Planning for 21st Century and Net Zero Energy Schools
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Learning Objectives

1. Understand how the district-wide Ed Specs were used to create site-specific Ed Specs.

2. Understand how the community needs and the academic requirements were integrated into the design of the schools.

3. Understand how the design of a building can foster what the district values as 21st Century Learning while allowing for flexibility to changes as the academic program and building evolves over time.

4. Understand how Net Zero Energy goals were incorporated into the Ed Specs and Design.
The Facts. . .

• 2017-18 enrollment: 80,592 students
  • 42,864 students grades PK-5
  • 16,964 students grades 6-8
  • 20,764 students grades 9-12
• 37th largest school district in America (2010)
• 55.1% Low Income
• 6.6% English language learner
• 14.7% students with disabilities
• Graduation Rate (2016): 87.6% and increasing
• Dropout Rate (2016): 8% and decreasing
The Facts...

- 177 schools and programs
  - Includes 34 charter and contract schools
- FY18 (2017-18) annual operating budget: $1.12 Billion
- New 21st Century Educational Specifications
- City Schools Design Standards
- LEED Silver mandated by MD’s High Performance Building Act

- 21st Century School Buildings Plan
  - Approximately $977M to modernize 23-28 buildings

VS

- BCPS Capital Improvement Plan (CIP)
  - ★ Graceland Park/O’Donnell Heights ES/MS Replacement School
  - ★ Holabird ES/MS Replacement School
Building Conditions

• 2017-2018 Buildings: 160
• Most buildings built between 1895 and 1995
  • 23% built before 1946
  • 74% built between 1946 and 1985
  • 3% built since 1985
• Buildings span 18.5 million square feet of space across 160 buildings
  • 17.5 million square feet district-owned buildings
  • 434,613 square feet in district owned modular and portable buildings
• Facility conditions is 60 percent district-wide, with students occupying 78% of its available space
  • 112 of 163 campuses or 69% had FCI scores 50 -75 meaning their condition is very poor
  • 44 of 163 campuses or 23% had FCI scores of 75 or higher, meaning they were candidates for replacement or surplus
High-quality, modernized buildings for all students: A massive and collective effort

- The district partnered with the community, state and the city to win support for Baltimore City Public Schools’ 21-Century Buildings Plan.
- In 2013, the funding and oversight structures to implement the plan were established.
- The current, first phase of the plan represents approximately $1 billion in building modernization.
- House Bill 860 charges the Maryland Stadium Authority (MSA) with overseeing the financing of the building plan and establishes a partnership between City Schools, the city, state and MSA.
It is about the Learning and the connection to the environment.
Core Concepts

Consistent and overriding concepts:

• Educational clustering to create small learning communities.
• Transformational thinking required not just in the development of facilities but also in teaching.
• Community use spaces and joint use of spaces and resources.
• Building should be light, bright and healthy learning environments with cutting edge sustainable concepts.
• Technology integration and ease of access for all.
Learning Environments

Where in the spectrum should City Schools be?

1. Traditional rows of classrooms
   All private spaces with no shared space.

2. Corridor breakout space
   Private classrooms with small group work area.

3. Collaborative space
   Classroom area designated as shared space.
   Teacher "owned" classroom.

4. Shared spaces
   Variety of space types all for shared use.
   Teachers move and share classrooms.
Educational Specifications: Every Building

• Examples of educational specifications that support innovative, high-quality teaching and learning:

  • **Flexible and adaptive space** so learning can happen anywhere
    • Collaborative spaces, movable walls, display boards

  • **Interactive social areas** that incorporate technology and are used during school day and after hours for working, learning, visiting
    • Workstations, cyber lounges, small performance areas

  • **Engaging spaces** that support diverse instructional delivery
    • Interactive learning labs, outdoor classrooms, rooftop gardens

  • Multifunctional spaces designed for **community/parent use**

  • Spaces that encourage **student and teacher collaboration**
    • Team-based learning, collaborative teaching, video conferencing, live streaming
Creating Site Specific Ed Specifications

- Enrollment Projections
- Community Needs
- School Programs
- School Specific Requests
The bigger picture...
Two Replacement Schools

- Graceland Park O’Donnell Heights Elementary/Middle School
- Holabird Elementary/Middle School
During Design: December 2015 Strategic Plan outlined 6 priority areas:

- Quality curricula and instruction
- Quality staff
- Climate and facilities
- Family and community engagement
- Responsible stewardship and excellent customer service
- Portfolio of great schools in all areas of the city

2017 Goals:

- Student Wholeness
- Literacy
- Leadership
Support development of 3 Net Zero Energy Schools (NZE) within BGE service area in Maryland.

$2.7M per school from The Maryland Energy Administration (MEA) to construct Graceland and Holabird as NZE with up to $533K for design support contractors.

Design Goal of < 25 kBTU/sf/yr for all school uses, not just daytime.

Originally, Holabird was to be minimum LEED Silver and “Net Zero Energy Ready” by repeating the same design as Graceland’s prototype but not getting the grant. However, it was awarded the grant in December 2016 to be NZE.
Benefits:

• **Funding** to help offset the incremental costs of designing and constructing a net zero energy school
• **Reduced utility costs** over the life of the new school
• **National recognition** as one of very few schools to achieve net zero energy status
• A “**living laboratory**” that can be used to educate students, educators, and community members about energy efficiency and renewable energy technologies.

Design Philosophy:

• Use energy efficiency measures to reduce building envelope energy
• Adjust procedures and human behaviors to conserve energy (without affecting comfort)
• Add renewable energy to produce remaining energy requirement over the year
• Remain grid connected
Your role and what we need from you

- Engage Champions in each Department and from each School
- Data Collection
- Be Open to Discussion about the Way You Operate
- Attend Break-Out Sessions in Design
- Develop Environmental Literacy Curriculum
- Attend Occupant Behavior Sessions
How do you fit into this?

• We succeed together
• Every decision we make together will have an impact on the operation of the school
• Our job is to challenge you
• Your job is to rethink assumptions
• This will be your building for 50+ years
• Collaboration starts now
Occupant Behavior is the Critical Overlay For Energy Efficiency

NET ZERO

USER ENGAGEMENT
NZE Occupant Behavior

Temperature
Heating + Cooling
Indoor Air Quality
Appliances
Envelope
Lighting
Orientation
Schedule Maintenance
Moisture Control
Occupant Behavior

Behavior

HVAC 44%
Lighting 21%
Plugs 11%
IT 6%
Kitchen 10%

Appliances
Envelopes
Indoor Air Quality
HVAC
Lighting
Orientation
Schedule Maintenance
Moisture Control
Occupant Behavior

BUILDING
BEHAVIOR

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Prototype Diagram

CLASSROOM WING

PRIVATE

PRIVATE

PUBLIC

LEARNING SPACES

COLLABORATIVE LEARNING AREA

COLLABORATIVE LEARNING AREA

DINING PERFORMANCE COMMUNITY

COMMUNITY USE

MAIN ENTRY FOR SCHOOL AND COMMUNITY

ADMINISTRATIVE / SUPPORT SPACES

SECONDARY COMMUNITY ENTRANCE

SCHOOL SUPPORT SPACES
Both are NZE.

January 2016: Graceland to be NZE and Holabird NZE “Ready” (not getting grant, but same design)

Case Study Opportunity:
- same school design
- 180 degree orientation difference
- 1 NZE and 1 NZER

December 2016: Holabird got the grant (design at 75% CDs so it benefited from engagement meetings and same design – added PV package to the contract documents)

Case Study Opportunity:
- same school design – both NZE
- 180 degree orientation difference (negligible in energy model)
- Different Principals – very autonomous
- Different Community Partnership Programs
Focus on Efficiency for Everything

Starting Point – Typical K-12 School
72kBtu/sf yr

- HVAC: 63%
- Lighting: 28%
- Kitchen: 4%
- IT: 2%
- Plugs: 3%

BCPS’s NZE K-8 Schools as of early 2017
<25 kBtu/sf yr (tracking 21 currently)

- HVAC: 44%
- Lighting: 16%
- Kitchen: 19%
- IT: 8%
- Plugs: 13%

*Average across climate zones


Source: CD Energy Model Analysis by CMTA Engineering for Graceland Park/O’Donnell Heights ES/MS and Holabird ES/MS
NZE Process...

01 Benchmark per Code
- ASHRAE 90.1-2010: 72 kBtu/sf yr
- 50% AEDG: 36 kBtu/sf yr
- NZE: 21-25 kBtu/sf yr

02 Get Buy-In from Everyone
- Administration
- Facilities
- Staff/Teachers/Students

03 Optimize Passive and High Performance Design Strategies

04 Offset with Renewable Energy

05 Monitor Performance

We are in Climate Zone 4
NZE Process. . .
Top 5 Strategies for Design

01 Optimize Envelope

02 HVAC Design – centralized DOAS with demand control ventilation

03 LED Lighting

04 Kitchen – Type II hood, more fresh food/less frozen

05 Real-time Energy Display (Energy Kiosk) tied into Submetering and BAS

High R-value walls, Window: Wall Ratio, roof free of equipment to make room for PV array
GRACELAND
8.5 acre site

HOLABIRD
6.8 acre site
Getting from an EUI of 35 (recommended Code benchmark) to EUI of 25 is hard work... and getting lower is exponentially harder.

New Design EUI for both schools: currently tracking 23 kBtu/sf yr

Existing EUI for Holabird: 82 kBtu/sf yr

Existing EUI for Graceland: 106 kBtu/sf yr

Energy Use Index
kBtu/sf yr

Energy Consumption

Renewable Energy

Buy-in on Your Goal
(comprehensive)

(level of intuitive change)
NZE Charrettes
Plug Load Reduction

Rapidly Advancing Technology
Construction Complete
January 2019

Wireless
Classroom Ed Tech
Equipment
Unoccupied Shutdowns
Beyond ENERGY STAR

Kitchen Equipment Selections

Minimizing & Eliminating Type II Hood

Hood Redesign

Geothermal DW Heater

Cooler/Freezer Design
Lighting

Overall Lighting Goals
0.5 Watts per square foot

Daylighting Control
Complexity/Cost

Building Level Control vs. Occupancy Sensors

Classroom Options
Lighting Options

Ceiling Height Affects

Indirect/Direct Fixtures

2x2 Fixtures

2x4 Fixtures

Results

30% Energy Reduction

$5,000 Savings per Classroom
HVAC

Geothermal
WSHP
Pumping
Demand Control Ventilation
Energy Recovery
Building Management System
Sensors/Controls
Vandal Resistance
PV Design

Roof Design

Cost of System
$1.6 Million or 4.5% of Budget

Every EUI saved equals $76,000 in PV costs

Solar Lab Learning Tools and Add-Alernate Transparent PV Entry Canopy
Green Day of Service

WHO PARTICIPATED?
2 Schools
14 G+P Volunteers
10 Teachers and dozens of students

WHAT DID THEY DO?
Paint 2 Sundials
Weed Garden
Frame and hang mosaic mural
Nutrition Demonstration
Solar Energy Demonstration
Vegetative Roof Demonstration
ICF Demonstration
Chalk Art Festival

WHY?
Kick off NZE Community Engagement
Get to know our school communities
Mr. Johnson’s Kindergarten Class 3-D printed building blocks to look like marshmallows, graham crackers, and chocolate bars

Learned from G+P about scale, section, and plan
NZE Process...
Top 5 Strategies for Use

1. Change Behaviors
2. Set realistic operating hours and schedules in energy model
3. Train staff in building controls
4. Identify NZE Champions for staff and students
5. Incorporate NZE into Curriculum for lessons
Curriculum Integration

Typical School Design Pattern

Facilities
  Educational Specifications ➔ Design ➔ Construction ➔ Operations

Educators ➔ Curriculum ➔ Teaching and Learning

Ideal School Design Pattern

Educators + Facilities

Teaching and Learning ➔ Curriculum ➔ Educational Specifications ➔ Design ➔ Construction ➔ Operations

Operations ➔ Educational Specifications ➔ Design
Kids observed the well drilling process, touched mud from 50’ and 375’ underground, and painted pictures for the contractors.
USER ENGAGEMENT (STUDENTS AND STAFF)

NZE Occupant Behavior

Charrettes/Workshops
Storyboard Dashboard,
Student Engagement,
Curriculum Tie-In
Discussions
Tour NZE Discovery in
Arlington
Year 2016

NZE Tour of Wilde Lake MS
and Peer Group Meeting
for Facilities and
Curriculum

Spring 2017

Bidding

Summer 2017

Construction of new
schools begins

Spring 2018

we are here
USER ENGAGEMENT (STUDENTS AND STAFF)
NZE Occupant Behavior

Tour Local NZE School Peer Group Meeting at Discovery ES (APS)

Construction Tours: 
School Staff, Students, Community Use Groups School Identity Art Project

School Opens Occupancy/Tours User Cards/Manuals Signage

Teach Math/Science Classes Train Teachers about Dashboard integration into curriculum

Fall 2018

Fall/Winter 2018

Summer 2020

Fall 2021
Discussion...

USER ENGAGEMENT
Building as a Teaching Tool
USER ENGAGEMENT
Building as a Teaching Tool
SOLAR PORCH/SCIENCE LAB

- Observe solar path and generation of energy
- Observe natural plant cycles in vegetative roof
CURRICULUM ENGAGEMENT
Site as a Teaching Tool

EDIBLE GARDEN

BIOFILTERS/RAINGARDENS

OUTDOOR CLASSROOM

GRACELAND

HOLABIRD

OUTDOOR CLASSROOM
Thank you!

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