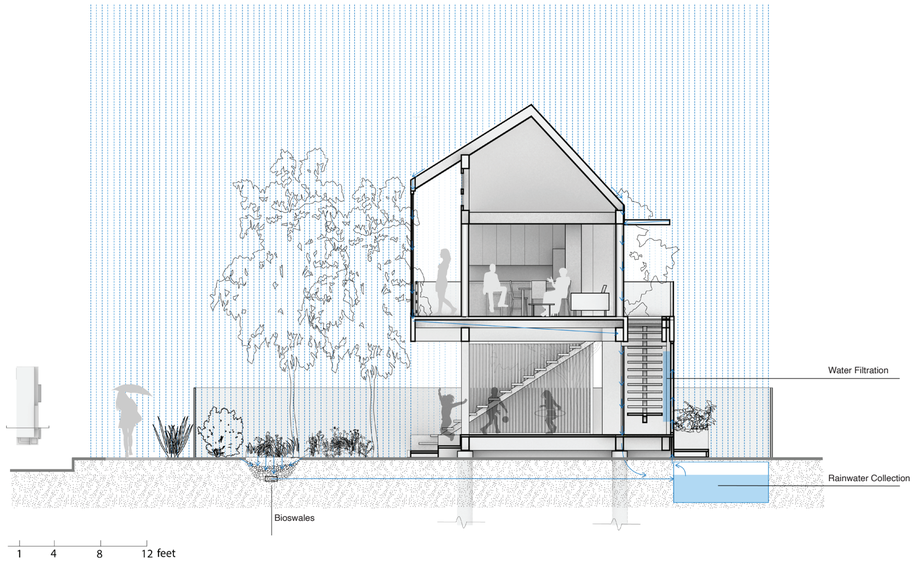
Design for Integration

Water and Ecosystem

According to Köppen-Geiger climate classification, Houston has a Cfa humid subtropical climate. It has an annual average rainfall of 48 inches and is prone to flooding. House@+12 has a rainwater harvesting system with one side rain gutter downspouts and a bioswale to control water runoff, reduce flooding and provide an on-site water source for irrigation, toilet flushing and potable domestic use. The raised structure further reduces the risk of flooding.

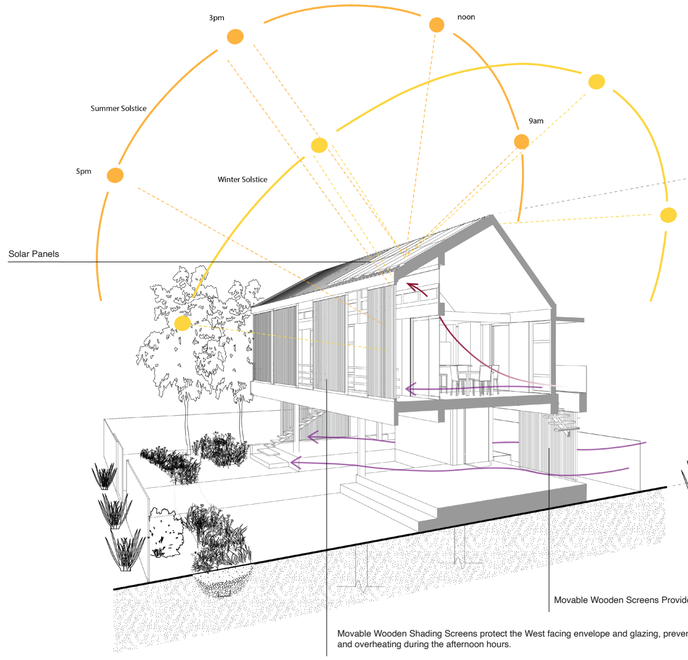


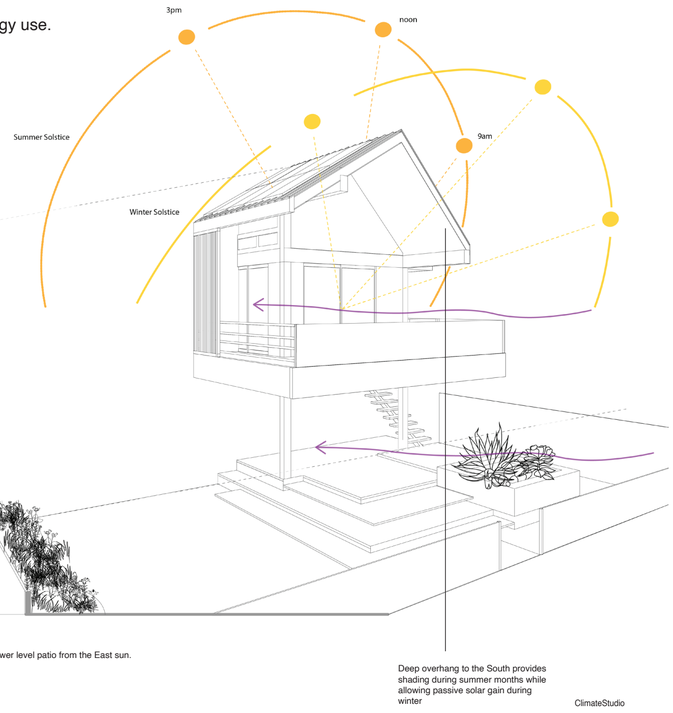
Rainwater Collection Potential*:
About 47095 gallons from the impermeable surfaces (roof and driveway) (using the simple rainwater harvesting formula roof area x .62 gpsf x .75 for losses and inefficiencies) x inches of rainfall. Assuming a 25-50 gallons per person per day and 2.5 occupants, the collection could suffice to meet annual demand.

* Reference: Texas Manual of Rainwater Harvesting)

Energy

House@+12 uses solar panels, cross ventilation, roof overhang and movable shading devices to decrease its total energy use.





Movable Wooden Shading Screens protect the West facing envelope and glazing, preventing glare and overheating during the afternoon hours.

Movable Wooden Screens Provide Shading to the lower level patio from the East sun.

Deep overhang to the South provides shading during summer months while allowing passive solar gain during winter

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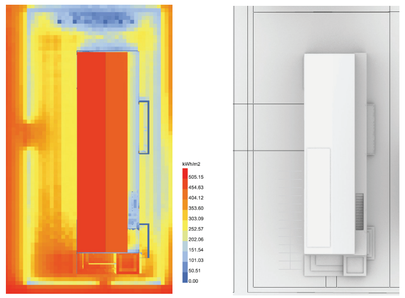
Energy

Electric Power Autonomy

A 6 kW solar (24 panels) on the West facing roof would allow meeting the ZeroTool Baseline Site EUI of 32kBtu/ft2/yr for 800 sqft.
Based on climate change scenarios, that may not suffice by 2080, when temperatures are projected to increase all year round by at least 3.2ºC in Houston (per comparison of the Typical Meteorological Year 3 climate data against future weather data obtained with the CCWorldWeatherGen tool by the University of Southampton and the commercially available WeatherShift™. According to the authors' research and outcome of simplified shoebox simulations (accepted for publication), cooling loads could increase by more than 50% for this level of envelope exposure without shading and other mitigation strategies. Therefore, it is assumed that a 10kW system may become necessary to remain a zero-net energy building and meet the current standard of thermal comfort in 2080.

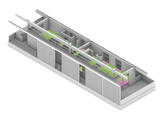


Grasshopper Ladybug

Energy and Well-Being

Daylight

The windows distribution, roof overhangs and movable shading devices - introduced to reduce heating and cooling loads - provide enhanced daylight performance while ensuring connection to the outdoor and visual (average UDI of 83% with ASE < 17%) and thermal comfort throughout the year.



Position of Movable screens tested

Daylight Availability without screens (left)
Daylight Availability with screens (right)

Without movable screens

With movable screens

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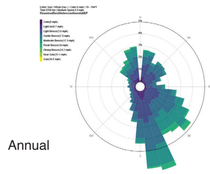
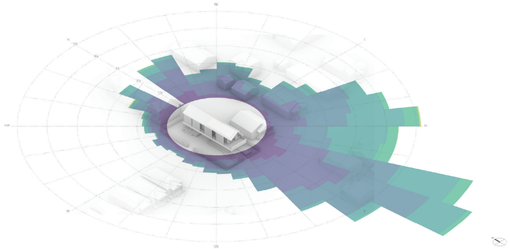
Cross Ventilation

The distribution of windows, the lower and upper openable portions and vertically stacked rows of windows provide cross-ventilation, taking advantage of the prevailing wind from the South, South-West, especially during Houston's annual cooling period.



Annual



March 21 to September 21

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