NAVIGATING ZERO CARBON BUILDING DESIGN AND CONSTRUCTION

Richard Williams Principal
Oleksandra Onisko Sustainable Buildings Consultant
AGENDA

1. What is the Process for ZCB design
2. Energy and the Business Case
3. How did we apply it: evolv1
ESTABLISHING OBJECTIVES & TARGETS

ESTABLISHING OBJECTIVE'S & TARGETS

**Environmental**
Employing green building practices and minimizing carbon emissions.

**Social**
Engaging with community and exemplifying corporate responsibility.

**Economic**
Promoting business excellence and maintaining highest ethical standards.
ESTABLISHING TARGETS

- Define specific performance criteria

<table>
<thead>
<tr>
<th>Decision Criteria</th>
<th>Weight</th>
<th>Systems Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Criteria</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost to implement</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Financial payback</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Impact on Leasable area</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Experience Criteria</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved user experience</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Innovation opportunity</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td><strong>Technology/Operations Criteria</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of implementation (complexity)</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Maintainability</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Environmental Criteria</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact of LEED scoring</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Energy savings</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Durability</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

**FINAL SCORE***

<table>
<thead>
<tr>
<th></th>
<th>Option 1 - High Efficiency Air System</th>
<th>Option 2 - Central Heat Pump and Geoexchange</th>
<th>Option 3 - Distributed Heat Pump and Geoexchange</th>
<th>Option 4 - Hybrid Option</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FINAL SCORE</strong>*</td>
<td>57</td>
<td>53</td>
<td>56</td>
<td>46</td>
</tr>
</tbody>
</table>

**Note:**
* Weighting - 1 (highest priority) to 10 (lowest priority)
** Rank - 1 (most favorable) to 5 (least favorable)
*** Final Score - Lowest score is best where Final Score = Σ (Weight)* (Rank)
ESTABLISHING TARGETS
INTRODUCTION TO EVOLV1
INTRODUCTION TO EVOLV1

- Net Positive Energy
- Net Positive Water
- Net Positive Air
- Commercially Viable
TRADITIONAL DESIGN MODEL
INTEGRATED DESIGN PROCESS
INTEGRATED DESIGN PROCESS

Project Effort and Impact

Time

PD SD DD CD PR CA OP

Ability to impact cost and functional capabilities
Cost of design change
Preferred design process
Traditional design process
INTEGRATED DESIGN PROCESS

Feasibility Ideas Funnel

- Establish Objectives
- Determine Criteria
- Analyze Options
- Final Recommendations
- Optimized Feasibility Solution
Establishing Targets

- Tenant Strategies
  - Occupancy, schedules, set points
  - Plug loads, equipment
  - Occupant behaviour strategies

- Passive Strategies
  - Siting and orientation
  - Building massing
  - Building envelope
  - Interior layout

- Active Strategies
  - Right-sizing of building systems
  - Energy efficiency
  - Alternative systems
  - Energy reclamation

- Renewable Strategies
  - Selection of site appropriate renewable system
  - Sizing of renewable system to meet energy reduction goals

Design Process Flow
MODELLING

1. PV Array to provide 105% of energy demands
2. Operable Windows to introduce ventilation air
3. Geo-Exchange Field for heating and cooling
4. Heat Exchange to tie into geo-exchange field
5. Labyrinth to pre-condition ventilation air
6. Displacement Ventilation for ground floor
7. Pre-Conditioned Ventilation for 2nd and 3rd floors
8. Displacement Ventilation through floor
9. Water Cooled VRF for heating and cooling across 2nd and 3rd floors
10. Domestic Hot Water generated from recovered heat in VRF system
11. Solar Wall to pre-condition ventilation air
12. Atrium/Stack Effect to naturally draw air through the atrium and spill air from each floor
13. Living Wall for natural filtration
14. Rain Water Collection
15. Rain Water Cistern
16. Living Machine to naturally filter grey and black water
17. Green Roof Canopy
MODELING

1. PV Array to provide 105% of energy demands
2. Operable windows to introduce ventilation air
3. Geo-Exchange Field for heating and cooling
4. Heat Exchange to tie into geo-exchange field
5. Daylight to pre-condition ventilation air
6. Displacement Ventilation for ground floor
7. Pre-Conditioned Ventilation for 2nd and 3rd floors
8. Displacement Ventilation through floor
9. Water Cooled VRF for heating and cooling across 2nd and 3rd floors
10. Domestic Hot Water generated from recovered heat in VRV system
11. Solar Wall to pre-condition ventilation air
12. Atrium/Stack Effect to naturally draw air through the atrium and spill air from each floor
13. Living Wall for natural filtration
14. Rain Water Collection
15. Rain Water Cistern
16. Living Machine to naturally filter grey and black water
17. Green Roof Canopy

Exterior Landscaping
Irrigation
Municipal/Sanitary Municipal/Waste
AGENDA

1. What is the Process for NZE NC design
2. Energy and the Business Case
3. How did we apply it: evolv1
Resource Budgets

- Annual Building and Irrigation Demands
  - Total Demand: 2,069,000 L/Year

- Building Roof Annual Rainwater Available
  - Total Available: 2,838,000 L/Year

- Site Annual Stormwater Volume
  - Total Available: 10,578,000 L/Year

<table>
<thead>
<tr>
<th>Water Type</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable Water</td>
<td>528,000 L/Year</td>
</tr>
<tr>
<td>Sinks, Showers</td>
<td></td>
</tr>
<tr>
<td>Non-Potable Water</td>
<td>1,541,000 L/Year</td>
</tr>
<tr>
<td>Toilets</td>
<td></td>
</tr>
</tbody>
</table>

- EUI: 125
- EUI: 100
- EUI: 75

~21,000 SF
ESTABLISHING TARGETS
MODELLING
MODELLING

1. **PV Array** to provide 10% of energy demands
2. **Operable Windows** to introduce ventilation air
3. **Geo-Exchange Field** for heating and cooling
4. **Heat Exchange** to tie into geo-exchange field
5. **Labyrinth** to pre-condition ventilation air
6. **Displacement Ventilation** for ground floor
7. **Pre-Conditioned Ventilation** for 2nd and 3rd floors
8. **Displacement Ventilation through floor**
9. **Water Cooled VRF** for heating and cooling across 2nd and 3rd floors
10. **Domestic Hot Water** generated from recovered heat in VRF system
11. **Solar Wall** to pre-condition ventilation air
12. **Atrium/Stack Effect** to naturally draw air through the atrium and spill air from each floor
13. **Living Wall** for natural filtration
14. **Rain Water Collection**
15. **Rain Water Cistern**
16. **Living Machine** to naturally filter grey and black water
17. **Green Roof Canopy**
MODELLING

1. PV Array to provide 105% of energy demands
2. Operable windows to introduce ventilation air
3. Geo-Exchange Field for heating and cooling
4. Heat Exchange to tie into geo-exchange field
5. Labyrinth to pre-condition ventilation air
6. Displacement Ventilation for ground floor
7. Pre-Conditioned Ventilation for 2nd and 3rd floors
8. Displacement Ventilation through floor
9. Water Cooled VRF for heating and cooling across 2nd and 3rd floors
10. Domestic Hot Water generated from recovered heat in VRF system
11. Solar Wall to pre-condition ventilation air
12. Atrium/Stack Effect to naturally draw air through the atrium and spill air from each floor
13. Living Wall for natural filtration
14. Rain Water Collection
15. Rain Water Cistern
16. Living Machine to naturally filter grey and black water
17. Green Roof Canopy
Elements of the Building Design

- Envelope – Roof, Wall and Window Constructions
- Lighting System and controls – daylight sensors
- Mechanical system
- Internal loads – plugs, people and processes
- How to limit risk and choose a viable option?
- Energy model combines the elements and evaluates the interaction between them
PARAMETRIC MODELLING

Building Design
The building design outlines the features that can affect energy use.