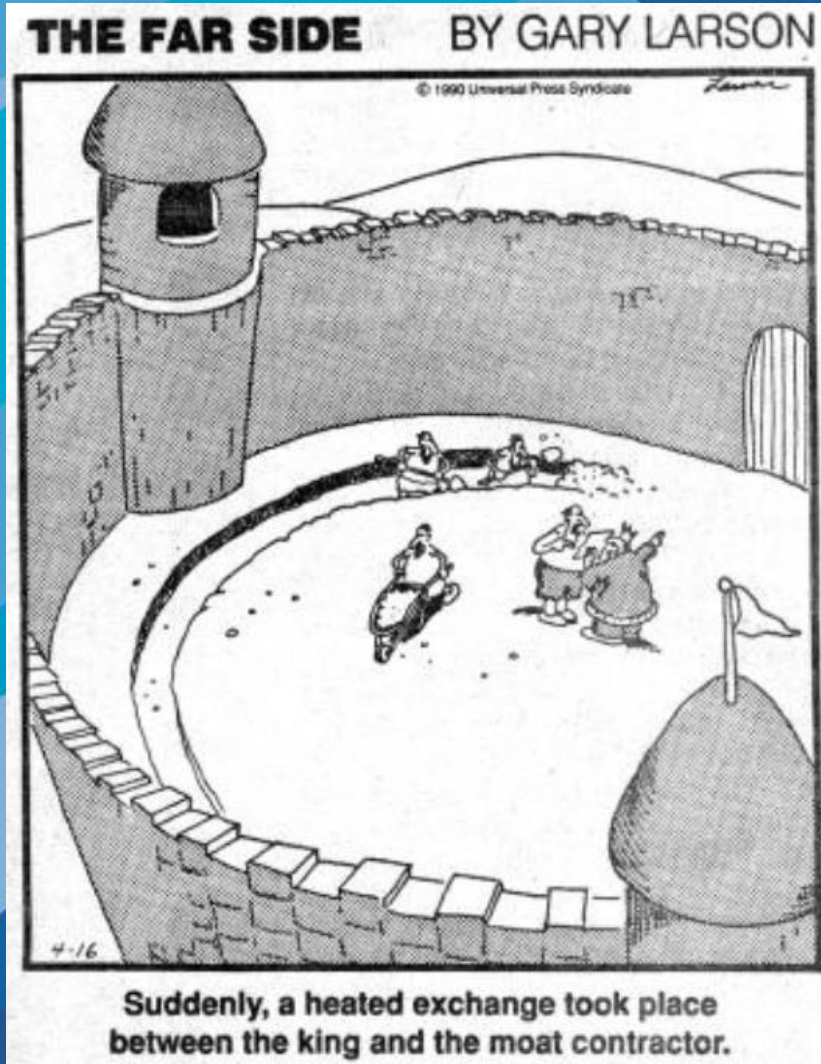
Campuses
throughout North
America & beyond

Who is Stantec?



Labbé, Laroche / Gagné, Leclerc and Associates

Infrastructure 101:



Alberta

Freedom To Create. Spirit To Achieve.

Government
of Alberta

Mandate

VISION

- Alberta Infrastructure will provide innovative, high quality and well designed public infrastructure for Alberta.

MISSION

- Through leadership, expertise and collaboration with our partners, support the provision of public infrastructure that contributes to the province's prosperity and quality of life.



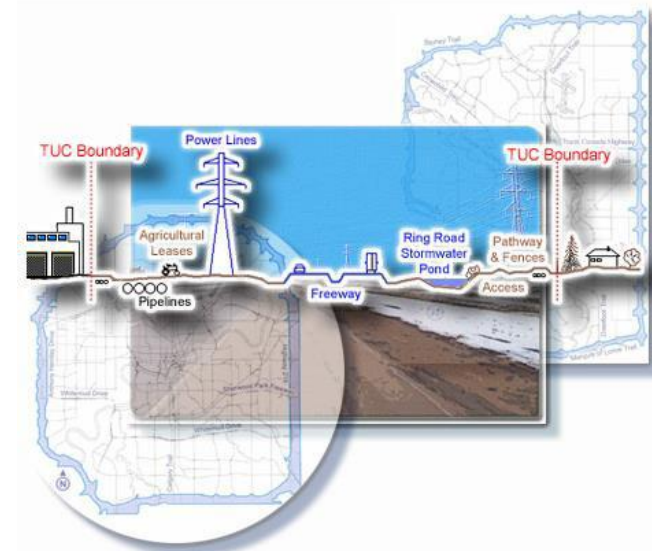
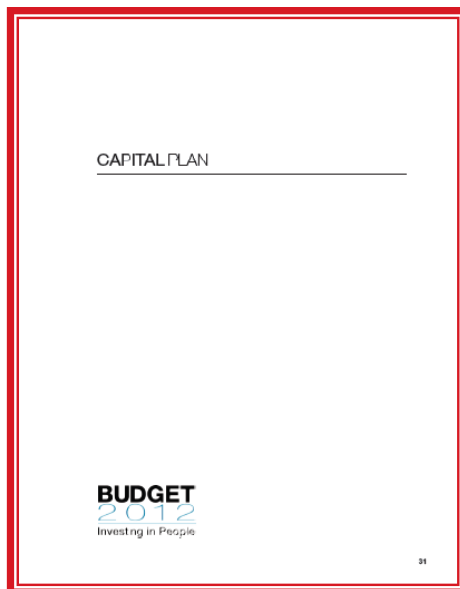
What Do We Do?

BUILD, MANAGE, AND MAINTAIN PUBLIC BUILDINGS



INFRASTRUCTURE PLANNING

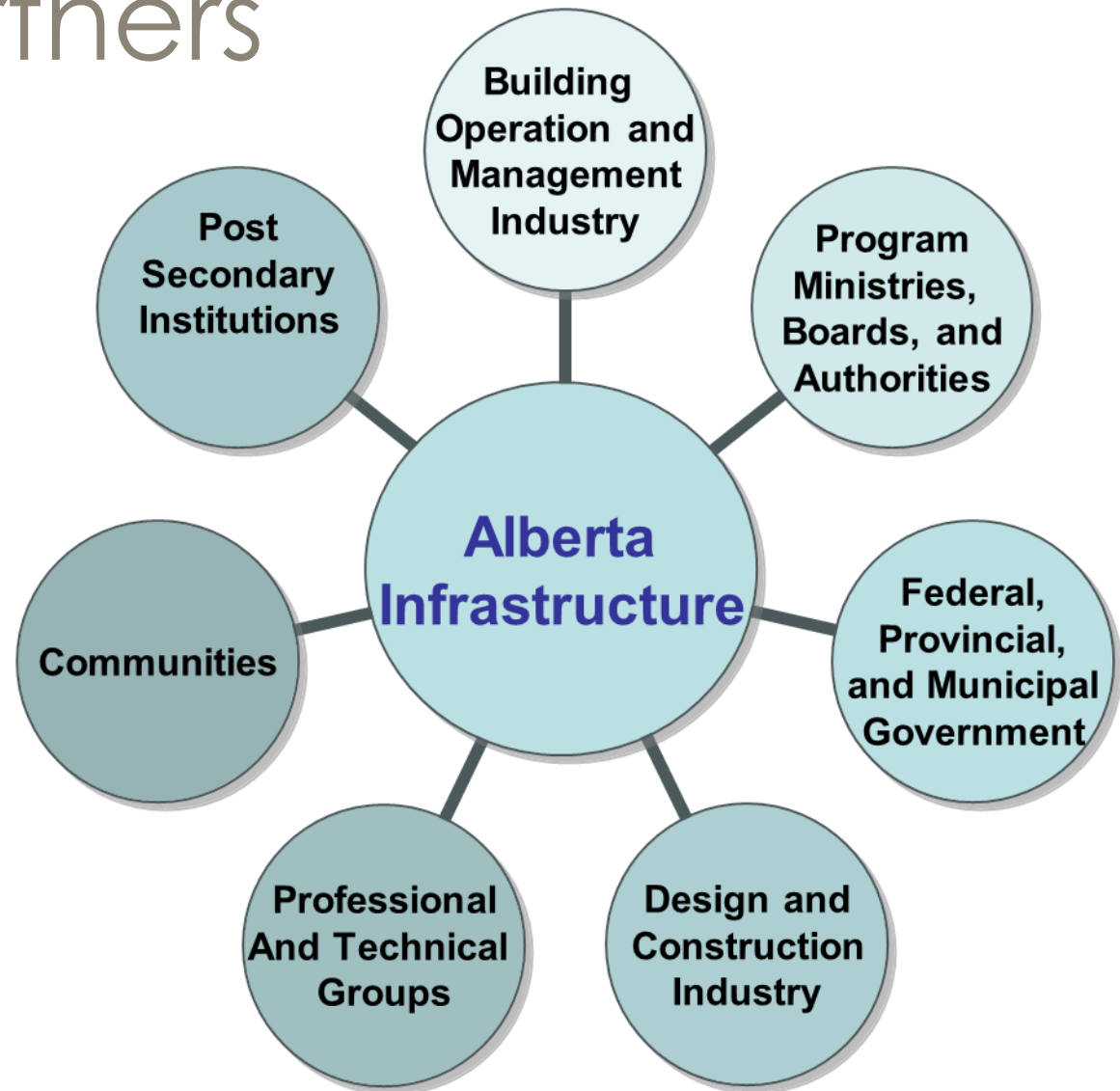
STRATEGIC LAND MANAGEMENT



We are an owner...



Key Partners



Key Drivers

1. Life Safety
2. Codes and Standards
3. Asset Preservation
4. Program Elements



Clients



- Healthcare
- Correctional
- Educational
- Judicial
- Administration Buildings
- Tourism Facilities

Design Excellence



- Inclusion of Processes and Procedures in PIMS
- Guidelines for Best Practices in Delivering High-Quality Built Environment
- LEED World/Federal/Provincial
- EUDA Awards

INTRODUCTIONS

Sustainability in Alberta

Congratulations!



- **185 LEED Schools (67 Certified)**
- **Robust performance specification**
- **PV incentives for schools**

...and Good Luck!



- **NECB 2011 Code**
- **LEED v4**
- **Carbon levy**
- **Energy Disclosure requirements**
- **CAGBC Zero Carbon Framework**

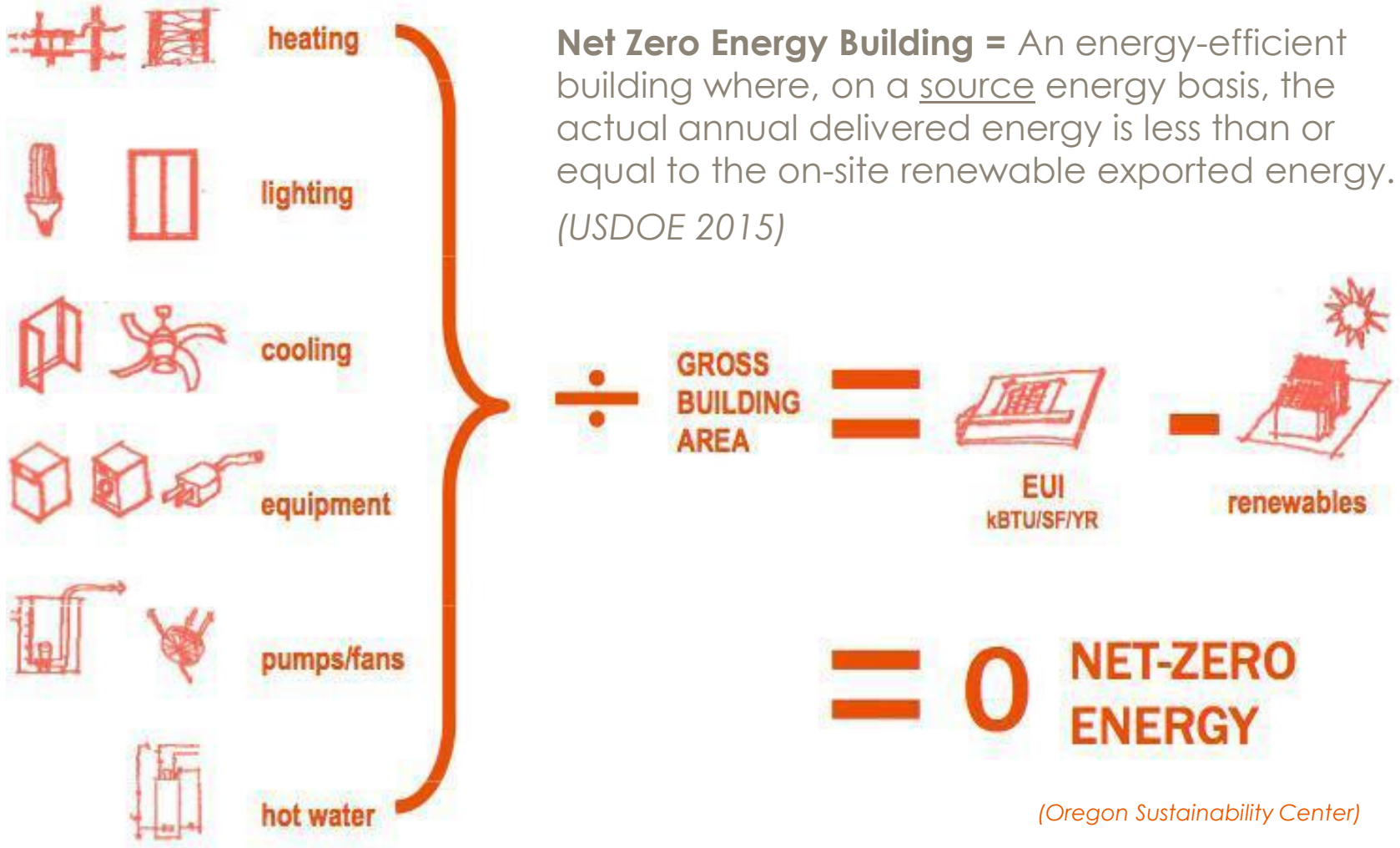
Remember this!

1. What exists is possible.
2. You are creating the future now.
3. Conservation first.
4. People matter.

WHAT

is a Net-Zero Energy School?

Net Zero (site) Energy



(Oregon Sustainability Center)

Energy Use Intensity (EUI)



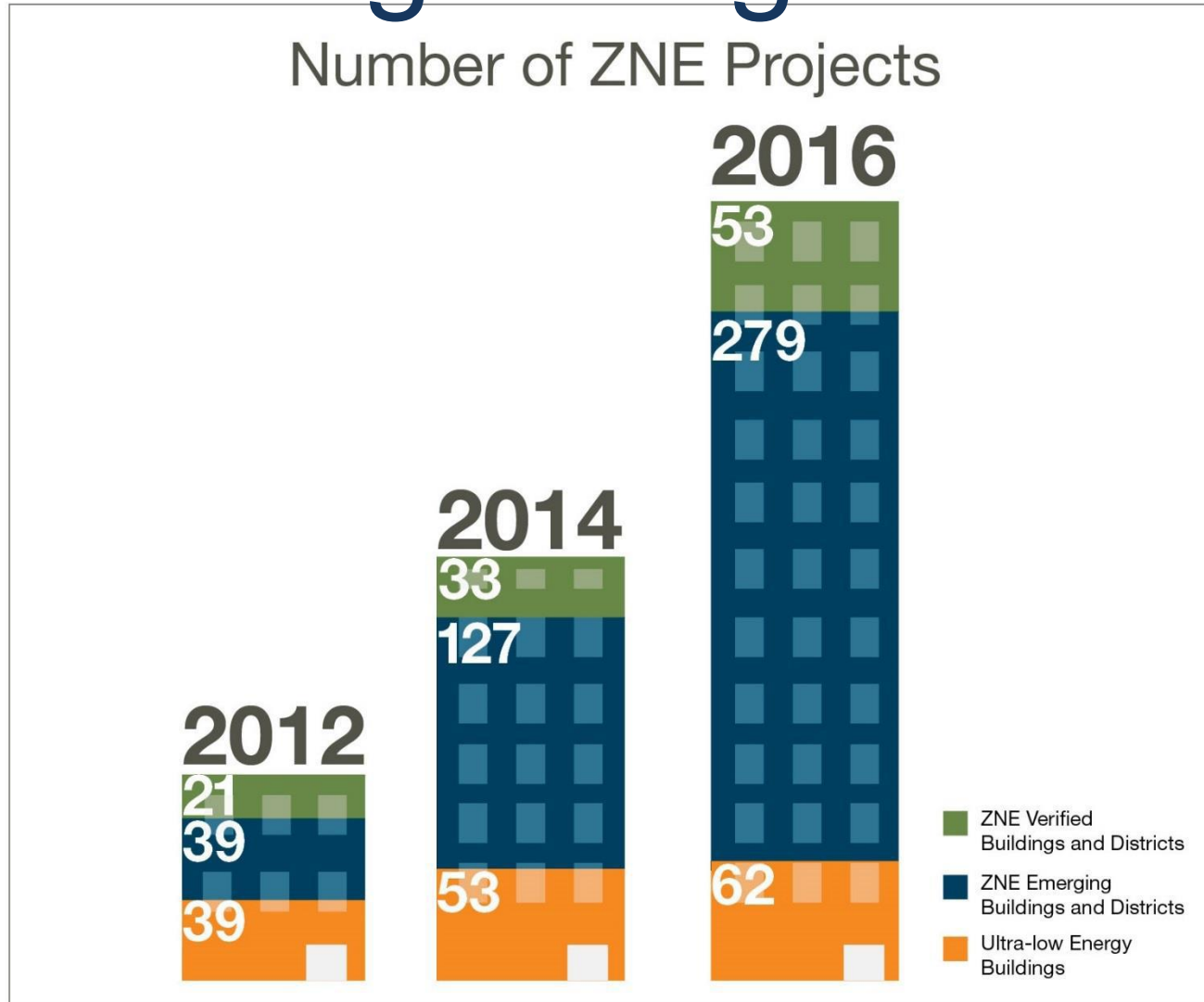
**kBTU per Square Foot
per Year**

K-12

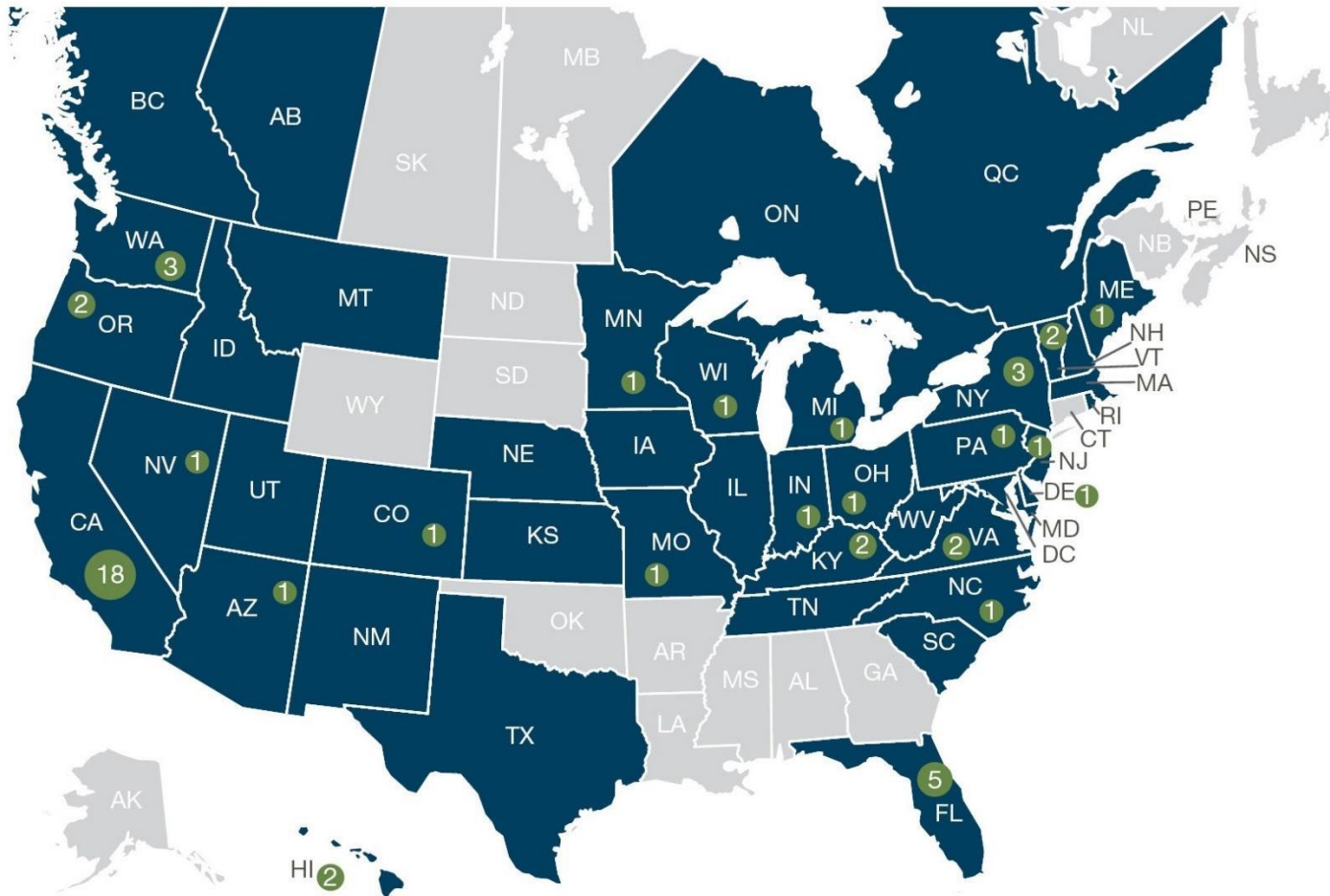
2003 Benchmark
75 kBTU/sf/year

2015 Target
22.5 kBTU/sf/year

NZE is a growing market...



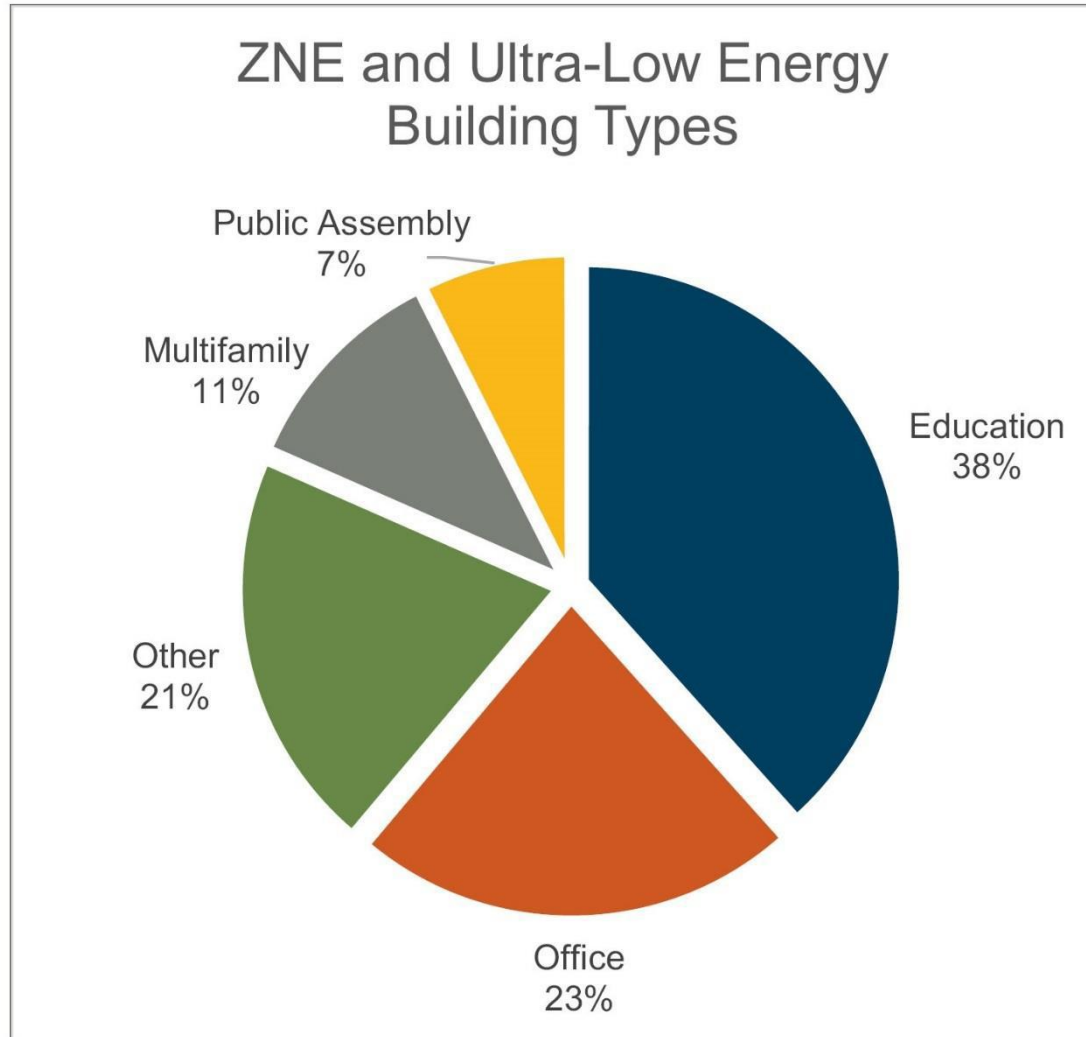
And it's everywhere...



Number of ZNE Verified Buildings

States and Provinces with
ZNE Emerging or Verified Buildings (44)

Who's doing it...





NREL Research Support Facility

RNL Design/Stantec



CUT-AWAY PERSPECTIVE

NREL Research Support Facility

RNL Design/Stantec



NREL Research Support Facility

RNL Design/Stantec



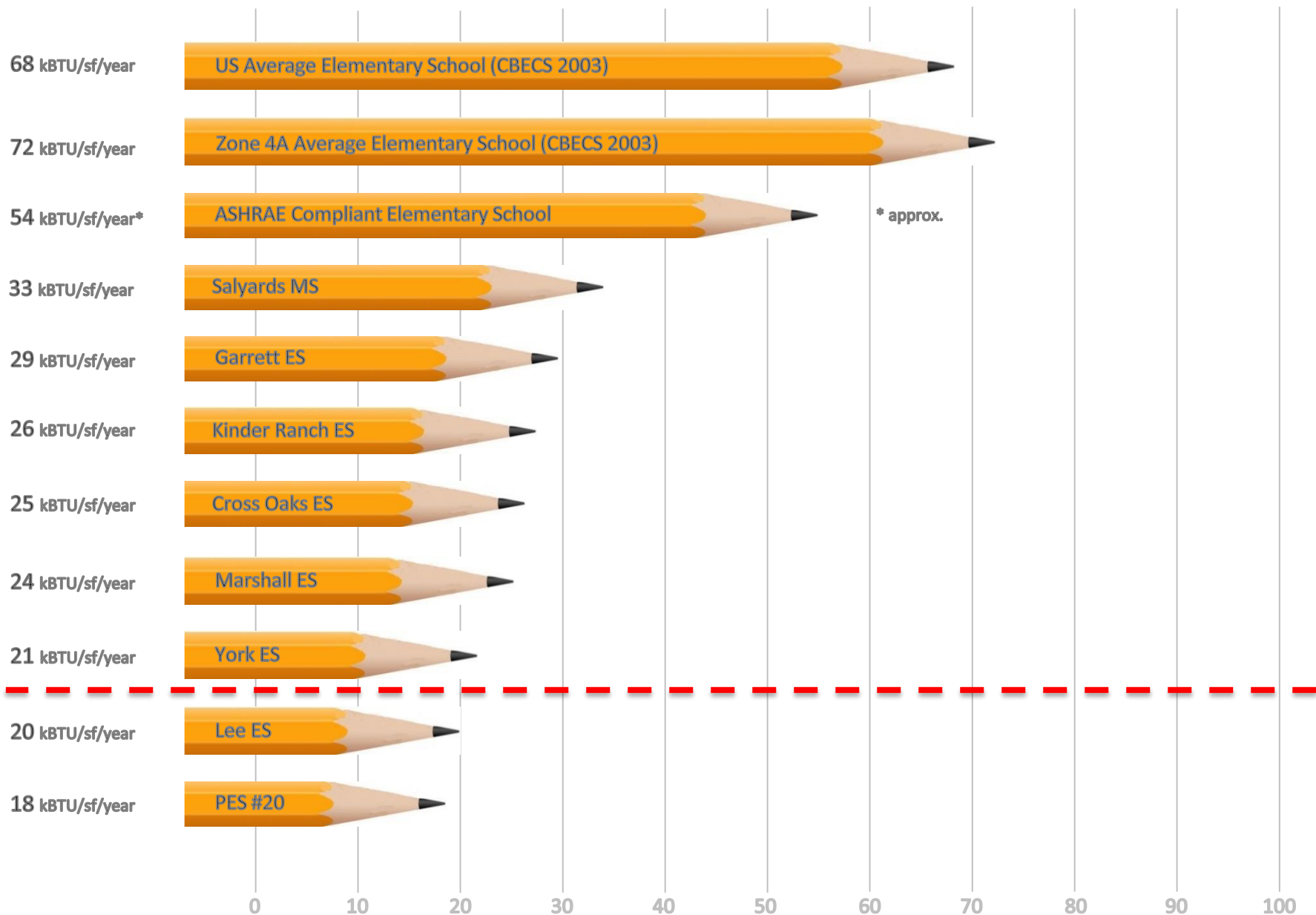
SMUD East Operation Center

RNL Design/Stantec



SMUD East Operation Center

RNL Design/Stantec



Elementary/Middle School Performance (kBTU/sf/year)



Lee Elementary School

Stantec



Lee Elementary School

Stantec



Rain water cistern, wind turbines and native gardens offer hands-on opportunities and 1,096 solar panels contribute to net-zero energy use.



Outdoor classrooms and gardens expand the learning environment. Sustainability features are displayed throughout the school acting as learning tools.



Lee Elementary School
Stantec





Dearing Elementary School

Stantec



DEARING ELEMENTARY SCHOOL

Dearing Elementary School

Stantec



Dearing Elementary School

Stantec



Horry County Elementary Prototype

SFL+A/Stantec



Horry County Elementary Prototype

SFL+A/Stantec



Horry County Middle School Prototype

SFL+A/Stantec



Horry County Middle School Prototype

SFL+A/Stantec



Initiative

Maryland Energy

ADMINISTRATION

Powering Maryland's Future

Program Authorization

- On **February 17, 2012**, as a result of Maryland Public Service Commission (PSC) Order 84698 relating to the merger of Exelon Corporation and Constellation Energy Group, **a \$113.5M Customer Investment Fund (CIF) was established.**
- On **November 8, 2012** MEA was awarded **\$9M of CIF funding** from the PSC for the purpose of designing and constructing three (3) new Net Zero Energy schools in the Baltimore Gas and Electric service territory.
- MEA works with the Maryland Public Schools Construction Program (PSCP) to identify and administer the program.

Why was this Program Enacted?

- At the time of MEA's application, there were **only six net zero energy** (NZE) schools in the nation.
- Implementing a successful Net Zero Energy School would establish Maryland's position as a **"green energy leader"**.
- Teaming experienced NZE school designers with local architect and engineering firms (A&E) would **improve the NZE school design expertise of local A&E firms**.

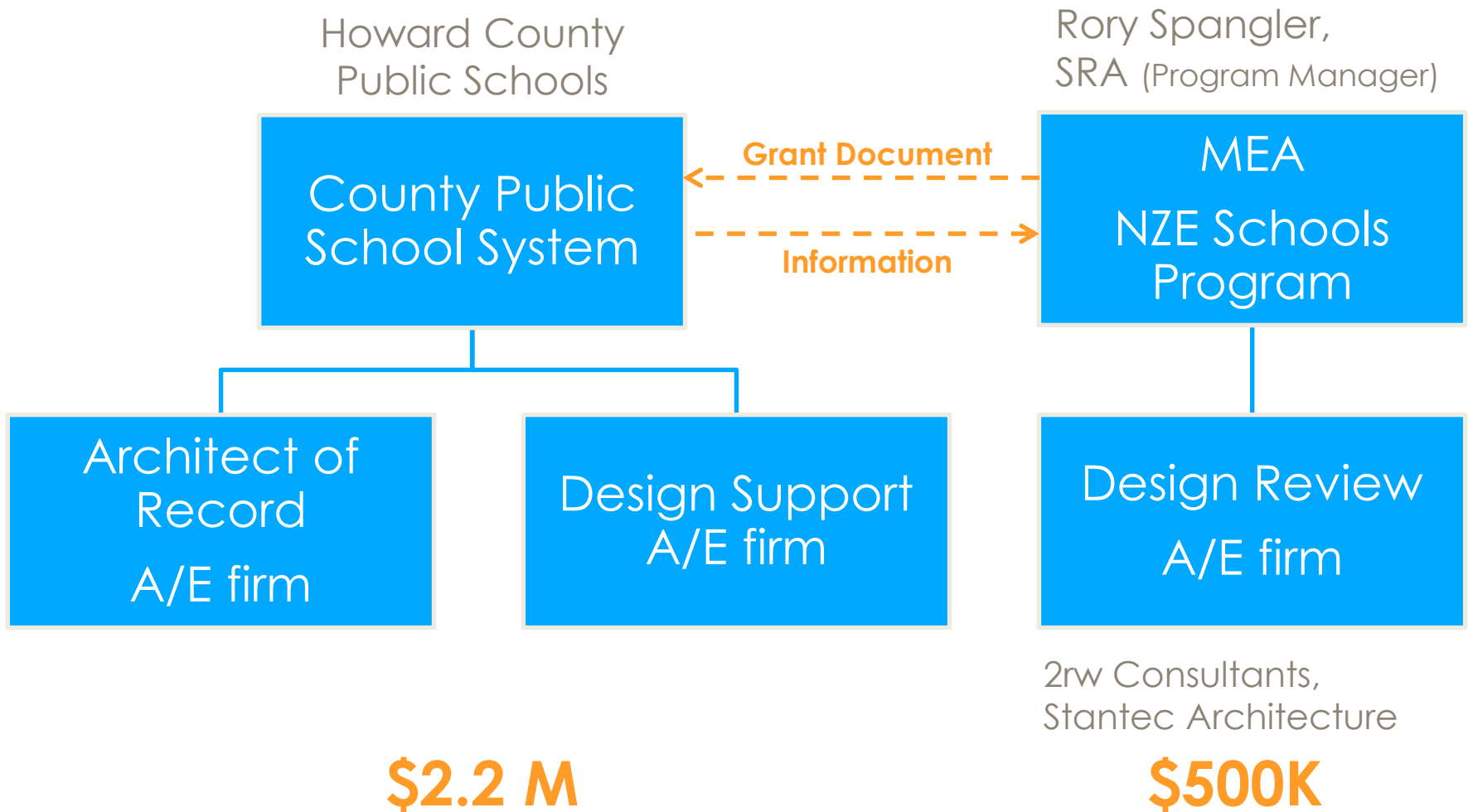
Eligibility / School Selection

- Should be a new school (no retrofits).
- Must be in the BGE service territory.
- Schools selected by MEA through discussions with the city and county school districts, and with the Maryland Public School Construction Program. To date, no application form has been required.

Design Requirements

- Net zero (site) energy (all fuels considered)
- $<25 \text{ kBtu/ft}^2/\text{year}$ (MEA requirement)
- Must consider all school uses, not just daytime educational use
- MEA funding support provides incremental cost reimbursement for design and construction from LEED Silver to Net Zero Energy

Program Overview



Program Goal



**Teach a Man to Fish –
Set a New Normal in Maryland**

Once we build up expertise in Maryland, we won't need to subsidize. Other states are well on their way in net zero school construction – and only the first few schools received extra state subsidies.



Wilde Lake Middle School

TCA Architects



Wilde Lake Middle School

TCA Architects

Wilde Lake Middle School

- EUI target of 25 kBTU/SF/year

It's not that tough...

- Reluctance to modify prototype
- Lacked incentive for exceptional performance
- Paid extra for renewables

WE CAN DO MORE!



Graceland Elementary

Grimm + Parker Architects

Graceland Elementary

Total MEA funding.....	\$2,800,000
Funding split/school....	\$1,400,000
Cost of PV / kW.....	\$3
PV system size (kW).....	467
Energy produced (kBTU).....	1,592,267
Building area (sf).....	87,321
Target EUI (kBTU/sf/year)	18.2

2 for 1!

WHY

is Net-Zero Energy important for schools?

SCHOOLS:

hold precious cargo,
have a long life span,
primary function is during the day,
are de facto centers of community,
are learning environments,
and are powerful symbols of our society



**People
want what
is best for
their kids!**



691

thousand students

and

47

thousand faculty

17

of Alberta's population
%

THE WALL STREET JOURNAL.

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<http://www.wsj.com/articles/SB1239773881428275>

BREAKING NEWS

Navy escorts U.S.-flagged commercial ships in Strait of Hormuz after Iran's seizure of a ship Tuesday

POLITICS

U.S. in Historic Shift on CO2

Businesses Brace for Costly New Rules as EPA Declares Warming Gases a Threat

By JONATHAN WEISMAN and SIOBHAN HUGHES

Updated April 18, 2009 11:59 p.m. ET

WASHINGTON -- The Obama administration declared Friday that carbon dioxide and five other industrial emissions threaten the planet. The landmark decision lays the groundwork for federal efforts to cap carbon emissions -- at a potential cost of billions of dollars to businesses and government.

The Environmental Protection Agency finding that the emissions endanger "the health and welfare of current and future generations" is "the first formal recognition by the U.S. government of the threats posed by climate change," EPA Administrator Lisa Jackson wrote in a memo to her staff.

The finding could touch every corner of Americans' lives, from the types of cars they drive to the homes they build. Along with carbon dioxide, the EPA named methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride as deleterious to the environment. Even if the agency doesn't use its powers under the Clean Air Act to curb greenhouse gases, Friday's action improves the chances that Congress will move to create a more flexible mechanism to do so.

On a conference call Friday with environmentalists, EPA officials stressed they would take a go-slow approach, holding two public hearings next month before the findings are official. After that, any new regulations would go through a public comment period, more hearings and a long review.

ordinary process of soliciting

But unless superseded by
d to stricter emissions limits.
ants and oil refineries to car

ly affecting some companies.
in Pittsburgh, says it is
is because of uncertainty



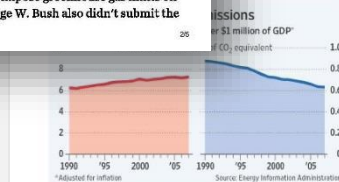
and emits greenhouse gases.

starting to move dirt, we would
until there's some clarity," said
an, vice president of investor

ancement marks a significant
turn in U.S. policy on climate change. The U.S.
has never ratified the Kyoto climate treaty.
President Bill Clinton, who signed the pact,
didn't submit it to the Senate for ratification
because of strong opposition to the deal,
which didn't impose greenhouse gas limits on
China and other developing economies. President George W. Bush also didn't submit the

Environment's EPA Says Case is
"Overheating"
(<http://blogs.wsj.com/environmentalcapital/2009/04/17/eps-overheating-cause-to-regulate-greenhouse-gas-emissions/>)

<http://www.wsj.com/articles/SB1239773881428275>



Republican Conference, sought a middle ground, proposing to focus carbon caps on coal-fired power plants and vehicle tailpipes -- and holding off any move until the nation emerges from recession.

American Electric Power, a utility giant with 5.2 million customers in states from Texas to Michigan to Virginia, is already considering what coal plants would have to be shuttered and how high rates would have to go to comply with either a regulatory or legislative mandates to curb carbon dioxide. AEP spokesman Pat Hemlepp said rate

increases stretch from 25% to 50% and beyond, depending on the climate change strategy that finally emerges from Washington.

A proposal by President Barack Obama would cap the emissions of greenhouse gases, then force polluters to purchase emission permits, which could be traded on the open market. The details of the cost of carbon credits have been left to Congress, although Mr. Obama has said he wants all emissions covered, with no allowance for free emissions, as some business groups and lawmakers want.

Heavy carbon emitters, such as utilities that rely on coal-fired power, would pay a hefty price, but the cost of compliance would be alleviated by purchasing extra emissions permits from companies that emit less or can more easily adapt with energy-saving technology.

Regulation, on the other hand, would probably exclude such flexibility, and simply force businesses to reduce emissions. Businesses also see a more favorable playing field in Congress than with EPA regulators, who do not have to face the voters.

Business Challenge

U.S. greenhouse-gas emissions in 2007 by sector, in billions of metric tons of CO₂ equivalent



"We're pretty confident that Congress is going to be much more sensitive to the economic impact of this than some unelected bureaucrats," said Hank Cox, a spokesman for the National Association of Manufacturers.

The impact of the EPA finding could be dramatic. Using the Clean Air Act, the EPA could raise fuel-efficiency standards for automobiles, such as by authorizing nationwide adoption of California's rules for greenhouse-gas tailpipe emissions.

That could require auto makers to produce more hybrid and electric vehicles, such as the Chevrolet Volt plug-in hybrid under development by General Motors Corp. The car carries a sticker of about \$40,000, or roughly twice the price of a Toyota Camry.

The EPA could also force new power plants to include emissions-reduction technology, such as carbon capture and storage, to clear whether emerging technologies to capture carbon are feasible.

Power plants to be retrofitted, such as with more-efficient

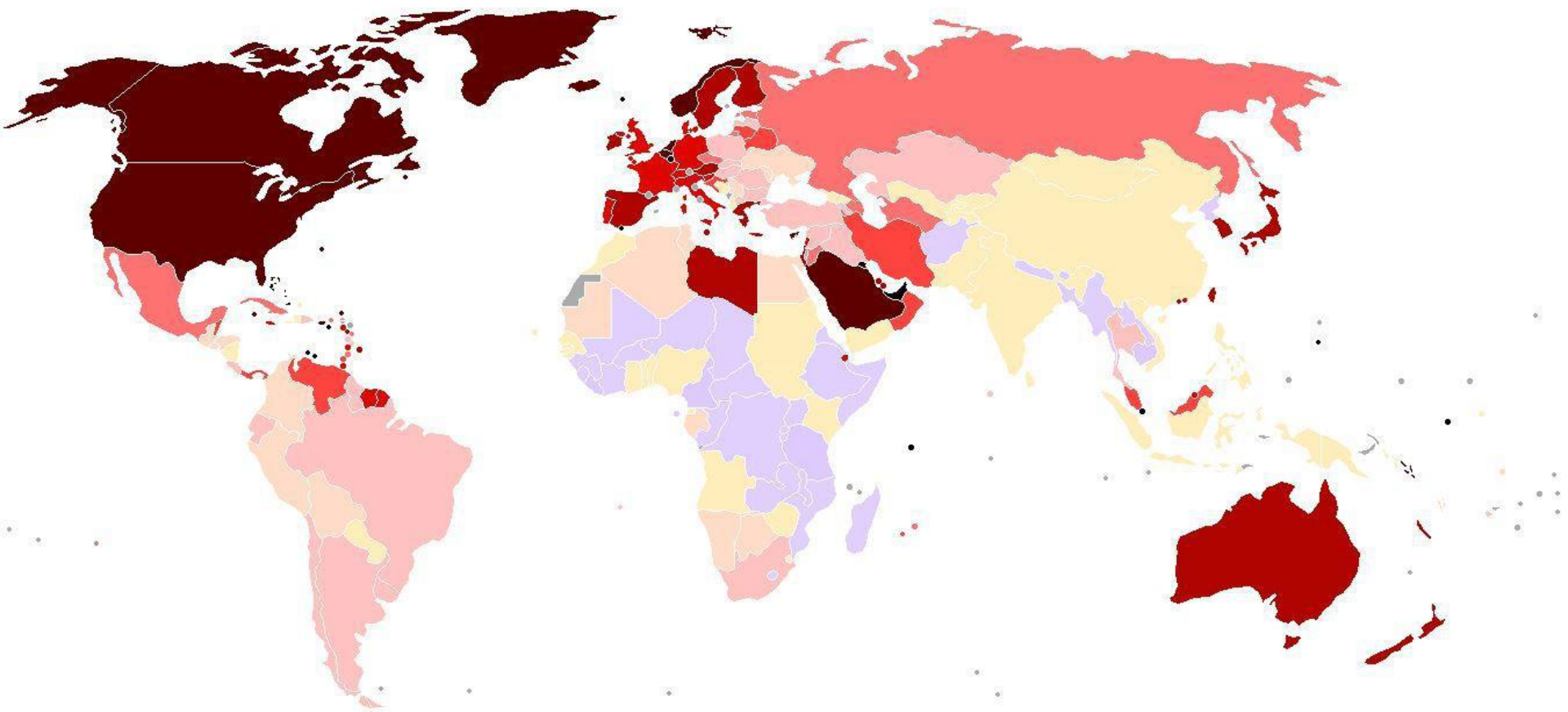
The U.S. emitted greenhouse gases equivalent to 631.9 metric tons of carbon dioxide per \$1 million of gross domestic product in 2007. In a chart that accompanied this article on the Environmental Protection Agency's finding that warming gases pose a threat, emissions were incorrectly labeled in billions of metric tons.

"Emissions endanger the health and welfare of **current** and future generations"

EPA – April 2009

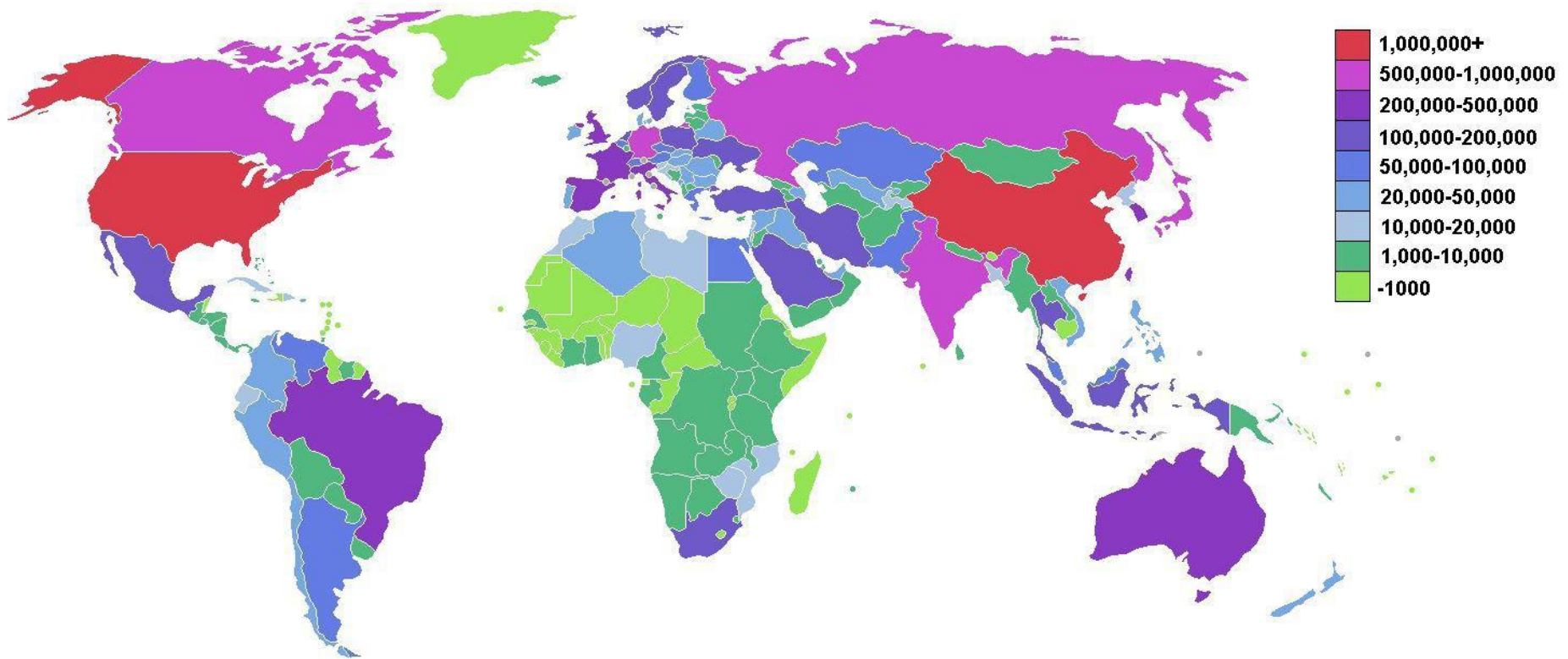


Fort McMurray, Alberta



Oil Consumption Per Capita

SOURCE: <http://upload.wikimedia.org/wikipedia/commons/9/9a/OilConsumptionpercapita.png>



Electricity Consumption

SOURCE: http://upload.wikimedia.org/wikipedia/commons/a/a3/Electricity_consumption_per_country_map.PNG

US ELECTRICITY CONSUMPTION

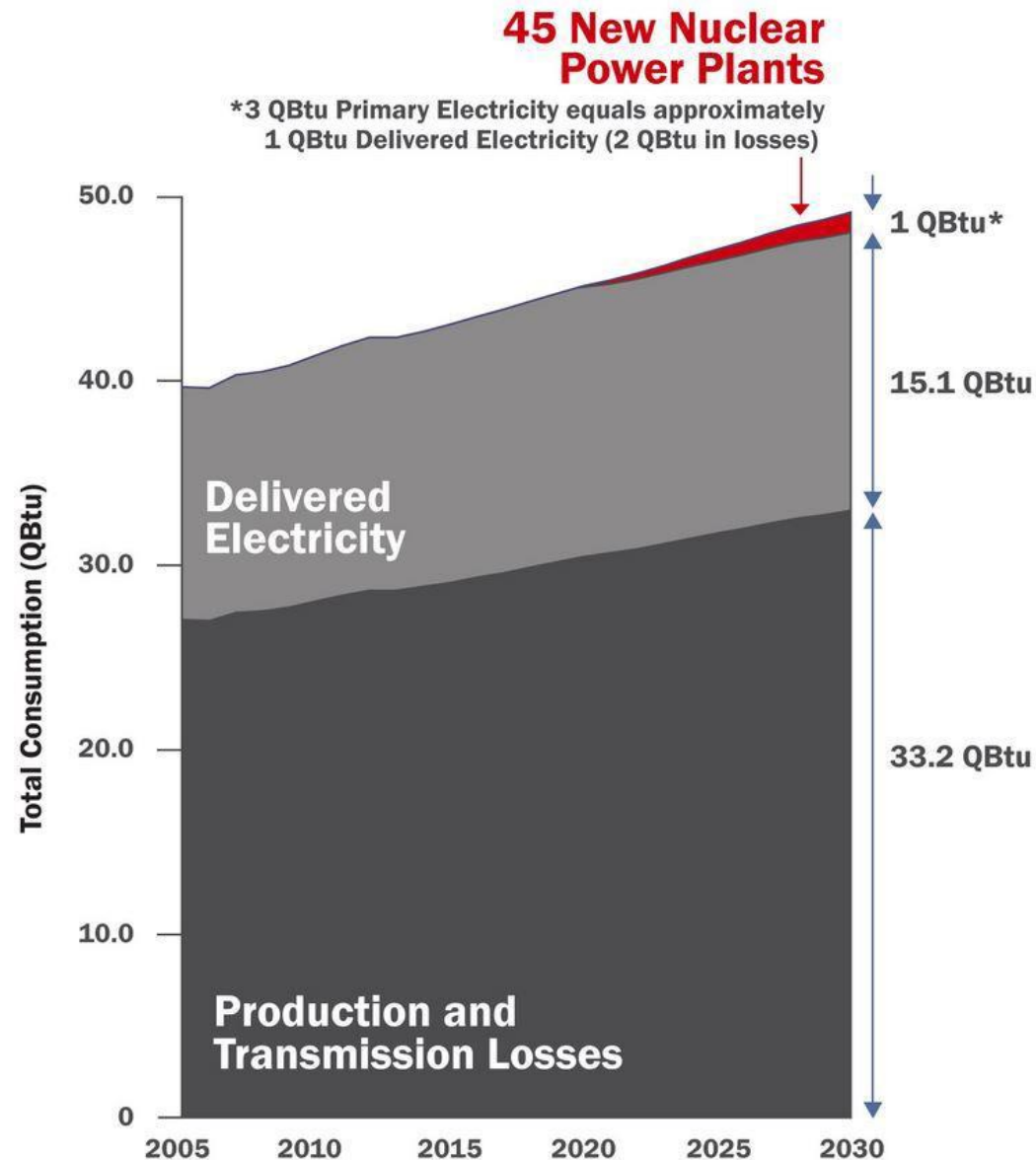
Note: Projections are based on an average nuclear plant capacity of 820 MW.

©2008 2030, Inc. / Architecture 2030

Data Source: US Energy Information Administration

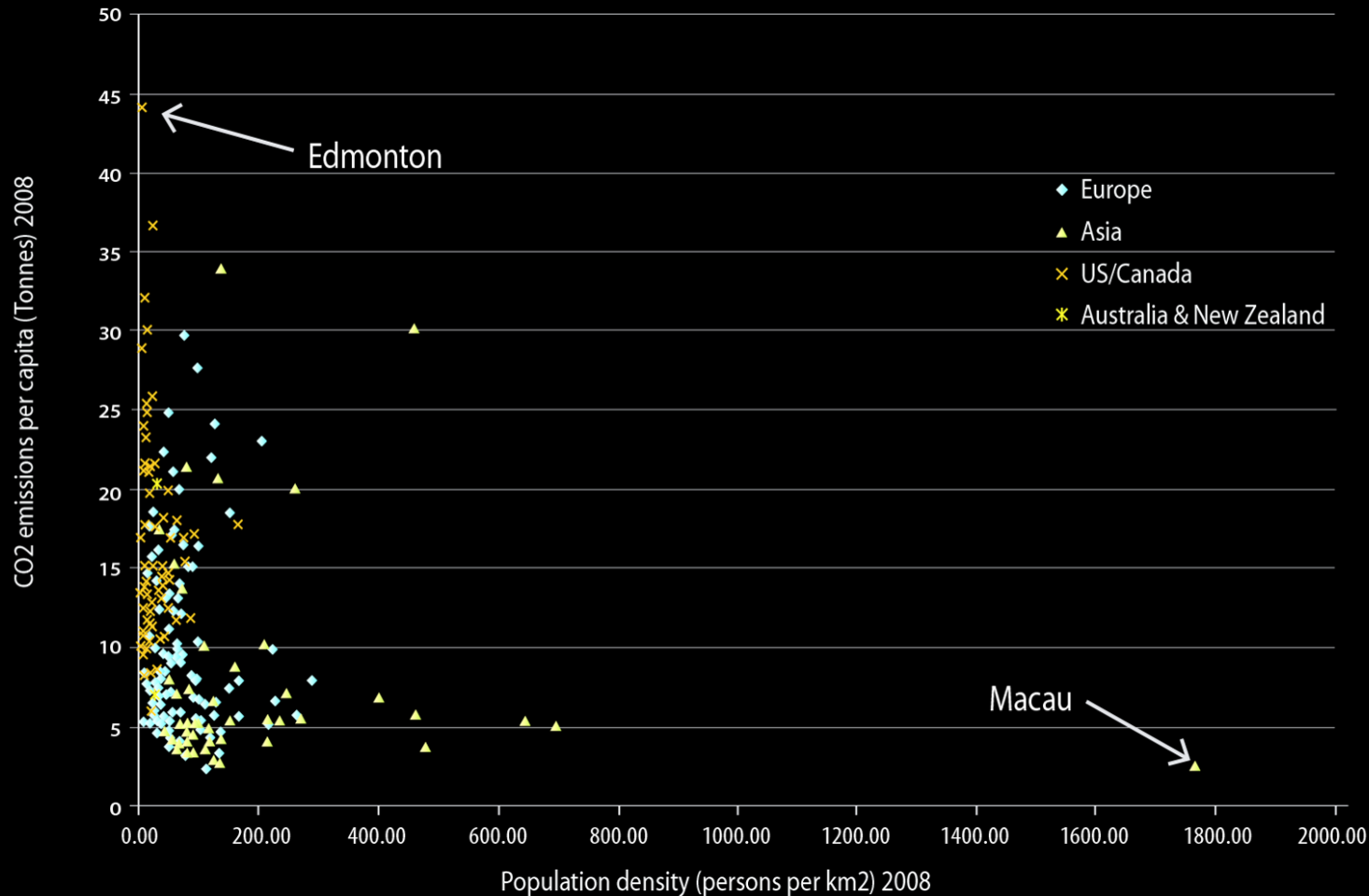
*2/3 of power generated
is never used!*

Electricity Generation



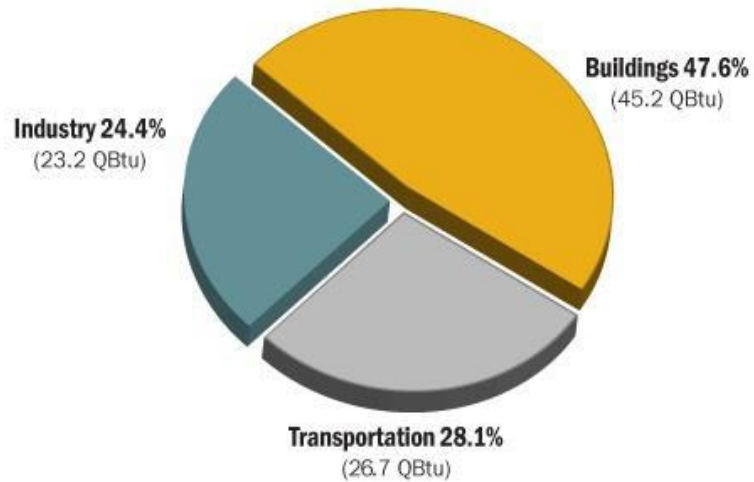
World Cities

Carbon Emissions per Capita and Urban Density

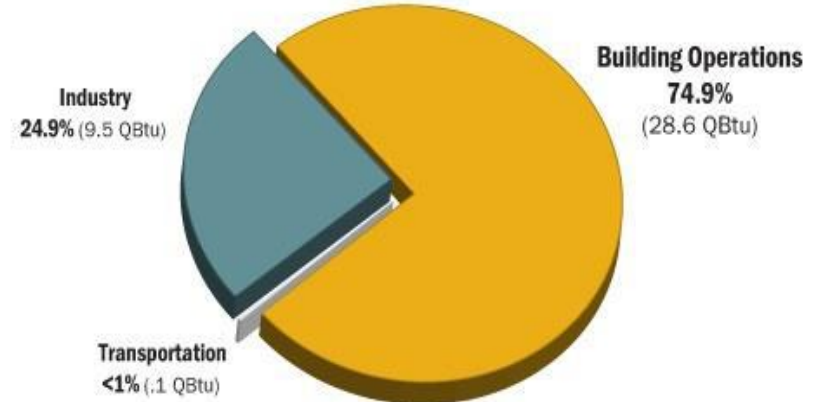


Credit: Luke Leung, SOM

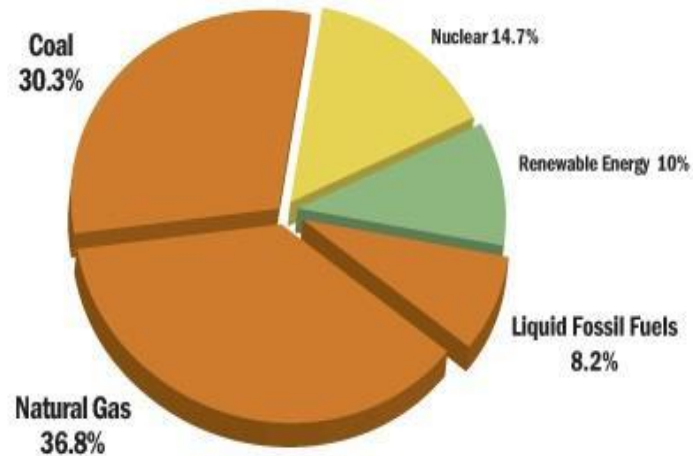
ENERGY CONSUMPTION



ELECTRICITY CONSUMPTION

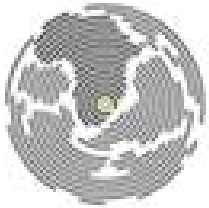


BUILDING ENERGY SOURCES



Buildings & Energy

ARCHITECTS TO PHASE OUT CARBON BY 2050

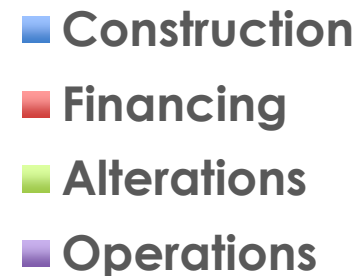
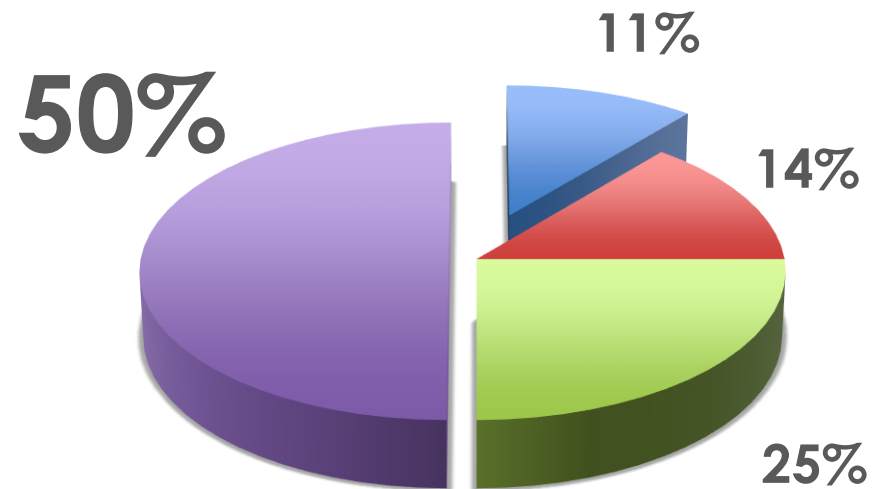


AS DECLARED AT THE 2014 UIA GENERAL ASSEMBLY IN DURBAN



- Budgets are tight and getting tighter
- Facilities operations costs are second only to staff salaries
- Every dollar saved in operations can be spent to meet other needs

Total Cost of Ownership

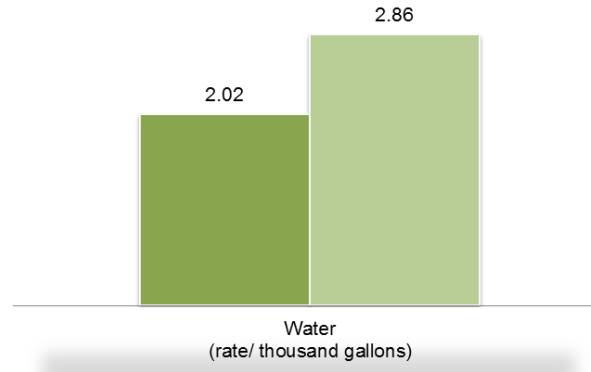


Cost of Ownership

Utility Costs

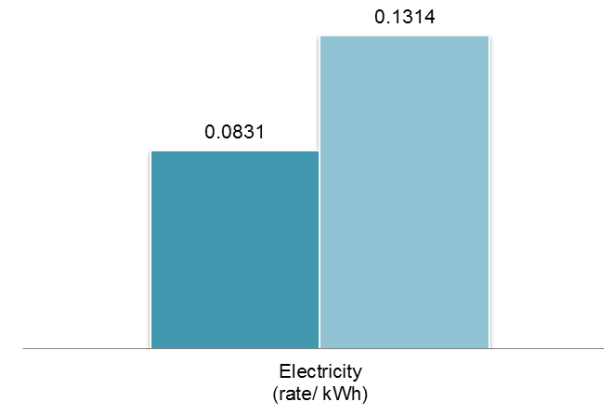
**Water Rate- 42% Increase
Northeast High School**

■ 2006 ■ 2008

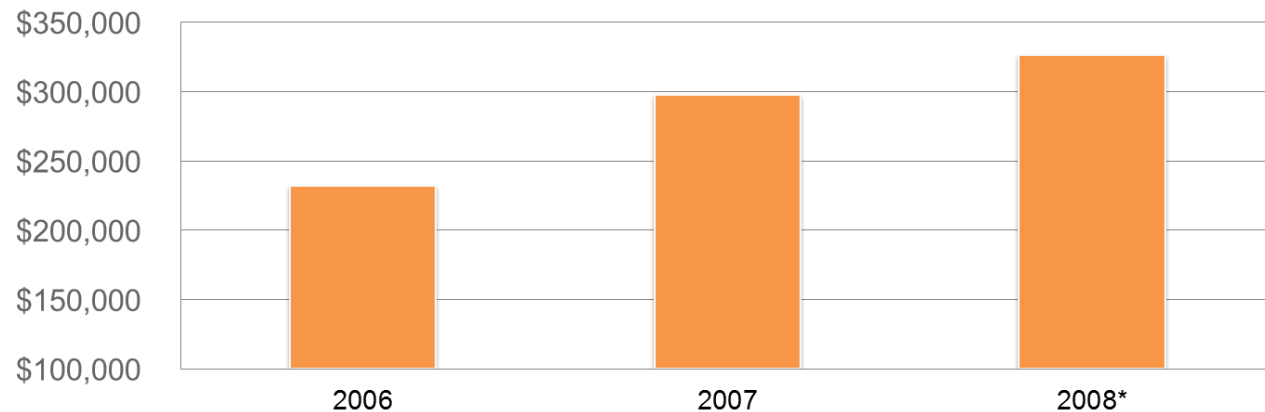


**Electricity Rate- 58% Increase
Northeast High School**

■ 2006 ■ 2008



**Total Energy Cost - 42% Increase
(between 2006-2008*projected)**





**REDUCE ENERGY
& BUILDING COSTS**

**INCREASE STUDENT
PERFORMANCE AND
ENGAGEMENT**

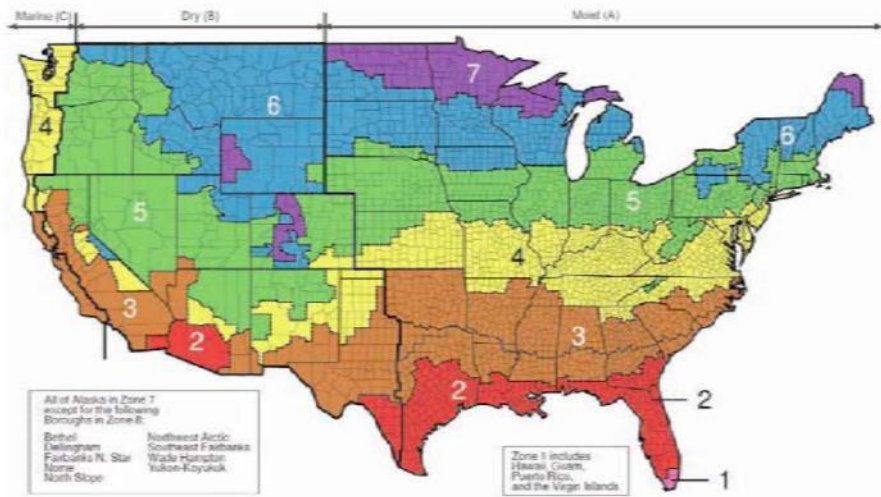
HOW

Do you deliver a Net-Zero Energy School?



Build the Team 12

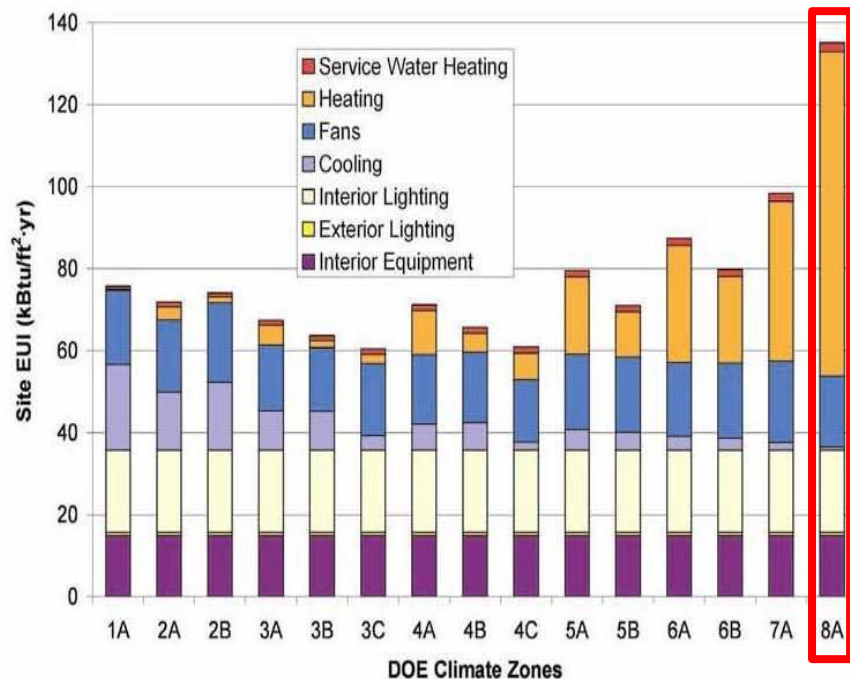
Utility Companies
Renewable Providers
Energy Modelers
Grants/Donors
Building Operators
Great Consultants
Great Contractors



Benchmark Energy Use 11

Average School
ASHRAE 90.1/LEED
NECB 2015

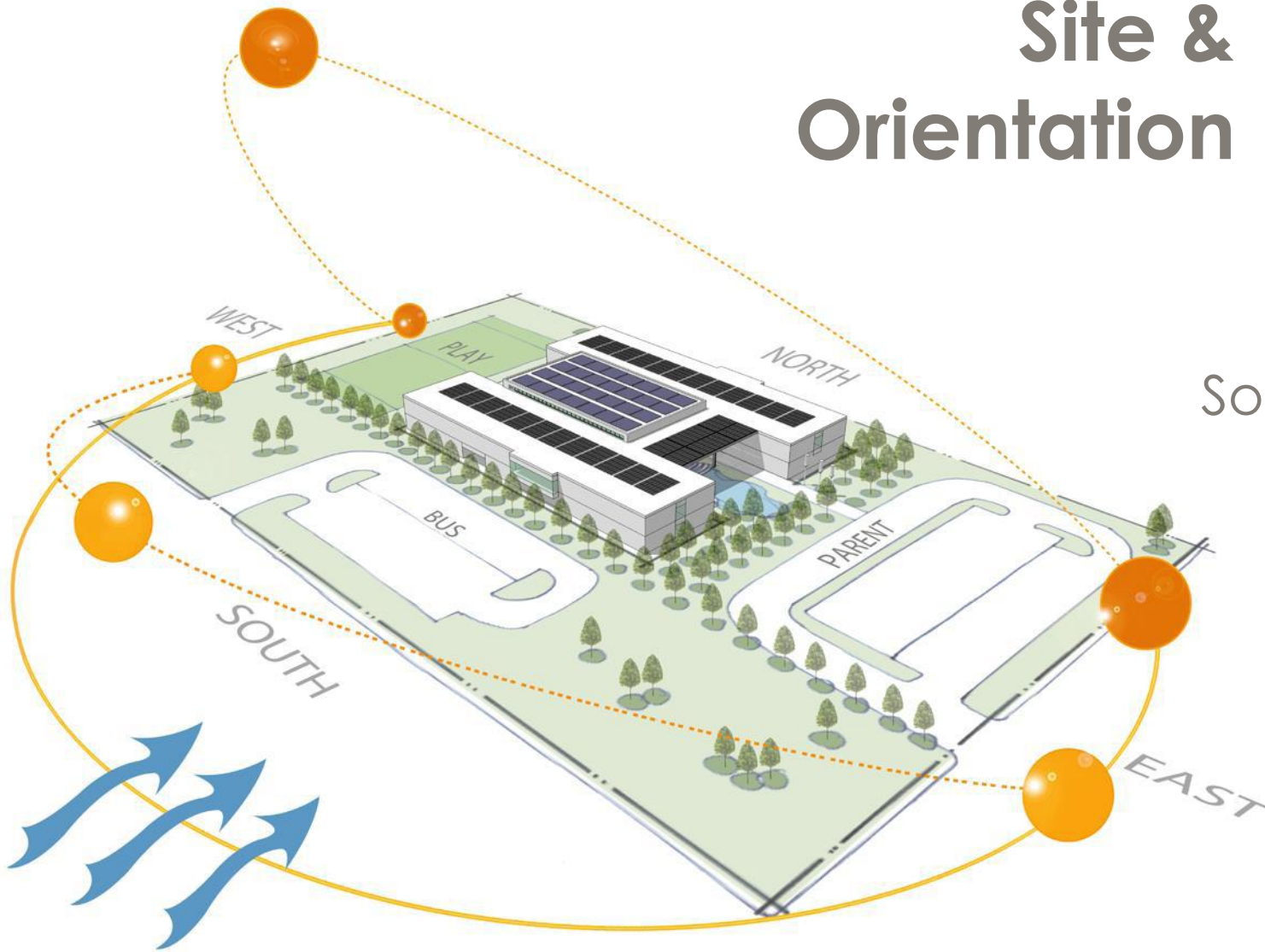
Set Aggressive Targets



Credit: Department of Energy Publication - the Advanced Energy Design Guide for K-12 Schools

Site & Orientation 10

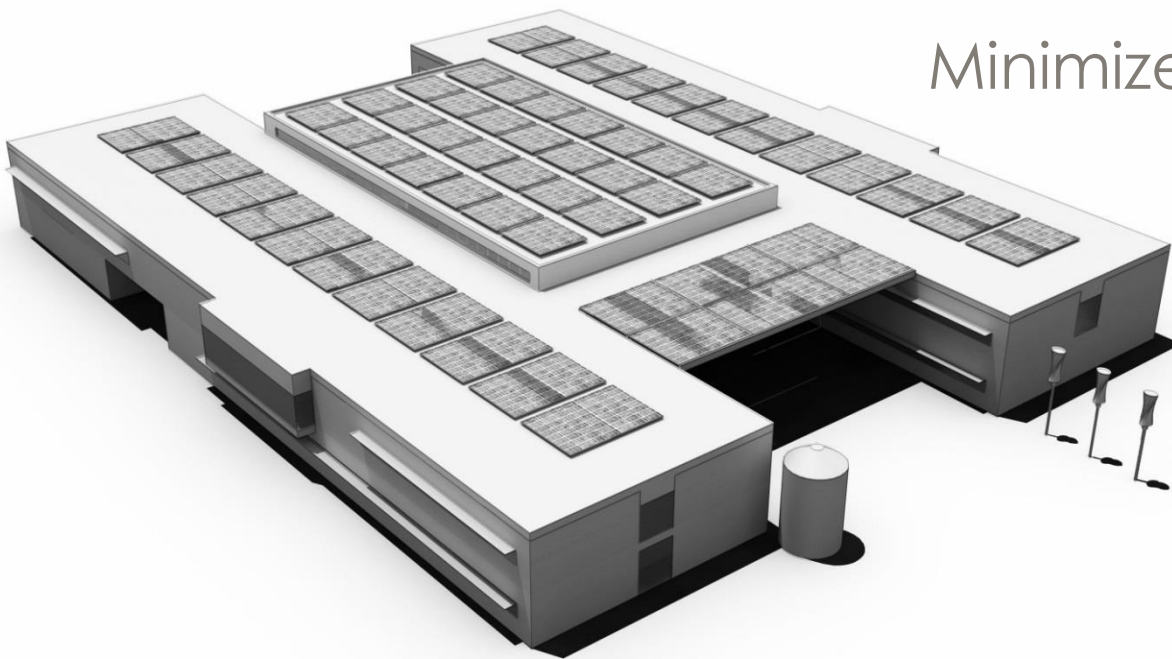
E-W Axis
Solar Access



Form & Massing

9

Simple Compact Form
Area to Envelope Ratio
Minimize Roof Equipment





Building Envelope 8

Mind the GAP!
Continuous insulation
Minimum R40 Roof
Minimum R20 Walls
Air barrier
Consider ICF
GWP of insulation



Aperture 7

Window to Wall Ratio
Exterior Protection
Glazing specifications
Watch the substitutions!



Advanced Lighting 6

Daylight harvesting
All LED (almost)
User-friendly controls



Advanced Systems 5



Right-Size Equipment
Geo-exchange
Dedicated Outside Air
Energy Recovery
Demand Control
Displacement Ventilation
Natural Ventilation
Don't forget the kitchen!



Building Controls 4

Keep it SIMPLE
Responsive to Users
Learn from the Building

AIR

NATURAL VENTILATION

Every classroom has windows that can be opened. When the outdoor temperature and humidity is just right, this green light will turn on. That means each classroom's heat pumps have turned off to save energy and it's a great time to open the windows and get fresh air from outside. When the light is off, make sure the windows are closed tightly.





Plug Load Control

3

User education
Policy & Procurement
Laptops & tablets
Building-level leadership
Get kids involved



Renewable Energy 2

Conservation first!
Use your roof wisely
Learning tools



Operations 1

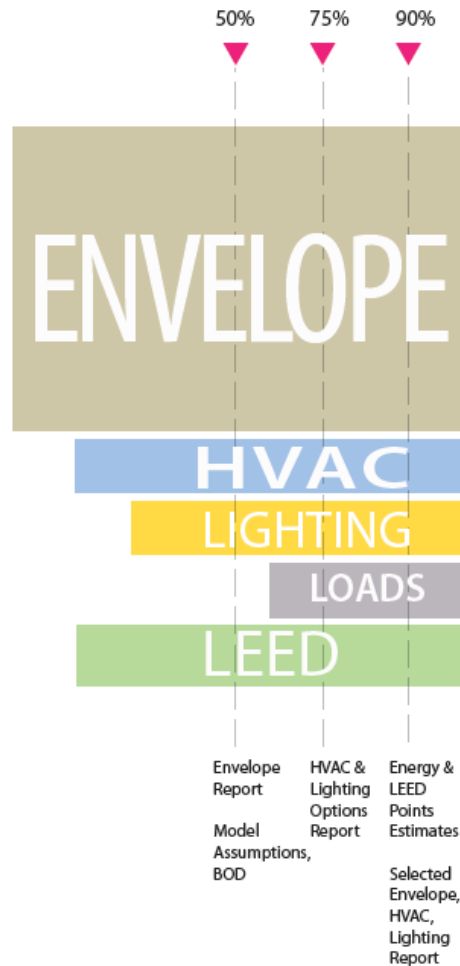
User/Operator Training
Commissioning
POE

CBE survey

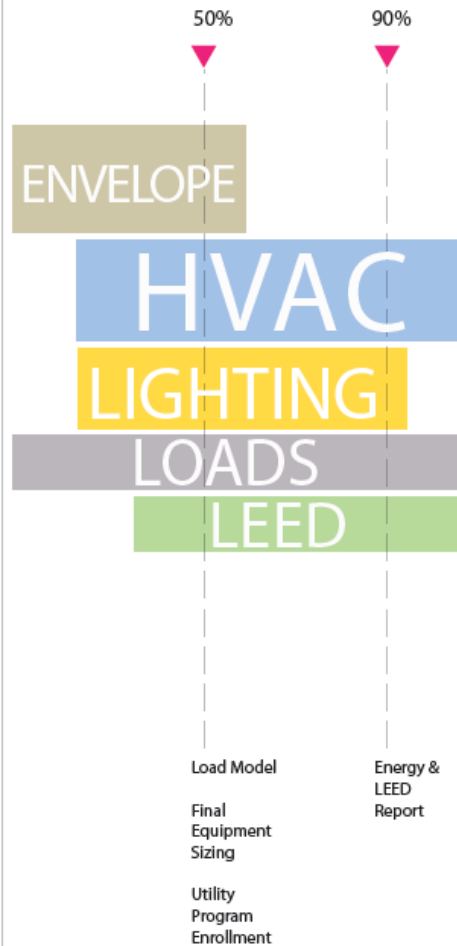
www.cbe.berkeley.edu

Modeling at every step...

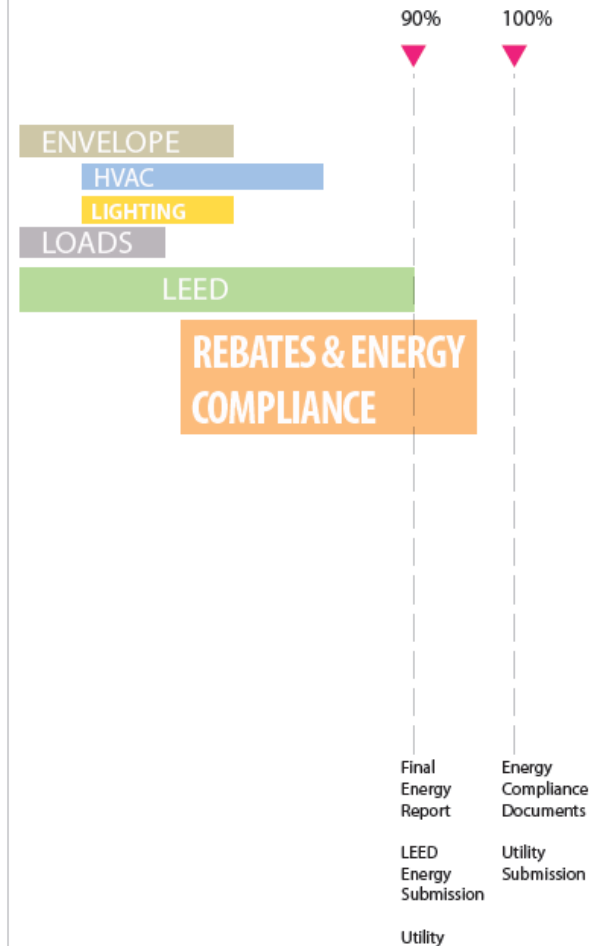
Schematic Design



Design Development



Construction Documents



Just like Grandma said...

**“No solar dessert
until you eat your
conservation veggies!”**



6X

cost to generate vs. conserve energy
(so don't forget about existing buildings)

WHAT does this mean for the Owner?

- Possible higher first cost
- Lower operating cost
- A smarter building
- Continuous Cx – monitor, evaluate, tweak, repeat
- Building as a research / teaching tool – “pass it forward”
- Changing procedures / habits - non-grease cooking, cleaning, security lighting, purchasing, etc.
- Saved operating costs can be used for funding education programs

WHAT does this mean for the Design Team?

- Integrated design
- Increased effort for site adapt (versus standard prototype)
- Leave no energy efficiency opportunities unturned
- Investigation of recent / emerging technologies and practices
- Educating the Owner on recommended technologies
- Consideration of inventive ways to use the building as a research / teaching tool
- Post occupancy monitoring & evaluation

BEYOND

Net-Zero Energy



Living Buildings Challenge

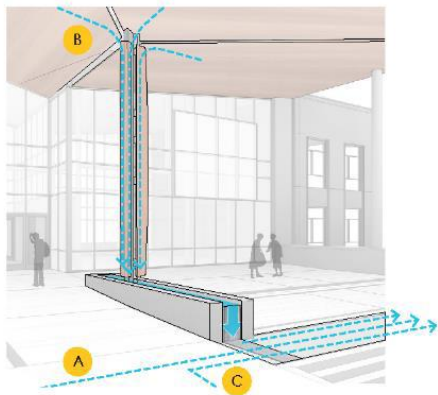
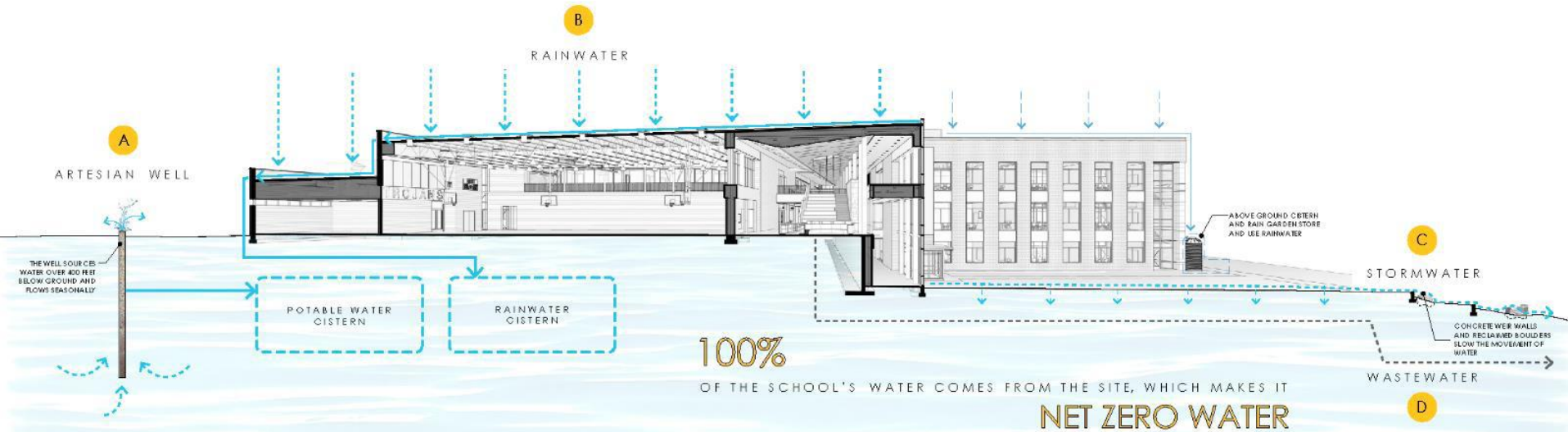
	LIVING BUILDING CHALLENGE 3.1			
	BUILDINGS	RENOVATIONS	LANDSCAPE + INFRASTRUCTURE	
PLACE				01. LIMITS TO GROWTH
	SCALE JUMPING		SCALE JUMPING	02. URBAN AGRICULTURE
			SCALE JUMPING	03. HABITAT EXCHANGE
				04. HUMAN-POWERED LIVING
WATER			SCALE JUMPING	05. NET POSITIVE WATER
ENERGY			SCALE JUMPING	06. NET POSITIVE ENERGY
HEALTH + HAPPINESS				07. CIVILIZED ENVIRONMENT
				08. HEALTHY INTERIOR ENVIRONMENT
				09. BIOPHILIC ENVIRONMENT
MATERIALS				10. RED LIST
			SCALE JUMPING	11. EMBODIED CARBON FOOTPRINT
				12. RESPONSIBLE INDUSTRY
				13. LIVING ECONOMY SOURCING
				14. NET POSITIVE WASTE
EQUITY				15. HUMAN SCALE + HUMANE PLACES
				16. UNIVERSAL ACCESS TO NATURE + PLACE
			SCALE JUMPING	17. EQUITABLE INVESTMENT
				18. JUST ORGANIZATIONS
BEAUTY				19. BEAUTY + SPIRIT
				20. INSPIRATION + EDUCATION

Net-Zero Water

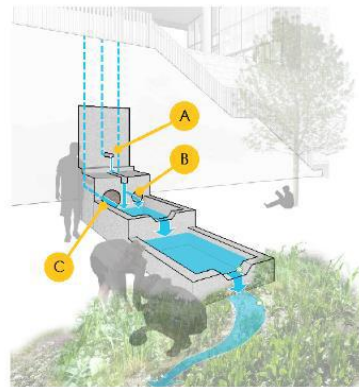


Frederick County Middle School

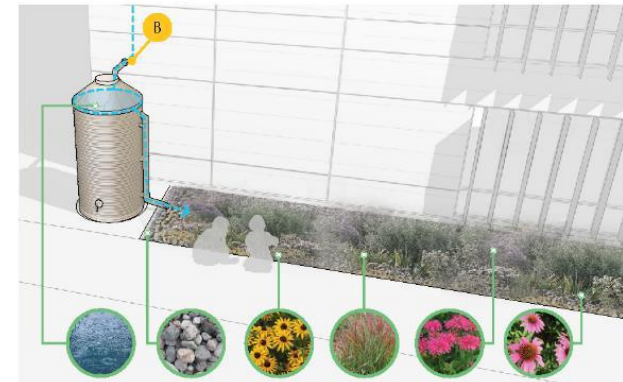
Net-Zero Water



COLUMN W/ INTEGRATED SCUPPERS CHANNELS RAINWATER AND DIRECTS IT (ALONG W/ WELL & STORMWATER) TO WATER QUALITY FOUNTAIN



EDUCATIONAL FOUNTAIN PROVIDES AN OPPORTUNITY TO COMPARE WATER QUALITY FROM THREE SOURCES OF SITE WATER



ABOVE-GROUND CISTERNS AND RAIN GARDENS AT THE END OF EACH SLC WITH NATIVE SPECIES FOR EXPLORATION AND STUDY OF LOCAL ECOSYSTEMS

Frederick County Middle School

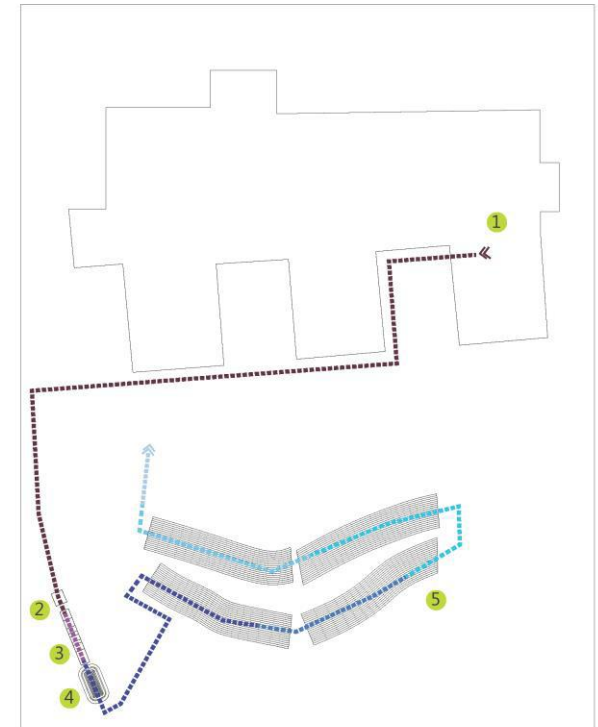
Net-Zero Water



WASTE WATER TREATMENT

The Waste Water Treatment System is a part of a closed loop at FCMS. They do not pump clean or dirty water on or off their site. Water is collected on site from wells and aquifers and then used in the school. The used water is then processed through the Waste Water Treatment System on site. They treat the water with an aerobic system and then use natural systems to help filter the water. This limits the amount of water runoff that pollutes local water ways and the Chesapeake Bay. Please be mindful of our rivers and waterways and do not pollute. Help the world by not using an excessive amount of the 3% of freshwater on Earth.

Below is a diagram depicting the different sites for the different processes in FCMS's Waste Water Treatment System



- 1 **SCHOOL**
- 2 **CONTROL BUILDING** A control building controls all the water treatment system
- 3 **TREATMENT** Series of tanks treating the dirty water with aerobic bacteria and other methods.
- 4 **CONSTRUCTED WETLAND** A field with pipes running beneath the surface releasing water into the ground surface.
- 5 **SUBSURFACE DRIP FIELD** A field with pipes running beneath the surface releasing water into the ground surface.
- WASTE WATER Used water collected from school ready to be processed through waste water treatment system.
- CLEAN WATER At the end of the loop, water is cleaned and ready to be re-use in school.

WELL Building Standard



WELL CONCEPT

CONCEPT FEATURE

AIR	Quality standards including filtration, cleaning protocols, microbe control, material safety
WATER	Testing and monitoring to control public water additives and system contaminants
NOURISHMENT	Promotion of healthy food options, nutrition labeling, safe food preparation and sourcing
LIGHT	Glare free and circadian lighting design, effects of surfaces & contrast, light quality, daylighting
FITNESS	Active design, enhanced ergonomics, activity incentives, and structured fitness programs
COMFORT	Physical and visual ergonomics; thermal, olfactory, and acoustic comfort
MIND	Organizational policies and transparency, biophilic design, flexible and adaptable spaces

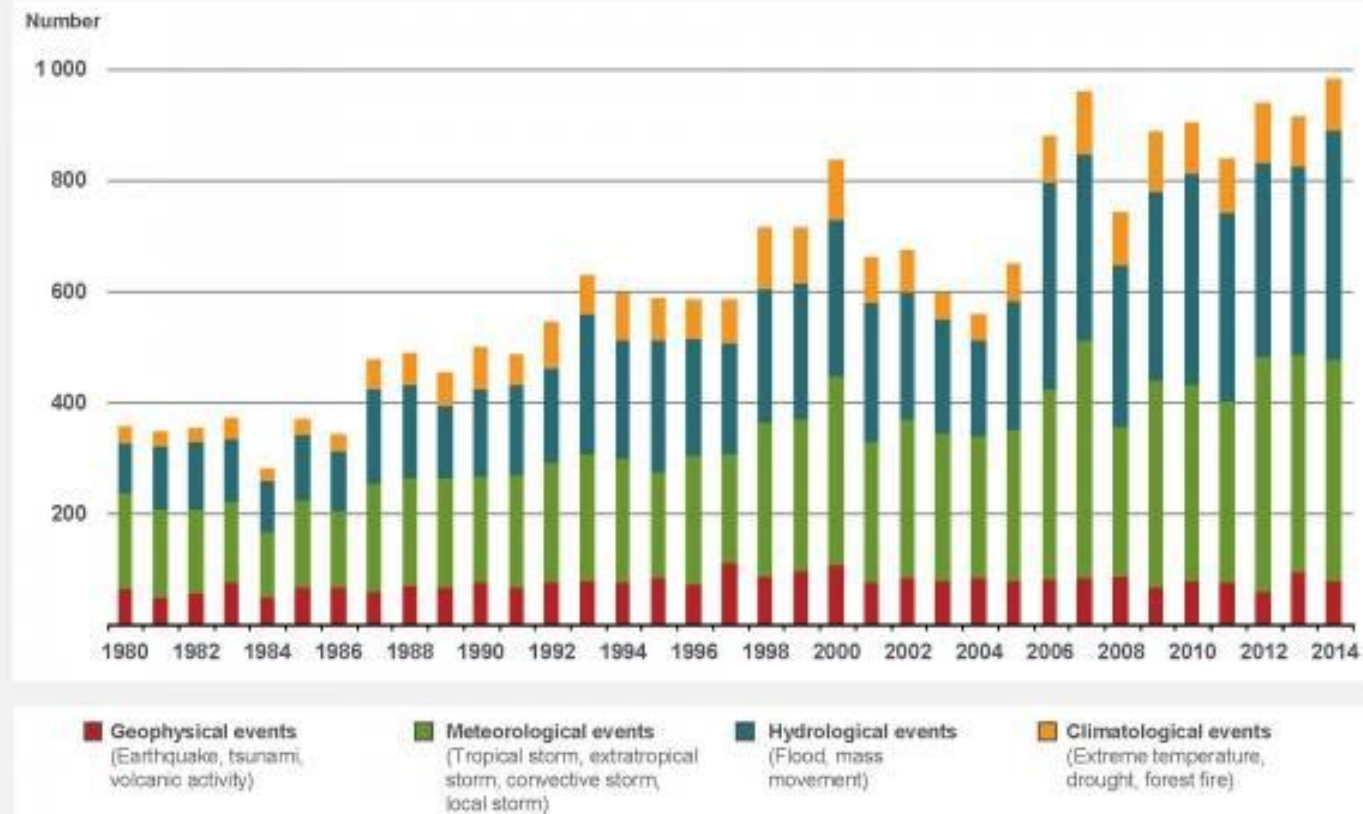
Resilience

NatCatSERVICE

Loss events worldwide 1980 – 2014

Number of events

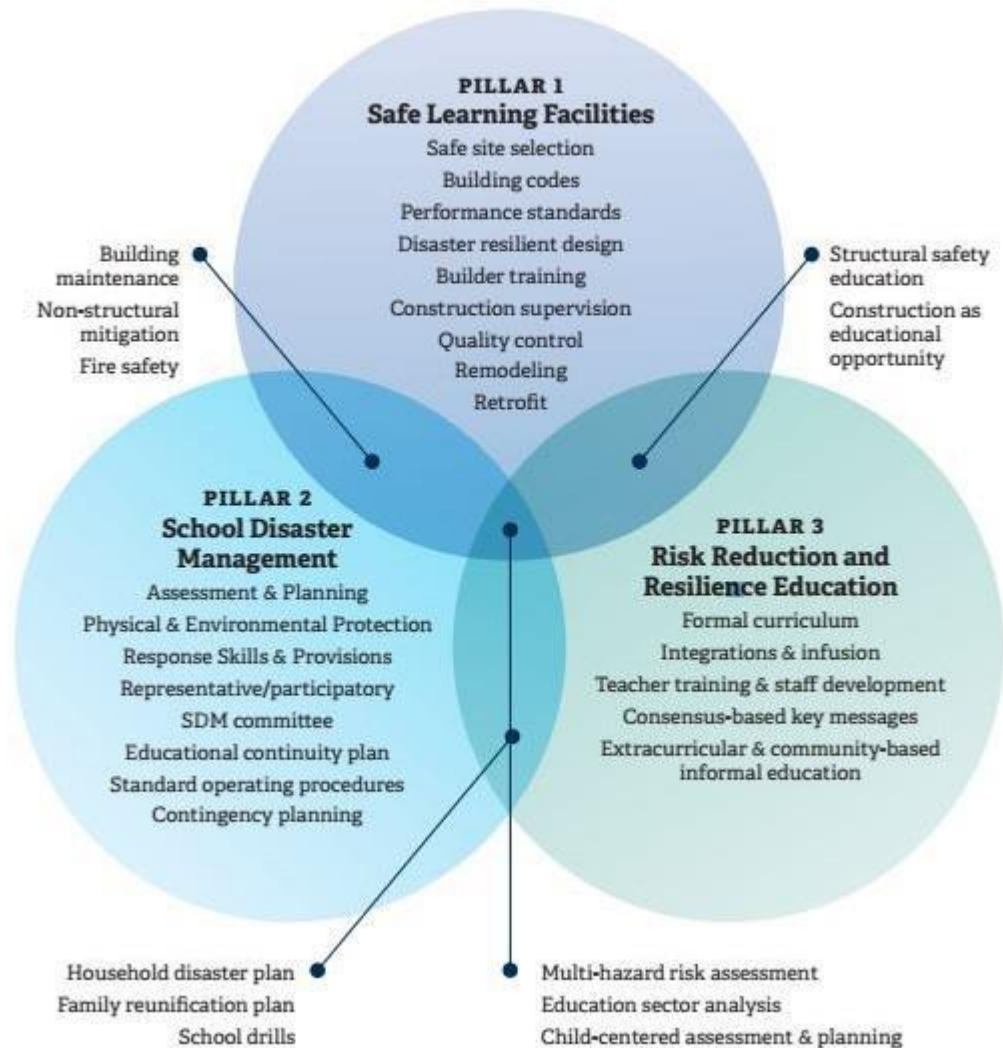
Munich RE 



© 2015 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE – As at January 2015

Source: Munich RE

Resilience



Source: UNISDR and Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector, "Comprehensive School Safety," <http://gadrres.net/uploads/files/resources/Comprehensive-School-Safety-Framework-Dec-2014.pdf>.



LEARN

What about learning?

Learning



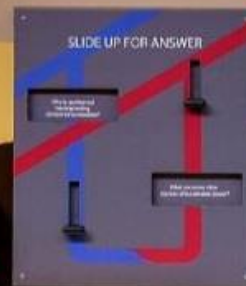
Enhanced
Engaging
Learning
Experiences



Garrett Elementary School

Stantec

HOW DOES YOUR SCHOOL STAY COOL?



Garrett Elementary School

Stantec



Gloria Marshall Elementary School

Stantec



Gloria Marshall Elementary School

Stantec



Gloria Marshall Elementary School

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Salyards Middle School

Stantec

What is the opportunity?

- LEED Certified and NZE (ready) schools
- Build on the performance specification
- Leverage carbon levy to support projects and build capacity
- Reduce O&M costs
- Provide engaging learning opportunities

Q&A

What do YOU want to know about Net-Zero?