Solar Decathlon: Energy Conscious Ōtautahi
University of Canterbury
Residential Retro-fit Housing | 04/18/2022
Team Introduction

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The Team

+Liam Cartwright
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Christchurch is in climate zone 5 (equivalent IECC zones 3 or 4)

Large group of houses built to out of date standards

Standards have been updated frequently yet remain behind the ball

Our focus house starts with an R-value across the envelope 56% lower than the current standard
Christchurch housing sector is focused on new suburbs and the replacement of single house plots with high density housing. This leaves old homes, often on subdivided plots, falling further behind every year. As these homes are cheap, they are often low income households. To cater for as wide a group as possible, we designed a modular retrofit. The package scales from the minimal package, the control system, to the full retrofit package at around 30% of the RV. Assessed on a case by case basis, the retrofit will be molded to maximize the energy efficiency of the house within a specified budget. Therefore, maximum budget for our selected house was $165,000 NZD.
Bay window removal
Window and door rethink
New kitchen layout
Transition to open space
Roof: R46
Wall: R25
Floor: R18
ACPH: 0.4

Engineering
Life Cycle Analysis

<table>
<thead>
<tr>
<th>Climate Change [kg CO2 eq]</th>
<th>A1-A5</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofs</td>
<td>466</td>
<td>27</td>
<td>0</td>
<td>-215</td>
<td>277</td>
</tr>
<tr>
<td>External Walls</td>
<td>105</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>118</td>
</tr>
<tr>
<td>Internal Walls</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Windows</td>
<td>383</td>
<td>776</td>
<td>5</td>
<td>-217</td>
<td>946</td>
</tr>
<tr>
<td>Ground Floors</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>954</td>
<td>816</td>
<td>5</td>
<td>-533</td>
<td>1,242</td>
</tr>
</tbody>
</table>

Total Climate Change Impact (A1-A5) 954 kg CO2 eq
Climate Change Impact Intensity 10 kg CO2 eq/m²

Forecasting

Embodied Carbon Analysis of Building Scenarios for 90yr Life

- Operation
- End-of-Life
- Maintenance
- Construction
- Product

Forecasting scenarios:
- BAU
- Re-build (2009)
- Re-build (2022)
- Retrofit

Building Scenario

Cumulative Emissions (kg CO2 eq)
Our HERs rating is 45

Our EUI is approximately 6.53 kBTU per Gross SF per year

Our BPI value is 0.62 (Pass: 1.55)
Comfort & Environmental Quality

- Cold
- Moisture Ingress
- Air Quality
- Acoustics
- Lighting
Improvements

- Heating
- Air Circulation
- Lighting

Open Plan Living
Considerations:
1) Careful construction of building envelope layers to ensure weather resistance
2) Maintaining layers for expected building lifespan
3) Ease and cost of installation
Occupant preferences
Pre-set Routines
Local Weather
Renewable Capacity
Smart Plugs
Mechanical Systems
Lighting
Appliance Control

openHAB
empowering the smart home

Integrated Performance
Team Learning
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