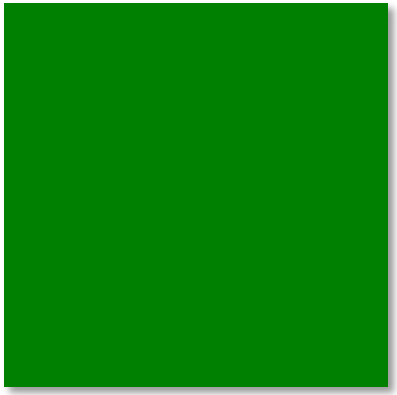
Keep it Beautiful – Make it Green
Sustainable Design in the 21st Century

Terri Meyer Boake
Professor | School of Architecture | University of Waterloo

GREEN



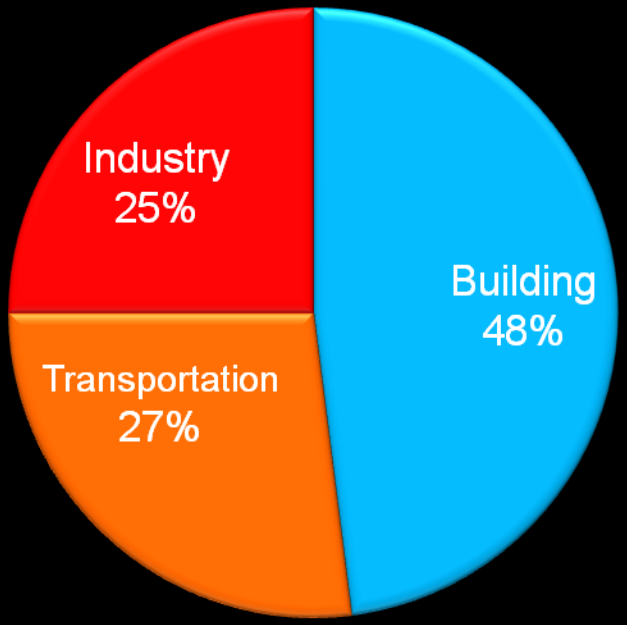
is NOT a Colour

Terri Meyer Boake BES BArch MArch LEED AP
Professor :: School of Architecture :: University of Waterloo

“The world will not evolve past its current state of crisis by using the same thinking that created the situation.”

– Albert Einstein

Energy Use by Developed Countries



The Global Warming Pie....

These values look at Secondary **Energy Use** by Sector in Canada (2006)

(*energy used by the final consumer i.e. operating energy*)

The LEAP to Zero Carbon and beyond…

- Energy Efficient (mid 1970s “Oil Crisis” reaction) – add insulation
  - High Performance (accountable) – C2000, Hot2000
  - Green (environmentally responsive) – Kyoto Protocol
    - Sustainable (holistic and accountable) – LEED ™
    - Carbon Neutral (Zero Fossil Fuel Energy) – Architecture2030
    - Restorative
    - Regenerative –
      Living Building Challenge

…a steady increase in the nature and expectations of performance criteria

ALLAN TANNENBAUM/THE LIFE IMAGES COLLECTION/GETTY IMAGES

The LEAP to Zero Carbon and beyond…

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- Regenerative – Living Building Challenge

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What is LEED?

Leadership in Energy and Environmental Design

- Green building rating system since 1996
- Widely used in Canada and the US
- Holistic marketing tool
- Platinum, Gold, Silver and Bronze Awards

What is the LEED System?

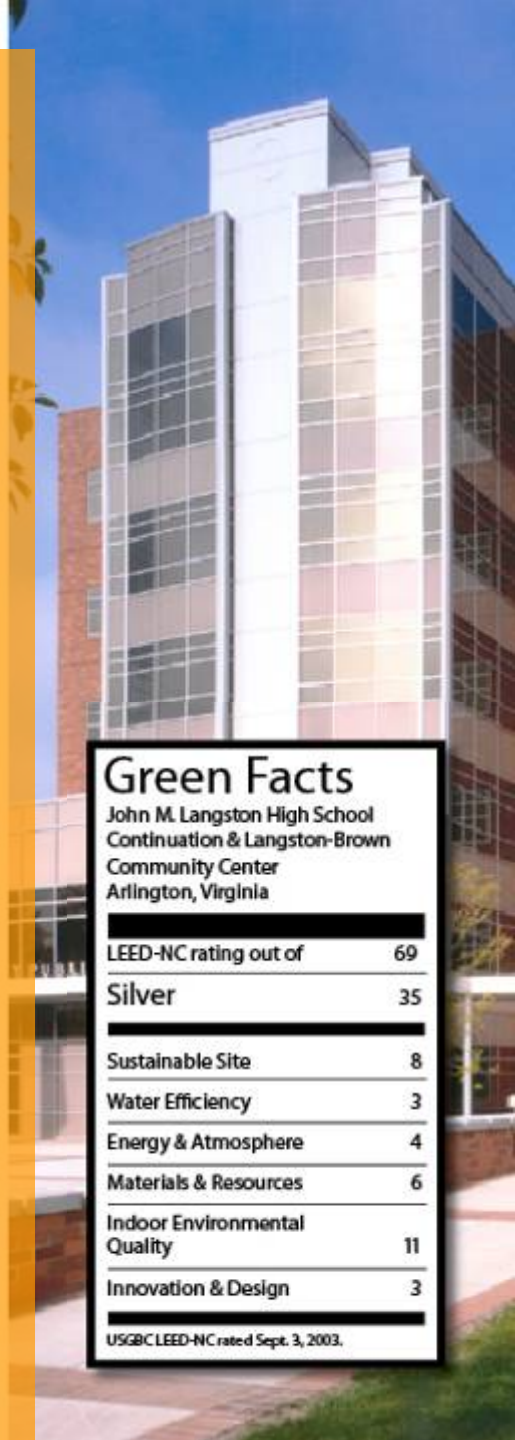
LEADERSHIP in ENERGY and ENVIRONMENTAL DESIGN

A leading-edge system for certifying DESIGN, CONSTRUCTION, & OPERATIONS of the greenest buildings in the world

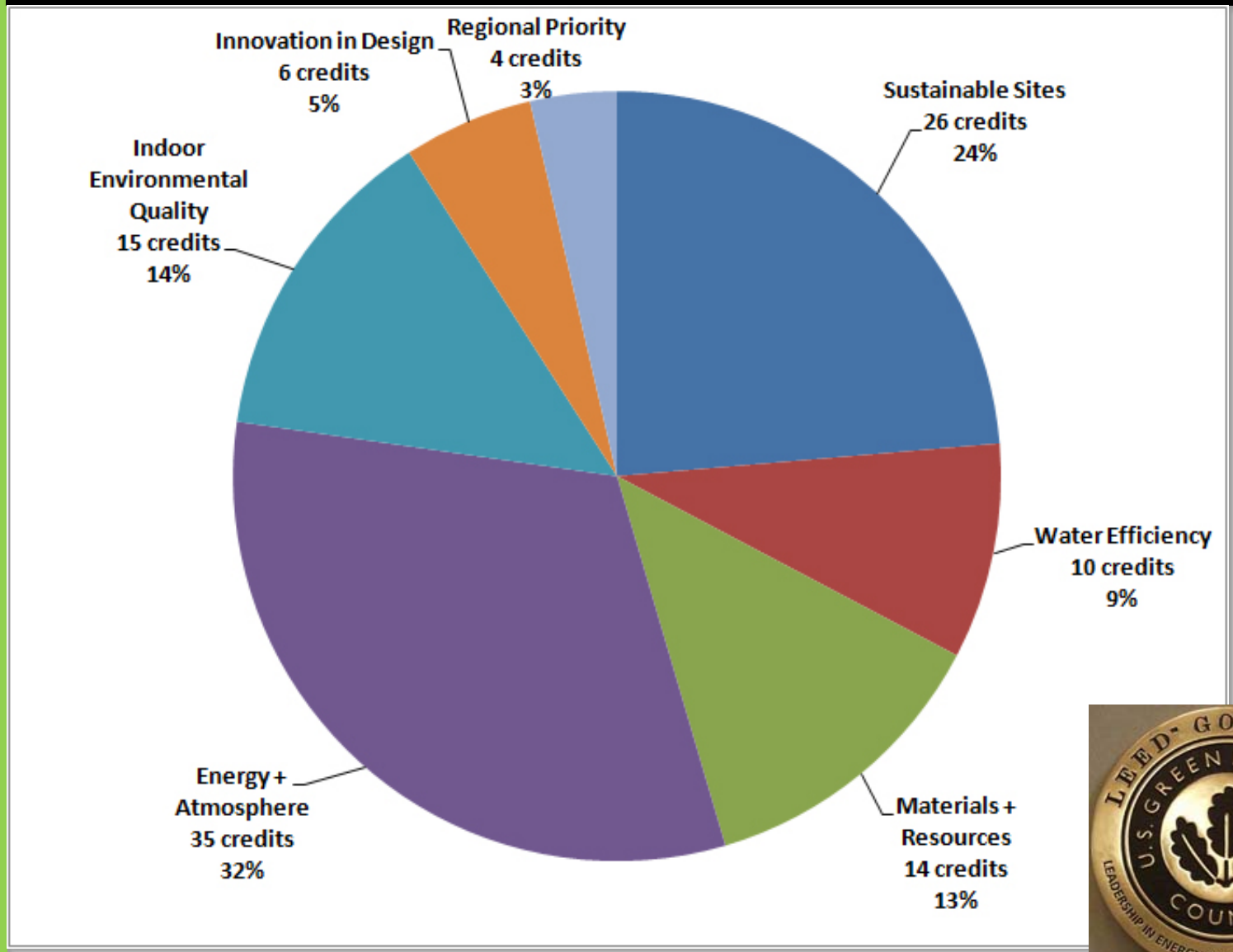
Scores are tallied for different aspects of efficiency and design in appropriate categories.

For instance, LEED assesses in detail:

1. Site Planning
2. Water Management
3. Energy Management
4. Material Use
5. Indoor Environmental Air Quality
6. Innovation & Design Process



LEED Credit Distribution



What is Architecture2030?

The fossil fuel **reduction standard** for all **new buildings** shall be increased to:

60% in 2010

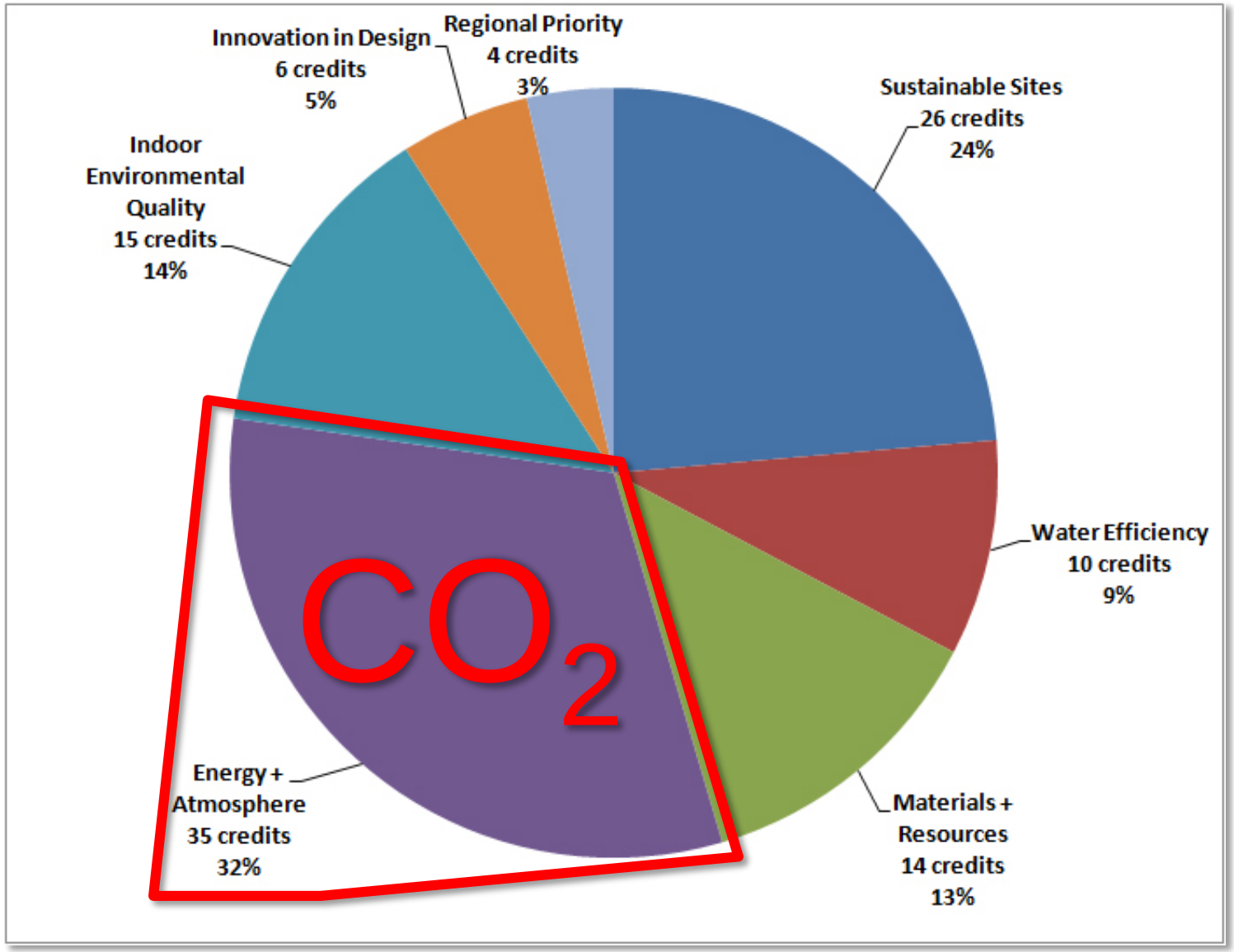
70% in 2015

80% in 2020

90% in 2025

Carbon-neutral in 2030 (using no fossil fuel GHG emitting energy to **operate**).

Source: www.architecture2030.org


Innovation in Design
6 credits
5%
Regional Priority
4 credits
3%
Sustainable Sites
26 credits
24%
Indoor
Environmental
Quality
15 credits
14%
Water Efficiency
10 credits
9%
CO_2
Energy +
Atmosphere
35 credits
32%
Materials +
Resources
14 credits
13%

Operating Energy of Building

80% of the problem!

Landscape + Site

Disturbance vs. sequestration

Embodied Carbon in Building Materials

People, “Use” + Transportation

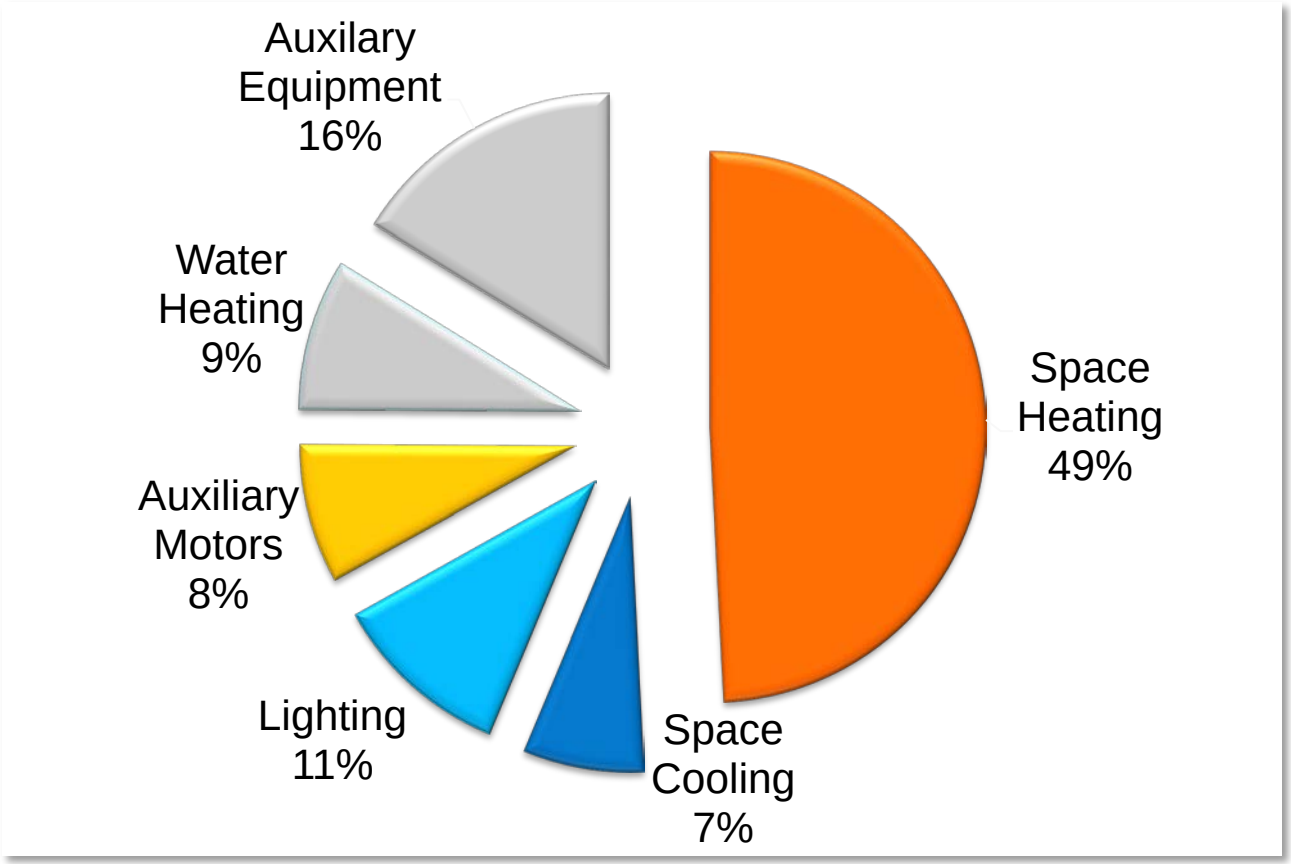
Renewables + Site Generation

Counting Carbon costs….

+ purchased offsets

Energy Use in Buildings: Operating Energy

Total Commercial/Institutional Secondary Energy Use by End Use in Canada (2006)



Source: Natural Resources Canada, 2006

Three Key Steps – IN ORDER:

#1 - Reduce loads/demand first

(conservation, passive design, daylighting, shading, orientation, etc.)

Three Key Steps – IN ORDER:

#1 - Reduce loads/demand first

(conservation, passive design, daylighting, shading, orientation, etc.)

#2 - **Meet loads efficiently and *effectively*** (energy efficient lighting, high-efficiency Mechanical Electrical and Plumbing equipment, controls, etc.)

#3 - **Use renewables to meet energy needs** (doing the above steps *before* will result in the need for much smaller renewable energy systems, making carbon neutrality achievable.)

Use purchased Offsets as a *last resort* when all other means have been looked at on site, or where the scope of building exceeds the site available resources.

Carbon Reduction: The Tier Approach

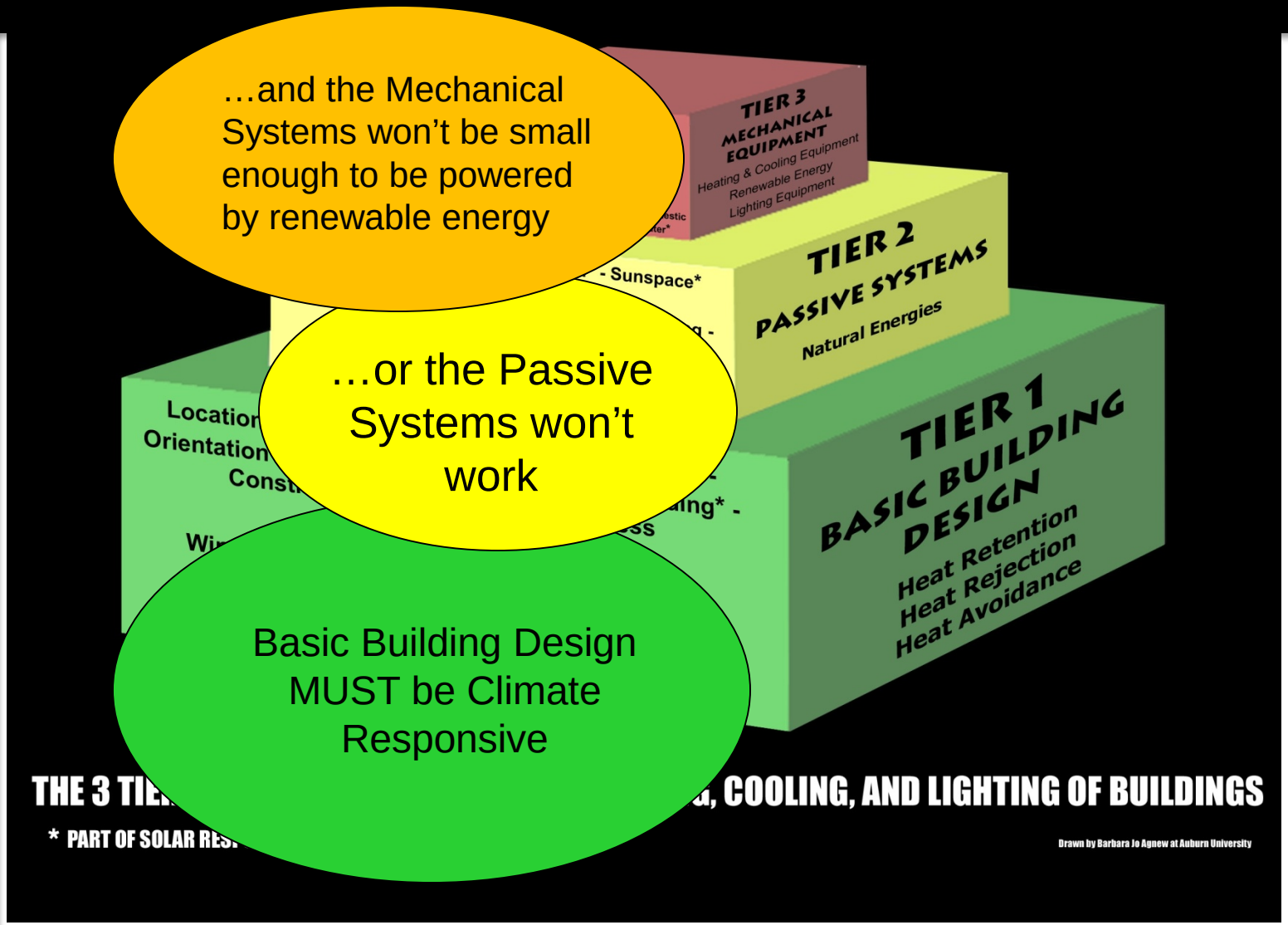
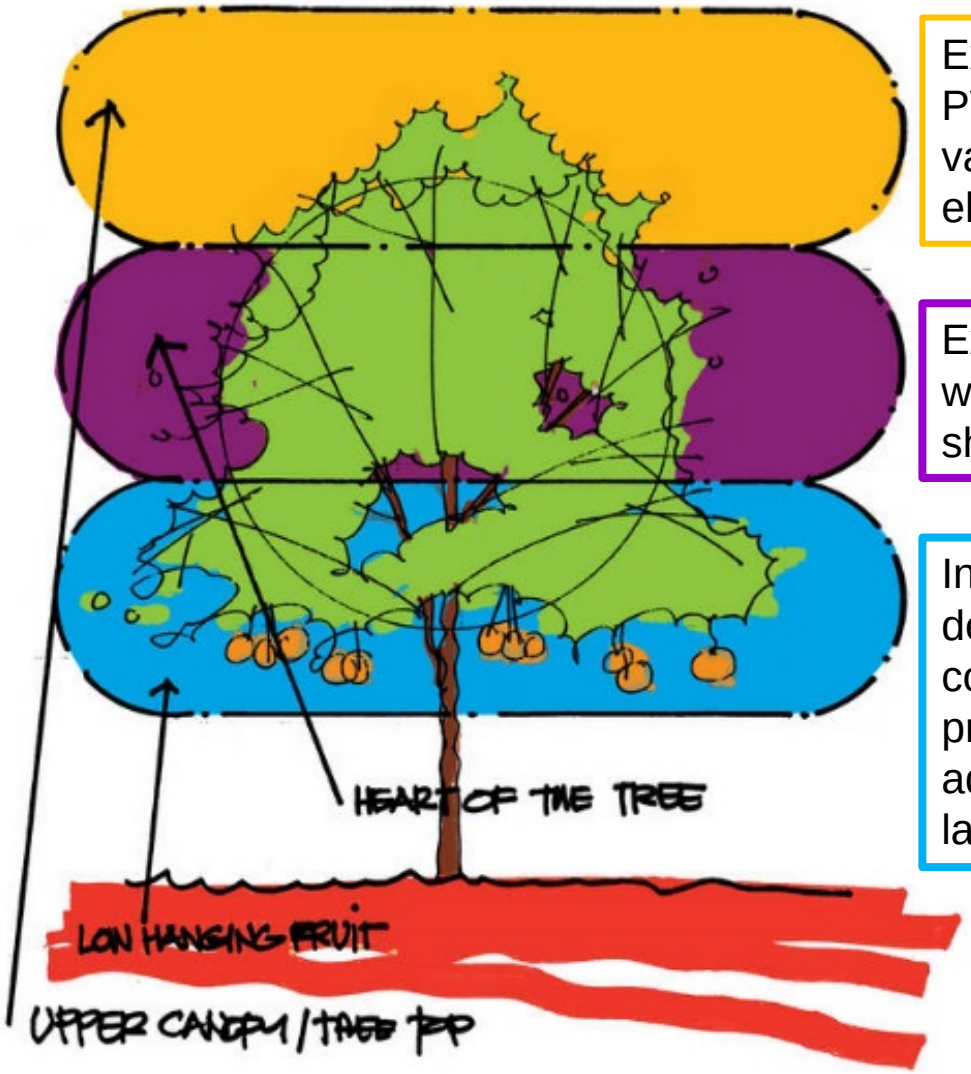


Image: Norbert Lechner, "Heating, Cooling, Lighting"

Low Hanging Fruit



Expensive systems such as PV, micro wind turbines, various mechanical and electrical equipment

Extra insulation, better windows, thermal mass, shading devices.

Initial site and climate based design decisions that really cost nothing but will benefit the project: climate, orientation, adjacencies, massing, landscaping

LEED™ PROJECTS

CERTIFIED
40 - 49 POINTS

SILVER
50 - 59 POINTS

GOLD
60 - 79 POINTS

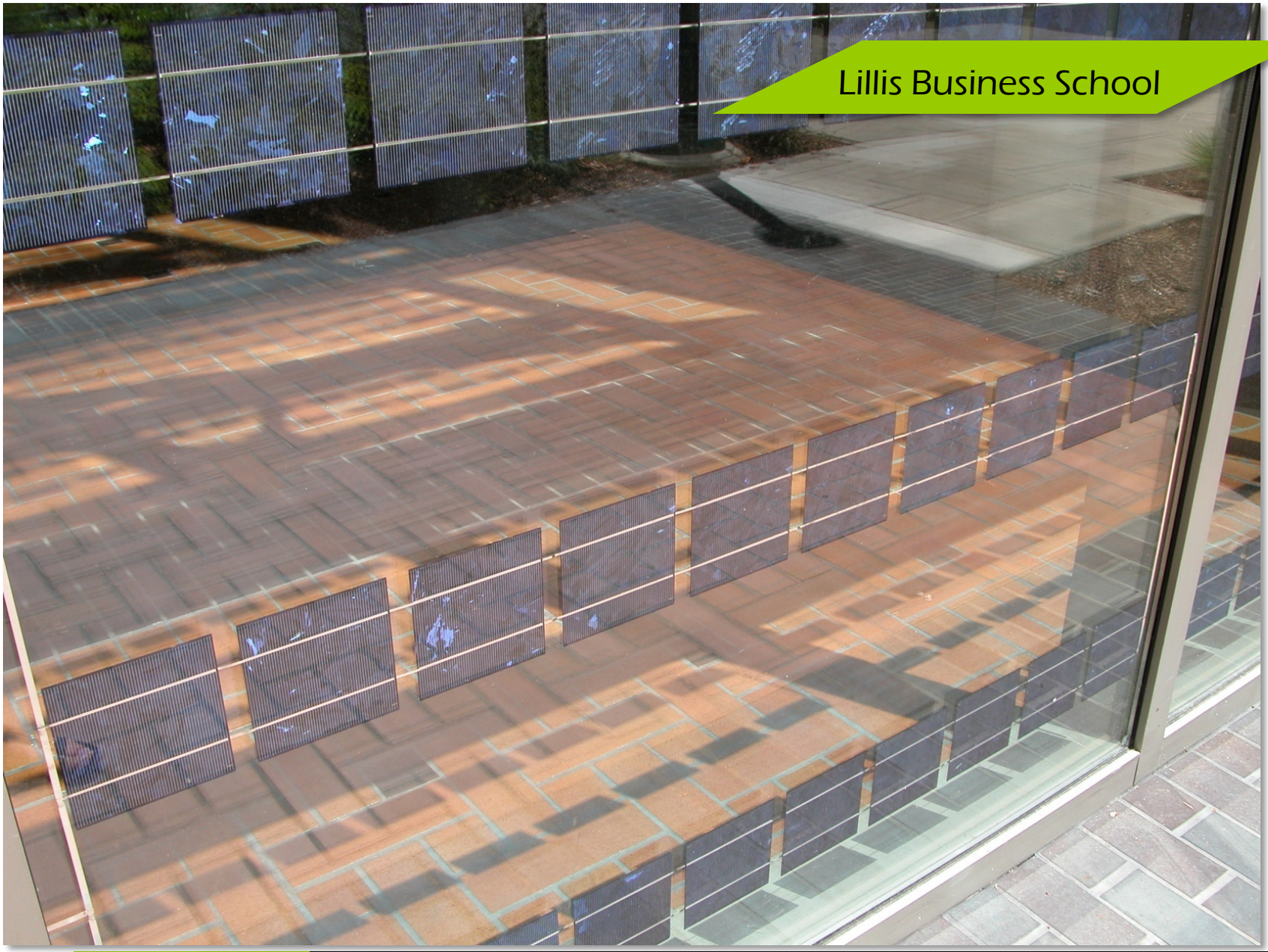
PLATINIUM
80+ POINTS

Lillis Business School

2002
Eugene, Oregon
Architects


Lillis Business School


Lillis Business School


Lillis Business School


Lillis Business School


Lillis Business School

Seattle City Hall

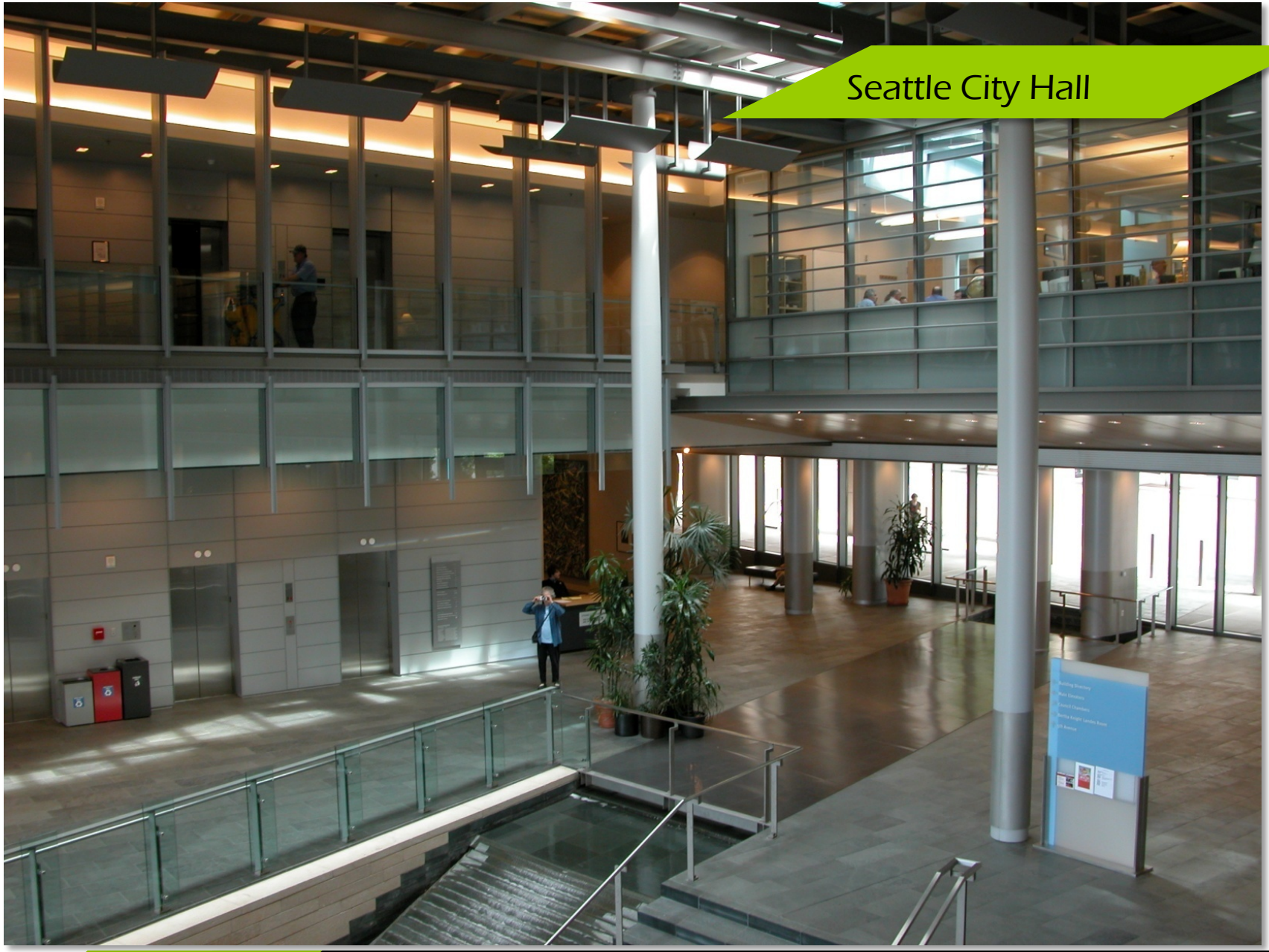
2005

Seattle, Washington

Bassetti Architects/Bohlin Cywinski Jackson

LEED Gold

Seattle City Hall


Seattle City Hall


Seattle City Hall

Seattle City Hall


Seattle City Hall

IslandWood Retreat

2005

Seattle, Washington

Mithune Architects

LEED Gold


IslandWood Retreat


IslandWood Retreat

IslandWood Retreat

IslandWood Retreat

IslandWood Retreat

Cambridge City Hall

2007

Cambridge, Ontario

Diamond and Schmitt Architects

Cambridge City Hall


Cambridge City Hall


Cambridge City Hall

Cambridge City Hall

The atrium provides daylight to the entire interior core of the building and also houses a “breathing wall”.

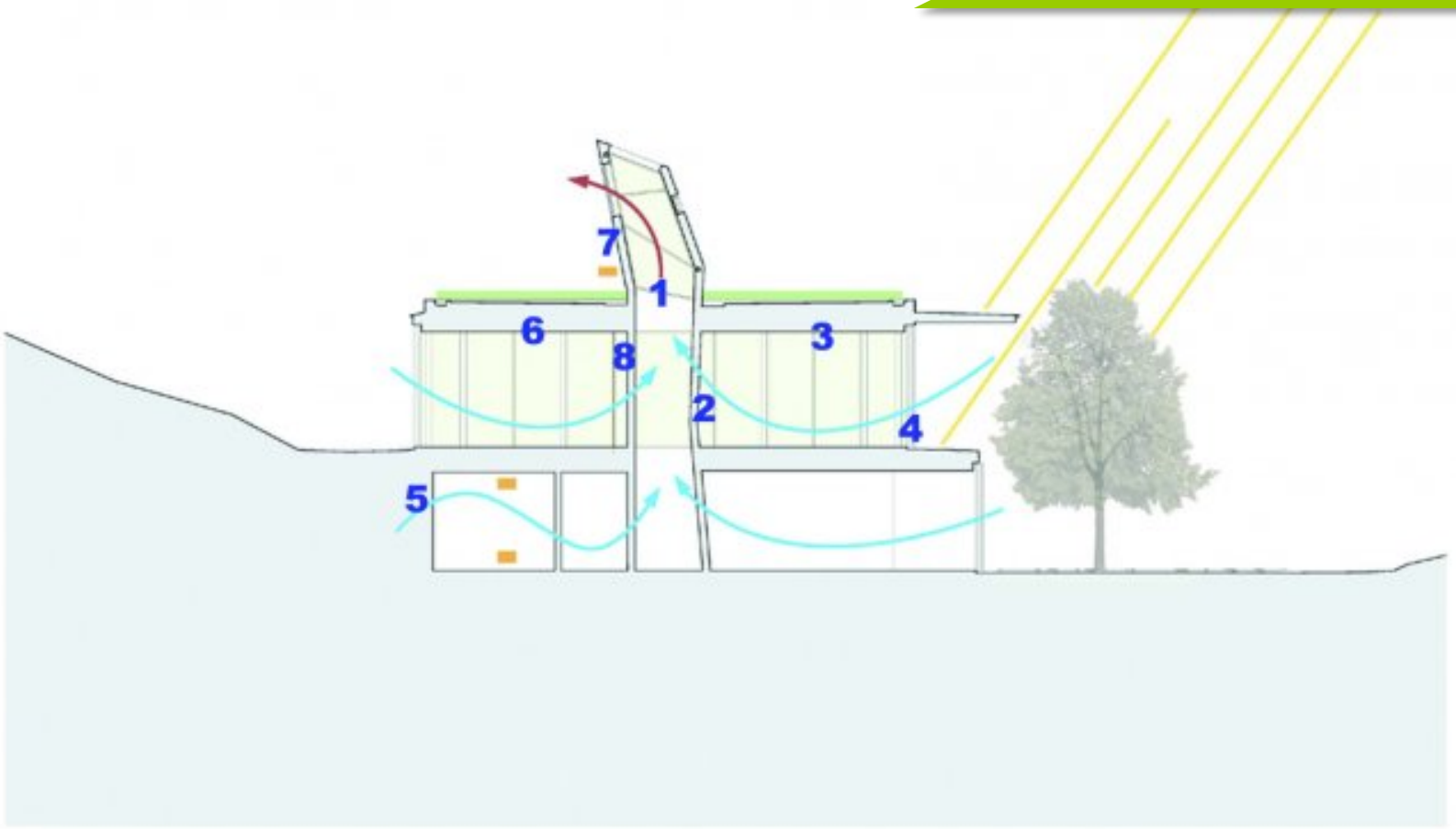

Cambridge City Hall

Humber Arboretum

2007
Toronto, Ontario
Taylor Hazell Architects
w/ architectsAlliance

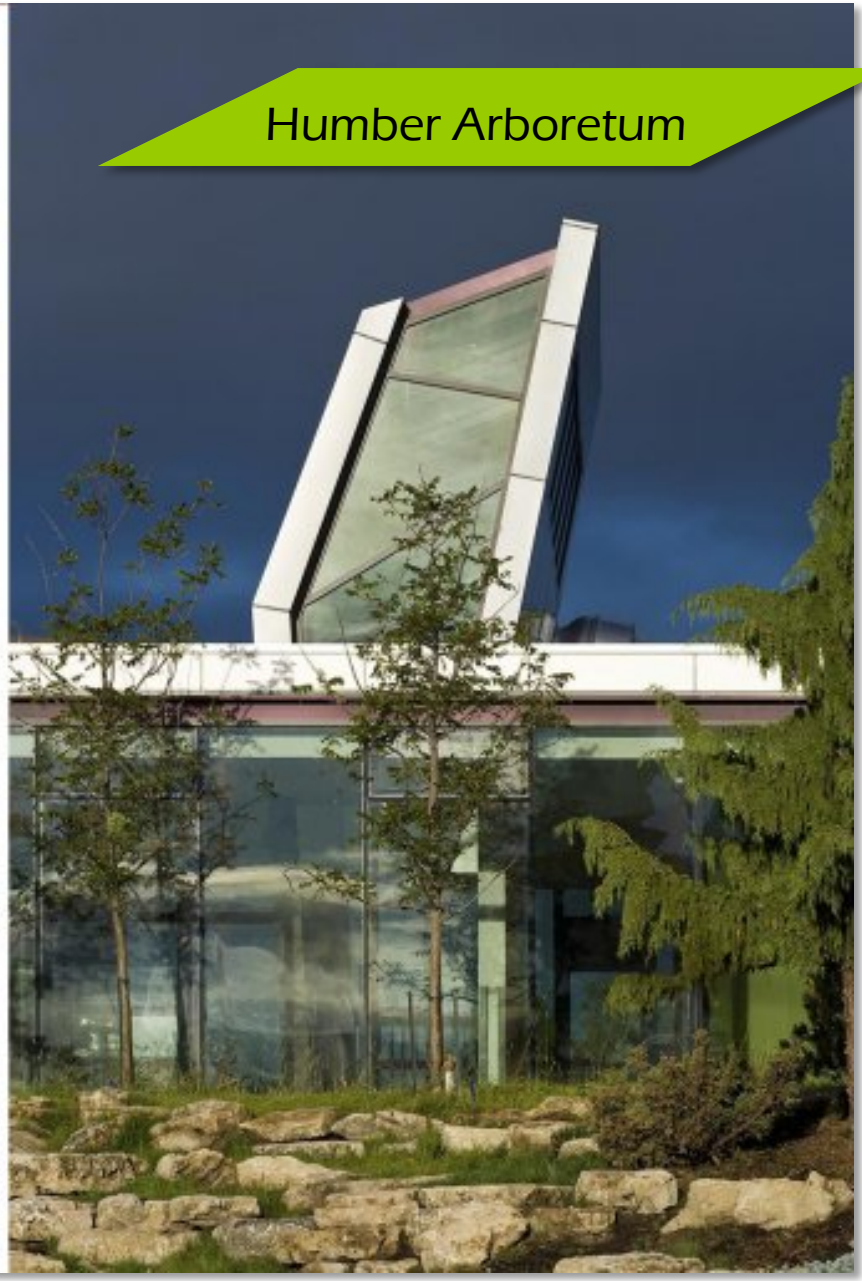
LEED Gold

Humber Arboretum



1 THERMAL CHIMNEY
2 VENTILATION AIR
3 BRISE SOLEIL
4 LANDSCAPE SHADING
5 INSULATING EARTHMASS
6 GREEN ROOF
7 SKYLIGHT
8 WARM PLANE

Humber Arboretum




Humber Arboretum

Manitoba Hydro

2009

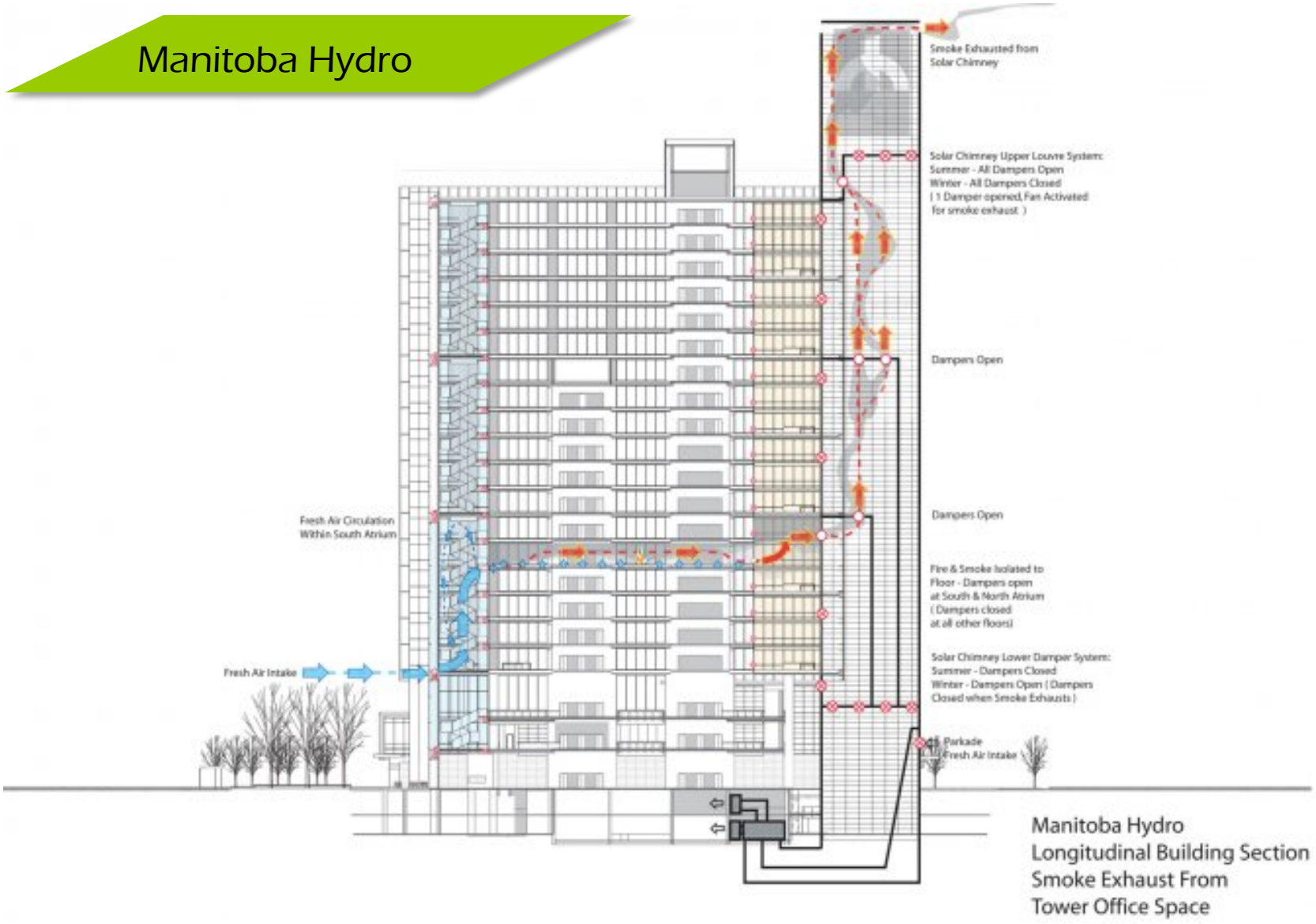
Winnipeg, Manitoba

KPMB Architects, Smith Carter, Transsolar

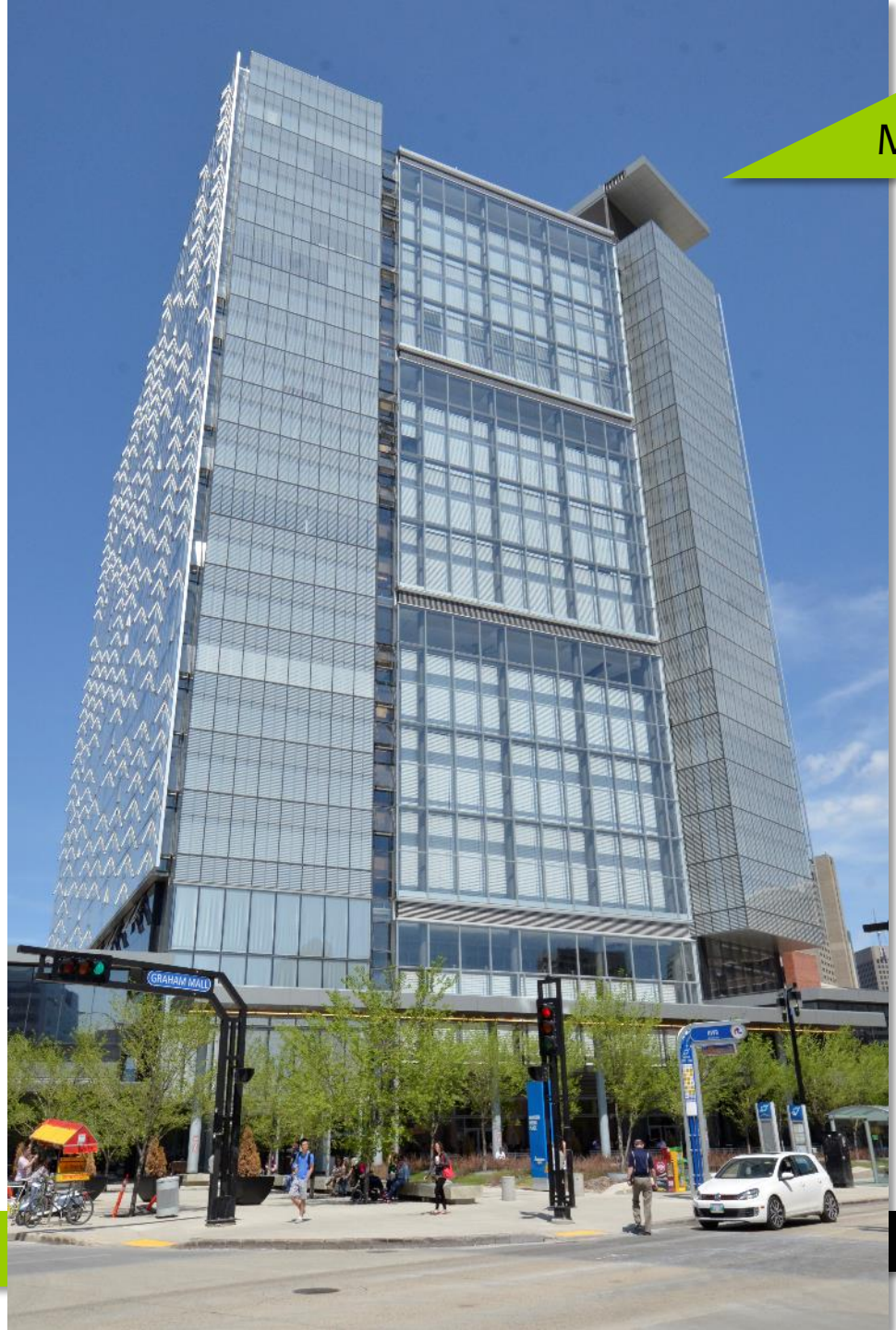
LEED Platinum

Manitoba Hydro

Manitoba Hydro

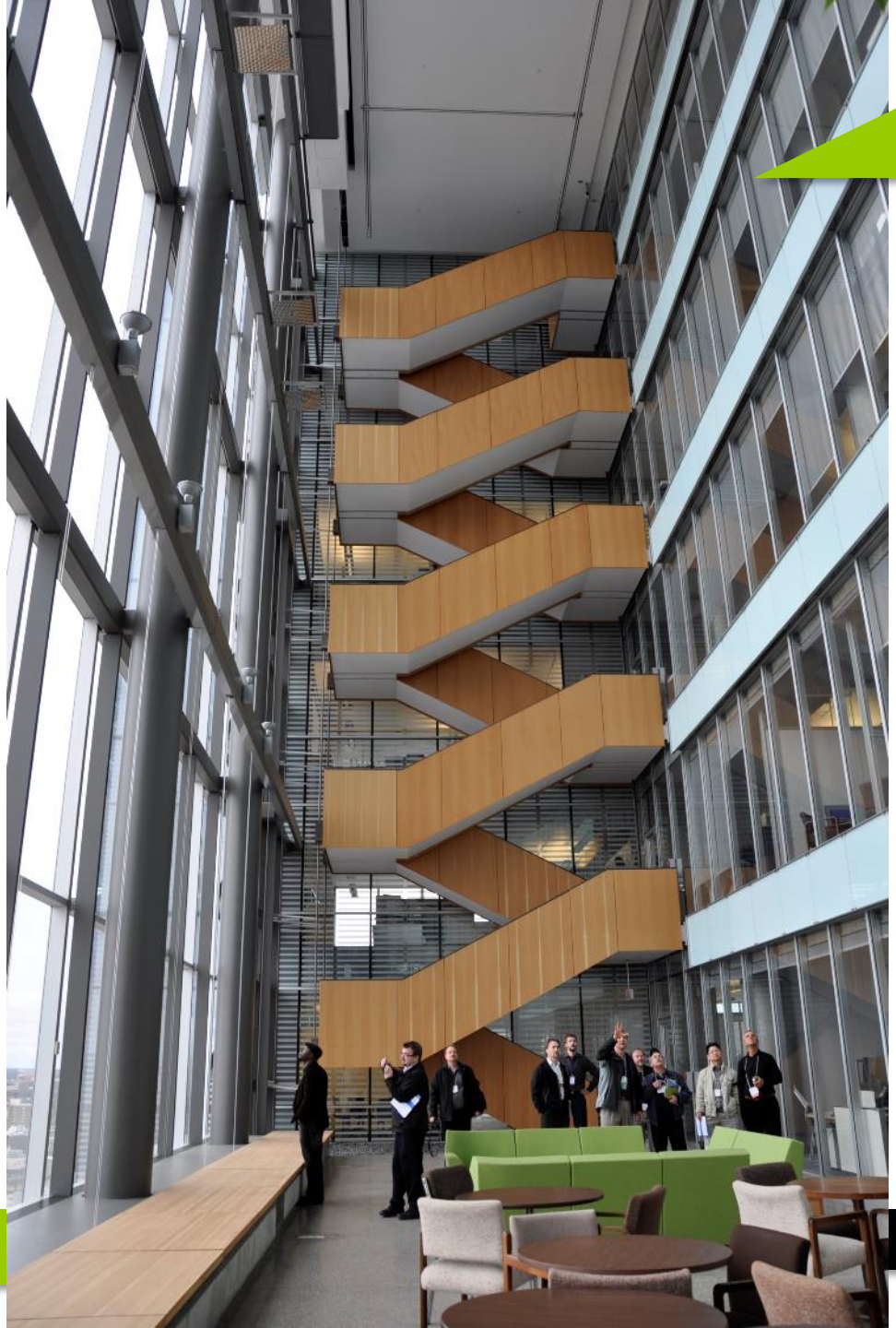


Manitoba Hydro
Longitudinal Building Section
Smoke Exhaust From
Tower Office Space



Manitoba Hydro

- South façade
- Solar atrium that acts as heat collector and buffer space



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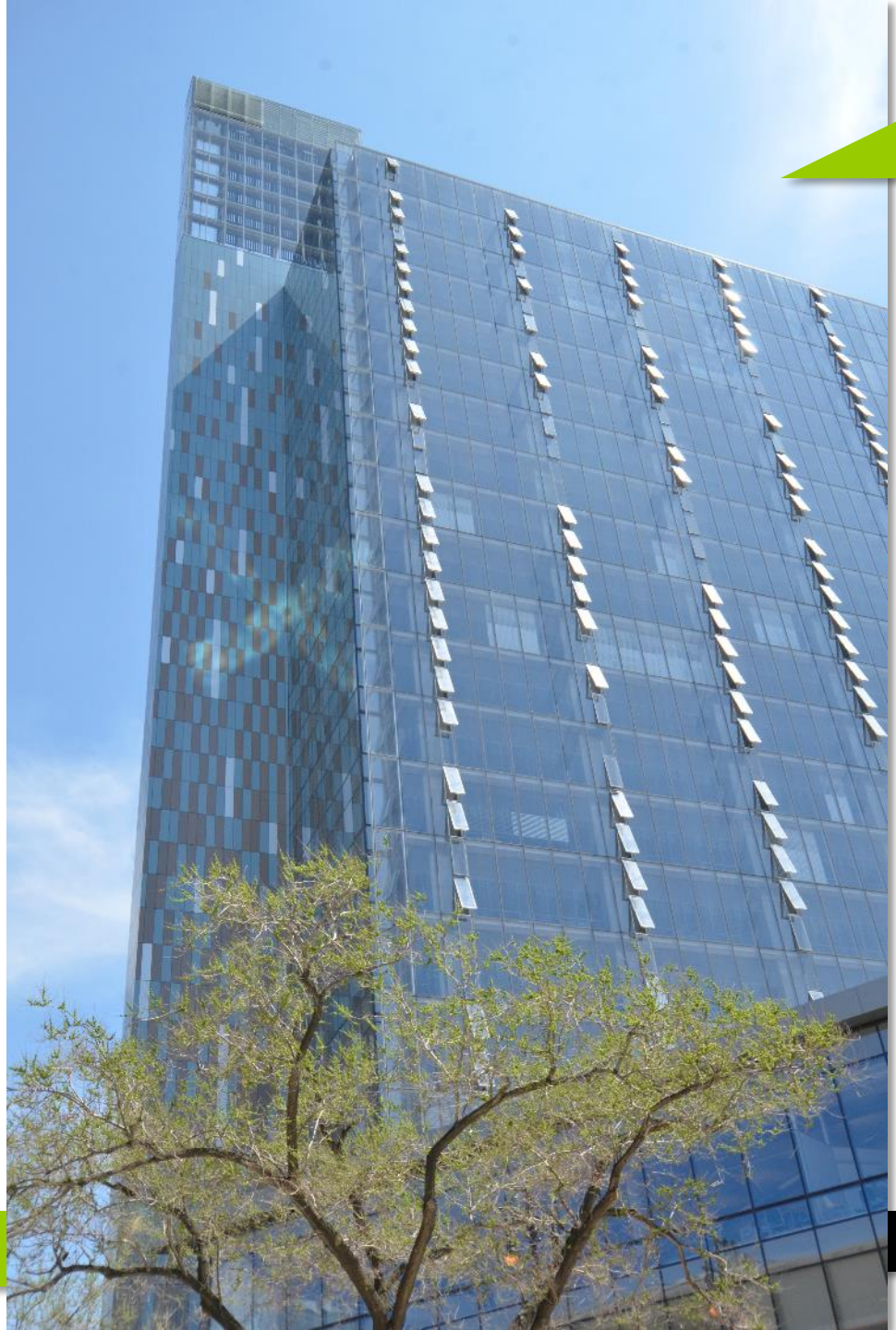
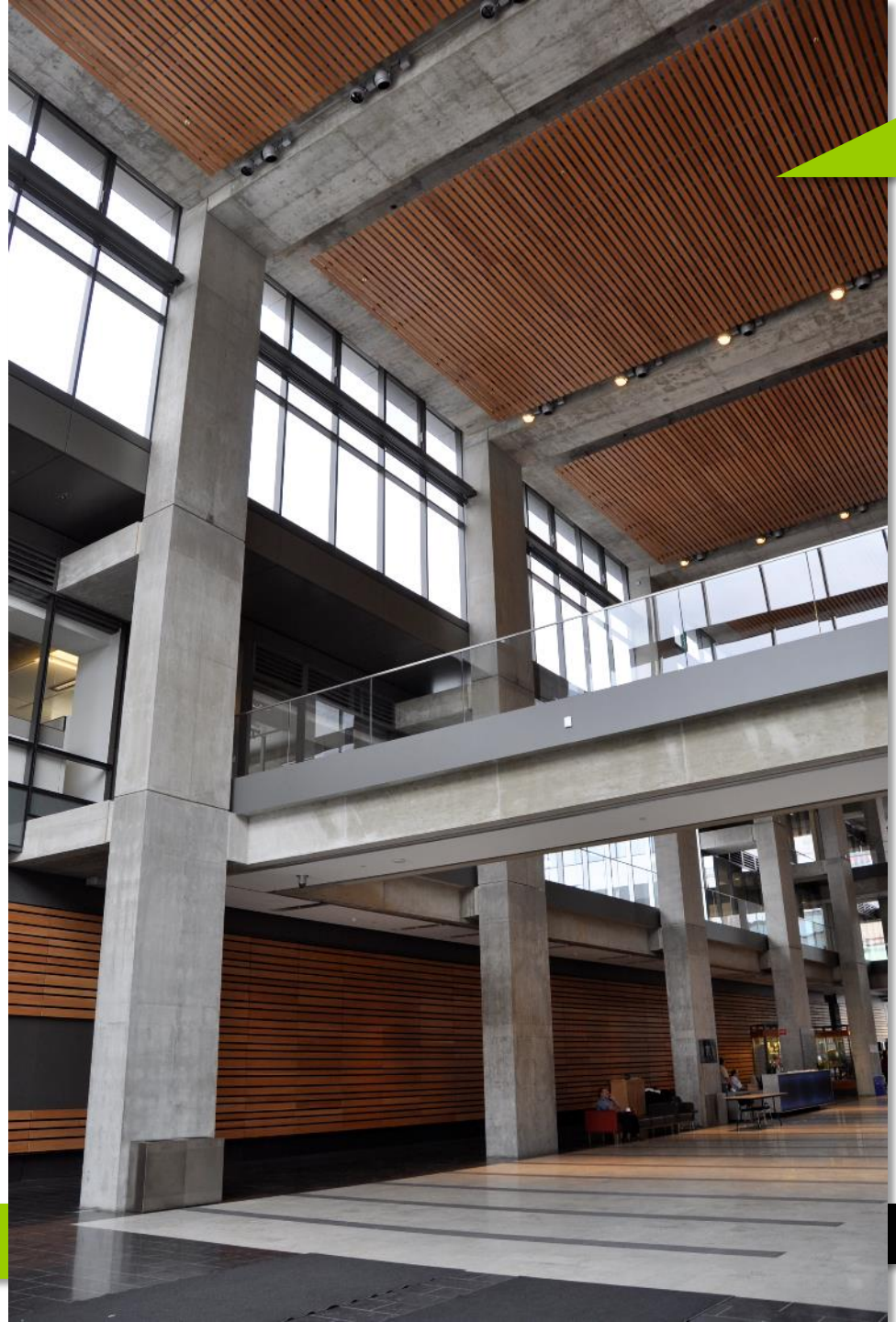


Manitoba Hydro

- West façade
- Double skin system with natural ventilation that is buffered
- Shading system in cavity



Manitoba Hydro

- Entry atrium
- EcoSmart Concrete
- Exposed concrete acts as thermal mass for heat storage
- Lots of natural light

Lakehead University

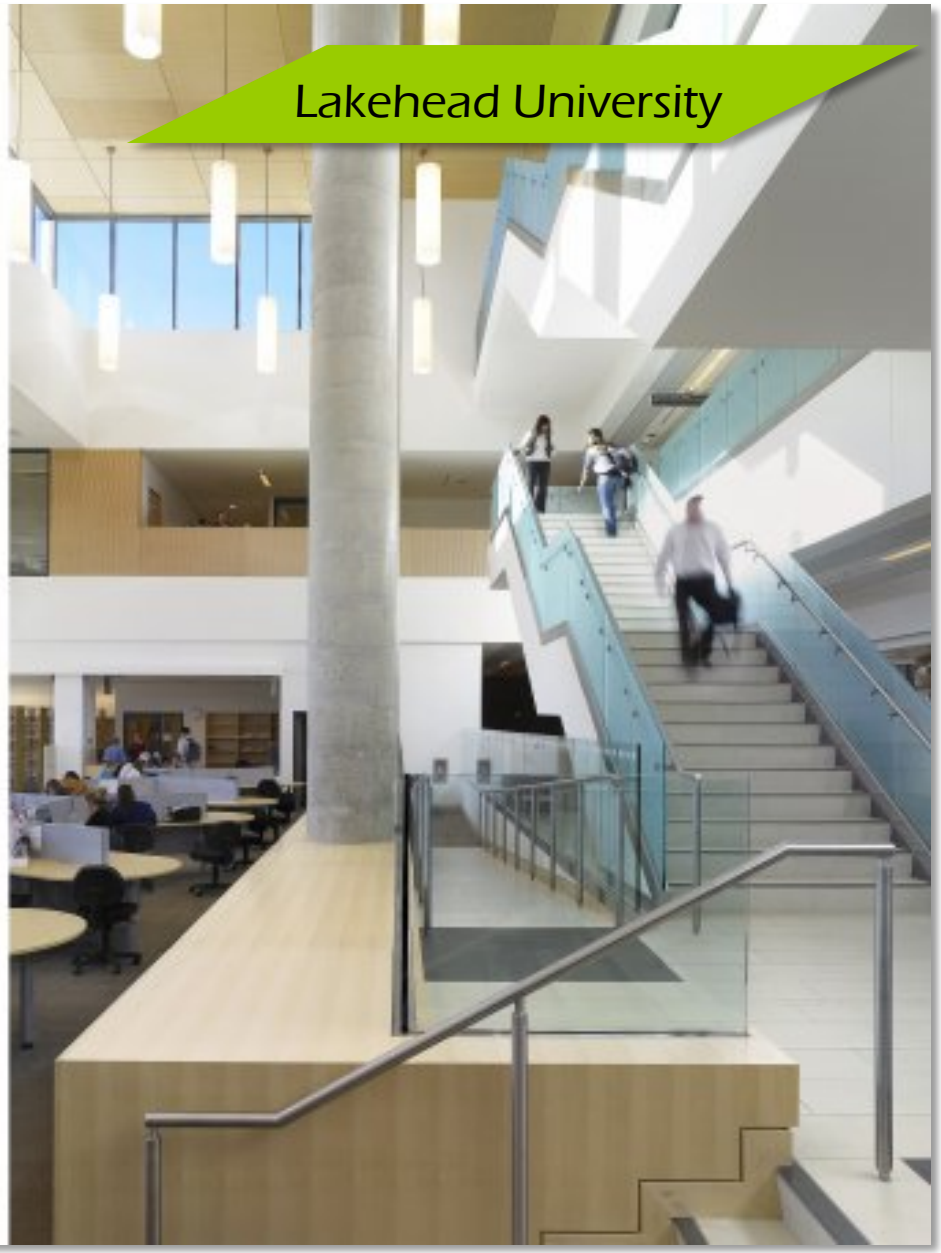
2010

Thunder Bay, Ontario

Moriyama & Teshima Architects

LEED Platinum


Lakehead University



Lakehead University

Evergreen Brickworks

2010

Toronto, Ontario

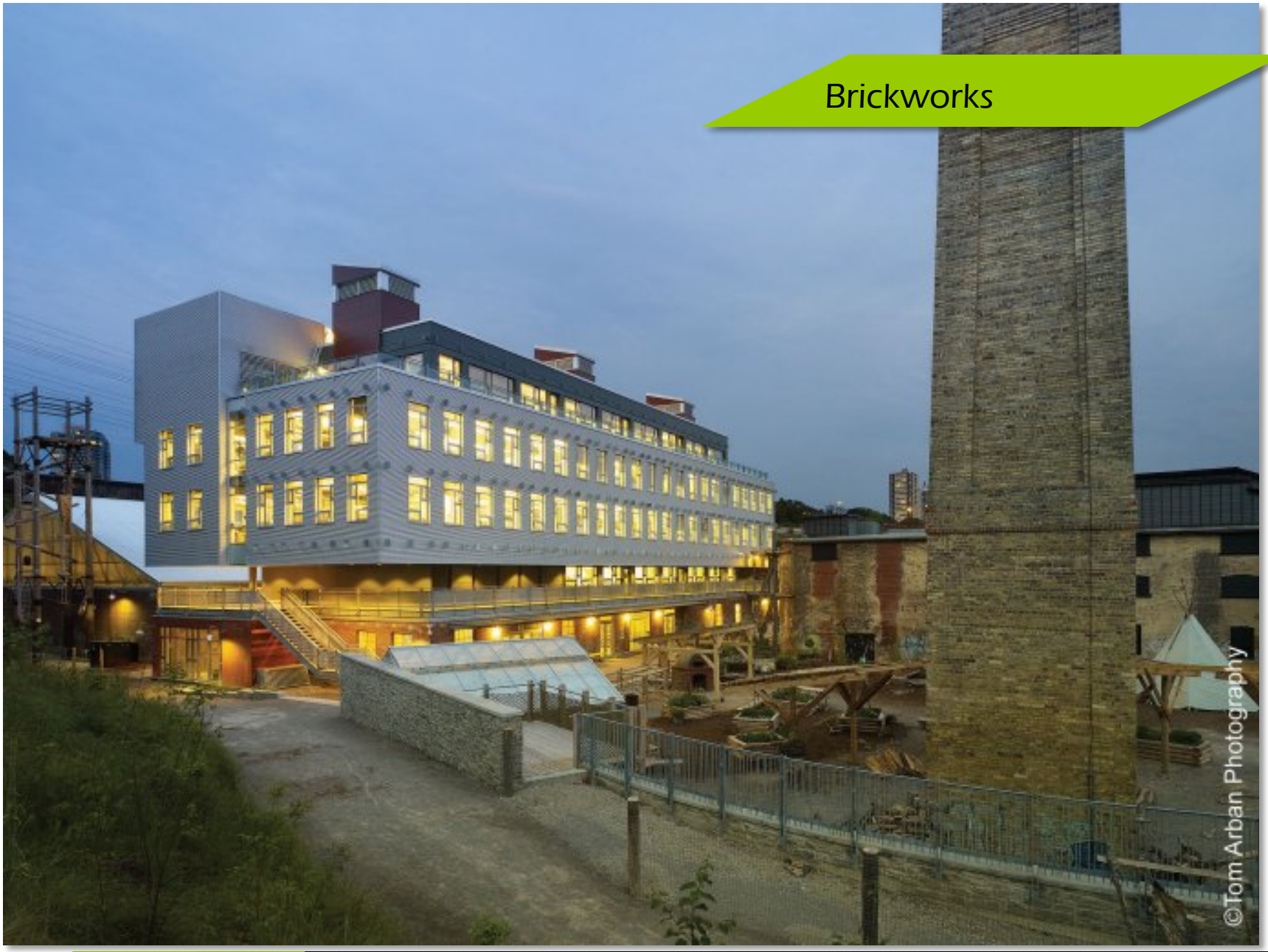
Diamond & Schmitt Architects

LEED Platinum


Brickworks


Brickworks

Brickworks



Brickworks

Brickworks

Measures taken to reduce automobile use

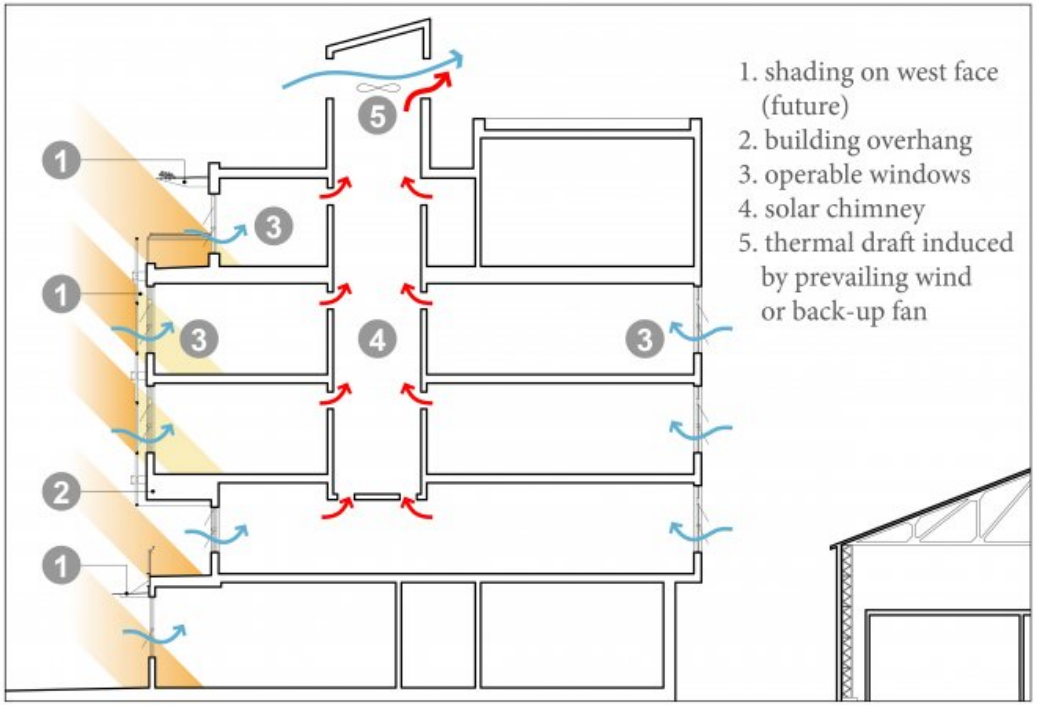
30 bike racks & shower facilities

2 dedicated parking spots for Alternative Fuel Vehicles

2 dedicated parking spots for Carpooling

2 Autoshare cars on-site

Brickworks



ROOF R-Value = R51
- Roof Insulation – AC FOAM II and ACFOAM III: min. 10"@ R5/inch = R50

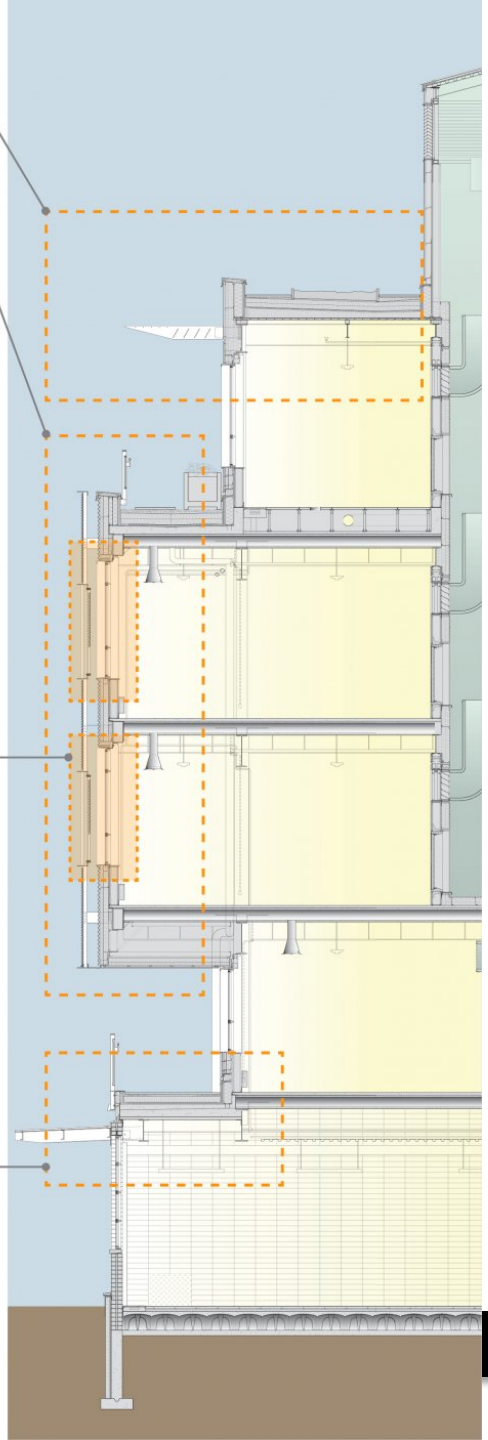
WALL R-VALUE = R34
- Insulation Board - Roxul Cavity Rock 6" @ R4.2/inch = R25.2
- Sprayed Insulation: BASF WALLTITE ECO min. 1.5" @ R5/inch = R7.5

WALL ASSEMBLY
- Corrugated galvalume siding and air space
- Two layers galvanized metal girts
- 150mm exterior insulation
- Blueskin AVB
- Glass reinforced gypsum sheathing
- 152mm metal studs
- 40mm sprayed interior insulation
- Services zone
- 16mm interior gypsum

WINDOW R-Value = R7.5
- 6mm annealed Softcoat LowE on surface 2
- 90% Krypton 10% Air
- Heat Mirror 75 film for east and north or Heat Mirror 88 film for west and south
- 90% Krypton 10% Air
- 6mm annealed
- Desiccant filled warm edge spacers

INSULATED WINDOW FRAMES
- Inline Fiberglass Windows Series 325, 400 and 700

ROOF R-Value = R51
- Roof Insulation – AC FOAM II and ACFOAM III: min. 10"@ R5/inch = R50



ENV 3, U of Waterloo

2011

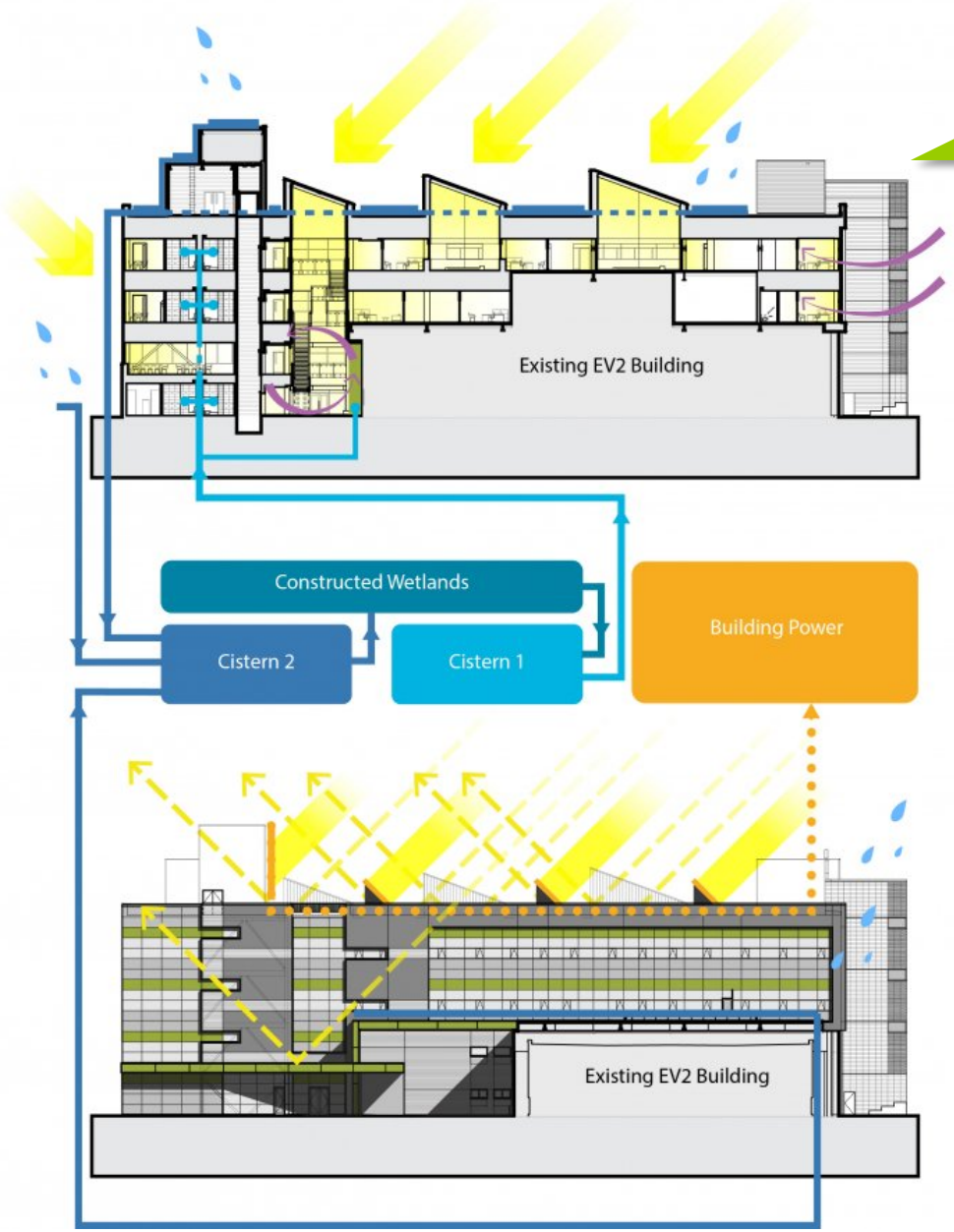
Waterloo, Ontario

Pearce McCluskey Architects

LEED Platinum


ENV 3
EV3

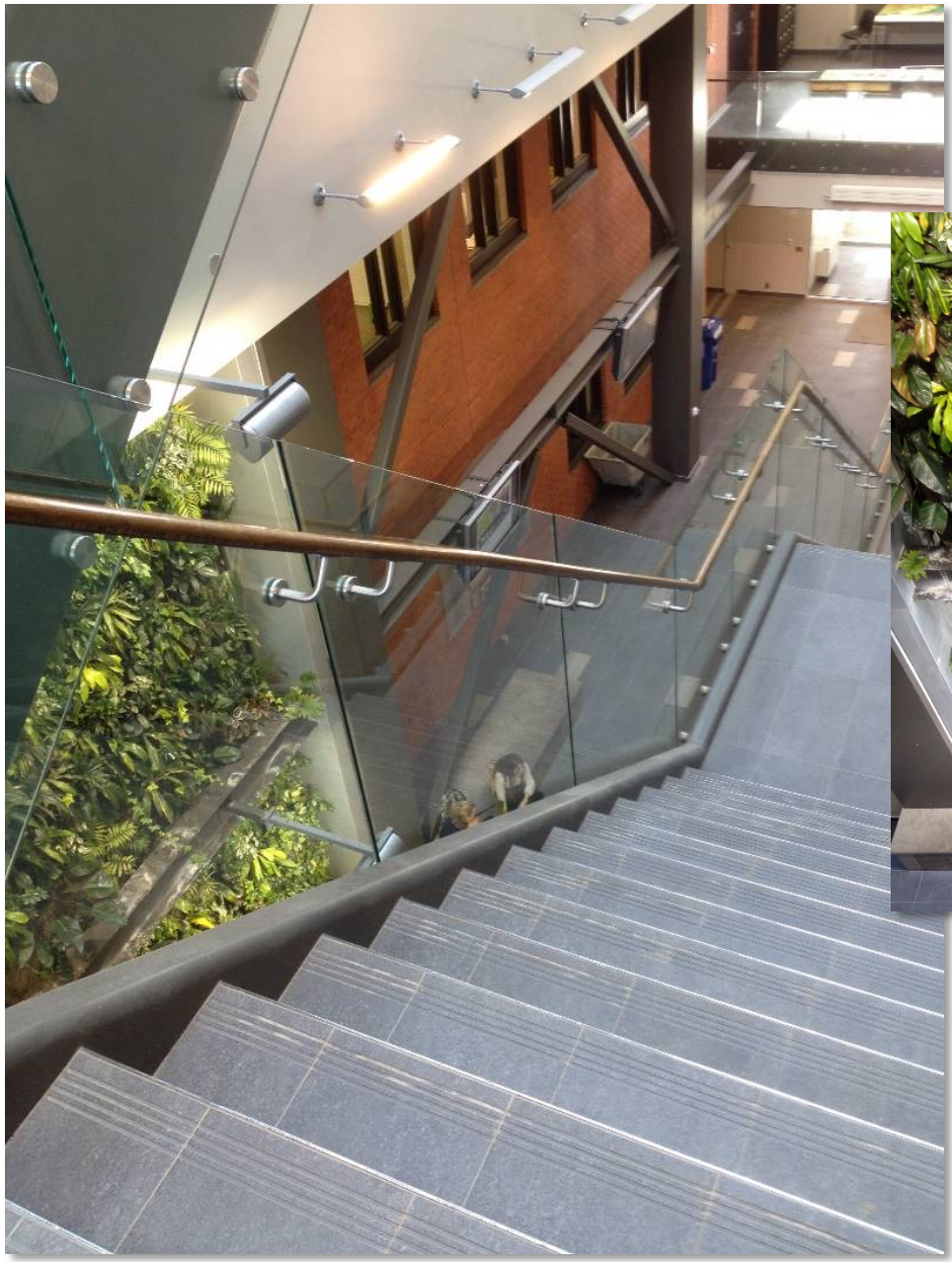
ENV 3

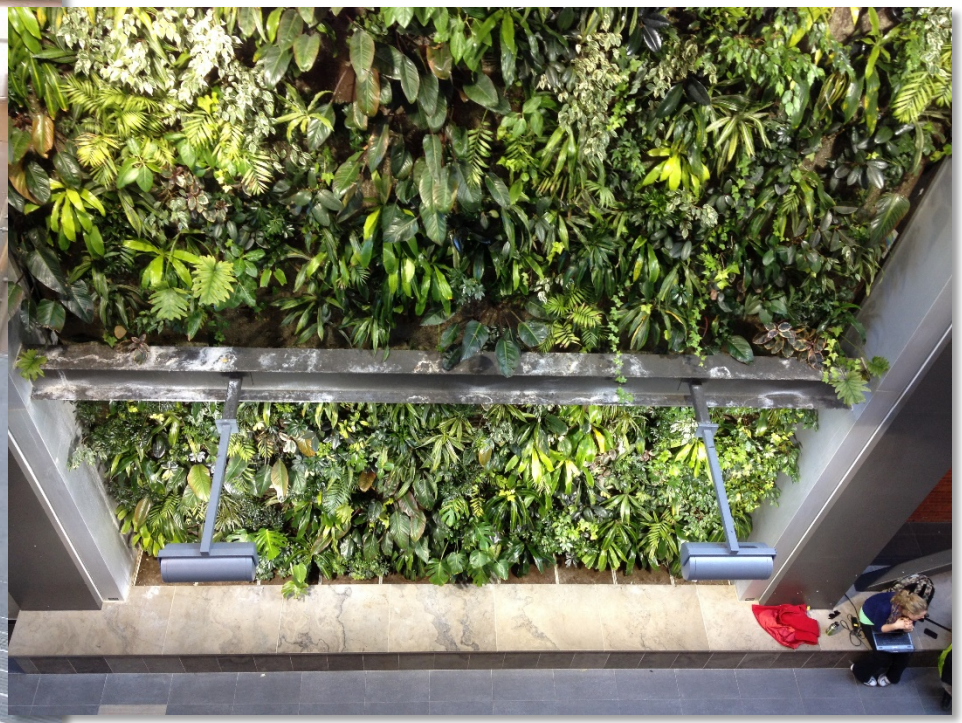

Existing EV2 Building
Constructed Wetlands
Cistern 2
Cistern 1
Building Power
Existing EV2 Building

ENV 3

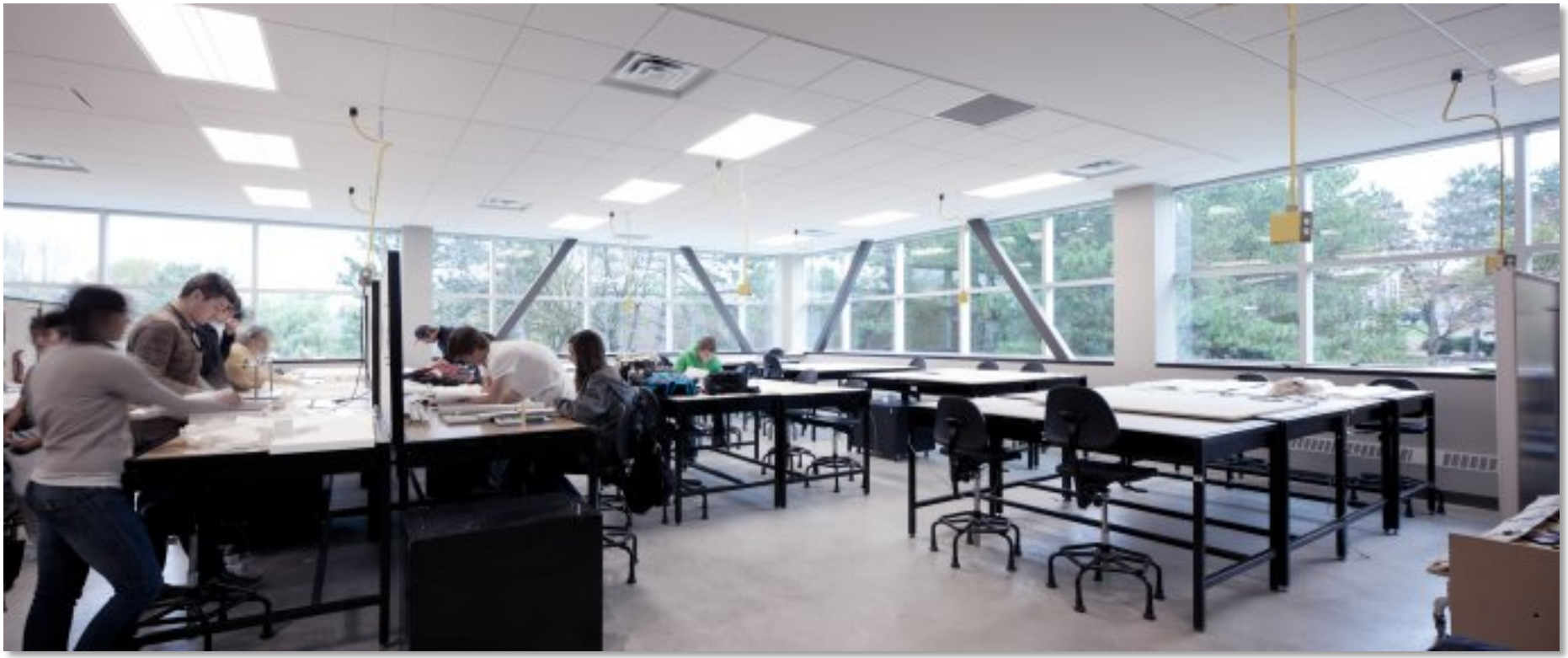
ENV 3

ENV 3





ENV 3



Waterloo North Hydro

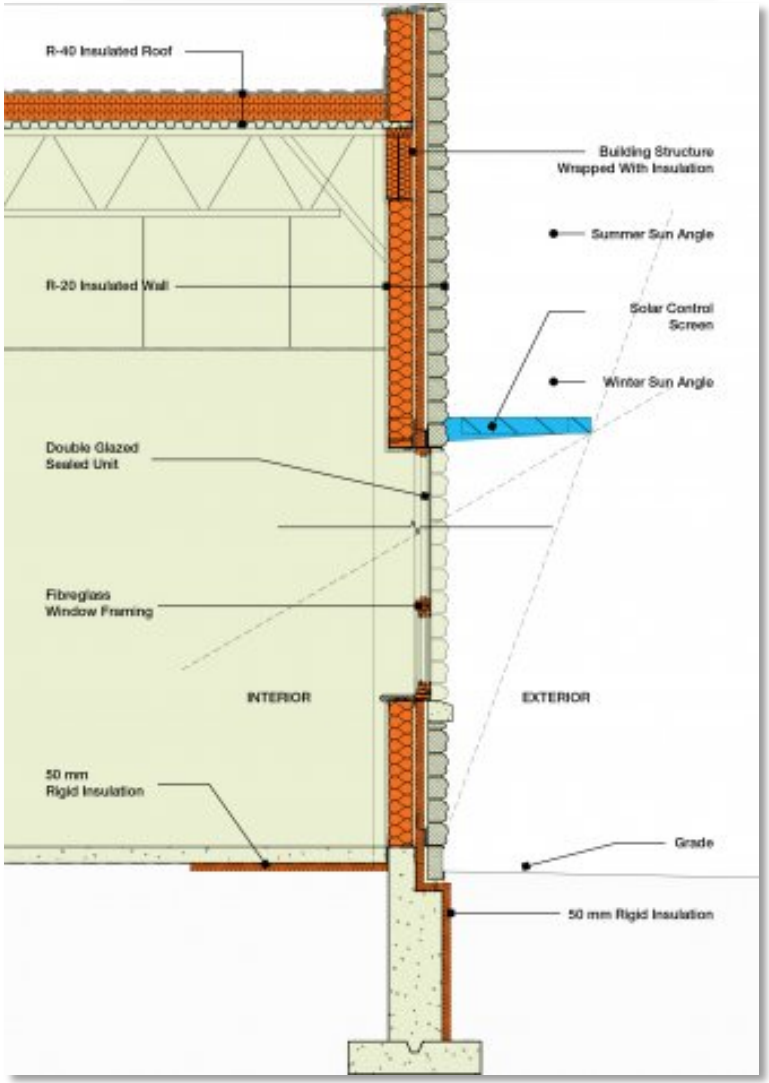
2012

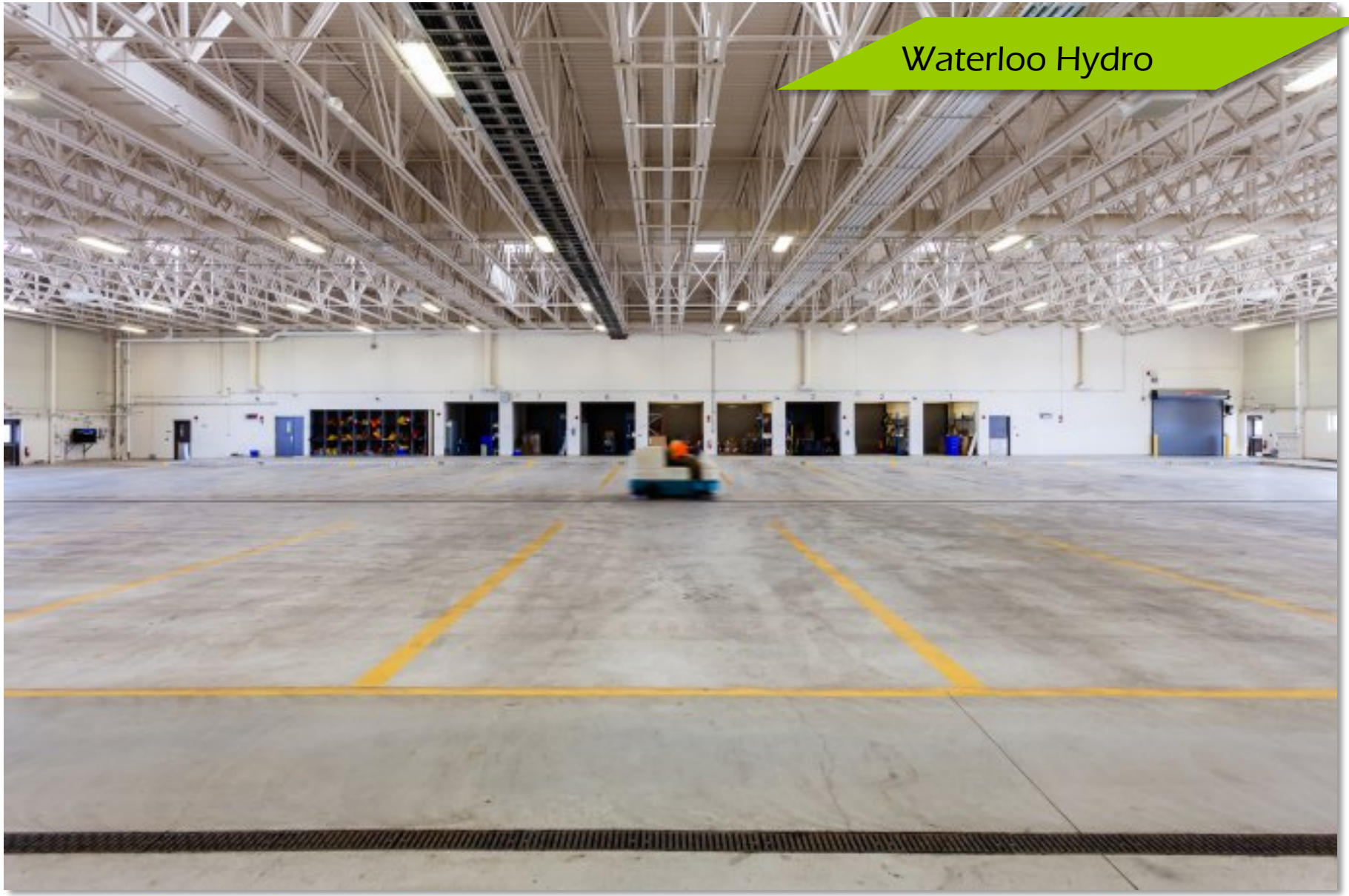
Waterloo, Ontario

McCallum Sather Architects

LEED Silver

Waterloo Hydro




Waterloo Hydro


Waterloo Hydro

CARBON NEUTRAL

Aldo Leopold Legacy Center

Baraboo, Wisconsin

The Kubala Washatko Architects
LEED™ Platinum 2007

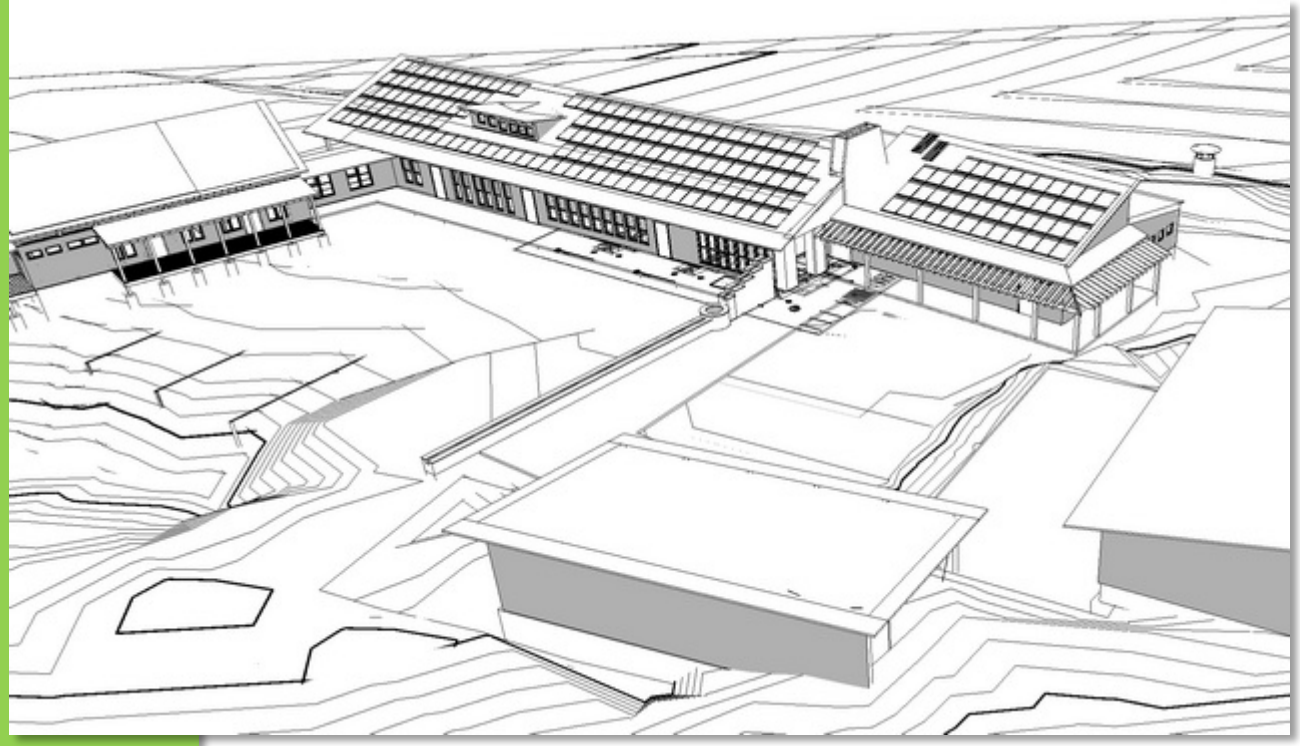
Technical information from Prof. Michael Utzinger, University of Wisconsin-Milwaukee

Aldo Leopold Center LEED™ Analysis

- 12/14 Sustainable Sites
- 5/5 Water Efficiency
- **17/17 Energy and Atmosphere**
- 7/13 Materials and Resources
- 15/15 Indoor Environmental Quality
- 5/5 Innovation and Design Process

- **61/69 Total**

- For more detailed info on the Leopold Center, visit
- http://www.aldoleopold.org/legacycenter/carbonneutral.html
- and
- http://leedcasestudies.usgbc.org/overview.cfm?ProjectID=946



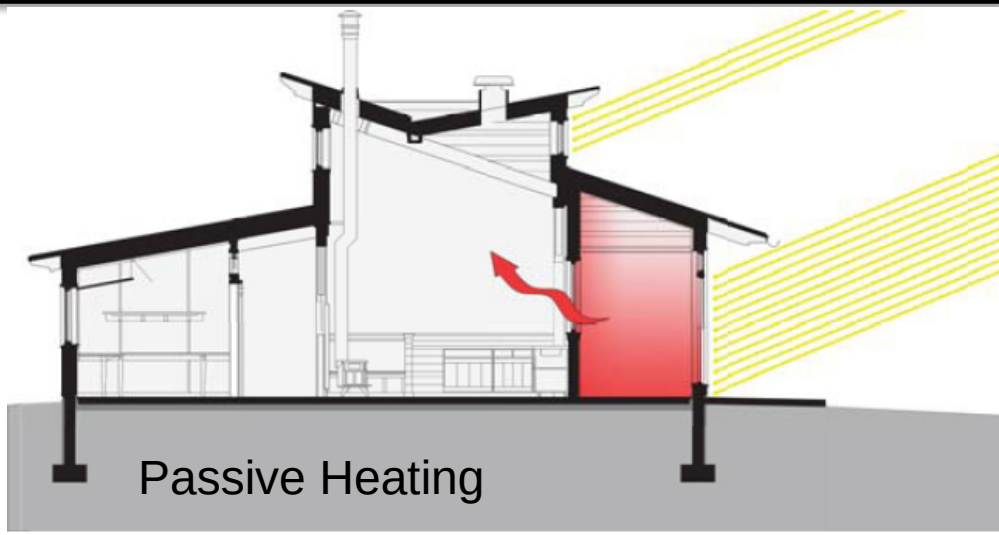
The South elevation is designed to capture energy.

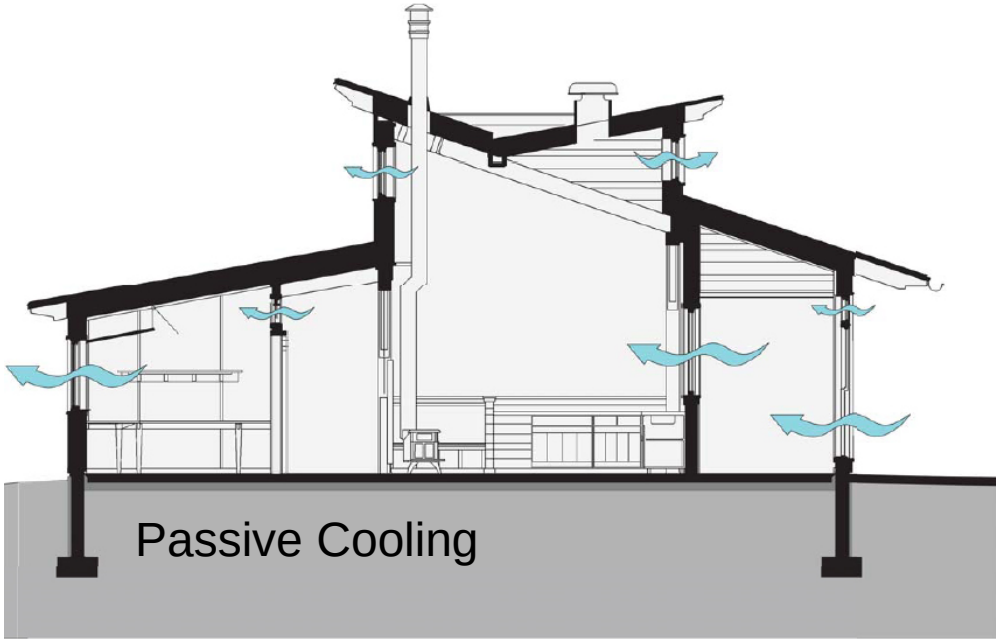
The North elevation is designed for thermal resistance, daylighting and ventilation.

The buildings were arranged in a U shape around a solar meadow that ensured access

Architectural Design Strategies

- Start with bioclimatic design
- Program Thermal Zones
- All perimeter zones (no interior zones – skin load dominated building)
- Daylight all occupied zones
- Natural ventilation in all occupied zones
- Double code insulation levels
- Passive solar heating
- Shade windows during summer





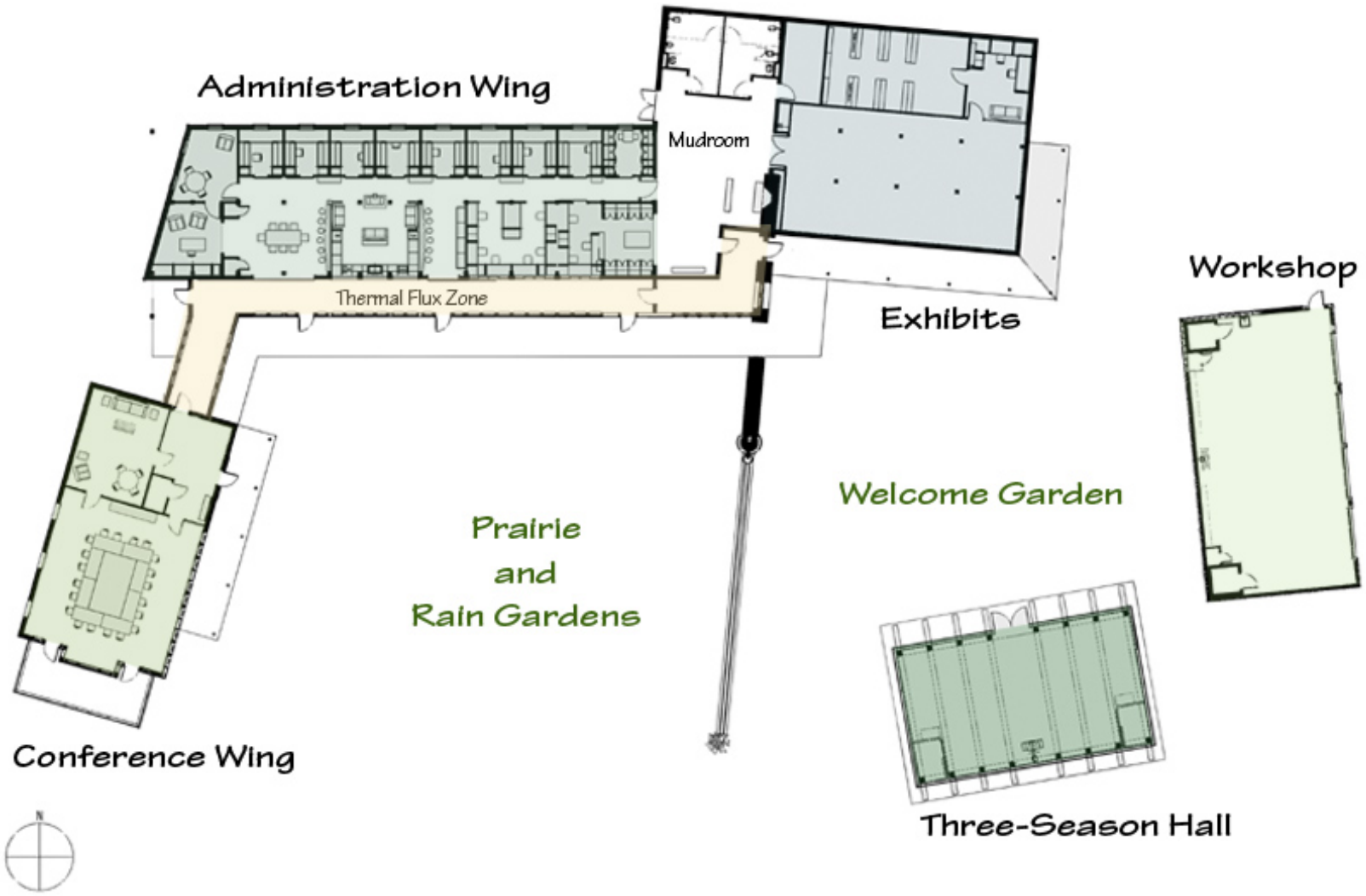
Energy and Atmosphere, 17 of 17 possible points: EA Credit 1

- EA Prerequisite 1, Fundamental Building Systems Commissioning
- EA Prerequisite 2, Minimum Energy Performance
- EA Prerequisite 3, CFC Reduction in HVAC&R Equipment
- EA Credit 1.1a, Optimize Energy Performance, 15% New 5% Existing
- EA Credit 1.1b, Optimize Energy Performance, 20% New 10% Existing
- EA Credit 1.2a, Optimize Energy Performance, 25% New 15% Existing
- EA Credit 1.2b, Optimize Energy Performance, 30% New 20% Existing
- EA Credit 1.3a, Optimize Energy Performance, 35% New 25% Existing
- EA Credit 1.3b, Optimize Energy Performance, 40% New 30% Existing
- EA Credit 1.4a, Optimize Energy Performance, 45% New 35% Existing
- EA Credit 1.4b, Optimize Energy Performance, 50% New 40% Existing
- EA Credit 1.5a, Optimize Energy Performance, 55% New 45% Existing
- EA Credit 1.5b, Optimize Energy Performance, 60% New 50% Existing
- EA Credit 2.1, Renewable Energy, 5%
- EA Credit 2.2, Renewable Energy, 10%
- EA Credit 2.3, Renewable Energy, 20%
- EA Credit 3, Additional Commissioning
- EA Credit 4, Ozone Depletion
- EA Credit 5, Measurement and Verification
- EA Credit 6, Green Power

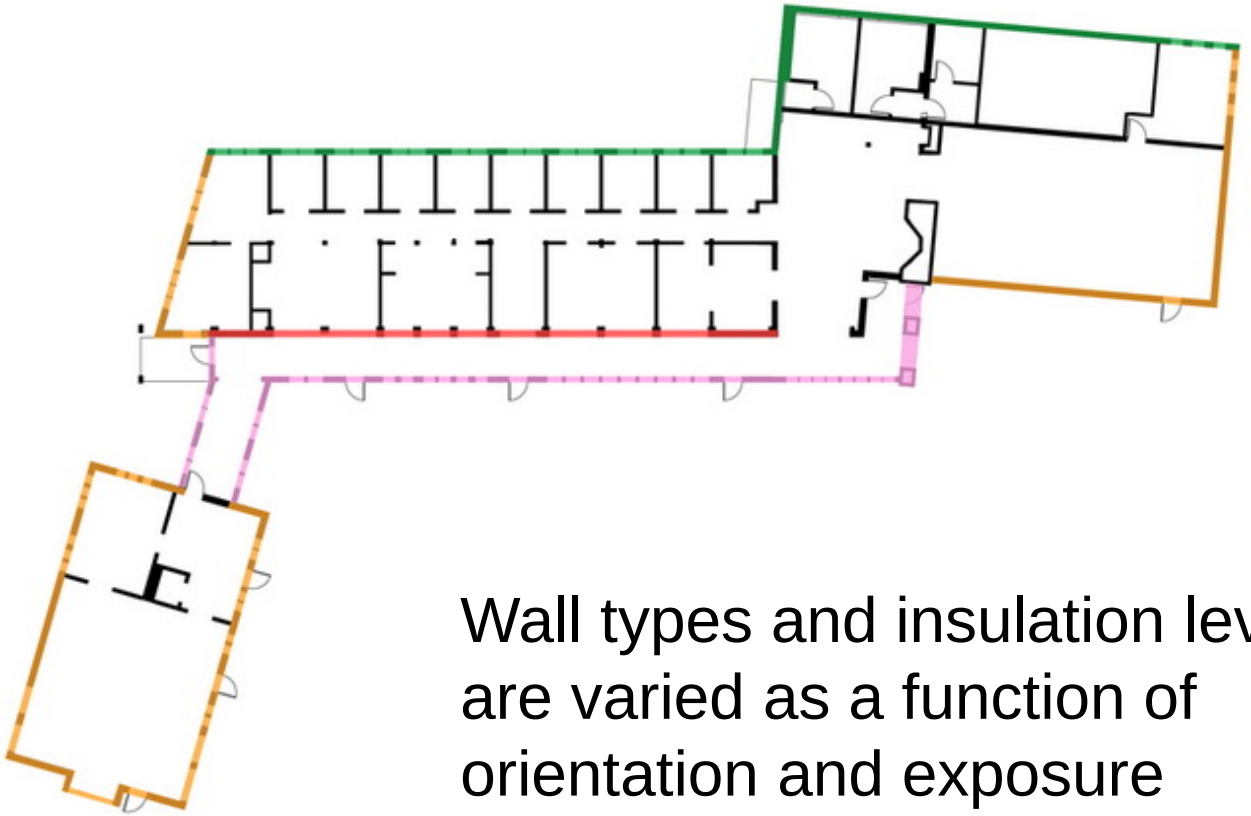
Operating energy

OPTIMIZE = REDUCTION
This needs to be the main area of focus for low Carbon design.

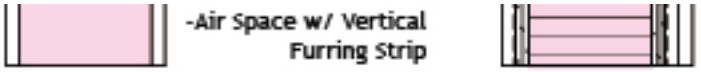
Thermal Zones ~ Perimeter Zones



Keep the buildings thin to allow for maximum daylight and use of solar for passive heating with operable windows to make natural ventilation work.



Wall types and insulation levels are varied as a function of orientation and exposure



-Air Space w/ Vertical Furring Strip

-1x Flatboard Exterior Wood Siding

Wall Type C
Interior to Exterior

-1x Interior Wood Siding

-Vapor Barrier

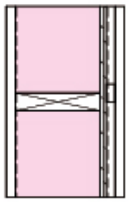
-2x8 Stud Walls with Sprayed Insulation

-1/2" Exterior Wall Sheathing

- Air Barrier

-Air Space w/ Vertical Furring Strip

-1x Flatboard Exterior Wood Siding



Wall Type D
Interior to Exterior

-1x Interior Wood Siding

-Vapor Barrier

-1 1/2" Rigid Insulation

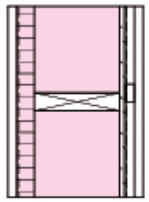
-2x8 Stud Walls with Sprayed Insulation

-1/2" Exterior Wall Sheathing

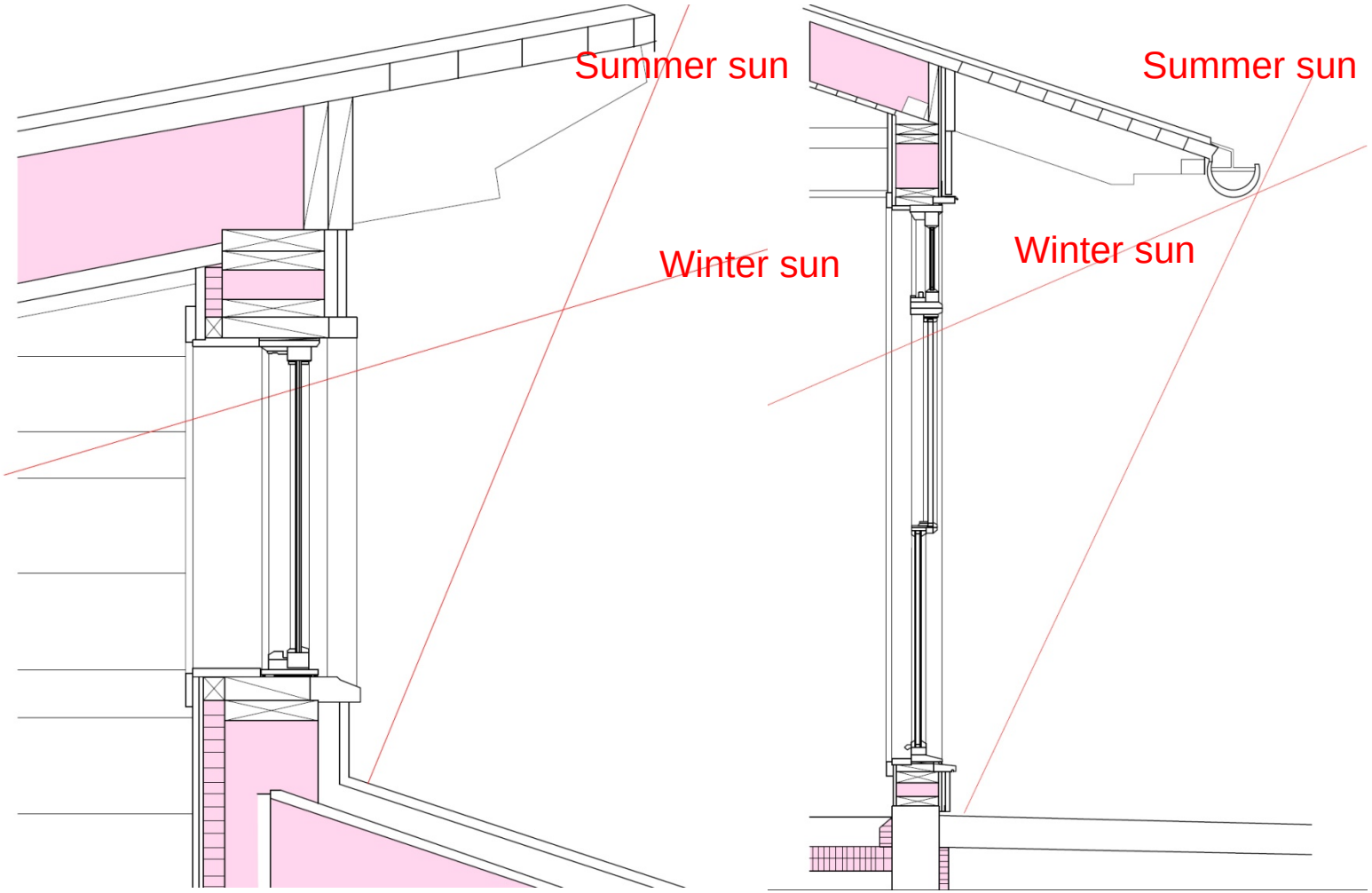
- Air Barrier

-Air Space w/ Vertical Furring Strip

-1x Flatboard Exterior Wood Siding



Passive Cooling: Shade Windows During Summer



Basic first tier principle of HEAT AVOIDANCE.

Natural Ventilation

- Natural ventilation strategy based on NO A/C provision for the building
- Operable windows
- Flow through strategy
- Insect screens to keep out pests

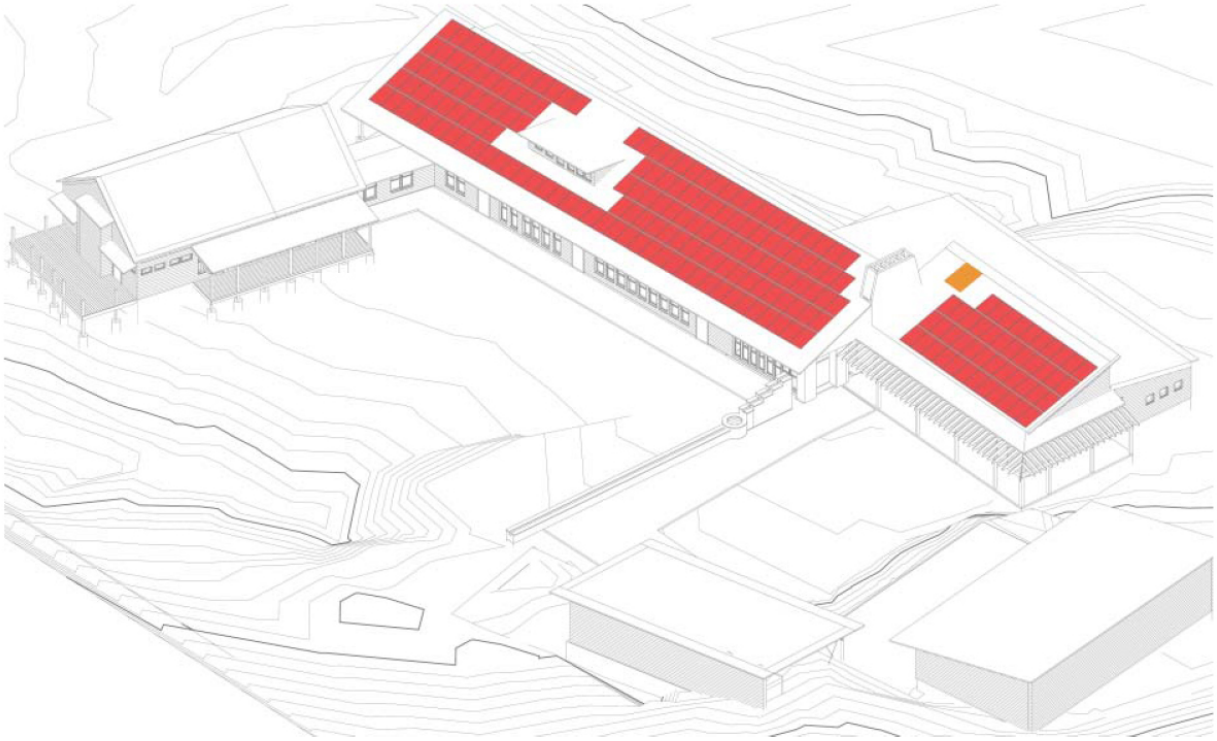
Energy and Atmosphere, 17 of 17 possible points: EA Credit 2 and Credit 6

- EA Prerequisite 1, Fundamental Building Systems Commissioning
- EA Prerequisite 2, Minimum Energy Performance
- EA Prerequisite 3, CFC Reduction in HVAC&R Equipment
- EA Credit 1.1a, Optimize Energy Performance, 15% New 5% Existing
- EA Credit 1.1b, Optimize Energy Performance, 20% New 10% Existing
- EA Credit 1.2a, Optimize Energy Performance, 25% New 15% Existing
- EA Credit 1.2b, Optimize Energy Performance, 30% New 20% Existing
- EA Credit 1.3a, Optimize Energy Performance, 35% New 25% Existing
- EA Credit 1.3b, Optimize Energy Performance, 40% New 30% Existing
- EA Credit 1.4a, Optimize Energy Performance, 45% New 35% Existing
- EA Credit 1.4b, Optimize Energy Performance, 50% New 40% Existing
- EA Credit 1.5a, Optimize Energy Performance, 55% New 45% Existing
- EA Credit 1.5b, Optimize Energy Performance, 60% New 50% Existing
- EA Credit 2.1, Renewable Energy, 5%
- EA Credit 2.2, Renewable Energy, 10%
- EA Credit 2.3, Renewable Energy, 20%
- EA Credit 3, Additional Commissioning
- EA Credit 4, Ozone Depletion
- EA Credit 5, Measurement and Verification
- EA Credit 6, Green Power

Renewables + Site Generation

If Optimization has not been exhausted, it is very unlikely that Renewable Energy will be adequate to power the mechanical systems.

#1 - Net Zero Energy Design



SOLAR PV DENSITY
(conditioned s.f.)
4.66 Watt / SF

SOLAR THERMAL DENSITY
(conditioned s.f.)
.012 SF / SF

Renewables + Site Generation

A $US250,000 PV array was included at the outset of the project budget and the building was designed to operate within the amount of electricity that this would generate.

Almost every square inch of roof was used for PV and solar hot water array mounting.

Ground Source Heat Pumps

Super insulate hot water runs to minimize heat losses.

Sustainable Sites, 12 of 14 possible points:
SS Credit 3

Landscape + Site

- SS Prerequisite 1, Erosion & Sedimentation Control
- SS Credit 1, Site Selection
- SS Credit 3, Brownfield Redevelopment
- SS Credit 4.2, Alternative Transportation, Bicycle Storage & Changing Rooms
- SS Credit 4.3, Alternative Transportation, Alternative Fuel Refueling Stations
- SS Credit 4.4, Alternative Transportation, Parking Capacity
- SS Credit 5.1, Reduced Site Disturbance, Protect or Restore Open Space
- SS Credit 5.2, Reduced Site Disturbance, Development Footprint
- SS Credit 6.1, Stormwater Management, Rate and Quantity
- SS Credit 6.2, Stormwater Management, Treatment
- SS Credit 7.1, Landscape & Exterior Design to Reduce Heat Islands, Non-Roof
- SS Credit 7.2, Landscape & Exterior Design to Reduce Heat Islands, Roof
- SS Credit 8, Light Pollution Reduction

Greening an existing brownfield can add plant materials to a site that are capable of sequestering carbon.

Sustainable Sites, 12 of 14 possible points:
SS Credit 4

People, "Use" + Transportation

- SS Prerequisite 1, Erosion & Sedimentation Control
- SS Credit 1, Site Selection
- SS Credit 3, Brownfield Redevelopment
- SS Credit 4.2, Alternative Transportation, Bicycle Storage & Changing Rooms
- SS Credit 4.3, Alternative Transportation, Alternative Fuel Refueling Stations
- SS Credit 4.4, Alternative Transportation, Parking Capacity
- SS Credit 5.1, Reduced Site Disturbance, Protect or Restore Open Space
- SS Credit 5.2, Reduced Site Disturbance, Development Footprint
- SS Credit 6.1, Stormwater Management, Rate and Quantity
- SS Credit 6.2, Stormwater Management, Treatment
- SS Credit 7.1, Landscape & Exterior Design to Reduce Heat Islands, Non-Roof
- SS Credit 7.2, Landscape & Exterior Design to Reduce Heat Islands, Roof
- SS Credit 8, Light Pollution Reduction

Alternative transportation reduces the GHG associated with travel to and from the building.

Sustainable Sites, 12 of 14 possible points:
SS Credit 5

- SS Prerequisite 1, Erosion & Sedimentation Control
- SS Credit 1, Site Selection
- SS Credit 3, Brownfield Redevelopment
- SS Credit 4.2, Alternative Transportation, Bicycle Storage & Changing Rooms
- SS Credit 4.3, Alternative Transportation, Alternative Fuel Refueling Stations
- SS Credit 4.4, Alternative Transportation, Parking Capacity
- SS Credit 5.1, Reduced Site Disturbance, Protect or Restore Open Space
- SS Credit 5.2, Reduced Site Disturbance, Development Footprint
- SS Credit 6.1, Stormwater Management, Rate and Quantity
- SS Credit 6.2, Stormwater Management, Treatment
- SS Credit 7.1, Landscape & Exterior Design to Reduce Heat Islands, Non-Roof
- SS Credit 7.2, Landscape & Exterior Design to Reduce Heat Islands, Roof
- SS Credit 8, Light Pollution Reduction

Landscape + Site

These credits can add plant materials to a site that are capable of sequestering carbon or repair existing natural landscape. Disturbance of the soil releases carbon into the atmosphere.

Sustainable Sites, 12 of 14 possible points:
SS Credit 7

- SS Prerequisite 1, Erosion & Sedimentation Control
- SS Credit 1, Site Selection
- SS Credit 3, Brownfield Redevelopment
- SS Credit 4.2, Alternative Transportation, Bicycle Storage & Changing Rooms
- SS Credit 4.3, Alternative Transportation, Alternative Fuel Refueling Stations
- SS Credit 4.4, Alternative Transportation, Parking Capacity
- SS Credit 5.1, Reduced Site Disturbance, Protect or Restore Open Space
- SS Credit 5.2, Reduced Site Disturbance, Development Footprint
- SS Credit 6.1, Stormwater Management, Rate and Quantity
- SS Credit 6.2, Stormwater Management, Treatment
- SS Credit 7.1, Landscape & Exterior Design to Reduce Heat Islands, Non-Roof
- SS Credit 7.2, Landscape & Exterior Design to Reduce Heat Islands, Roof
- SS Credit 8, Light Pollution Reduction

Landscape + Site

Operating energy

Heat island reduction lowers summer temperatures and reduces cooling load. *(Impossible to quantify…)* If plantings are used to do this, they can sequester carbon as well.

Materials and Resources, 7 of 13 possible points:
MR Credit 4

Embodied Carbon in Building Materials

- MR Prerequisite 1, Storage & Collection of Recyclables
- MR Credit 2.1, Construction Waste Management, Divert 50%
- MR Credit 2.2, Construction Waste Management, Divert 75%
- MR Credit 4.1, Recycled Content: 5% (post-consumer + 1/2 post-industrial)
- MR Credit 4.2, Recycled Content: 10% (post-consumer + 1/2 post-industrial)
- MR Credit 5.1, Local/Regional Materials, 20% Manufactured Locally
- MR Credit 5.2, Local/Regional Materials, of 20% Above, 50% Harvested Locally
- MR Credit 7, Certified Wood

Many of the MR credits will impact embodied carbon but it is not currently part of the calculation.

Materials and Resources, 7 of 13 possible points: MR Credit 5

Embodied Carbon in Building Materials

- MR Prerequisite 1, Storage & Collection of Recyclables
- MR Credit 2.1, Construction Waste Management, Divert 50%
- MR Credit 2.2, Construction Waste Management, Divert 75%
- MR Credit 4.1, Recycled Content: 5% (post-consumer + 1/2 post-industrial)
- MR Credit 4.2, Recycled Content: 10% (post-consumer + 1/2 post-industrial)
- MR Credit 5.1, Local/Regional Materials, 20% Manufactured Locally
- MR Credit 5.2, Local/Regional Materials, of 20% Above, 50% Harvested Locally
- MR Credit 7, Certified Wood

People, "Use" + Transportation

The Leopold Foundation had a most unusual circumstance, owning their own Forest. However it is not that difficult to source materials locally.

#2 - Site Harvested Lumber:

Embodied Carbon in Building Materials

The building was designed around the size and quantity of lumber that could be sustainably harvested from the Leopold Forest.

Indoor Environmental Quality, 15 of 15 possible points: EQ Prerequisite 2

- EQ Prerequisite 1, Minimum IAQ Performance
- EQ Prerequisite 2, Environmental Tobacco Smoke (ETS) Control
- EQ Credit 1, Carbon Dioxide (CO_2) Monitoring
- EQ Credit 2, Increase Ventilation Effectiveness
- EQ Credit 3.1, Construction IAQ Management Plan, During Construction
- EQ Credit 3.2, Construction IAQ Management Plan, Before Occupancy
- EQ Credit 4.1, Low-Emitting Materials, Adhesives & Sealants
- EQ Credit 4.2, Low-Emitting Materials, Paints
- EQ Credit 4.3, Low-Emitting Materials, Carpet
- EQ Credit 4.4, Low-Emitting Materials, Composite Wood
- EQ Credit 5, Indoor Chemical & Pollutant Source Control
- EQ Credit 6.1, Controllability of Systems, Perimeter
- EQ Credit 6.2, Controllability of Systems, Non-Perimeter
- EQ Credit 7.1, Thermal Comfort, Comply with ASHRAE 55-1992
- EQ Credit 7.2, Thermal Comfort, Permanent Monitoring System
- EQ Credit 8.1, Daylight & Views, Daylight 75% of Spaces
- EQ Credit 8.2, Daylight & Views, Views for 90% of Spaces

COMMON SENSE

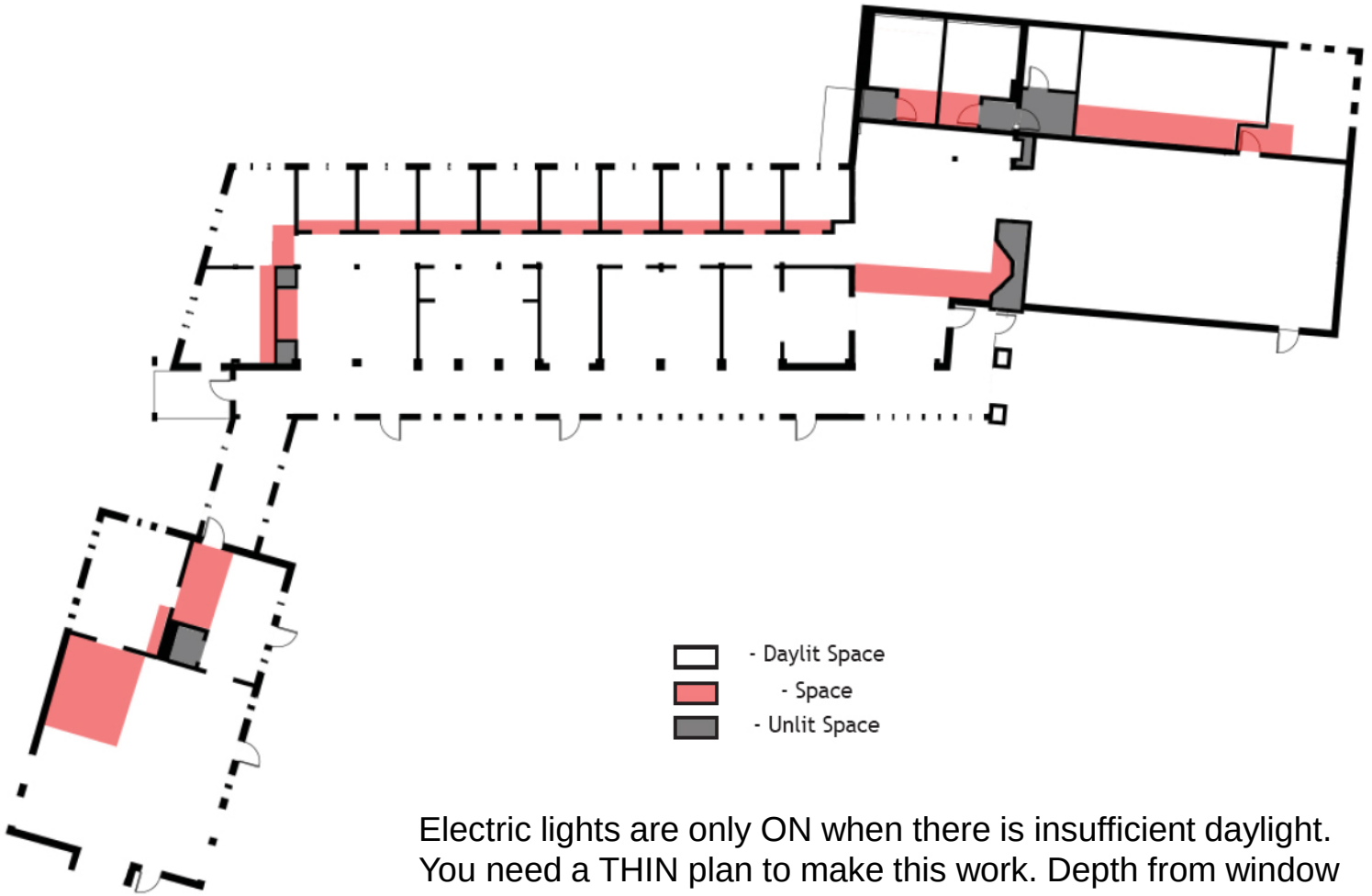
This requirement presents a huge impediment in Foreign countries.

Indoor Environmental Quality, 15 of 15 possible points: EQ Credit 8

- EQ Prerequisite 1, Minimum IAQ Performance
- EQ Prerequisite 2, Environmental Tobacco Smoke (ETS) Control
- EQ Credit 1, Carbon Dioxide (CO2) Monitoring
- EQ Credit 2, Increase Ventilation Effectiveness
- EQ Credit 3.1, Construction IAQ Management Plan, During Construction
- EQ Credit 3.2, Construction IAQ Management Plan, Before Occupancy
- EQ Credit 4.1, Low-Emitting Materials, Adhesives & Sealants
- EQ Credit 4.2, Low-Emitting Materials, Paints
- EQ Credit 4.3, Low-Emitting Materials, Carpet
- EQ Credit 4.4, Low-Emitting Materials, Composite Wood
- EQ Credit 5, Indoor Chemical & Pollutant Source Control
- EQ Credit 6.1, Controllability of Systems, Perimeter
- EQ Credit 6.2, Controllability of Systems, Non-Perimeter
- EQ Credit 7.1, Thermal Comfort, Comply with ASHRAE 55-1992
- EQ Credit 7.2, Thermal Comfort, Permanent Monitoring System
- EQ Credit 8.1, Daylight & Views, Daylight 75% of Spaces
- EQ Credit 8.2, Daylight & Views, Views for 90% of Spaces

Operating energy

Daylight All Occupied Zones



Electric lights are only ON when there is insufficient daylight. You need a THIN plan to make this work. Depth from window cannot exceed 5 m.

Watch out for finish colours. The natural colour of the wood made the left hand space more difficult to light naturally.

LIVING BUILDING CHALLENGE

Beauty & Inspiration

A Living Building tells a story.

Indoor Quality

Maximize health, minimize impact.

Materials

Safe, healthy and responsible for all species.

Water

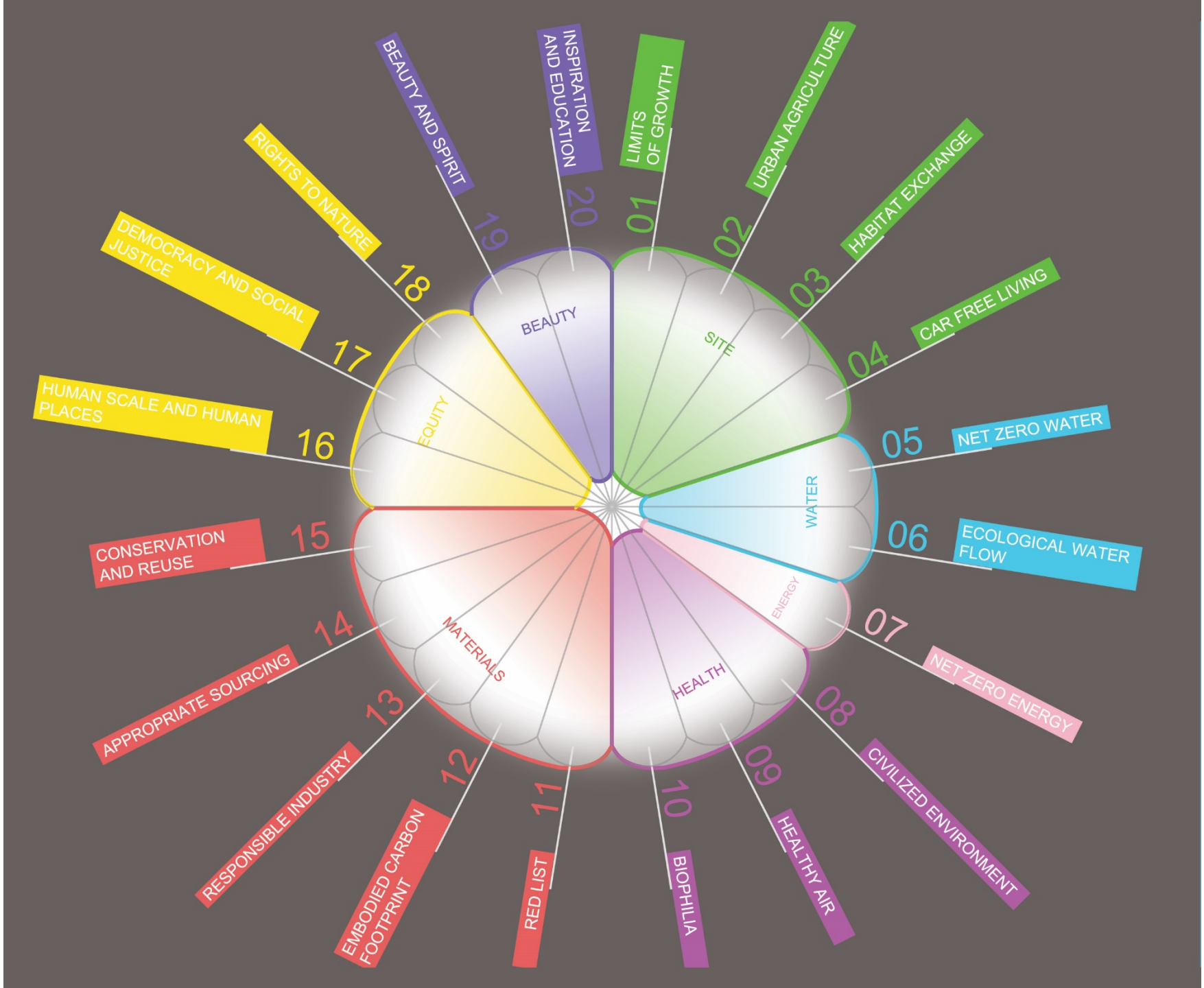
A Living Building is water independent.

Site

Humanity has co-opted enough land; it is time to draw boundaries and declare it enough.

Energy

A living building relies solely on current solar income.


BEAUTY
SITE
WATER
ENERGY
HEALTH
MATERIALS
EQUITY
01 LIMITS OF GROWTH
02 URBAN AGRICULTURE
03 HABITAT EXCHANGE
04 CAR FREE LIVING
05 NET ZERO WATER
06 ECOLOGICAL WATER FLOW
07 NET ZERO ENERGY
08 CIVILIZED ENVIRONMENT
09 HEALTHY AIR
10 BIOPHILIA
11 RED LIST
12 EMBODIED CARBON FOOTPRINT
13 RESPONSIBLE INDUSTRY
14 APPROPRIATE SOURCING
15 CONSERVATION AND REUSE
16 HUMAN SCALE AND HUMAN PLACES
17 DEMOCRACY AND SOCIAL JUSTICE
18 RIGHTS TO NATURE
19 BEAUTY AND SPIRIT
20 INSPIRATION AND EDUCATION

http://cirs.ubc.ca/building/building-overview/certification-recognition/

CIRS - UBC

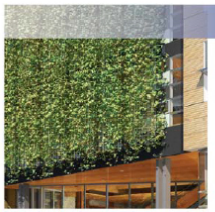
2011

Vancouver, British Columbia

Perkins + Will

Sustainable Strategies for

CENTRE FOR INTERACTIVE RESEARCH ON SUSTAINABILITY



SITE ECOLOGY

- Live within the footprint of building site
- Net positive impact on the ecology of the site
- Planted solar shade on west façade

ENERGY

- High performance building envelope
- Waste heat recover from adjacent building
- Building integrated PVs and geoexchange system

WATER

- Harvest and store rainwater on site
- Treat rainwater for potable water consumption
- Treat grey and black water on site with solar aquatics system

MATERIALS

- Four-storey wood structure with wood cladding
- Locally or regionally sourced materials
- Building designed for modification and disassembly

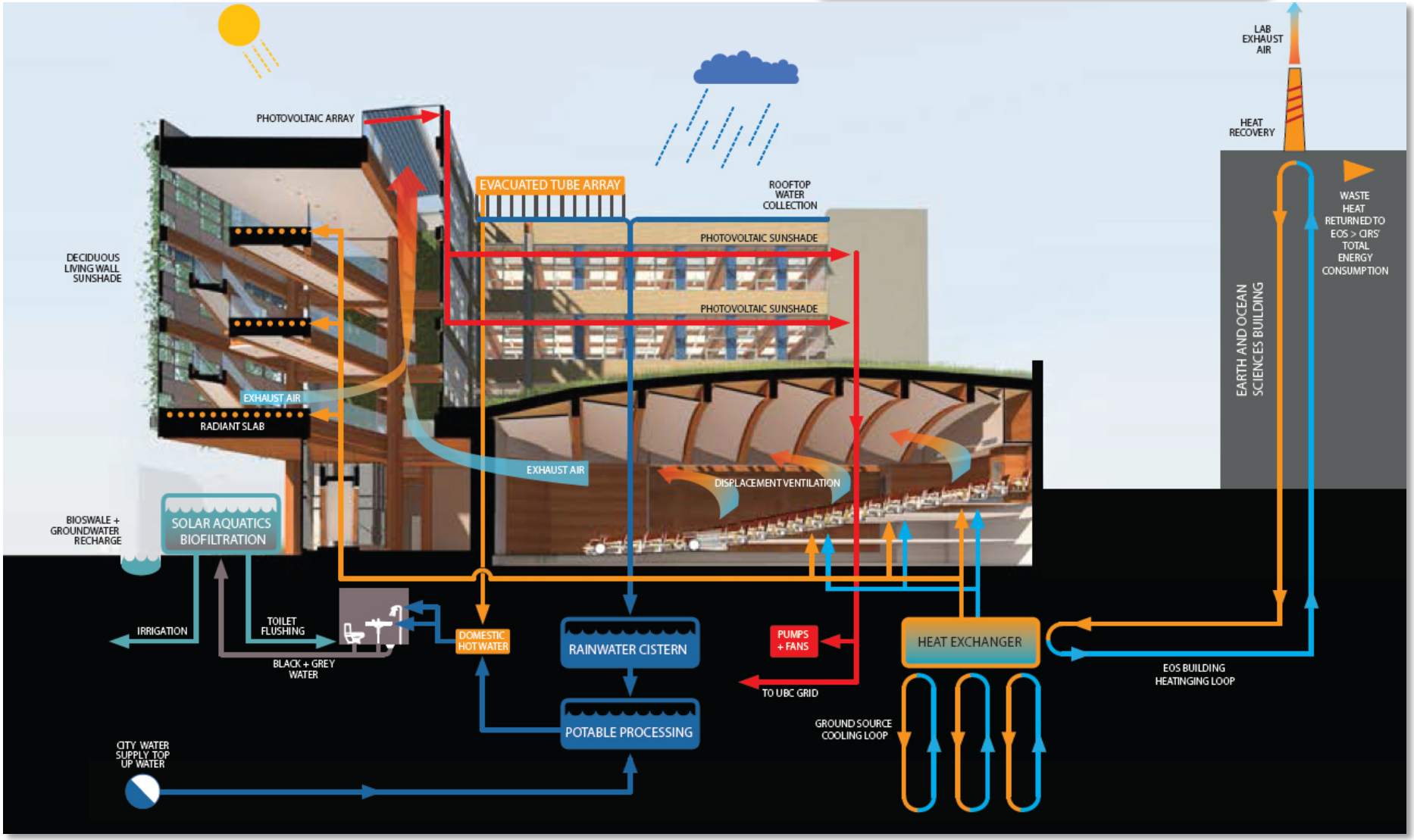
HEALTH / COMFORT

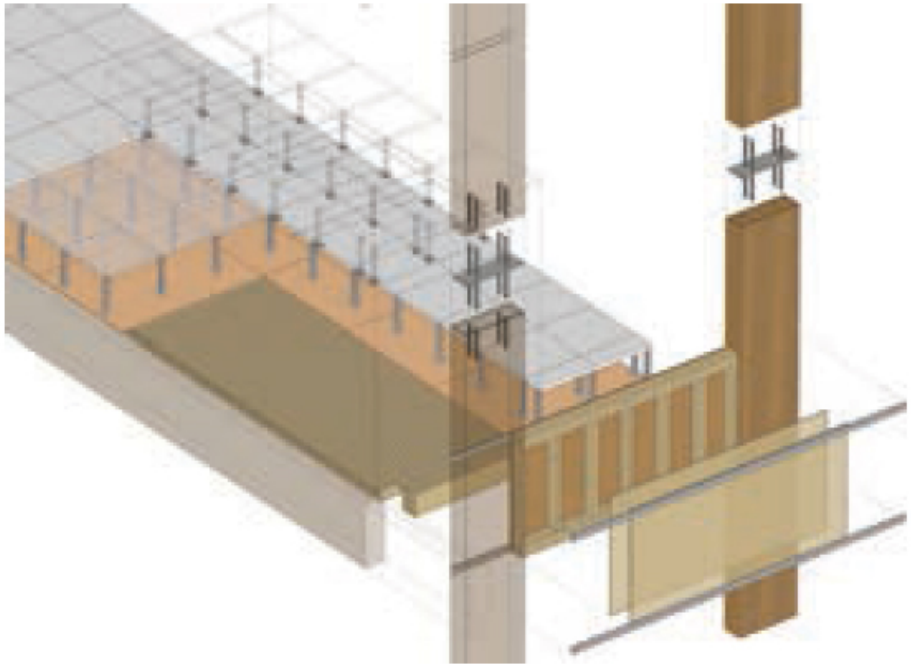
- Natural ventilation with operable windows
- 100% daylighting for all occupied spaces
- Central atrium space serves as social space

Building Adapting to Seasonal Changes

CENTRE FOR INTERACTIVE RESEARCH ON SUSTAINABILITY

CIRS


PHOTOVOLTAIC ARRAY
EVACUATED TUBE ARRAY
ROOFTOP WATER COLLECTION
LAB EXHAUST AIR
HEAT RECOVERY
WASTE HEAT RETURNED TO EOS > CIRS' TOTAL ENERGY CONSUMPTION
DECIDUOUS LIVING WALL SUNSHADE
PHOTOVOLTAIC SUNSHADE
PHOTOVOLTAIC SUNSHADE
EARTH AND OCEAN SCIENCES BUILDING
EXHAUST AIR
RADIANT SLAB
EXHAUST AIR
DISPLACEMENT VENTILATION
BIOSWALE + GROUNDWATER RECHARGE
SOLAR AQUATICS BIOFILTRATION
IRRIGATION
TOILET FLUSHING
BLACK + GREY WATER
DOMESTIC HOT WATER
RAINWATER CISTERN
PUMPS + FANS
HEAT EXCHANGER
TO UBC GRID
EOS BUILDING HEATINGING LOOP
GROUND SOURCE COOLING LOOP
POTABLE PROCESSING
CITY WATER SUPPLY TOP UP WATER



CIRS's wood structure sequesters 600 tonnes of carbon, helping achieve net-zero carbon in construction and operations.

CIRS


CIRS


CIRS

CIRS


CIRS


CIRS

CIRS

Photovoltaics integrated into the skylights also provide shade from the sun


CIRS

CIRS


CIRS

CIRS


Food Scraps
Recyclable Containers
Paper
Garbage
Is that really garbage?
Sort it Out.
UBC sustainability
* FREE *
Please help yourself


Food
Soiled and Compostable Paper
No Plastics
Plastic
Metal
Glass
Cartons
Food Scraps


nd Compostable Paper
No Plastics
Plastic
Metal
Glass
Cartons
Cups+Lids (No Sleeves)
Cup Sleeves
Paper
EMPTY
Recyclable
Containers
Pap


Glass
Cartons
Cups+Lids (No Sleeves)
Cup Sleeves
Paper
STOP
Paper


Hardbite
Paper
STOP
Is that really garbage?
Garbage


CIRS

CIRS

http://www.bullittcenter.org/2015/04/01/bullitt-center-earns-living-building-certification/

Bullitt Center

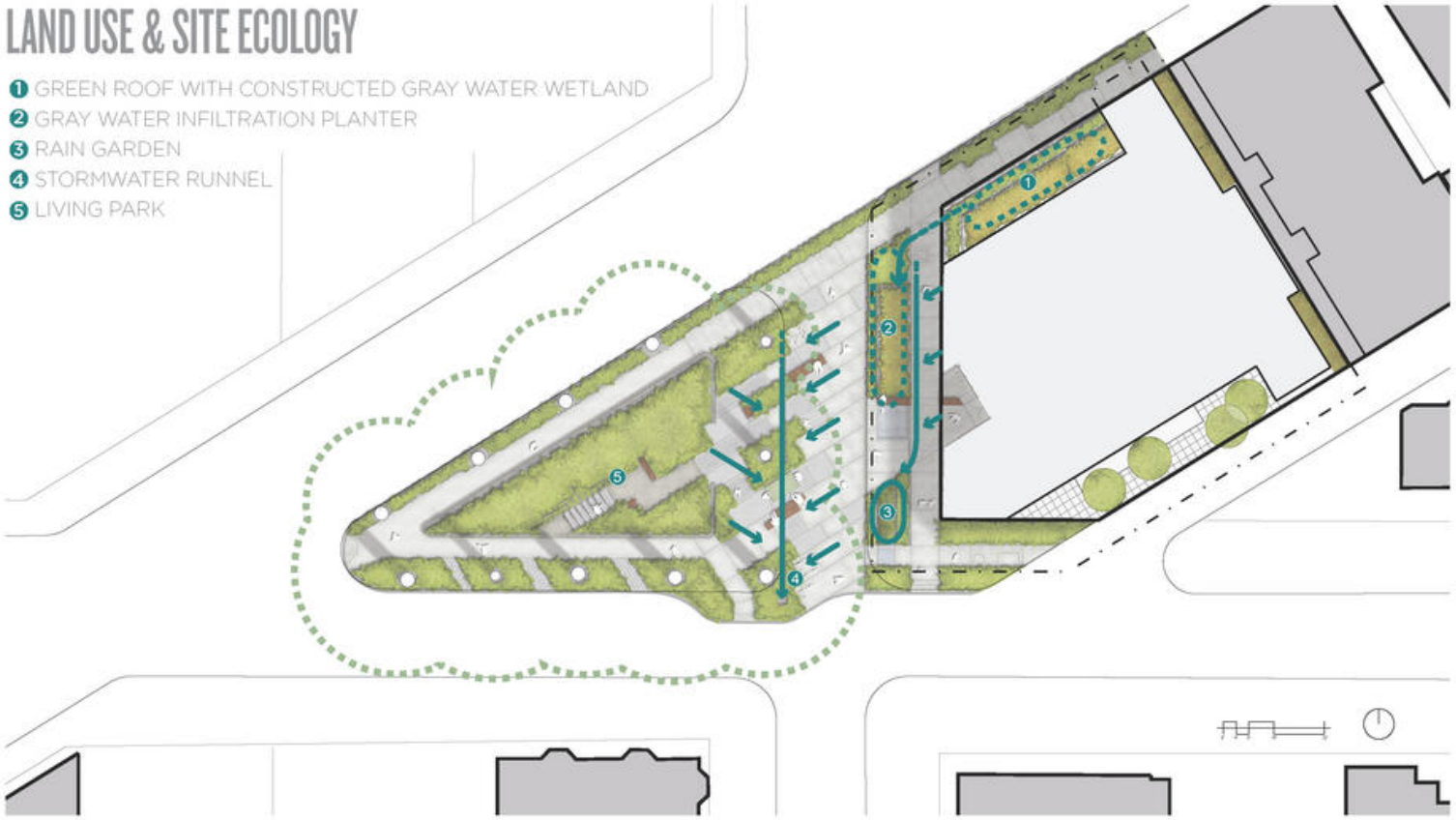
2013

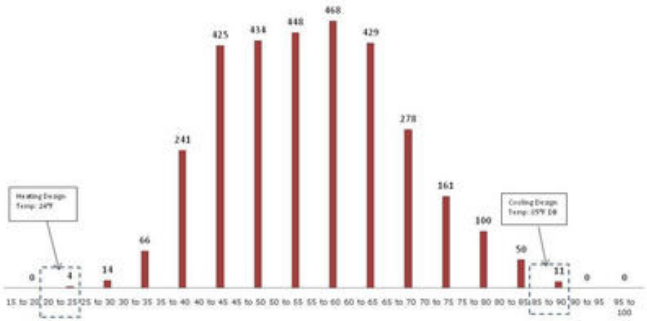
Seattle, Washington

The Miller Hull Partnership

LAND USE & SITE ECOLOGY

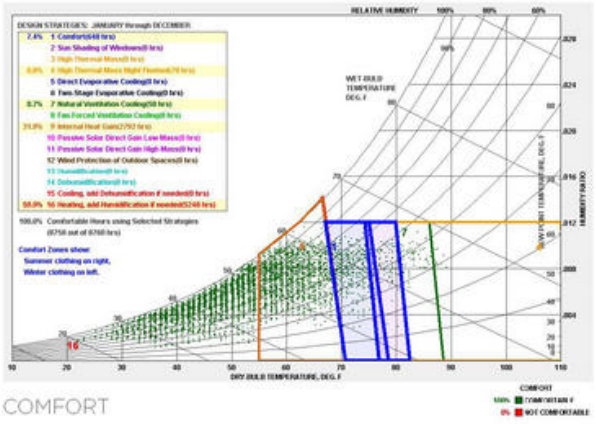
1. GREEN ROOF WITH CONSTRUCTED GRAY WATER WETLAND
2. GRAY WATER INFILTRATION PLANTER
3. RAIN GARDEN
4. STORMWATER RUNNEL
5. LIVING PARK



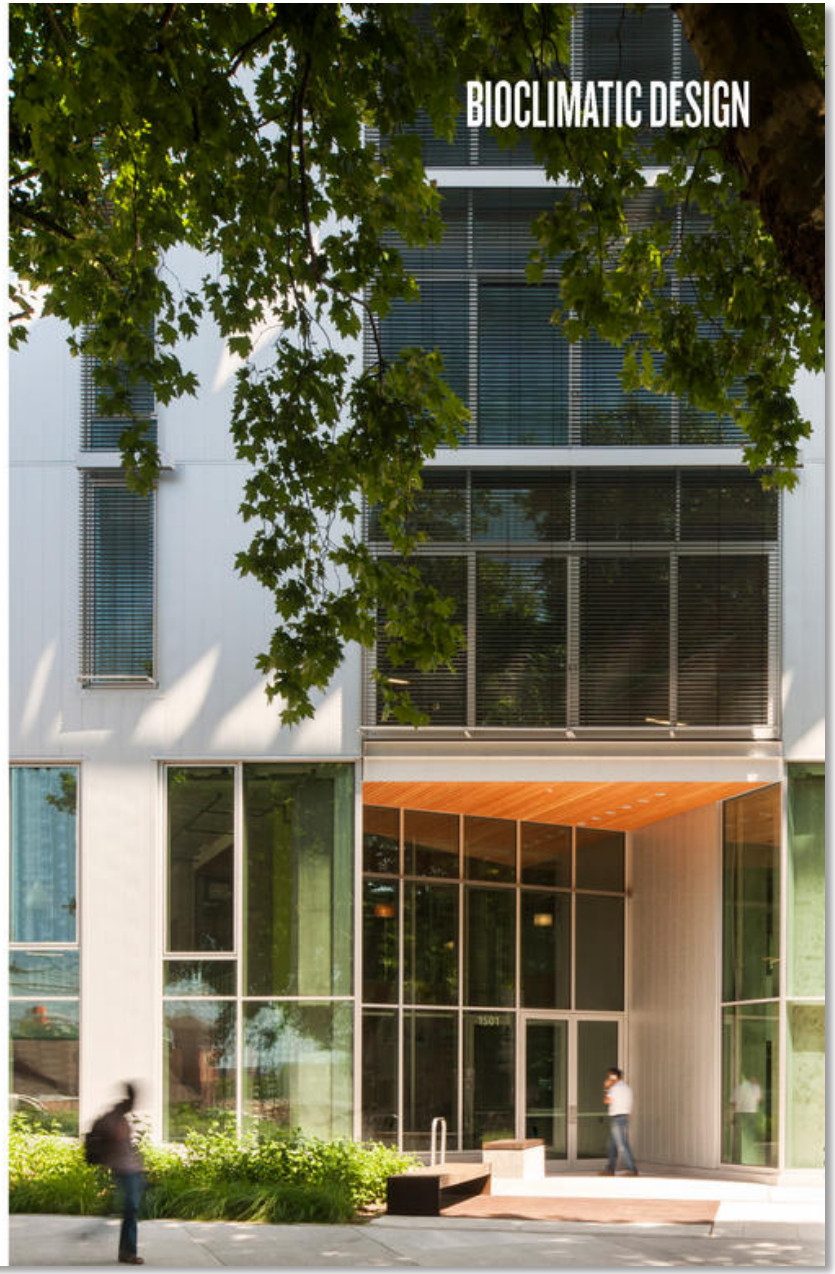


NUMBER OF HOURS AT 5-DEGREE TEMPERATURE RANGES
(full year: 6AM-6PM)

AVERAGE PRECIPITATION (rainwater collection)



COMFORT



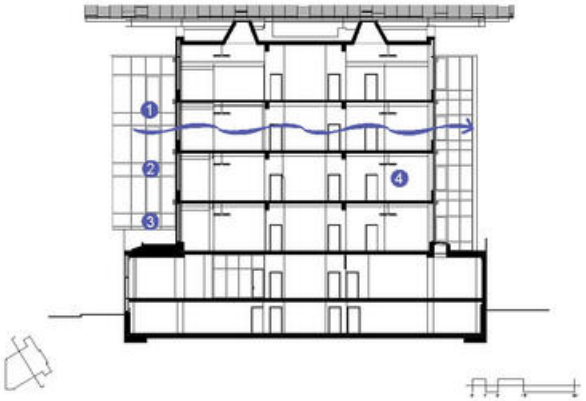
LIGHT & AIR

ENVELOPE

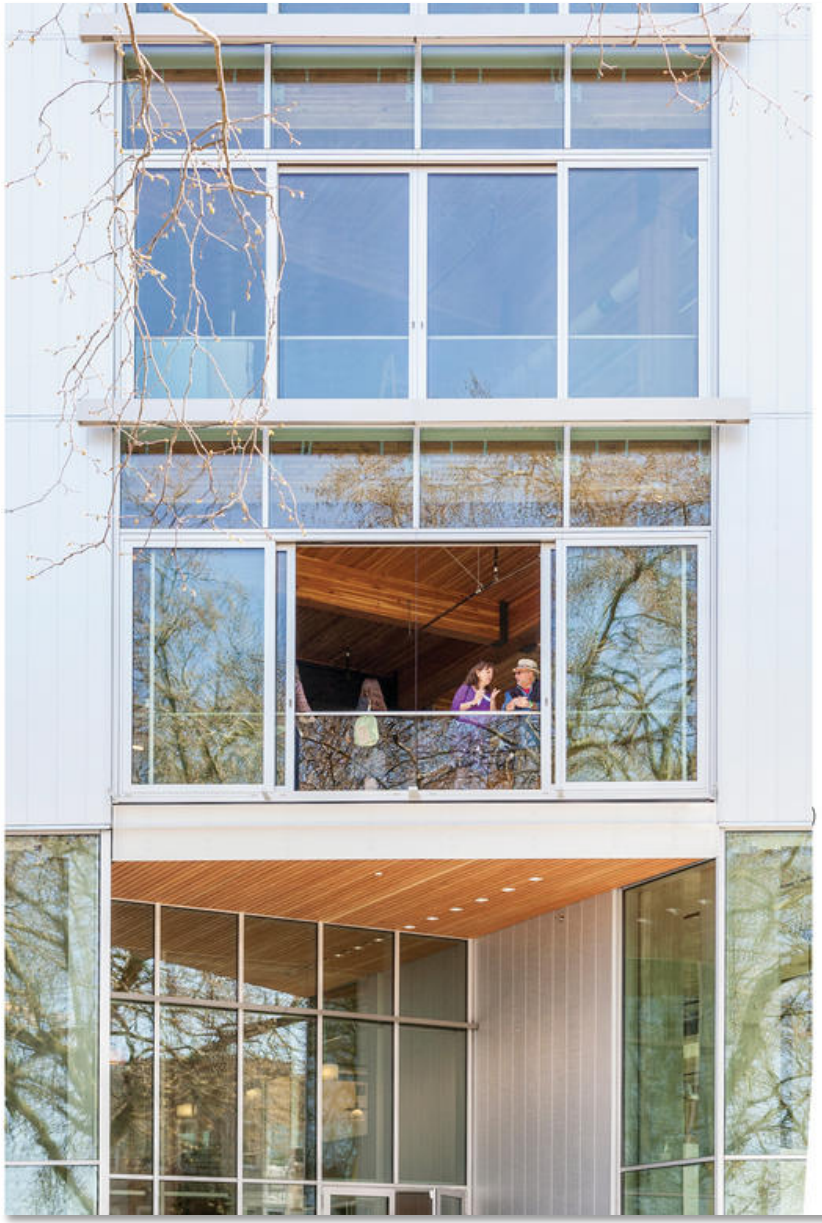
1. OPERABLE WINDOWS FOR VENTILATION & COOLING
2. TRIPLE-GLAZED HIGH PERFORMANCE WINDOWS
3. OPERABLE BLINDS MINIMIZE HEAT AND GLARE

COOLING

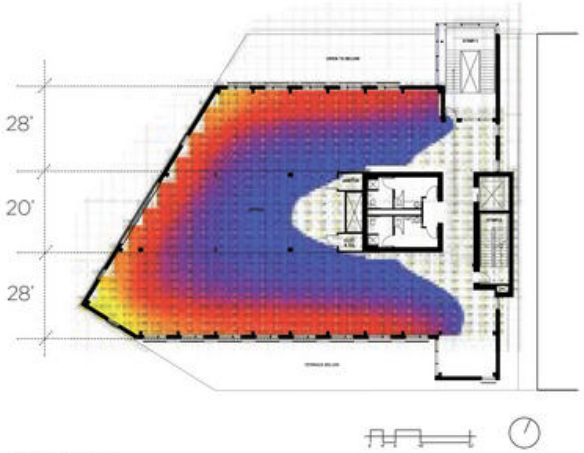
4. CEILING FANS FOR THERMAL COMFORT



West facade with exterior motorized shades on upper stories. Ground floor is shaded by the trees in the park.

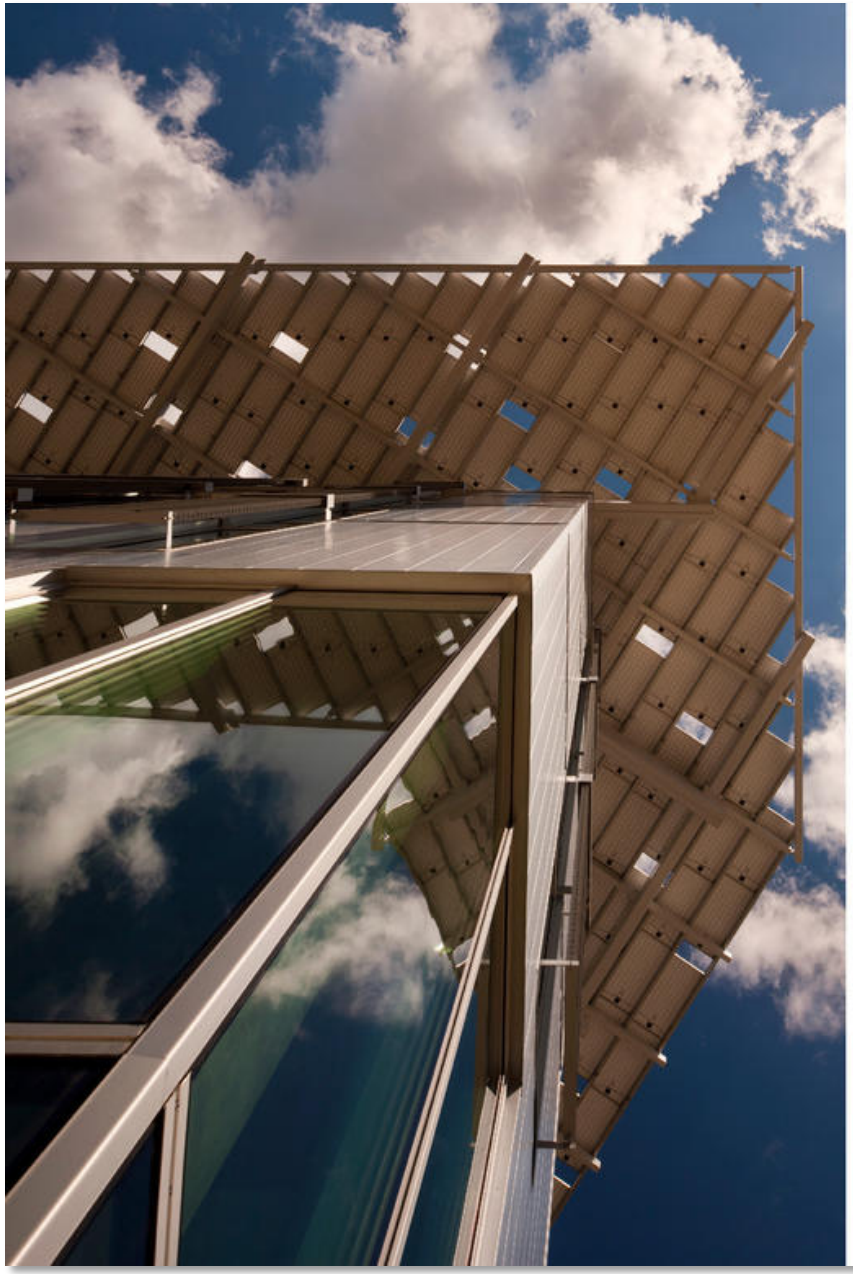


LIGHT & AIR

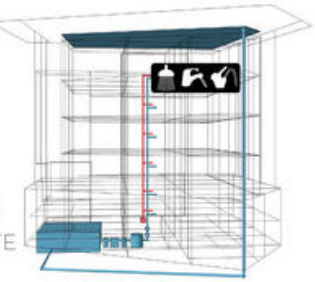


DAYLIGHT

TYPICAL FLOOR 75% DAYLIT

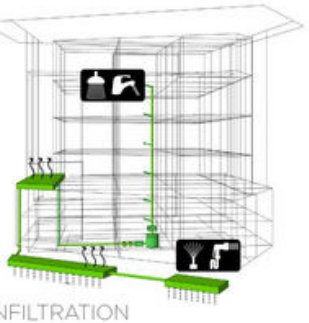


WATER CYCLE



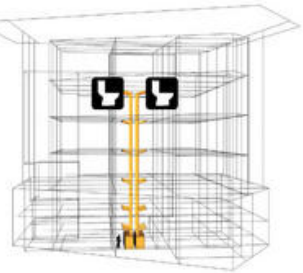
RAINWATER COLLECTION

100% DEMAND MET ON SITE
50.000 GALLON CISTERN



GREYWATER

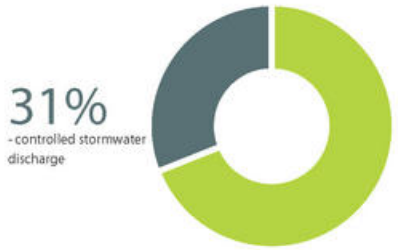
100% TREATMENT ON SITE
EVAPOTRANSPIRATION & INFILTRATION



WASTE COMPOST

100% TREATMENT ON SITE

WATER CYCLE



31%
- controlled stormwater discharge

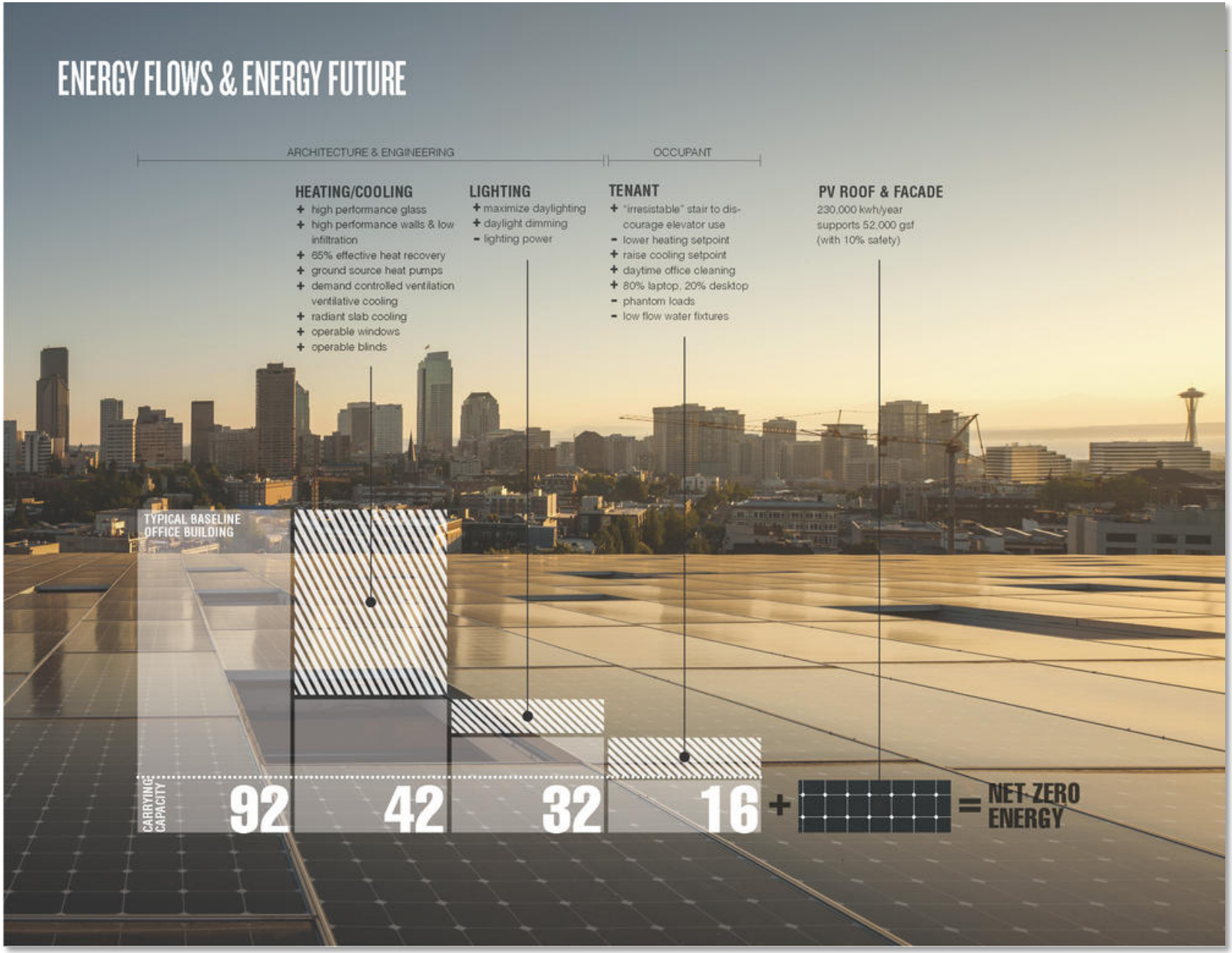
69%
- collected
- stored
- treated and used
- returned to soil and groundwater

BULLITT CENTER

39%
- stormwater runoff

61%
- evapotranspiration
- infiltration to native soils and groundwater

DOUGLAS FIR FOREST


ENERGY FLOWS & ENERGY FUTURE
ARCHITECTURE & ENGINEERING
OCCUPANT
HEATING/COOLING
+ high performance glass
+ high performance walls & low infiltration
+ 65% effective heat recovery
+ ground source heat pumps
+ demand controlled ventilation ventilative cooling
+ radiant slab cooling
+ operable windows
+ operable blinds
LIGHTING
+ maximize daylighting
+ daylight dimming
- lighting power
TENANT
+ "irresistable" stair to discourage elevator use
- lower heating setpoint
+ raise cooling setpoint
+ daytime office cleaning
+ 80% laptop, 20% desktop
- phantom loads
- low flow water fixtures
PV ROOF & FACADE
230,000 kwh/year
supports 52,000 gsf
(with 10% safety)
TYPICAL BASELINE OFFICE BUILDING
CARRYING CAPACITY
92
42
32
16
+
=
NET-ZERO ENERGY

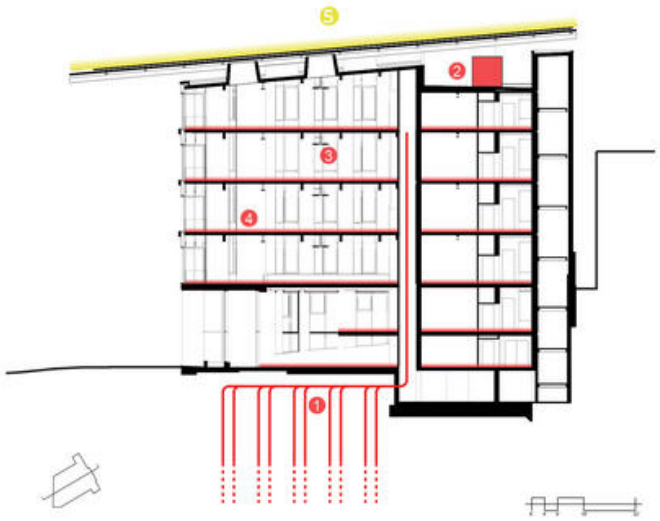
ENERGY FLOWS & ENERGY FUTURE

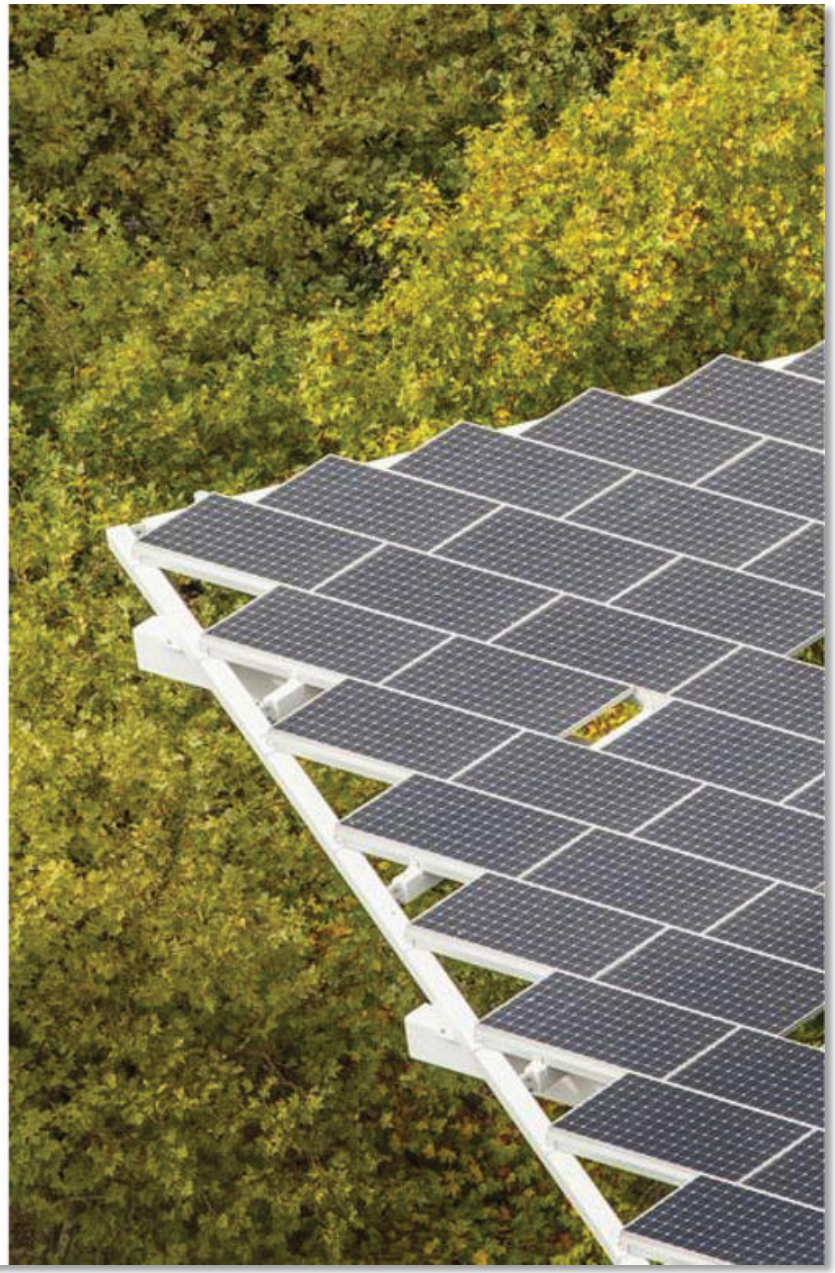
HEATING/COOLING/FRESH AIR

1. 26 (400-FOOT DEEP) CLOSED LOOP GEOTHERMAL WELLS
2. DEDICATED HEAT RECOVERY VENTILATION
3. CEILING FANS FOR THERMAL COMFORT
4. RADIANT IN-FLOOR HEATING & COOLING

ENERGY PRODUCTION

5. 244 KW PV ARRAY





MATERIALS & CONSTRUCTION

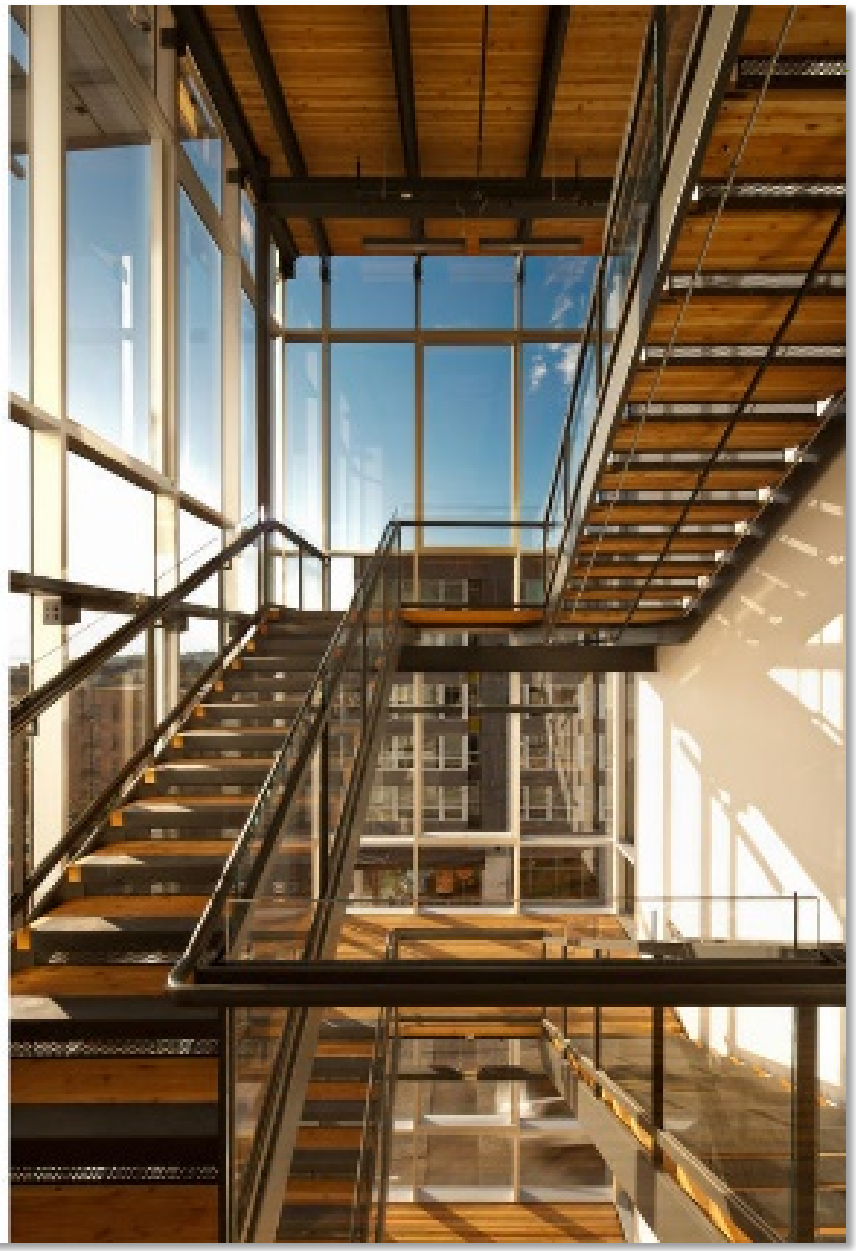
VOLUME OF WOOD USED:
24,526 CUBIC FEET

US & CANADIAN FORESTS GROW THIS MUCH WOOD IN:
2 MINUTES

CARBON STORED IN WOOD:
545 METRIC TONS OF CO_2

AVOIDED GREENHOUSE GAS EMISSIONS:
1,158 METRIC TONS OF CO_2

TOTAL POTENTIAL CARBON BENEFIT:
1,703 METRIC TONS OF CO_2




Bullitt Center

Bullitt Center

Plantings chosen should be:

- Natural to the area
- Perennial
- Able to survive with minimal watering
- Use NON potable (drinking) water

- *Readjust our thinking about what is beautiful?*

Bullitt Center

Bullitt Center


Bullitt Center

http://www.dialogdesign.ca/projects/york-region-forest-stewardship-education-centre/

Targeting
Living
Building
Challenge

Bill Fisch Forest Stewardship and Education Centre

2016
York Region, Ontario
DIALOG Design

The first Living Building Challenge contender in Ontario, conservation strategies including:

- a high-performance envelope with R-40 walls and R-60 roof;
- a window-to-wall ratio of less than 30%;
- and triple-glazed windows oriented for optimal solar orientation
- 35kW photovoltaic array contributes to the net positive energy result. net zero water, with rain and well water meeting 100% of occupant needs.

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Energy

Electrical System:

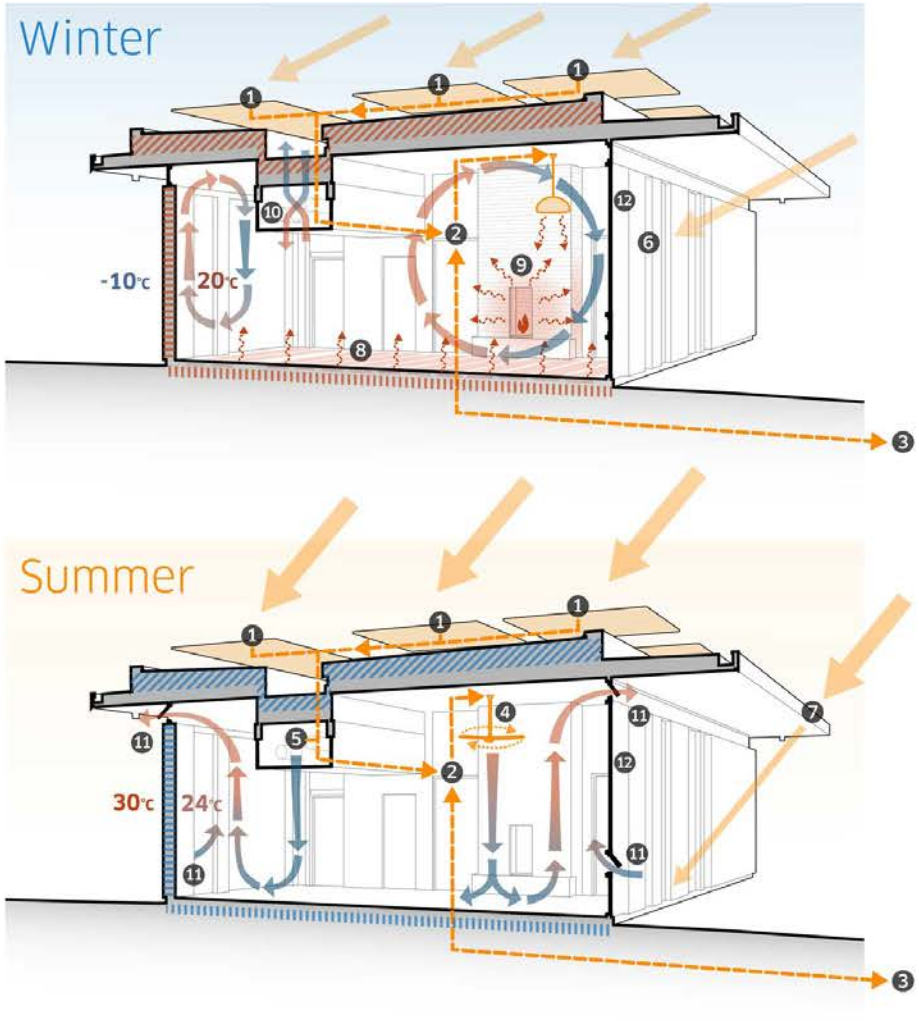
1. Photovoltaic solar panels w/ micro-inverters
2. Net meter
3. Grid connection
4. Displacement fan
5. Air conditioning

Thermal System:

6. Solar heat gain
7. Deep overhang shading
8. Radiant floor
9. Wood burning hearth
10. Heat recovery ventilator
11. Natural ventilation
12. Triple-glazed window assembly

Insulation:

- R60 roof assembly
- R40 wall assembly
- R30 insulated slab



Electricity Generation/Use:

[Predicted]

[Annual]

+8Mwh/yr **Net Positive**

[October-May]

+12Mwh

-22Mwh

[April - September]

-10Mwh

+28Mwh

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Water

Rainwater Harvesting:

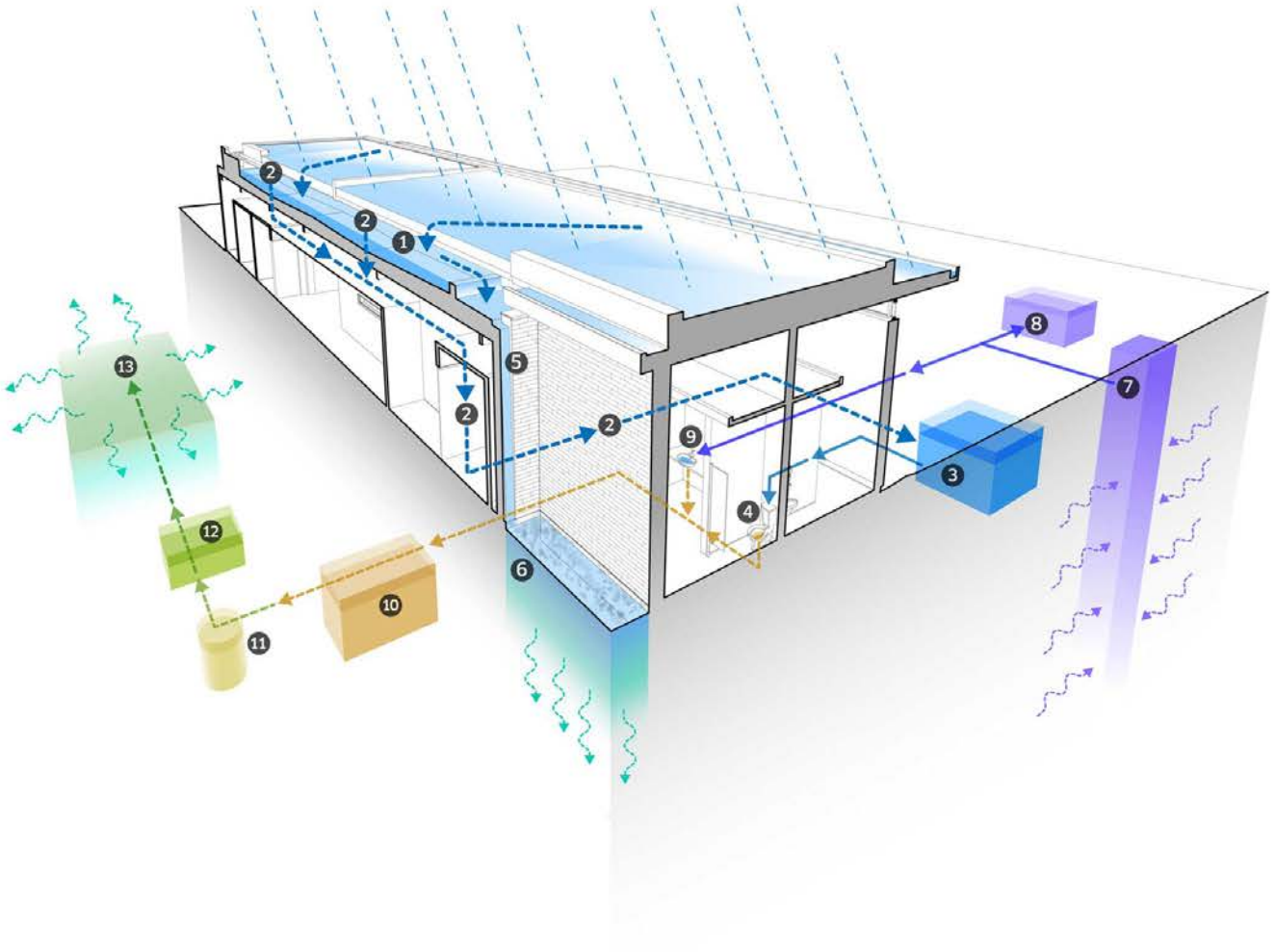
1. Central collection trough
2. Rainwater collection system
3. Rainwater cistern
4. Non-potable fixtures (toilets, urinals)
5. Vertical trough to ground
6. Ground infiltration

Wellwater:

7. Existing well
8. Fire orotection reservoir
9. Potable fixtures (sink, shower)

Wastewater Treatment:

10. Sewage collection tank
11. Septic pump chamber
12. Biofilter processing unit
13. Tertiary water infiltration bed



Non-potable water
Potable water

Rainwater
Well Water
Ground Infiltration
Blackwater
Secondary Treated
Tertiary Treated

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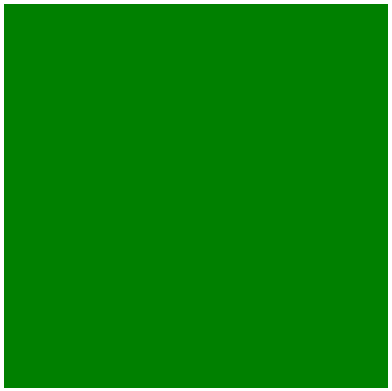
「無後為大」– 孔子

"Future generation is the most important" — Confucius.

"Treat the Earth well. It was not given to you by your parents. It was loaned to you by your children." — Kenyan Proverb.

"It's not easy being green." – Kermit the Frog, 1972.



Thank you!

Terri Meyer Boake

tboake@uwaterloo.ca