Issue 01 • April 2022
acumen.architecture.com.au/environment

ISSN 2651-9828

Case study: Welcome to the Jungle House

Clinton Cole

Cover image. Architectural and sustainable expression of the facade street frontage. The solar panel array can be seen in the right-hand side elevation in black (Image: Murray Fredericks).

Project summary

Welcome to the Jungle House (WTTJH) is a home designed to fit within the existing building's reconstructed masonry fabric and is an archetypal model of future sustainable carbon neutral living. It is located on a 98sqm triangular site in an inner-city Sydney heritage-conservation area, typified by late Victorian row terrace housing and post-industrial warehouses (Figure 1). It provides a model for design innovation and sustainable living, where sustainability, landscape and architecture exist symbiotically; where food, nature, garden, environment, energy, waste, water and architectural aesthetic deliberately coexist in harmony, all the while reinstating its corner block significance from a previously decrepit two-storey shop top house (Figure 2). Sustainability benchmarks — particularly with regard to water, thermal comfort and energy —far exceeded NSW State Government BASIX requirements (see Project details) through a rigorous implementation of systems such as a solar panel facade, rainwater storage, aquaponics system, native and productive plantings, recycled timber and energy-efficient appliances and lighting.

Figure 1. New home preserving heritage (Image: Murray Fredericks)

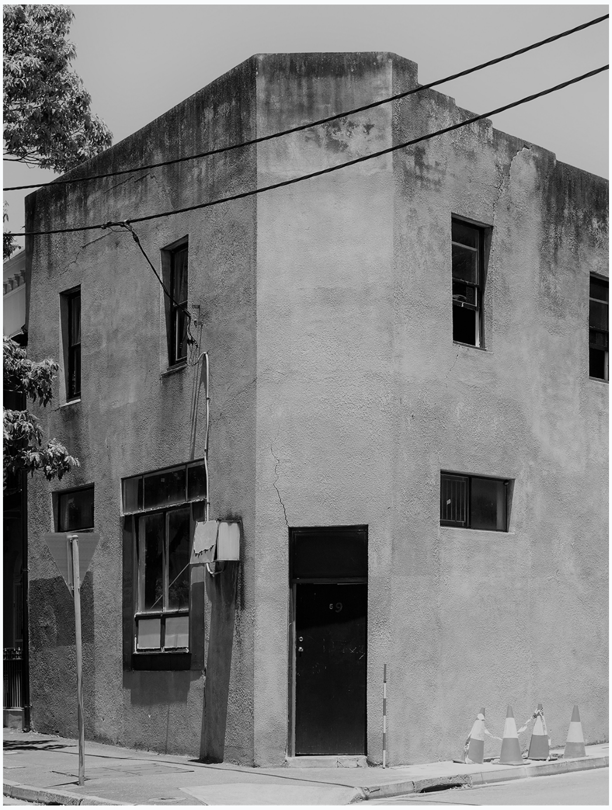


Figure 2. Existing house (Image: Clinton Cole)

Project details	
Project name	Welcome to the Jungle House
Project type	Attached terrace house (corner) redevelopment
Procurement type	Owner as architect and builder
Year of design completion	2017
Year of project completion	2019
Location • Land + nation • Climate zone • Bioregion	• Gadigal Land, Eora Nation • Climate Zone 5: Warm Temperate • Sydney Basin
Site area	98 sqm
Gross floor area m^2	Existing: 123 sqm. New: 185 sqm
Net lettable area m^2 (retail tenancies)	N/A
Number of levels	Three plus roof garden
Number of residents, occupants, visitors	Five occupants
Sustainability benchmarks and ratings achieved	BASIX: • Thermal Comfort: Pass • Energy – Target: 40 – Score: 90 • Water – Target: 40 – Score: 60 NatHERS rating: 7.4 Carbon Neutral: Gold Standard Planned Emission Reduction (PERs) 07/09/20

Project team	
Owner(s) / client(s)	Clinton Cole, Hannelore Henning
Architect(s)	Clinton Cole, CplusC Architectural Workshop
Consultants	• Structural Engineering: SDA • Heritage Planner: Weir Phillips • Town Planner: James Lovell & Associates • Interior Design & Furniture Procurement: Jase Sullivan • Landscape Design and Construct: Bell Landscapes • Hydraulics and Plumbing: J.H.Gordon Plumbing • Electrical systems design and Installation: Electrolite Contracting • Photovoltaics & Battery: Australia Wide Solar
Builder	CplusC Architectural Workshop

Integration

The conception of WTTJH was shaped by the ethos of the architects CplusC as a holistically sustainable, educational and liveable model of housing, while sensitively navigating heritage and area development control constraints. The bespoke home is a response to the flexibility needed for a growing family that incorporates socially, economically and environmentally sustainable features without sacrificing typical levels of comfort. The project advocates for sustainable and regenerative design on both a macro and micro level, balancing broader public and educational needs and private lifestyle and family needs.

The project's intentions were to educate by sharing knowledge with the profession and associated designers, craftspeople and builders.

A C-Bus home automation system ensures a low-maintenance, easy to manage framework of active sustainable systems without compromising daily activity. The system provided significant advantages in terms of complete control over ventilation and the switching of lighting and creating lighting moods through a single switch or device. The home automation system learns preferences and can be controlled and monitored remotely. App-controlled services include energy regulation, irrigation schedules, aquaponic pH levels and lighting. Having control over how the system was set up and able to be constantly adapted to the changing needs of a family that lived fluidly across three floors took significant pressure off the electrical documentation and design. The programming performed by the electrical contractor directly on site in a near-completed project meant this approach had significant advantages over conventional electrical systems. This was the last project by CplusC in which the home automation system was hard wired, as more cost-effective wireless systems have since become readily available.

Community

The location has a walkability score of 96 in accordance with Walk Score. WTTJH is positioned between Redfern train station and the University of Sydney's architecture and engineering faculties. It therefore presented the opportunity to serve not only as a model for sustainable living, but also as an educational tool by which sustainable principles are actively promoted to inspire passers-by through its architectural expression, such as the solar panel facade (See Energy) and integrated native vegetation (Cover image).

Figure 3 and Figure 4. Ground floor and first floor plan (Source: CplusC Architectural Workshop)

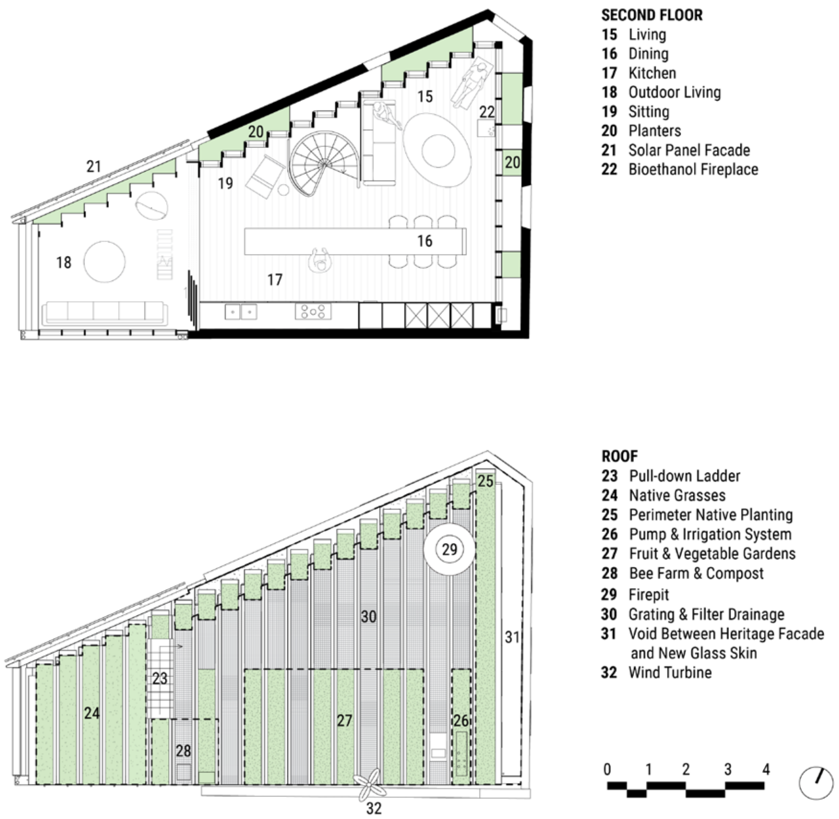


Figure 5 and Figure 6. Second floor and roof plan (Source: CplusC Architectural Workshop)

WTTJH also fosters connection to the local community through the occupant's distribution of excess seasonal fruit and vegetables from the rooftop garden and passionfruit vine to surrounding neighbours.

Country

The values of respecting nature and land were passed down to the team from the original custodians of the land by Yuin Elder Uncle Max 'Dulumunmun' Harrison, who performed a traditional smoke ceremony on the site upon commencement of construction. Values of shared knowledge and connection to site continue to be shared with the community, neighbours, and students through educational tours such as Sydney Open.

A selection of native Australian vegetation was planted in responsiveness to the local flora Act. The vegetation acts as a catalyst for nurturing biodiversity within the locality, while the visibility of the native rooftop planting from the ground plane enhances the streetscape (Cover image).

Site permeability has been addressed through the vegetated roof which acts as an elevated ground plane and enables rainwater capture, which is diverted into both the fishponds and rainwater tank serviced by a weather-smart system (see Water below).

Water

A 'Waterplex' 5000L toroid (donut) underground water tank provides non-potable rainwater storage provisions for irrigation, aquaponics system and toilet flushing.

A 1600L aquaponics system creates a cyclical flow of water through the different garden systems within the house (Figure7). Fish wastewater is pumped to the vegetable garden on the roof which promotes bacteria growth, in turn providing the vegetables and plants with nitrogen promoting plant growth. Excess rainwater drains through the soil and into the irrigation system, to an underground storage tank (separate from the rainwater storage tank) where it is filtered and pumped back to the fishpond in a semi-closed loop (Figure 7). The wall planters which punctuate the external facade skin are serviced by a weather smart 'WaterMe' remote system which responds to real-time weather for optimal irrigation.

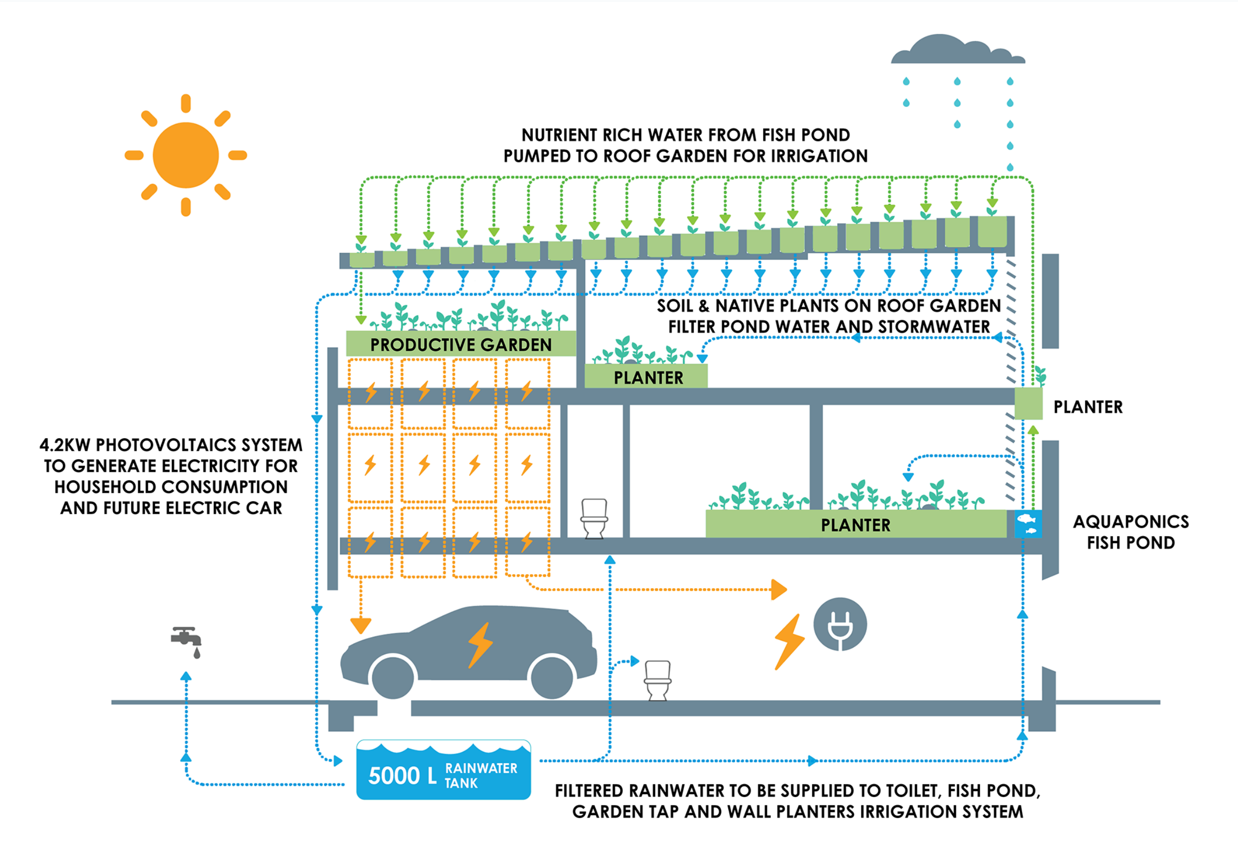
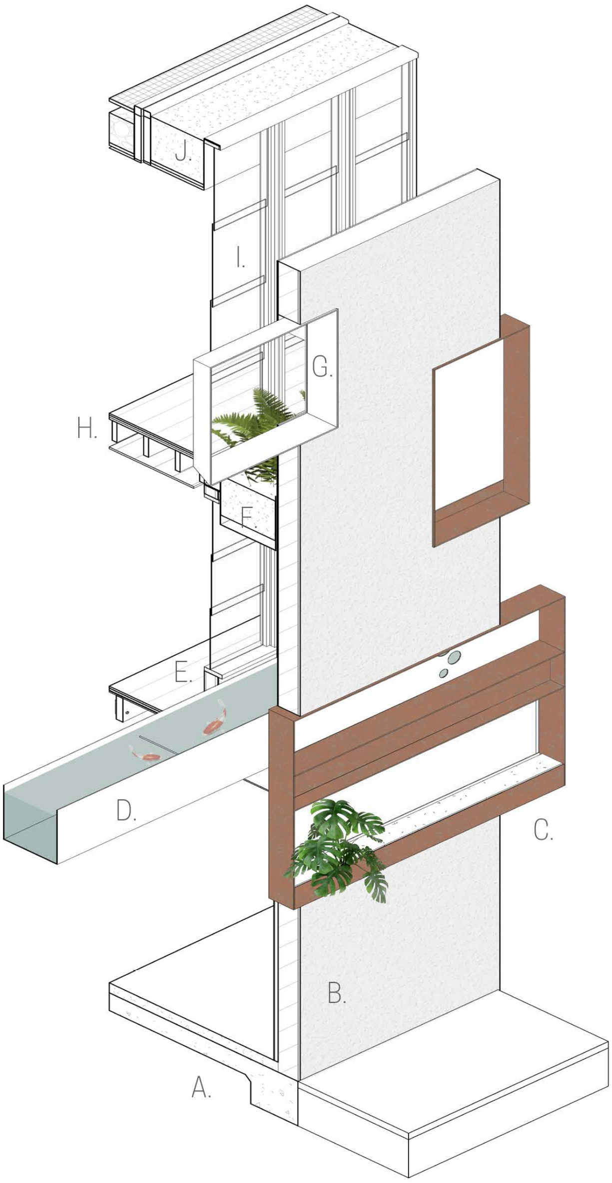


Figure 7. Integrated sustainable systems (Image. CplusC Architectural Workshop)

Economy

As the project was undertaken by the owner who was also the architect, builder, supervisor and construction manager, market comparisons were difficult to establish. However, the project was completed at approximately $6000/sqm excluding architect fees, construction margin and supervision.

A number of innovative measures in response to climate mitigation such as the aforementioned sustainable systems are rarely found in normal practice. A local network of hydraulic, structural, heritage, planning and sustainability consultants established over the last 20 years made the design and construction process a successful collaborative exercise. The dedicated use of recycled and ethically sourced materials from local manufacturers and suppliers enhanced both the local economy and waste management (also see Resources).



LAYERED FACADES

A_ 180mm concrete raft slab with 100mm topping slab, burnished finish, providing a thermal mass to the house that is shaded in summer, keeping the whole house cool, and receives sunlight in winter to radiate heat back into the house at night. Electric heating is built into the topping slab as a provision if needed, powered by the solar panel array.

B_ 200mm blockwork wall, rendered on the exterior and fibre-cement sheeted on the interior as part of a raw material palette. The texture of the exterior render pays homage to the historical significance of the site and allows the street-level plants to climb over its surface.

C_ 10mm corten steel opening & planter bed. The weathered steel material was used on the existing facade openings, to identify the original from the new. A glimpse of the fish pond can be seen from the street through the bubble motif windows.

D_ 1600L, 6mm galvanised steel fish pond. Forming part of the aquaponic system, the pond sits adjacent to the kids' bedrooms.

E_ Exposed timber beams to the Ground Floor, black film plywood, acoustic underlay, timber substrate and engineered floorboards compose the flooring of the First Floor. Operable windows to the fish pond allow interaction & fascination as part of daily routine.

F_ The internal skin separates from the exterior masonry wall at the First Floor, with a layer of 6mm galvanised steel planter beds bracing the two, and providing a layer of greenery for transpiration-cooling natural ventilation.

G_ 6mm white powder-coated steel frames establish the new openings in the facade, providing a perfect amount of natural light through to the interior with minimal direct heat gains.

H_ Spotted gum timber ceiling, floor joists, plywood, acoustic underlay, timber substrate and engineered floorboards compose the flooring of the Second Floor.

I_ 140x40mm western red cedar window frames provide far superior insulation properties to windows than aluminium frames, and the fully operable facade allows maximum ventilation through the living spaces when needed.

J_ Galvanised steel planter beds sit nested between twin 140x40mm hardwood ceiling beams, a vital part of the home's aquaponic system and providing space for the family to grow native plants, vegetables and fruits.

Figure 8. Integrated aquaponics system (Source: CplusC Architectural Workshop)

Australian Institute of Architects

Energy

The prefabricated steel structure allowed for efficient construction and, while having higher initial embodied energy, requires less maintenance and will outlive alternative timber structural elements (Figure 9). The steel columns have been angled to cut out afternoon sun in summer, acting as shade devices as well as structural supports.

The northern, street facing facade harnesses solar energy with a 4.23kW photovoltaic (PV) system that is fixed in place with a clip system (Cover image), allowing for panels to be serviced and replaced with future models that may have higher efficiency, maximising the flexibility of the home in response to technological change. Photovoltaic energy monitoring software allows monitoring of the PV's performance. A 9.8kWH lithium-ion LG Chem battery provides solar battery storage for energy collected throughout the day to be used during peak times, night and morning, reducing energy consumption from the mains grid. The battery and photovoltaics system provide approximately 55% of the household needs.

A central spiral staircase spanning all three floors acts as a lightwell and also uses the stack effect to draw cool air from the thermal mass of the exposed concrete slab and masonry wall spaces in the ground floor spaces, through the bedroom and living spaces above, pushing hot air out of the operable glass skin on the top floor in the warmer months (Figure 10).

Energy-efficient appliances and lighting include bedroom ceiling fans, low energy, automated LED lighting and 'ComfortHeat' 8500W electric in-slab heating.

Figure 9. Steel structure assembly (Image: Murray Fredericks)

Grid energy is provided by a carbon neutral energy supplier to offset the operational energy required beyond that produced by the PV system. Operationally, WTTJH uses 83kWh/sqm/yr of grid energy, sourced from a carbon-neutral energy provider.

The small number of thermal bridges, knowingly allowed to occur, were considered relatively insignificant compared to the benefits of seals and insulation deployed, as well as the selection of timber doors and windows. Non-thermally broken aluminium door and window systems are significantly less thermally efficient than timber. As the thermal bridges occurred on sections of steel that were 300mm long and 25mm thick, the thermal bridging was far less traversable than, for example, a steel door or window frame.

The original design was conceived as a wholly timber structure including a solid timber facade. However, this concept had to be discarded when, much to the astonishment of the team, the building was found to be listed as a contributing heritage item by council.

The team subsequently faced the issue of supporting a 2.5 storey masonry wall that was leaning 350mm over the footpath. As it was impossible to support the existing heritage facade, it was demolished and required to be re-built exactly as it looked (Figure 1). Even new masonry walls with an internal timber frame over this height are unable to perform with structural adequacy. The structural engineer designed the structure to not only support the proposed building, but also to resist lateral pressure from the neighbouring terraces as they were all slowly sinking into the old Boundary street river system, explaining why the original building was leaning 350mm towards the street. Effectively acting as a 2.5 storey bookend to a row of sinking terraces, the structural and geotechnical engineers specified 24x9 metre concrete piers drilled into rock to prop up the neighbours. The requirement to rebuild the facade, as opposed to a wholly timber structure, significantly increased the project cost and contributed substantially higher embodied energy to the built outcome.

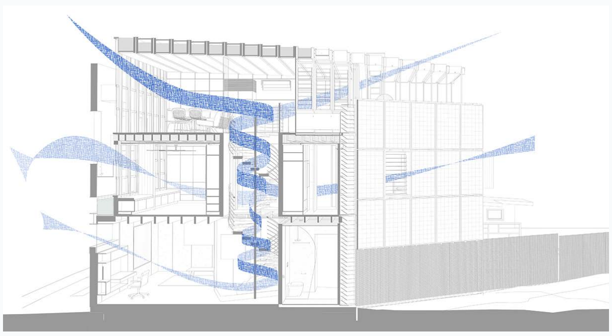


Figure 10. Stack effect (Source: CplusC Architectural Workshop)

Figure 11. Master bedroom pop-out window
(Image: Michael Lassman)

Figure 12. 600mm cavity between facade layers
(Image: Michael Lassman)

Well-being

WTTJH includes north, east, and west solar access and outlook, with all habitable spaces orientated towards the outdoors, enabling maximised cross ventilation. The glazed inner skin is fully operable, providing occupants full control to optimise cooling winds during the summer. A low energy air-conditioning unit has been installed as a backup system during heat waves. The master bedroom contains an oversized timber pivot window to balance privacy to neighbouring houses and borrow views from a nearby tree canopy while also allowing for ventilation and privacy through the pop-out windows (See Figure 11). The reconstructed masonry facade shields a new inner glazed facade. This 600mm facade cavity houses a number of planter beds and allows the penetration of daylight through each space – without compromising privacy – to a high pedestrian-active street (See Figure 12).

The children's bedrooms were positioned directly adjacent to the aquaponics fishpond, which in combination with the rooftop vegetable garden creates an educational connection for the children and their food sources.

Resources

A Life Cycle Analysis (LCA), performed through the One Click tool post-construction, has shown the embodied carbon of the project as 574kgCO2-e/m2, which aligns with the 2020 targets (600kgCO2-e/m2) of RIBA's 2030 Climate Challenge for domestic buildings.

The aluminium louvre galleries were initially modelled as solid, rather than extruded 20x40mm frames which resulted in a significant impact on the perceived embodied energy of the aluminium in the initial calculations. The importance of accurate Building Information Modelling down to realistic extrusions of louvre galleries is crucial in developing a thorough LCA that reflects the as-built outcome.

Recycled timber is used throughout the home in the window framing, floor structure, walls, and ceiling. Locally sourced, recycled timber sourced from Architectural Hardwood Joinery was used extensively as benchtops, stairs, flooring and seating.

Materials were designed to a standard grid of dimensions to minimise offcuts, and any waste was passed on to a waste contractor which operates at 95% landfill diversion.

Steel was a large component of the total embodied energy but came as no surprise. There was a calculated decision to prioritise the effective design of the green roof steel troughs over the embodied energy consequences of the concept and detailing. Had a simpler conventional design for the green roof been pursued, the results would have seen a lower embodied energy. However, as it was the owner/architect/builder's own home and the first time in their 25 years of education and practice that the opportunity presented itself, some personal preferences informed the final outcome of the green roof and its optimal usage and food production for the family.

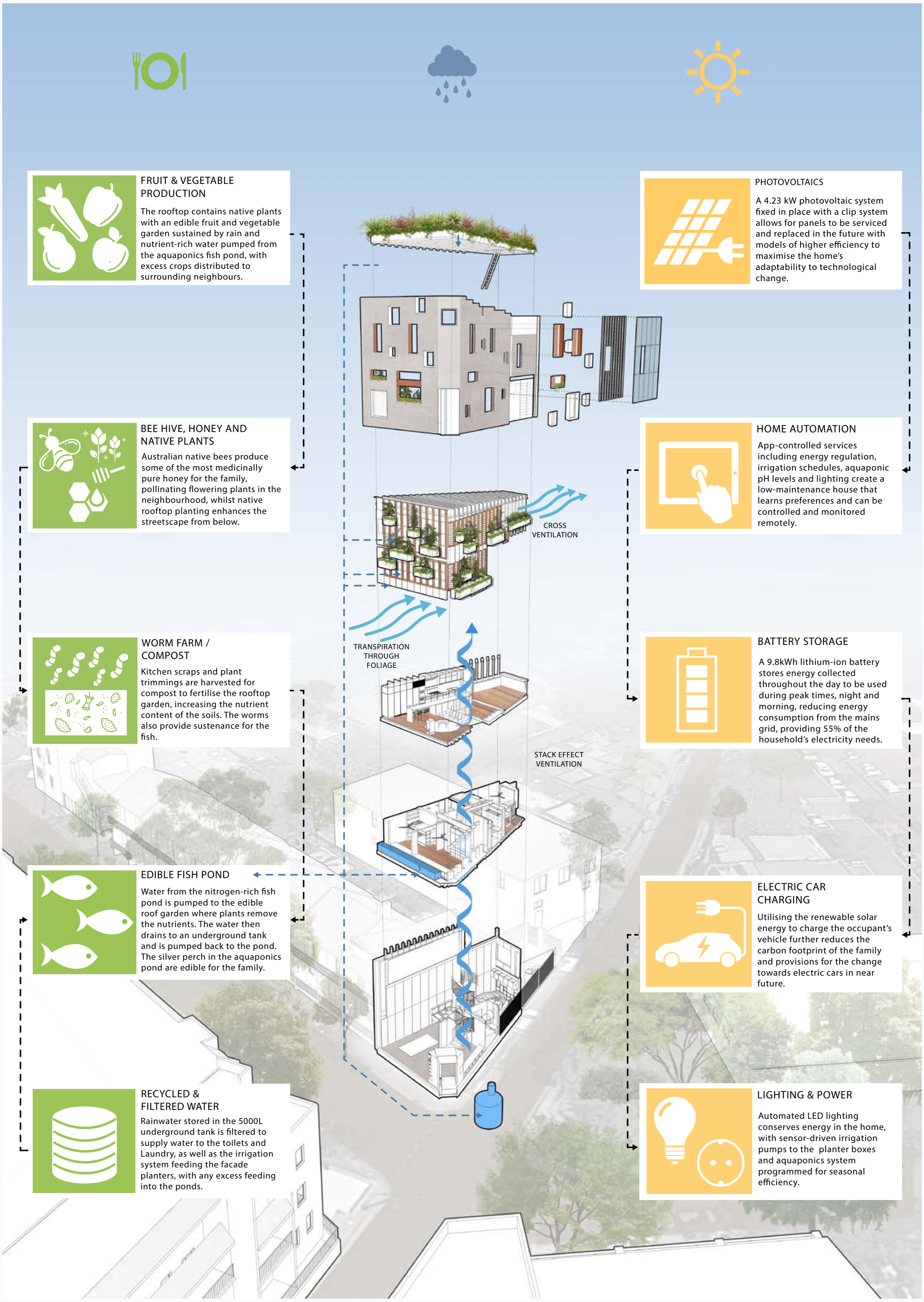


Figure 13. Systems of sustainability within the house (Image: CplusC Architectural Workshop)

Change

Provisions are made for electric car charging (to be achieved via a lead extending through the external facade to the outdoor car space) as electric car uptake continues to rise. Spatial planning has been designed in a flexible manner to allow the house to adapt to the occupants' lifestyle without compromising the sustainable systems employed. A custom built-in bunk bed with an adjacent room accessible via a bi-fold door creates provision for a third individually occupied bedroom when the children are older (Figure 4). While the children are young the adjacent room is used for playing and for occasional use by visiting guests with a fold down Murphy bed for sleeping (See Figure 14, fold-down bed concealed in cabinets).

The garage space at the rear of the ground floor (Figure 3) has been designed with high ceilings in anticipation of future modifications to accommodate another bedroom with access to the adjacent bathroom (if required) and is currently used as a flexible studio space.

The productive garden, water retention system and solar charged battery storage are designed for household self-sufficiency and responsiveness to climate change.

Ultimately, allowing every family member to have their own space and spaces to come together is probably the most important factor in achieving a home that will stand the test of time with a family as they grow. The ground floor is flexible and has the potential to become a self-contained occupancy in the future (Figure 3).

Figure 14. Flexible provisions for children's bedroom (Image: Michael Lassman)

Discovery

The premise of the WTTJH was an exercise in understanding architecture as a form of consumption and the resulting design was a re-evaluation of the traditional home as a 'machine for sustaining life' and a model by which such values are promoted to the public.

The LCA was performed as a post-construction reflection tool (see Resources), which highlighted environmentally detrimental materials not suitable for future use, including the extensive use of Corian in one of the bathrooms which contains bauxite, significantly impacting the total embodied carbon.

WTTJH seeks to redefine the role of residential architecture as a symbiotic conversation between landscape, food, nature, garden, environment, energy, waste, water and beauty.

The use of local materials, educational outlook and sustainable systems returns architecture to an environmentally and socially driven design.

References

Royal Institute of British Architects (RIBA) (n.d.) *2030 Climate Challenge*, RIBA website, accessed 08.12.21.

About the Author

Clinton Cole

Clinton Cole is the founder and director of CplusC. He holds two degrees in Architecture and is a registered architect, a licensed builder and accredited construction supervisor. With over 20 years of experience in the architecture and building industry, the success of the CplusC brand can be attributed to Clinton's unwavering dedication to producing premium quality, genuine sustainable architectural solutions. Regularly invited to present his ideas to industry peers, academic panels and design publications, Clinton is a highly respected member of the profession, recognised for his contributions to both the architecture and construction industries.

Australian Institute of Architects