A Resilient Home for New Families

- Fire resistant
- No compromise on comfort
- Net zero energy
- Affordable
Team Information

Ancora Imparo
I am still learning

9th Materials Engineering program
Academic Ranking of World Universities (2019)

21st Civil Engineering program
QS World University rankings (2020)

75th University Worldwide
Times Higher Education (THE) World University rankings (2020)
Site details and House Layout

- Located in Tarneit, Victoria

- Climate similar to San Francisco

- Bushfire prone, Bushfire Attack Level (BAL) 12.5 is considered to protect against ember attacks and low radiant heat
Site details and House Layout

- Located in Tarneit, Victoria
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<table>
<thead>
<tr>
<th>Landscaping</th>
<th>House Exterior</th>
<th>Roof</th>
<th>Doors and Windows</th>
<th>Other Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Away from steep hillsides</td>
<td>External sprinkler system</td>
<td>Simple design (with minimal tilting and avoid roof valleys and skylights)</td>
<td>Protected by compliant bushfire shutters or screens</td>
<td>Smoke alarms</td>
</tr>
<tr>
<td>Enough cleared lands between the house and the bush</td>
<td>Inbuilt water storage</td>
<td>Fully sarked Gutter guards are installed (to help keep the gutters clear and free of debris)</td>
<td>Weather strips or draught excluders</td>
<td>Attached evacuation plan</td>
</tr>
<tr>
<td>Bushfire-resistant plant and tree species</td>
<td>Firebreak between nearby vegetation and the house</td>
<td>Toughened glass windows</td>
<td>Water and gas pipes are buried at least 300mm in the ground</td>
<td></td>
</tr>
<tr>
<td>Use fire-resistant or fire-retardant treated timbers</td>
<td>Windows are built 400mm above an external surface</td>
<td>Cascade windows (can act as an escape route from fire)</td>
<td></td>
<td></td>
</tr>
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Site details and House Layout

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Surreal Estate
SINGLE SUBURBAN FAMILY HOUSING
Sustainability

Embodied Environmental Energy

Architecture
Embodied Environmental Impact

- From material selections to life cycle analysis
- Making the majority of the house timber, includes a suspended timber floor
- Trade-off: the use of polyethylene and spray foam
<table>
<thead>
<tr>
<th>Materials</th>
<th>Intended use</th>
<th>Service and comments</th>
<th>R-value (K·m²/W)</th>
<th>Embodied energy BTU/lb (primary)</th>
<th>CO₂ footprint lb/lb (primary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terracotta roof tiles</td>
<td>Exterior finish</td>
<td>Excellent environmental resistance and durability</td>
<td>0.05</td>
<td>5.59 * 10³</td>
<td>1.82</td>
</tr>
<tr>
<td>Roof sarking</td>
<td>Water &amp; air control</td>
<td>Excellent environmental resistance and durability</td>
<td>1.3</td>
<td>499</td>
<td>0.0698</td>
</tr>
<tr>
<td>earth wool (made of 80% recycled glass) rigid insulation</td>
<td>Thermal control</td>
<td>-</td>
<td>6</td>
<td>4.34*10³ (glass)</td>
<td>0.721 (glass)</td>
</tr>
<tr>
<td>Rockwool rigid insulation</td>
<td>Thermal control</td>
<td>-</td>
<td>2.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Recycled gypsum board</td>
<td>Vapor control</td>
<td>Limited durability</td>
<td>-</td>
<td>2.24*10³</td>
<td>0.317</td>
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<tr>
<td>Polyethylene ground cover</td>
<td>Water &amp; Air control</td>
<td>Excellent environmental resistance and durability</td>
<td>-</td>
<td>3.25*10⁴</td>
<td>2.96</td>
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<tr>
<td>earth wool batts</td>
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<td>2.7</td>
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<td>Timber floorboards</td>
<td>Interior finish</td>
<td>Limited durability</td>
<td>0.7</td>
<td>4.99*10³</td>
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- From material selections to life cycle analysis
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Environmental analysis of two building material

Concluding the results of the analysis of 2 alternatives of the Slovak masonry family-houses, the reduction of the environmental impacts was reached by up to 61.0% in particular structures and by up to 10.5% overall, simply by the change of several building materials in structures. Thus, even relatively easy changes in material composition may lead to a reduction of environmental impacts.

Acknowledgments This research has been carried out within the project of Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences No. 1/0481/13 titled Study of building materials environmental impacts.
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<th>Value 2</th>
<th>Value 3</th>
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Architecture

Integrate form and function seamlessly through smaller features and materiality
Site Plan

• Plant-life conserves water

• Optimises thermal and wind properties

• Aim to be as self-sustaining as possible

• Conveniently located

• Easy access to public transport

Landscaping
• Designed for Australian culture
• Utilises mostly native Australian flora
• Conservation of water
• Edible native plants encourage promoting indigenous practices
• Aromatic lavender acts as a natural insect repellent
• Weeping grass and Dwarf Mondo grass is low maintenance
• Vegetable and herb gardens provide fresh produce

Central location on plot
• Reduces energy consumption
• Access to optimal wind direction for passive heating and cooling
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Exterior Design

- Materiality
- Orientation of external features

Materials
Locally sourced
- High insulating capabilities
- Withstand a wide range of weather conditions
- Low maintenance
- Cost-effective

- Perfect for bushfire prone areas
- Strong hardwood
- Thermal insulation
- Stable long-term

External Features
Vegetable gardens close to kitchen
Water tank close to water heating system
Accommodates larger scale entertainment
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Floor Plan

- Open floor plan
- Orientation-based design
- Multi-functional
- Optimises passive design principles
Living Arrangements

- Maximises flexibility
- Living and bedroom spaces can be altered
- Creates a more open and modular space
LIVING SPACES ARRANGEMENT
ALTERNATIVE BEDROOM ARRANGEMENT
Passive Design

- Encourages passive air-flow
- Sunlight penetration is maximised
Interior Design

Internal Timber Cladding and Flooring
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Engineering

Bushfire Resistance
TIMBER SIDING
AIR CAVITY
RIGID INSULATION
FRAME CAVITY INSULATION
PLYWOOD SHEATHING
HOUSE WRAP
**Triple Glaze, U-Value: 0.24**

**Adhesive Sub-sills & Flashings**

**Suspended Timber Floor**
Building Systems

- Centralize utilities
- Maximize efficiency
- Optimize maintenance

HVAC

Water systems
HVAC

- Air-source heat pump
- Central air handler
- Ceiling mounted ducting
- Supply duct sizing: 20"
- Exhaust duct sizing: 12"
- HSPF: 9.5
- Heat Recovery Ventilator
Water systems

- Centralized water fixtures
- Minimize heat loss
- 1,850 gal rainwater tank next to garden
MAIN APPROACHES

- Standard-accordance
- Removal of areas that may catch fire

- Landscaping
- Water Tank
- Sprinkler System
- Firebreak
- Cascade Windows
- Gutter Guards
- Evacuation App
MAIN APPROACHES

- Standard-accordance
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LANDSCAPING
SPRINKLER SYSTEM
WATER TANK
FIREBREAK
GUTTER GUARDS
CASCADE WINDOWS
DOWS

EVACUATION APP
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SINGLE SUBURBAN FAMILY HOUSING
Energy Performance

Annual Energy Consumption

8323 kWh
5.87 kWh/sq ft
30% heating

HERS Index

35 without PV
-25 with PV

Click to know more!
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Design 10% more
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- Green credentials (NatHERS & Green Star)
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Design 10% more

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Efficient appliances & lightings (ENERGY STAR) and passive heat design
15% window-to-wall ratio
North-facing

Cross-flow ventilation

Thermal zoning
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  - PV & Powerwall

15% window-to-wall ratio
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Thermal zoning
Surreal Estate
SINGLE SUBURBAN FAMILY HOUSING
Tarneit is an affordable, burgeoning outer-west suburb
Where it is Hardest to Afford a Home

<table>
<thead>
<tr>
<th>Rank</th>
<th>City</th>
<th>Housing Market Affordability Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hong Kong</td>
<td>20.9</td>
</tr>
<tr>
<td>2.</td>
<td>Vancouver</td>
<td>12.6</td>
</tr>
<tr>
<td>3.</td>
<td>Sydney</td>
<td>11.7</td>
</tr>
<tr>
<td>4.</td>
<td>Melbourne</td>
<td>9.7</td>
</tr>
<tr>
<td>5.</td>
<td>Santa Cruz</td>
<td>9.6</td>
</tr>
<tr>
<td>6.</td>
<td>San Jose</td>
<td>9.4</td>
</tr>
<tr>
<td>7.</td>
<td>Los Angeles</td>
<td>9.2</td>
</tr>
<tr>
<td>8.</td>
<td>Tauranga/Bay of Plenty</td>
<td>9.1</td>
</tr>
<tr>
<td>9.</td>
<td>Auckland</td>
<td>9.0</td>
</tr>
<tr>
<td>10.</td>
<td>San Francisco</td>
<td>8.8</td>
</tr>
<tr>
<td>11.</td>
<td>Sunshine Coast</td>
<td>8.7</td>
</tr>
<tr>
<td>12.</td>
<td>Honolulu</td>
<td>8.6</td>
</tr>
<tr>
<td>13.</td>
<td>Victoria</td>
<td>8.5</td>
</tr>
<tr>
<td>14.</td>
<td>Gold Coast</td>
<td>8.4</td>
</tr>
<tr>
<td>15.</td>
<td>Greater London</td>
<td>8.3</td>
</tr>
</tbody>
</table>

What ratio is considered affordable?
- Severely unaffordable: ≥5.1
- Seriously unaffordable: 4.1–5.0
- Moderately unaffordable: 3.1–4.0
- Affordable: ≤3.0

Tarneit is an affordable, burgeoning outer-west suburb.
Target Market

The average working Australian family

15% more affordable than Melbourne city

Average home in Tarneit
$277,800 USD
Realestate.com.au 2020

Mean household income
$72,282 USD
Australian Bureau of Statistics (ABS) 2017-18

Low bracket cost to build a home in Victoria
$185,128 USD
Budget Direct 2019

*AUS TO USD EXCHANGE RATE (1:0.62)
Financial Feasibility

- **Tesla solar battery Powerwall**
  $7,120 USD

- **Total Construction Costs**
  $190,611 USD

- 80% of expenses are incurred during usage

**The 1% Rule**
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SINGLE SUBURBAN FAMILY HOUSING
Overview

- Focus on bushfire resistance
- Highlight affordability
- Sustainable
- Encourage passive energy design
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SINGLE SUBURBAN FAMILY HOUSING