James Cole NetZero
Elementary School (ES) Division
Team

- Songhao Wu
  MS Civil Engineering

- Bhavya Rathna Kota
  MS Construction Management

- Namratha Kullachanda
  MS Civil Engineering

- Zach Schreiber
  MS Engineering Technology

- Emilio Rojas
  BS Design and Construction Integration

- James Rieser
  MS Engineering Technology

- Brian Tedeschi
  MS Engineering Technology

- Henry Liu
  MS Engineering Technology

- Jun Kim
  MS Environmental and Ecological Engineering
Outline

- Architecture
- Comfort & Indoor Environmental Quality (IEQ)
- Engineering
- Operation
- Energy
- Innovation
- Resilience
- Financial feasibility
- Market potential
Site Information
Stockwell, IN
Phased net zero energy design

Model for school renovations

Increasing sustainability education

Mindfulness

Disaster recovery center

Reasonable financial ROI
Floor Plan

- Entrance
- Gymnasium
- Kitchen
- Cafeteria
- Offices
- Art
- Reading
- Music
- Storage
- Classrooms
- Library

Legend:
- N (North)
Existing Features

- High Ceilings
- South Side Windows
- Earth berm
- Central common area
Exterior
James Cole User Assessment of Building

- Target population – staff and teachers
- Objective: understand user perspective of James Cole's IEQ (existing structure)

Indoor sound quality (frequency) – Echoing of sound is an issue

Interior lighting level – approx. 40% dissatisfied
Proposed Features

- Acoustic Barriers/Panels
- Integrated smart lighting
- Adding Biophilic elements
- Use of colors and textures
Tackling Lighting Issue

Natural lighting
- Windows and clerestory windows
- Change in lighting intensity with proximity

Integrated Smart Lighting
- Occupancy Sensors
- Section lighting controls
- Optimize/uniform interior light
- Daylight Sensors & dimmers (optional)
Interior Classroom

- LED lights equipped with motion sensors and dimmers
- Sound baffles - Geometry imitating bee hive
- Work display boards
- Seating/working platform options
- Blinds - To control the daylighting
- Flexible furniture arrangement by providing detachable single desk
- Additional storage spaces
Heating & Cooling

Geothermal Well Field

AHU Heat Pump

AHU w/ ERV

Zone Heat Pump (38 Total)

Zone Pumps
Ventilation

Make up AHU with ERV

ERV Annual Energy Savings
Operations

- Building Automation System (BAS)
- Recommissioning
- Training

BAS KPI's to help focus maintenance strategies

<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Key Performance Indicator (KPI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal Heat Pump</td>
<td>Loop Temperatures between 40 °F (winter) and 90 °F (summer)</td>
</tr>
<tr>
<td>Air Handling Unit</td>
<td>Runs according to timed schedule</td>
</tr>
<tr>
<td>Hot Water</td>
<td>Temperature and run time within specified limits</td>
</tr>
<tr>
<td>IEQ</td>
<td>CO₂ levels within recommended threshold for school</td>
</tr>
<tr>
<td>Solar</td>
<td>Array efficiency within 10% of expected performance</td>
</tr>
</tbody>
</table>

Annual Propane Use

- Porpane Use (Gal)
- 2018 vs 2019
Energy Use

EUI Results

Source EUI (kBtu/sq ft)

- Space Heating & Cooling
- Mechanical Systems
- Plug Loads
- Lighting
- Propane Heating

Energy Saving Targets

- Building Envelope: 37%
- Lighting: 10%
- Hot Water: 3%
- Plug Loads: 25%
- Re-commissioning: 25%
- Source EUI (kBtu/sq ft)

2018, Retrofit, NZEB
Energy Production

- 300 kW DC Solar Array
- Annual Production: 400 MWh
Biowall

Plenum

Fan

Cleaned air

Return Duct

Tray

(Plants and growth media)
## Resilience

<table>
<thead>
<tr>
<th>Risk</th>
<th>Likelihood</th>
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<tbody>
<tr>
<td>Severe Storm</td>
<td>High</td>
</tr>
<tr>
<td>Fire</td>
<td>Moderate</td>
</tr>
<tr>
<td>Flood</td>
<td>Low</td>
</tr>
<tr>
<td>Global Flu Pandemic</td>
<td>Very Low</td>
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</tbody>
</table>

![Resilience Image](image_url)
## Financial Analysis & Feasibility

<table>
<thead>
<tr>
<th></th>
<th>Plug Loads</th>
<th>Recommisioning</th>
<th>Lighting</th>
<th>Bio wall</th>
<th>Solar</th>
<th>Hot Water</th>
<th>Window</th>
<th>Roof</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Cost ($)</strong></td>
<td>3,500</td>
<td>21,800</td>
<td>33,750</td>
<td>33,900</td>
<td>569,000</td>
<td>46,400</td>
<td>300,000</td>
<td>850,000</td>
<td>662,000</td>
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<tr>
<td><strong>First Year Energy Savings ($)</strong></td>
<td>4,460</td>
<td>4,460</td>
<td>5,550</td>
<td>0</td>
<td>44,200</td>
<td>820</td>
<td>2,200</td>
<td>4,460</td>
<td></td>
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<tr>
<td><strong>Breakeven Year</strong></td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>15</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td><strong>20 Year NPV ($)</strong></td>
<td>109,000</td>
<td>193,000</td>
<td>200,400</td>
<td>57,800</td>
<td>210,000</td>
<td>-34,800</td>
<td>-267,900</td>
<td>-784,700</td>
<td>770,200</td>
</tr>
<tr>
<td><strong>Priority Level</strong></td>
<td>Do Now</td>
<td>Do Now</td>
<td>Do Now</td>
<td>Do Now</td>
<td>Do Now</td>
<td>End of Life</td>
<td>End of Life</td>
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</table>
Market Analysis

IN Voucher Program Participation

Students Participating

School Year Ending


IN Voucher Program Participation
Impact on Occupants

• Quality of Life
  • Mindfulness and wellness

• Education Enhancement
  • Integration of sustainable systems into STEM education
Market-ready construction
Phased Net Zero

Phase I (Do Now)
- Reduce Plug Loads
- Re-commission mechanical systems
- Upgrade to LED Lights

Phase II (Do Soon)
- Install solar array
- Install five Biowalls

Phase III (End of Life)
- Roof upgrade
- Window upgrade
- Hot water system upgrade

Phase IV (Optional)
- Install acoustic baffles
- Install UV Lights
Ability to Replicate

1. Form a team
2. Analyze school
3. Set renovation goals
4. Check Financial Feasibility
5. Phased Net Zero
Special thanks to our industry partners