Team 689 Executive Summary

The group aims to design a net-zero and water wise building for the Evolve Community Library utilizing energy and water simulation tools such as, RETScreen, Ecotect Weather Tool, Vasari for Autodesk, and Rainwater Harvesting Design and Costing Tool.

I. Preliminary Design Decisions

Ecotect Weather Tool was used in determining the optimum building orientation and passive system adaptations. Based on a compromise between over-heating and under-heating due to solar radiation, the team took into consideration that 142.5 degrees to the true north was determined to be the best orientation. As a result of mapping out potential passive systems on the psychometric chart to determine whether the adaptation will benefit the comfort level of a community library, it is determined that three systems can be efficiently adapted in Toronto's climate: passive solar heating, thermal mass, and natural ventilation.

II. Achieving Net-Zero Energy

The two strategies are to first minimize the net-energy consumption and maximize net-energy production.

a) Minimizing net-energy consumption

Energy Analytical Models of a base case model and four scenarios were generated using Vasari to provide approximate net-energy consumption for each case. Each scenario had adjusted parameters from the scenario before in an attempt to reduce the consumption. The aim was to reach a simulation result that is close to the top quarter percentile energy benchmark from City of Toronto's Energy and Conservation Demand Plan 2014-2019. A few conclusions can be made from analyzing the results of these scenarios.

To decrease the annual net-energy consumption:

1. **Using passive measures** such as a central courtyard for natural day lighting, passive heating, and using stack effect to promote natural ventilation, the southern façade utilizes a double skin and the courtyard greenhouse preheat air during the winter (11% net consumption reduction)

2. **Increase building thermal mass and insulation**: the use of thermal mass walls and concrete construction helps to retain heat (25% net consumption reduction)

3. **Reducing operating volume for heating and cooling**: The lower the occupied volume of space in the house, the less overall energy is required for space heating and electricity usage (2% reduction)

b) Maximizing net energy production

The group considered wind, ground source, and solar energy as the three potential energy generating sources on-site. Wind energy option was abandoned through wind studies which indicate that wind energy is not viable source energy, unless the wind plant height was increased to heights inappropriate for the community. Energy production of GSHP (Ground Source Heat Pump) and PV (Photovoltaic) were evaluated using RETscreen to design and size the systems to maximize capacity.
On-site energy production through a ground source heat pump and PV panels, which will produce a combined 976,901 kwh/yr. All of this produced an approximate net energy gain of 63%.

III. Achieving Water-Wise Design

The three strategies are to minimize the water consumption, maximize rain water collection, and on-site recovery of wastewater. Rainwater Harvesting Design and Costing Tool were used to optimize net water consumption. As a result, the team succeeded in reducing 70% of the net demand by switching to water efficient fixtures (toilet, faucets, and urinals). To maximize rain water collection, the entire roof surface is designed to harvest water. As a result, rain water collected off sets the net water demand by 29%. The team opted for a living machine system for non-potable water treatment on-site. The living machine is in theory self-sufficient and is able to recover a great percentage of waste water. This system decreases the demand for rain-water collection during the winter months.
Out of the calculated 1550 m^3/yr of water of the optimized net demand, 50% was from the recovered water in the living machines, 29% was from collected rainwater, 14% was to be from municipal sources, and 9% from other losses. In the end, 77% of the water will be recoverable.

Team 689

THE WELL LIBRARY

For centuries, libraries have stood as symbols of enlightenment, learning, and civility in a society. In the dawn of this new sustainable age where the call for sustainability and environmental concern is growing, libraries have an opportunity to be a part of this reality. A traditional library is a repository of information through its print collection. However, in this current day, knowledge is being conveyed in a variety of new mediums.

The following boards will illustrate how our building:
(1) Minimizes wind and shadowing impact on the surrounding neighbourhood
(2) Finds a balance between maximum roof surfaces for PV panels and aesthetics
(3) Orients roof surfaces to form a cohesive system in harvesting rain water
(4) Maximizes the south façade and creating light wells for natural day-lighting and passive solar heating while minimizes heat loss on the north façade (combined point 10 with 4)
(5) Controlling the large amount of solar heat gain with sun-shading devices
(6) Creates educational and high performance ‘living machines’ that filter water
(7) Use a high-performance and contextually appropriate building envelope with optimal insulation and materials
(8) Optimizes indoor air quality using a green wall, living machine, and natural ventilation methods
(9) Uses renewable sources like a ground source heat pump and PV panels in a closed-loop system
(10) A continuous ramp is used for circulation in the library space, allowing for universal access in the building, further strengthening community participation in the building

By utilizing site research, benchmark studies, and our own simulations and calculations, the forms, spaces, and components have been optimized for sustainable excellence. One of the main features in the design is how the roofs drain water towards the central greenhouse that houses a rainwater filter and storage tank, which is connected to a larger water circulation system throughout the building. At the same time, our group has created a design that does not solely prioritize performance, but balances a multitude of other factors for a holistic design result that we feel is appropriate for this site.

Our proposal is more than just creating a library with excellent environmental awareness, environmentally sustainable and low-impact systems, and high performance and efficient components. It aims to embody a fuller definition of sustainability, beyond the quantifiable metrics of energy or water. **Our team identifies social (community) sustainability and personal well-being and comfort as integral parts to the whole of the building.**

When spaces are relevant, flexible, appropriate for its context, and provide comfortable spaces for learning or community activity, the building will hopefully be used for generations to come, changing according to the changing realities of this Toronto neighbourhood. It will support community health and activity, stimulating life and ideas, which make communities sustainable in the long-run.

3 ASPECTS of SUSTAINABILITY

{ We have identified **three** main aspects of sustainability that we want to achieve in the context of this community library. Though not exhaustive, these aspects cover a lot of ground and encapsulate a critical interrelationship of building systems. }

1 ENVIRONMENTAL

Environmental Impact of Materials
Renewable **Energy** Sources
Energy Consumption **Reduction**
Life Cycle Analysis
High Performance Building Envelope
Building Heating and Cooling
Water Consumption Reduction and **Conservation**

+

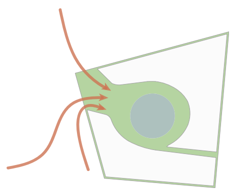
2 COMMUNITY

Educate Community with **Exposed Sustainability Features**
Integrate into **Community Fabric**
Stimulate Community Activity
Share of Ideas, Interactions between Distinct Demographic Group
Durability of Design
Adaptation with Time
Appropriate and Relevant to the **Neighbourhood**

+

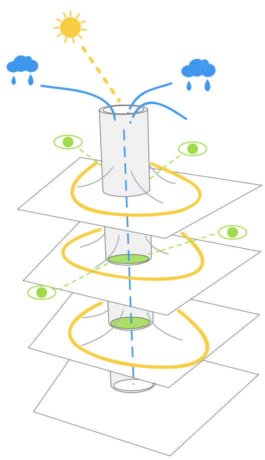
3 PERSONAL

Occupant Comfort, Experience, and Needs
Spatial Layout, Exciting Spaces
Accessibility
Circulation
Creating an **Identity**
Building Comfort Components Speaks about Sustainable Building Element



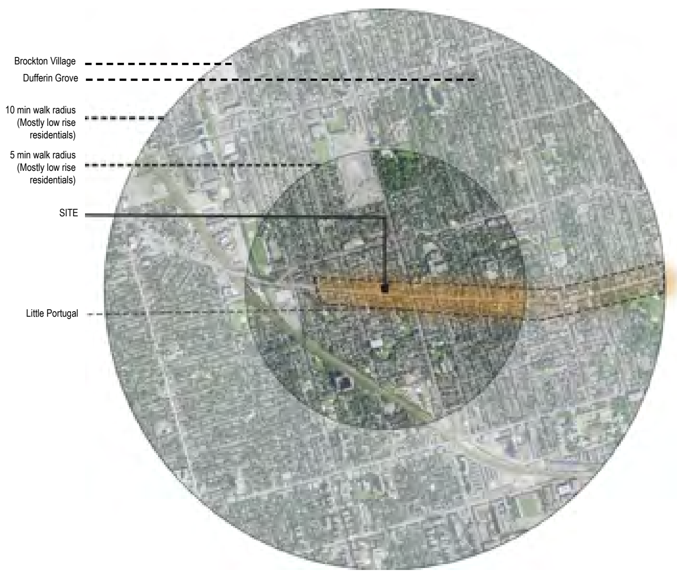
MAIN SPATIAL CONCEPT

A central ‘life-giving’ space, or heart is enclosed within the encapsulating building forms. A sense of shelter and an inward-focus is achieved here. Circulation then occurs around this central space. This becomes the entrance into the building, shielded from the noise and activity from the main street.



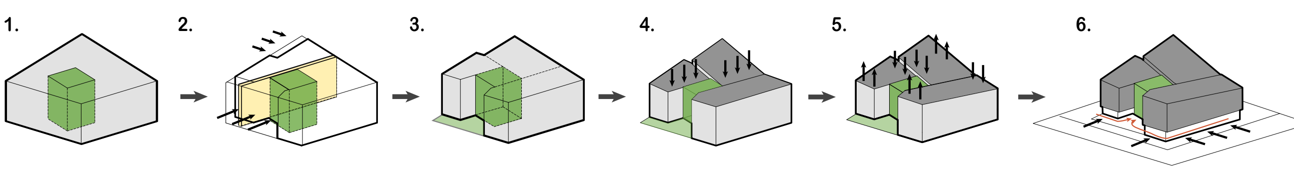
“THE HEART” OF THE BUILDING

Central green space: Within this central ‘heart’, we imagine it to be a multi-use, complex, and alive portion of the building. From here, various elements are sent to the other portions of the building. This space can provide a connection to the elements, daylight, solar heat, ventilation, water collection and purification, and view, etc.



SITE PROXIMITY AND OVERVIEW

MAIN SPATIAL CONCEPT



1. With the given site, we extruded a form up to the appropriate zoning height. We created a central ‘heart’ that would perform many **sustainable and passive functions** that are **visible** to the public, as well as beautifying the center of the building

2. We then massaged the extrusion through a subtractive process. The rear of the building was pushed in, to allow for trees to be planted in the back alley to **mediate the view** from residential to our building. We created our main entrance as entering the central green space. We also placed the entrance here because of the **natural circulation flow** from the neighbourhood to the north. It would also provide a quiet entrance off of the noisy Dundas. A circulation path is also created through the site, **linking** it to the alleyway on the east

3. We then divided the form into **functions**. The library portion was placed at the front of the building, so that its study spaces could receive lots of **natural light**, be seen from the street, and have good views. Community spaces were placed at the back, but still very close to the main entrance. These spaces required less light, so would be serviced by clerestory daylighting. The support spaces were placed in the far corner of the building, where they could be serviced by the laneway. These spaces also require no light and view

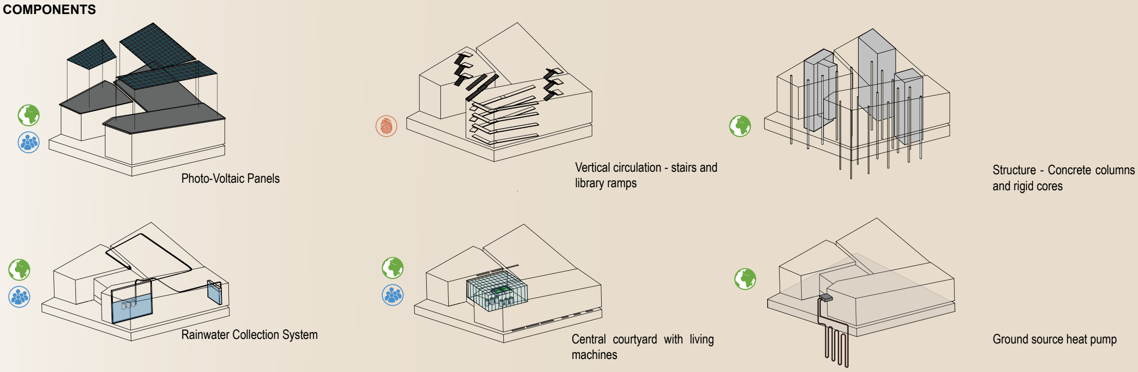
4. Next we got to work massaging the form. We tilted the roofs towards the south, so that our **PV panels** could receive an optimal amount of **solar radiation**. Tilted roofs creates celerestory windows to drive natural ventilation.

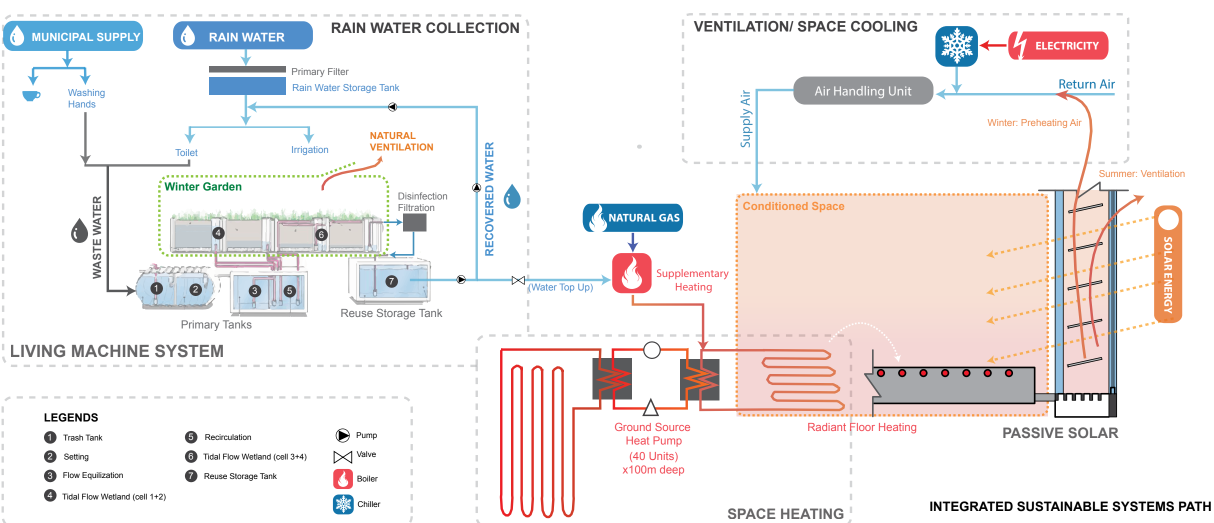
5. The roofs were tilted along another axis towards the central greenhouse – this was for the purpose of **gathering** gravity-driven **rainwater** towards our **feature tank** in the greenhouse space

6. We then set back the ground floor and made it more visually permeable, so that the library function could be read clearly from the street. By setting the ground floor back, it **lightens the form** of the building and implies a movement from the sidewalk, around the building, and into the sheltered front entrance. Also, by setting the ground floor back, **light wells** were then able to be placed to give the basement floor daylighting

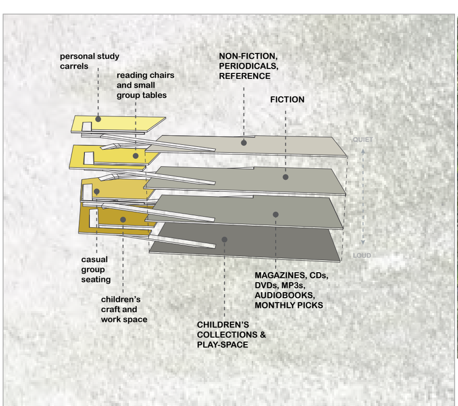
Basement, Children's Play Area

MAIN BUILDING COMPONENTS





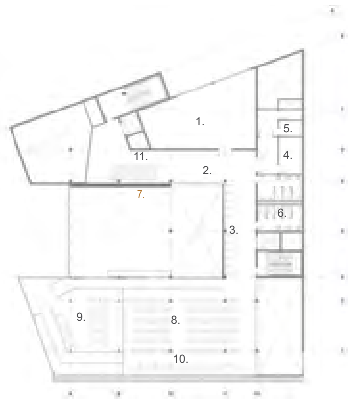
INTEGRATED SUSTAINABLE SYSTEMS PATH



Second Floor Plan - 1 : 400

LEGEND:

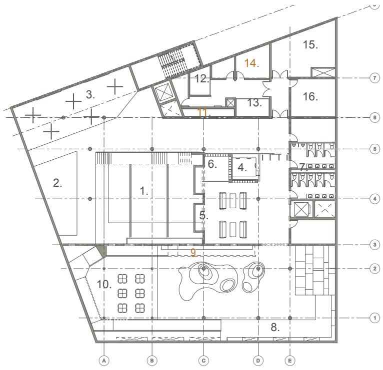
[1] Interior courtyard
[2] Living machines
[3] Multi-use room
[4] Open office/workstations
[5] Breakout room
[6] Server room
[7] Thermal mass wall
[8] Air handling unit room
[9] Janitor closet
[10] Washrooms
[11] Lounge
[12] Collections: fiction
[13] Reading area
[14] Work tables



Third Floor Plan - 1 : 400

LEGEND:

[1] Conference space
[2] Breakout
[3] Lounge
[4] Chair storage
[5] Janitor closet
[6] Washrooms
[7] Thermal mass wall
[8] Collections: non-fiction, periodicals, and reference materials
[9] Study carrels
[10] Study benches
[11] Feature wall



Basement Floor Plan - 1 : 400

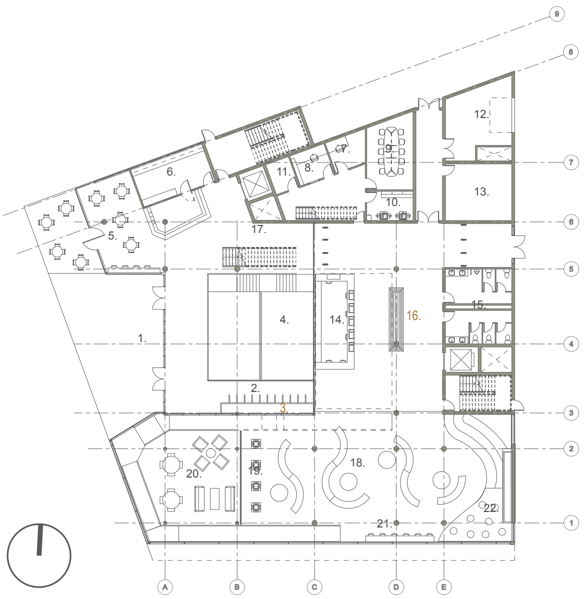
LEGEND:

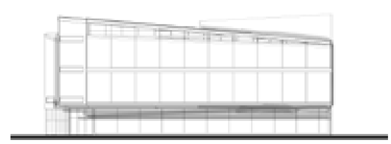
[1] Activity stairs
[2] Performance stage
[3] Flexible gallery space
[4] Basement entrance front desk
[5] Under-stair nooks
[6] Children's cubbies
[7] Washrooms
[8] Children's play spaces
[8] Reading nooks and shelves
[9] Viewing ports to water tank
[10] Children's workspace
[11] Primary filter tank (with viewing glass)
12] Reuse storage tank
[13] Closed system heating tank
[14] Building systems control room
[15] Geothermal room
[16] Boiler room

GROUND FLOOR LEGEND:

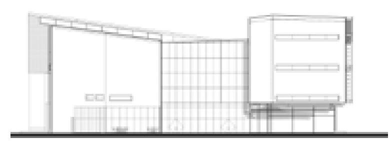
[1] Entrance
[2] Vertical bike storage
[3] Rainwater collection display tank
[4] Activity stairs
[5] Café (open to outside)
[6] Kitchen
[7] Librarian's office
[8] Librarian's assistant
[9] Staff meeting room
[10] Copy/print room
[11] Office storage
[12] Loading dock
[13] Sorting room
[14] Front desk with self-service check-out
[15] Washrooms
[16] Greenwall feature wall
[17] Feature mural wall
[18] Collections: magazines, audiobooks, CDs, DVDs, e-books, MP3s
[19] Catalogue stations
[20] Study area
[21] Study benches
[22] Beanbag sitting area

(Indicates spaces or components with educational opportunities about sustainability)





South Elevation - 1 : 400



West Elevation - 1 : 400

EVOLVING WITH TIME.....

ZINC CLADDING | BRICKS | MURALS | INFORMATION | LIVING MACHINE | PLANTS

Main Floor, Lobby

WATER WISE IS TO BE ACHIEVED IN THREE STEPS:

1 Reduce Net Water Demand — **70%*** Net Demand Reduction

a) optimized water fixtures: toilet, faucet, urinal
b) appropriate plant selection to reduce irrigation (ex. living machine doubles as a planter, living wall)

2 Rain Water Harvesting — **29%** of Net Demand

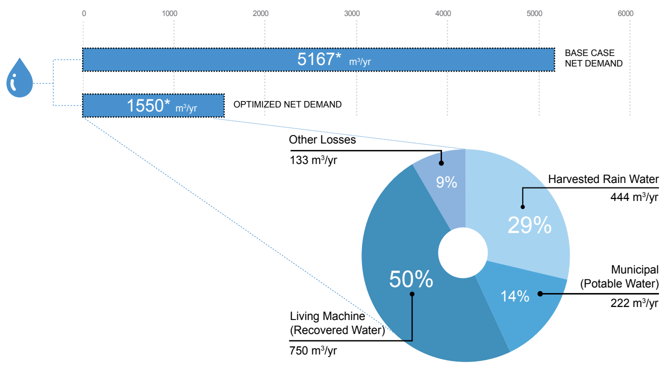
a) maximize roof surface area for rain collection
b) pre-filter of rain water before storing to reduce water loss

3 On-Site Non-Potable Water Treatment — **50% - 91%*** of Net Demand

a) living machine system provides almost a closed-loop waste water treatment system

A technology for treating wastes and purifying water by using living components of nature's own purification process

Advantages:
1. Aesthetic: biological systems of fish, and plants
2. Treatment of indoor air (breakdown of VOCs)
3. *Completely self-sustaining in theory



Water Sources to Meet Net Water Demand*

* Results calculated using Rainwater Harvesting Design & Costing Tool

NET WATER RECOVERABLE of 77%

NET ZERO ENERGY IS TO BE ACHIEVED IN FOUR STEPS:

1 Passive Measures — 11%* Net Consumption Reduction

2 High Performance Envelope — 29%* Net Consumption Reduction

3 Reduce Operating (Heating + Cooling) — 2%* Net Consumption Reduction

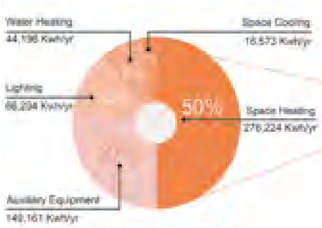
to achieve **benchmark*** net consumption

4 On-Site Energy Production

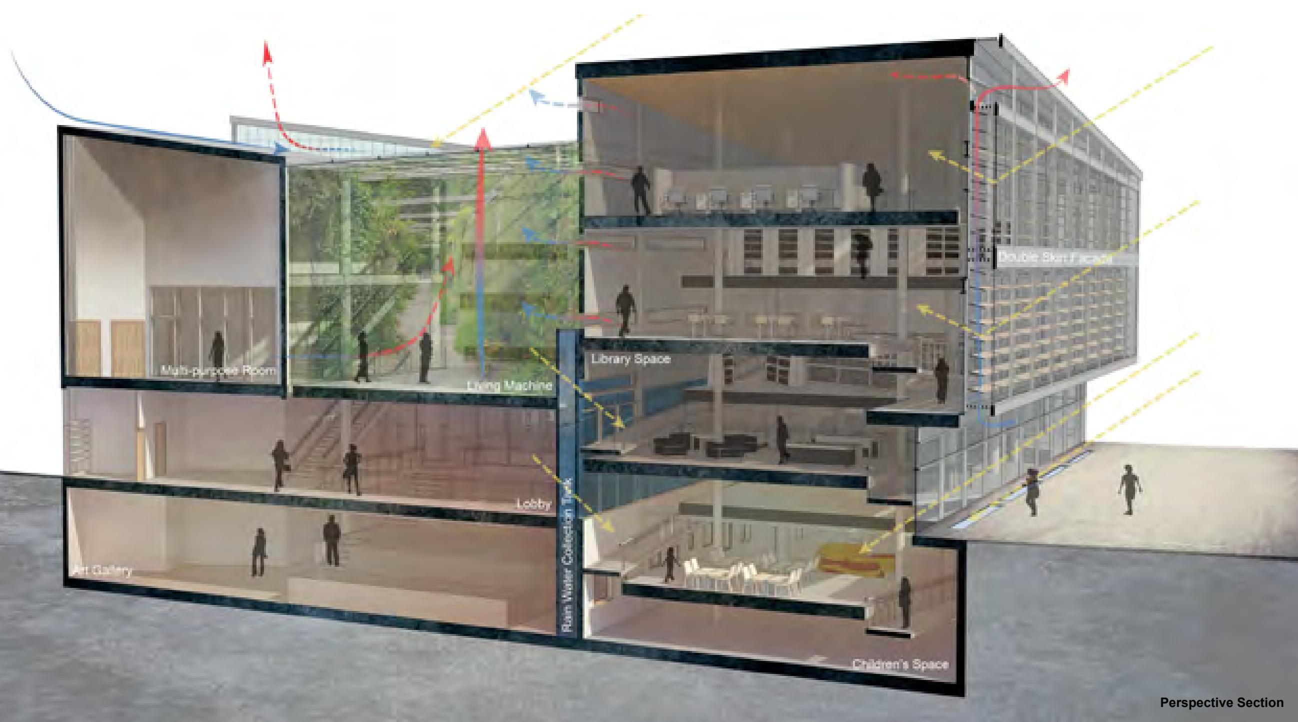
a) ground source heat pump (40 Units x 100m deep) — 105,000* Kwh/yr

b) photovoltaics (843 panels) — 1,424,348* Kwh/yr

NET ENERGY GAIN of 63%



Energy Use Distribution, Institutional*



Perspective Section