Net Zero Energy Schools
What, Why and How

Banff, Alberta - May 18, 2017
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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?

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

- **Energy & Resources**
  - Oil & Gas
  - Mining
  - Power

- **Infrastructure**
  - 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?
Suddenly, a heated exchange took place between the king and the moat contractor.
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

BUDGET 2012
Investing in Regina
We are an owner...

Design

Plan

Deliver

Commission

Renew/Dispose

Operate & Maintain

Accommodate
Key Partners

Alberta Infrastructure

- Building Operation and Management Industry
- Program Ministries, Boards, and Authorities
- Federal, Provincial, and Municipal Government
- Design and Construction Industry
- Professional And Technical Groups
- Communities
- Post Secondary Institutions
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.
4. People matter.
WHAT is a Net-Zero Energy School?
Net Zero Energy Building = An energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy. 

(USDOE 2015)

(Oregon Sustainability Center)
Energy Use Intensity (EUI)

**AIA 2030 Commitment Targets**

- **K-12**
  - 2003 Benchmark: 75 kBTU/sf/year
  - 2015 Target: 22.5 kBTU/sf/year
NZE is a growing market...

Number of ZNE Projects

- 2012:
  - ZNE Verified Buildings and Districts: 21
  - ZNE Emerging Buildings and Districts: 39
  - Ultra-low Energy Buildings: 39

- 2014:
  - ZNE Verified Buildings and Districts: 33
  - ZNE Emerging Buildings and Districts: 127
  - Ultra-low Energy Buildings: 53

- 2016:
  - ZNE Verified Buildings and Districts: 53
  - ZNE Emerging Buildings and Districts: 279
  - Ultra-low Energy Buildings: 62
And it’s everywhere…
Who’s doing it…

ZNE and Ultra-Low Energy Building Types

- Public Assembly: 7%
- Multifamily: 11%
- Other: 21%
- Office: 23%
- Education: 38%
NREL Research Support Facility
RNL Design/Stantec
NREL Research Support Facility
RNL Design/Stantec
SMUD East Operation Center
RNL Design/Stantec
Elementary/Middle School Performance (kBTU/sf/year)
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.
Horry County Middle School Prototype
SFL+A/Stantec
Maryland Energy Administration

Powering Maryland’s Future

Initiative
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 kBtu/ft2/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

Howard County Public Schools

County Public School System

Architect of Record A/E firm

Design Support A/E firm

MEA NZE Schools Program

Design Review A/E firm

Rory Spangler, SRA (Program Manager)

Grant Document

Information

2rw Consultants, Stantec Architecture

$2.2 M

$500K

Maryland Can Be A Mover
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

- 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 (watt): $3

PV system size (kW): 467

Energy production (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 of Alberta’s population 17%
Emissions endanger the health and welfare of current and future generations.
Fort McMurray, Alberta
Oil Consumption Per Capita

SOURCE: http://upload.wikimedia.org/wikipedia/commons/9/9a/OilConsumptionpercapita.png
2/3 of power generated is never used!
World Cities

Carbon Emissions per Capita and Urban Density

Credit: Luke Leung, SOM
Buildings & Energy

Source: US Energy Information Administration
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

Cost of Ownership
Utility Costs

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

- 2006: 2.02
- 2008: 2.86

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

- 2006: 0.0831
- 2008: 0.1314

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

- 2006: $215,000
- 2007: $275,000
- 2008*: $310,000
INCREASE STUDENT PERFORMANCE AND ENGAGEMENT

REDUCE ENERGY & BUILDING COSTS
HOW

Do you deliver a Net-Zero Energy School?
Build the Team

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

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

E-W Axis
Solar Access
Form & Massing

Simple Compact Form
Area to Envelope Ratio
Minimize Roof Equipment
Building Envelope

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

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

Daylight harvesting
All LED (almost)
User-friendly controls
Advanced Systems

Right-Size Equipment
Geo-exchange
Dedicated Outside Air
Energy Recovery
Demand Control
Displacement Ventilation
Natural Ventilation

Don’t forget the kitchen!
Building Controls

Keep it SIMPLE
Responsive to Users
Learn from the Building

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.

VMDO Architects
Plug Load Control

3

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

Conservation first!
Use your roof wisely
Learning tools
Operations

User/Operator Training
Commissioning
POE
CBE survey

www.cbe.berkeley.edu
Modeling at every step…
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

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<td>10. RED LIST</td>
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<td>11. EMBODIED CARBON FOOTPRINT</td>
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<td>13. LIVING ECONOMY SOURCING</td>
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<td>14. NET POSITIVE WASTE</td>
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<td>15. HUMAN SCALE + HUMANE PLACES</td>
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<td>16. UNIVERSAL ACCESS TO NATURE + PLACE</td>
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<td>18. JUST ORGANIZATIONS</td>
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<td>19. BEAUTY + SPIRIT</td>
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<td>20. INSPIRATION + EDUCATION</td>
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Net-Zero Water

100% of the school’s water comes from the site, which makes it Net Zero Water.

- Column w/ integrated scupper 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 FCMMS. 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 sewer systems and then use several systems to help filter the water. This limits the amount of water used in the process and keeps the water from being mixed into rivers and waterways and do not pollute. Help the world by not using an excess amount of the Wastewater on Earth.

Below is a diagram depicting the different sites for the different processes in FCMMS’s Waste Water Treatment System.

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

******* **WASTE WATER**

******* **CLEAN WATER**

At the end of the loop, water is cleaned and ready to be reuse in school.

Frederick County Middle School
## WELL Building Standard

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

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Resilience

Loss events worldwide 1980 – 2014
Number of events

Source: Munich RE
Resilience

LEARN

What about learning?
Learning

Thoughtful Building Design

+ 

Thoughtful Curriculum Design

Enhanced Engaging Learning Experiences
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?