Building Energy Use
Building energy use is affected by design features and operational systems.

- Hot Water
- Heating
- Envelope
- Cooling
Features
There are many options for the design features and building systems that need to be evaluated.

Hot Water
- Hot water use reduction
- Efficient water heating
- Solar thermal

Heating
- Standard gas boiler
- Efficient gas boiler
- Direct electric
- Heat pumps
- Solar thermal

Envelope
- Average performance double glazing
- High performance double glazing
- Triple glazing
- Wall insulation
- Roof insulation

Cooling
- Solar shading
- Natural ventilation
- Reflective surfaces
- Passive cooling
- Chiller, standard performance
- High performance chiller
Calculating Building Cost with Choices

The hard costs of the features and building systems affect the overall building construction cost.

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# Calculating Energy Use Cost from Choices

The operational costs of the features.

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- 0 Chiller, standard performance
- $$$ High performance chiller
Choosing Feature Options
Including capital and operational costs allows for informed choices.

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Offsetting Energy Use with Renewable Energy Generation

To create net zero.

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Cheap building > Expensive running costs

(25 years)
Expensive building > Cheap running costs

(25 years)
NET PRESENT VALUE

Scenario C

Building > Zero energy costs

(25 years)
COMPARING SCENARIOS

Scenario A

- Operation Expenses
- Interest
- Inflation
- Purchase Price

Scenario B

- Operation Expenses
- Interest
- Inflation
- Purchase Price

Scenario C

NET ZERO

- Interest
- Inflation
- Purchase Price

(25 years)
MODELLING TOOLS & METHODOLOGY

- EnergyPlus, JEplus, Sketchup
ENERGY MODELLING

Mechanical System
Envelope performance
Lighting power

Interact within the energy model
Result in various Energy Use Intensities

The cost of PV was included as a variable
Each combination of systems results in a specific net present value. Associated annuity is calculated.
Select the path that fits
- Parallel Coordinates visualization
THE SOLUTION

Environmental  Economic  Social
AGENDA

1. What is the Process for NZE NC design
2. Energy and the Business Case
3. How did we apply it: evolv1
LESSONS LEARNED – SITE USAGE

- Parking vs. Green Space vs. Renewables
LESSONS LEARNED – SYSTEMS
LESSONS LEARNED - ONSITE PV
LESSONS LEARNED – SPACE USAGE

- Restaurant
LESSONS LEARNED – SPACE USAGE

- Lowest EUI and NPV
LESSONS LEARNED – OCCUPANT BEHAVIOR

- Densities, schedules and equipment
LESSONS LEARNED - OCCUPANT BEHAVIOR

- Densities, schedules and equipment

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- Thermal Energy Demand Intensity (TEDI) = 23.8 kWh/m²
- Zone 6 < 34 kWh/m²
LESSONS LEARNED - EMBODIED CARBON

- PRODUCT (A1 to A3)
- CONSTRUCTION PROCESS (A4 & A5)
- USE - MAINTENANCE & REPLACEMENT (B2 & B4)
- USE - OPERATIONAL ENERGY USE (B6)
- END OF LIFE (C1 to C4)
LESSONS LEARNED – ZERO CARBON BALANCE

Net Emissions =
(Direct Emissions + Indirect Emissions + Biomass Emissions) −
(Avoided Emissions from Offsite Green Power +
Avoided Emissions from Exported Green Power)
LESSONS LEARNED – INTEGRATED DESIGN


- **Effort/Effect**
  - Green: Ability to impact cost and functional capabilities
  - Red: Cost of design change
  - Blue: Preferred design process
  - Black: Traditional design process

**Time**
- PD
- SD
- DD
- CD
- PR
- CA
- OP

**Project Effort and Impact**
Benefits: Leadership in ZNE

- ZNE projects have grown by 75% since 2015
BUILDING DESIGN IS CHANGING...

...AND WE'RE READY FOR IT