



BUILDING ENERGY 15

MARCH 3-5, 2015 AT THE SEAPORT WORLD TRADE CENTER

AIA Provider: **Northeast Sustainable Energy Association**

Provider Number: G338

Design and Energy Modeling for Net Zero Energy

Course Number

John Swift, Jr., PE, LEED, CEM

Course Date

Credit(s) earned on completion of this course will be reported to **AIA** **CES** for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

This course is registered with **AIA**

Course Description

Significantly reducing energy use in commercial buildings is a challenge. Doing so in cold climates even more so. Getting to Net Zero Energy use in these climates, now that's what we call a tough. But with good design and engaged tenants, the near impossible becomes entirely possible, practical, and fun. This panel will describe key strategies for greatly reducing energy consumption in commercial buildings in cold climates with a focus on smart choices for building design, high performance mechanical systems and the tenant's role. Specific strategies and systems will be discussed with pros, cons, and application advice. Several Net Zero Energy commercial buildings in cold climates will be highlighted to show the theory in practice.

Learning Objectives

At the end of the this course, participants will be able to:

1. Describe relevant characteristics and factors in assessing the potential for a zero net energy building.
2. Describe the process and relationship between design and energy modeling teams during the design process.
3. Describe how to establish energy goals on a project based on the project's critical need.
4. Using several case studies, describe system interactions between different building systems as they contribute to building energy use.

ONE WAY TO ACHIEVE NET ZERO...



BARRIERS TO ZNE COMMERCIAL BUILDINGS

- **Insufficient technical knowledge & “push”**
- **Perceived higher first cost**
- **Lack of building operator training**
- **Lack of high performance energy standards**
- **No regulatory compliance mechanism**
- **Lack of tenant motivation to save energy**
- **Lack of developer incentives to provide efficient systems**
- **Insufficient sub-metering**
- **“Green” buildings that fall short of ideal**

NREL: FIVE PRIORITIES FOR IMPROVEMENT

- **Thermal Insulation**
 - including air-tight building envelope with high performance glazing
- **Lighting Equipment**
- **Plug and Process Loads**
http://www.esource.com//system/files/files/2012-01/ESource-CEC-WC-1-12-PlugLoads_0.pdf
- **HVAC Components**
- **Passive Strategies**
 - **daylighting, natural ventilation, passive solar heating, passive solar avoidance**

Source: Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector, National Renewable Laboratory, December 2007

NREL: FOUR IMPORTANT CHARACTERISTICS

- **Number of stories**
- **Plug and process loads**
- **Use (Principal Building Activity)**
- **Location (Climate Zone)**

Source: Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector, National Renewable Energy Laboratory, December 2007

ENERGY MODELING WORKFLOW PROCESS

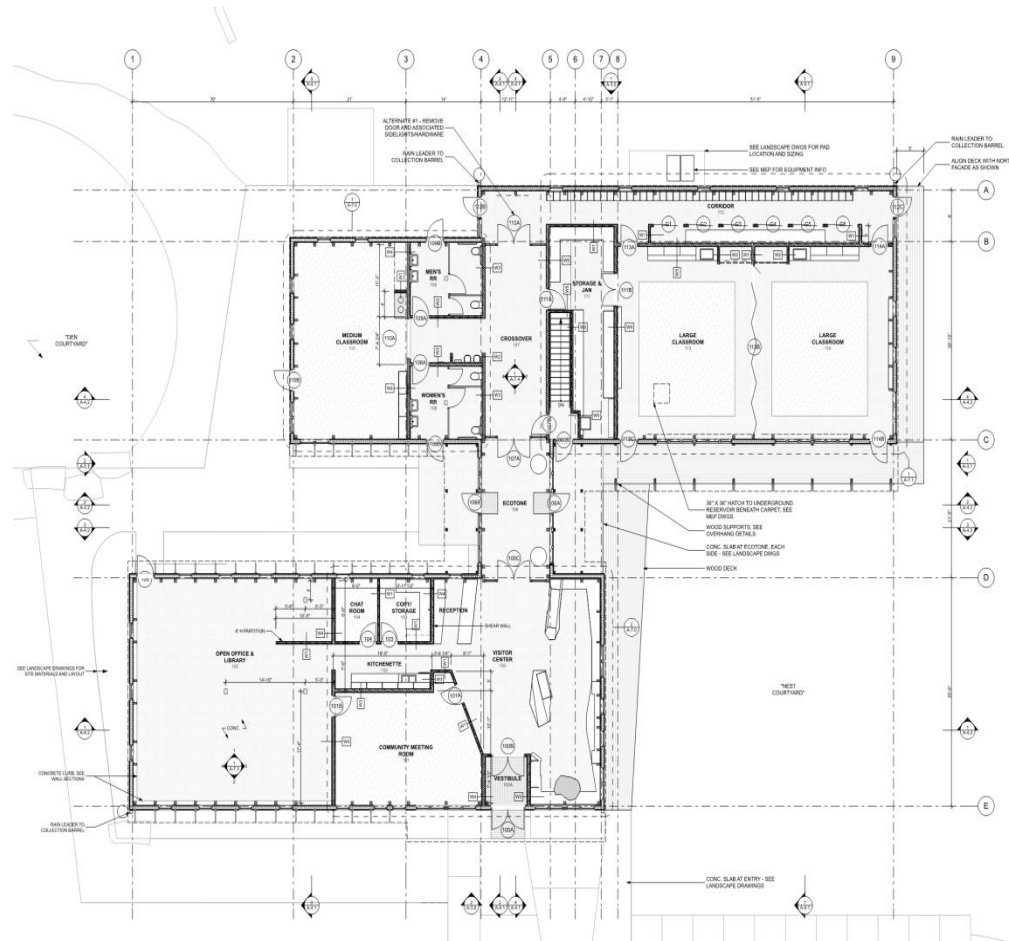
- **Levels of Analysis**
 - **Macro-Conceptual:**
 - Simplified Massing Models
 - Study of Building Massing and Orientation
 - Performance Analysis
 - Daylighting Potential
 - Natural Ventilation Analysis
 - **Micro-Conceptual:**
 - Study of Design Feature
 - Applied to Small Portion of the Building
 - Optimize the Design for Climate, Location
 - Test Options
 - **Detailed Energy Analysis:**
 - Representation of the Building "As Designed"
 - Help Optimize Performance
 - Assess Energy Consumption at Each End Use
 - Perform Life Cycle Studies

HITCHCOCK CENTER FOR THE ENVIRONMENT



PROJECT BRIEF

- Type: Assembly/Educational
- Location: Amherst, MA
- Total Area = 9,100 sf
- Total Stories: 1 Story
- Program:
 - Classrooms
 - Office
 - Meeting Room
 - Exhibition Room

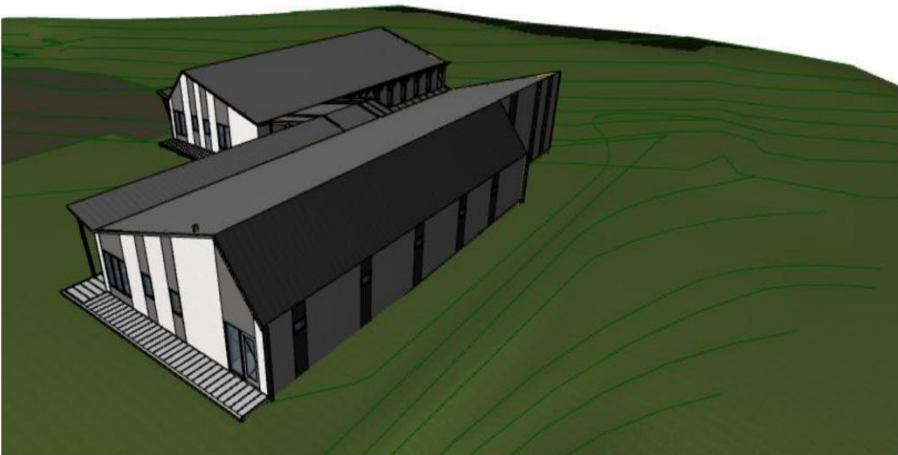




1 View from NW
SCALE: 1/4" = 1'-0"



2 View from SE
SCALE: 1/33.33



3 View from NE
SCALE: 1/38.40



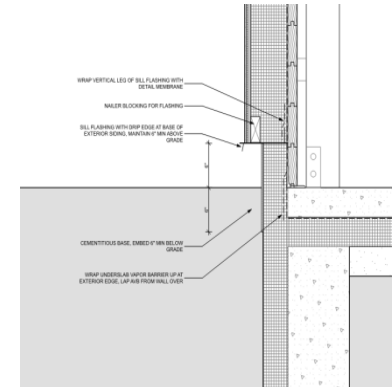
4 View From SW
SCALE: 1/4" = 1'-0"

ENERGY CONSERVATION MEASURES SUMMARY

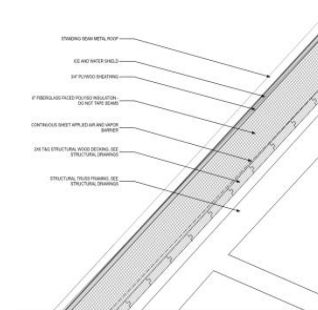
- High-performance Envelope
- External Shading
- High-performance Lighting Fixtures
- Daylight Harvesting
- Natural Ventilation
- Extended Thermal Comfort
- Energy Recovery Units
- High-efficiency, heat recovery VRF units
- Photovoltaic Array

BUILDING ENVELOPE – OPAQUE CONSTRUCTION

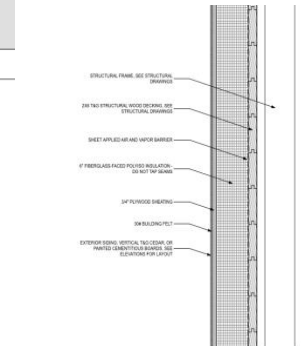
Model Input Parameter	Proposed Building Design		
	Description	Insulation R-value	Assembly U-factor / F-factor / C-factor [BTU/hft ² ·F]
Roofs	Insulated (6" Polyiso) Roof	R-39	U-0.022
	Reflectivity		0.30
Walls - Above Grade	Insulated (6" Polyiso) Wall	R-39	U-0.023
Walls - Below Grade	Insulated Below-grade Wall	R-20	U-0.026
Slab-On-Grade Floors	Fully Insulated (4" XPS) Unheated Slab	R-20	F-0.261



12 TYPICAL EXTERIOR WALL BASE
SCALE: 1/16" = 1'-0"



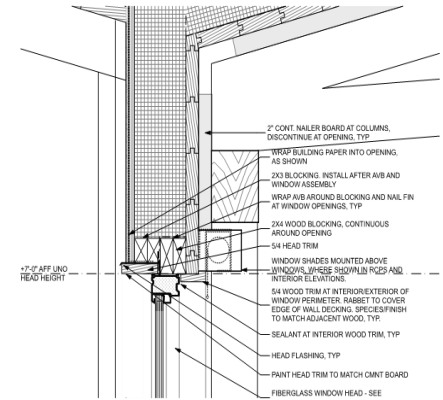
3 TYPICAL ROOF ASSEMBLY
SCALE: 1/16" = 1'-0"



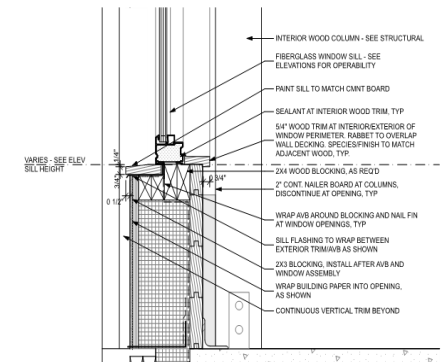
8 TYPICAL EXTERIOR WALL ASSEMBLY
SCALE: 1/16" = 1'-0"

BUILDING ENVELOPE – FENESTRATION

Model Input Parameter	Proposed Building Design ¹				
	Description	Center-of-Glass U-factor	Assembly U-factor [BTU/hft ² °F]	SHGC	VLT
Vertical Glazing	Alpenglass 5H - Fixed	U-0.14	U-0.16	SHGC-0.43	VLT-0.56
	Alpenglass 5H - Casement	U-0.14	U-0.20	SHGC-0.38	VLT-0.48



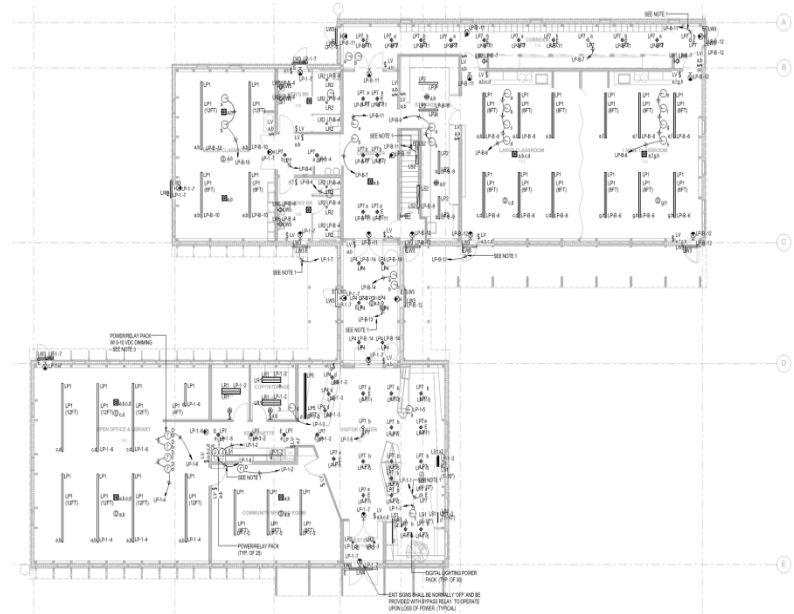
1 Window Head, Typ
SCALE: 1 1/2" = 1'-0"



6 Window Sill, Typ
SCALE: 1 1/2" = 1'-0"

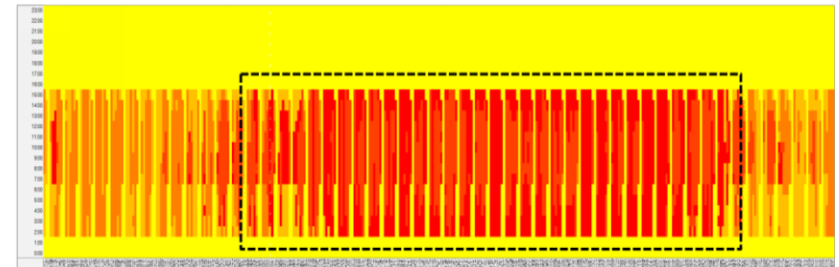
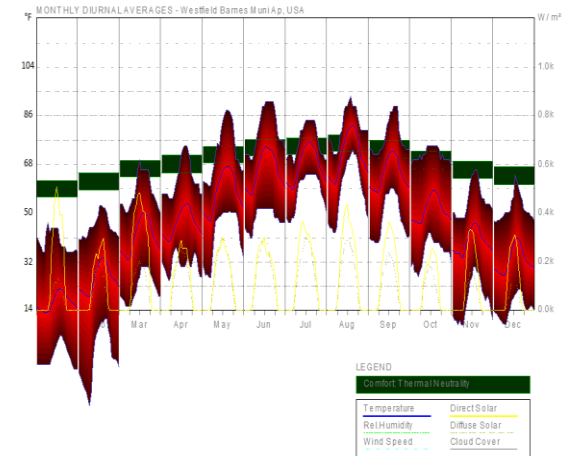
LIGHTING

- Average LPD = 0.4 W/sf
- High-efficiency Fixtures
- LED Lighting
- Daylight Harvesting in Classroom and Community Meeting Room

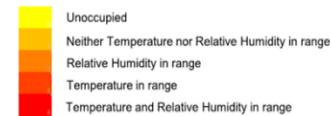


NATURAL VENTILATION

- The building will be in natural ventilation mode when the outside ambient temperature is between 66°F to 78°F and when the outside relative humidity is between 0%-60%.
- HVAC systems will be turned OFF during natural ventilation mode.

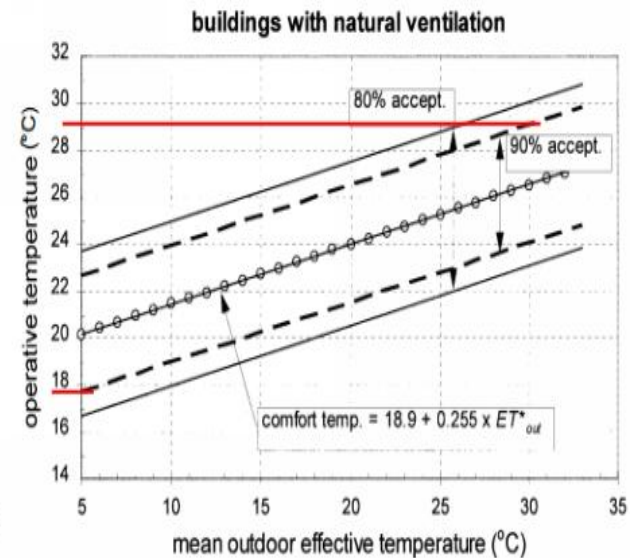
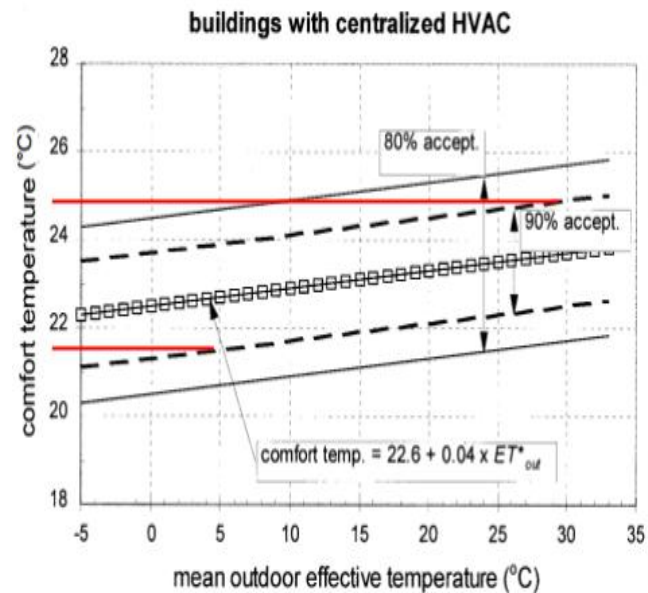


Legend:



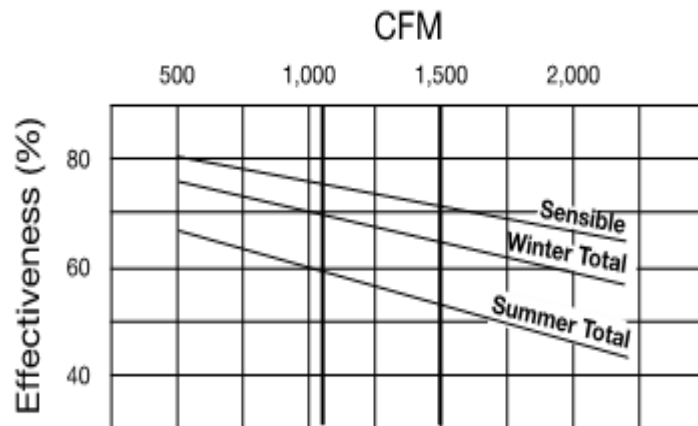
EXTENDED THERMAL COMFORT

- Indoor Setpoints:
 - Heating: 66°F/61°F
 - Cooling: 78°F/83°F



ENERGY RECOVERY UNITS

- Enthalpy Wheel
 - Sensible Efficiency = 75%

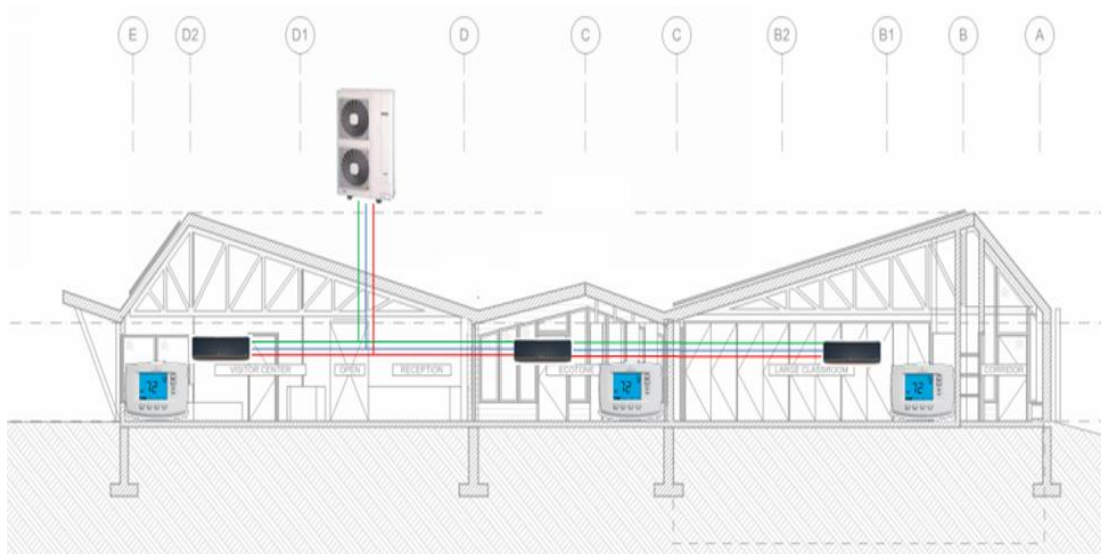


*At AHRI 1060 standard conditions
(See certified data on page 73 for core components.)



VARIABLE REFRIGERANT FLOW UNITS

VRF Model	Capacity (kBtu/h)		Cooling (EER)		Heating (COP)	
	Cooling	Heating	Full-Load	Part-Load	Full-Load	Part-Load
PURY-HP96	92	96	11.4	16.5	3.46	5.10
PURY-HP144	137	144	12.5	16.7	3.47	6.48



VARIABLE REFRIGERANT FLOW UNITS

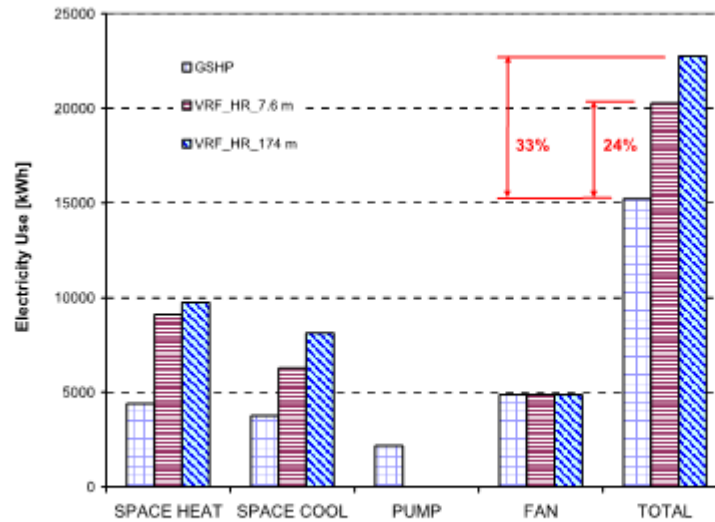
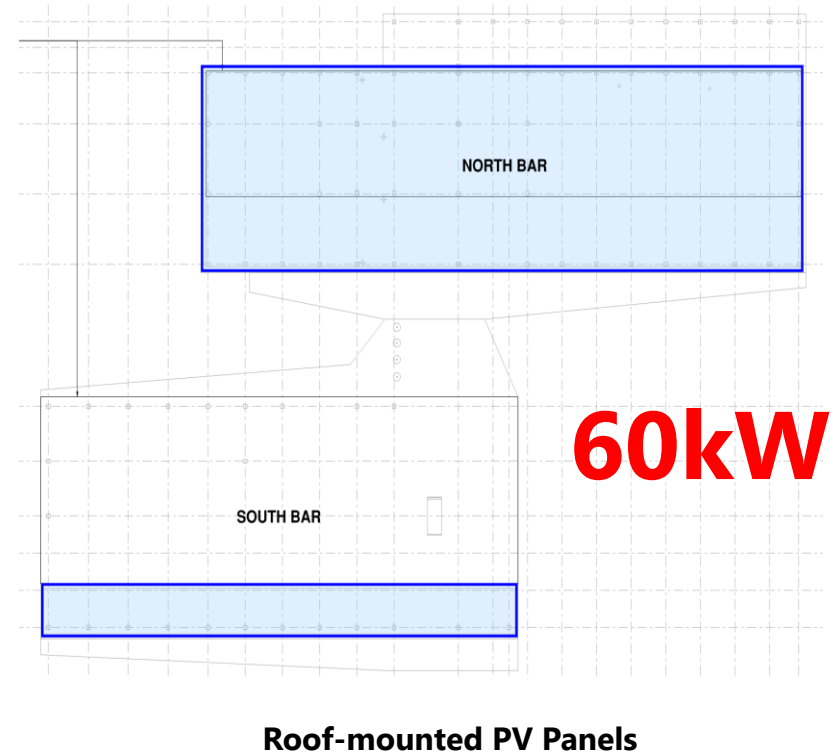


Figure 6 - Annual electricity consumption of the VRF and GSHP systems in Chicago

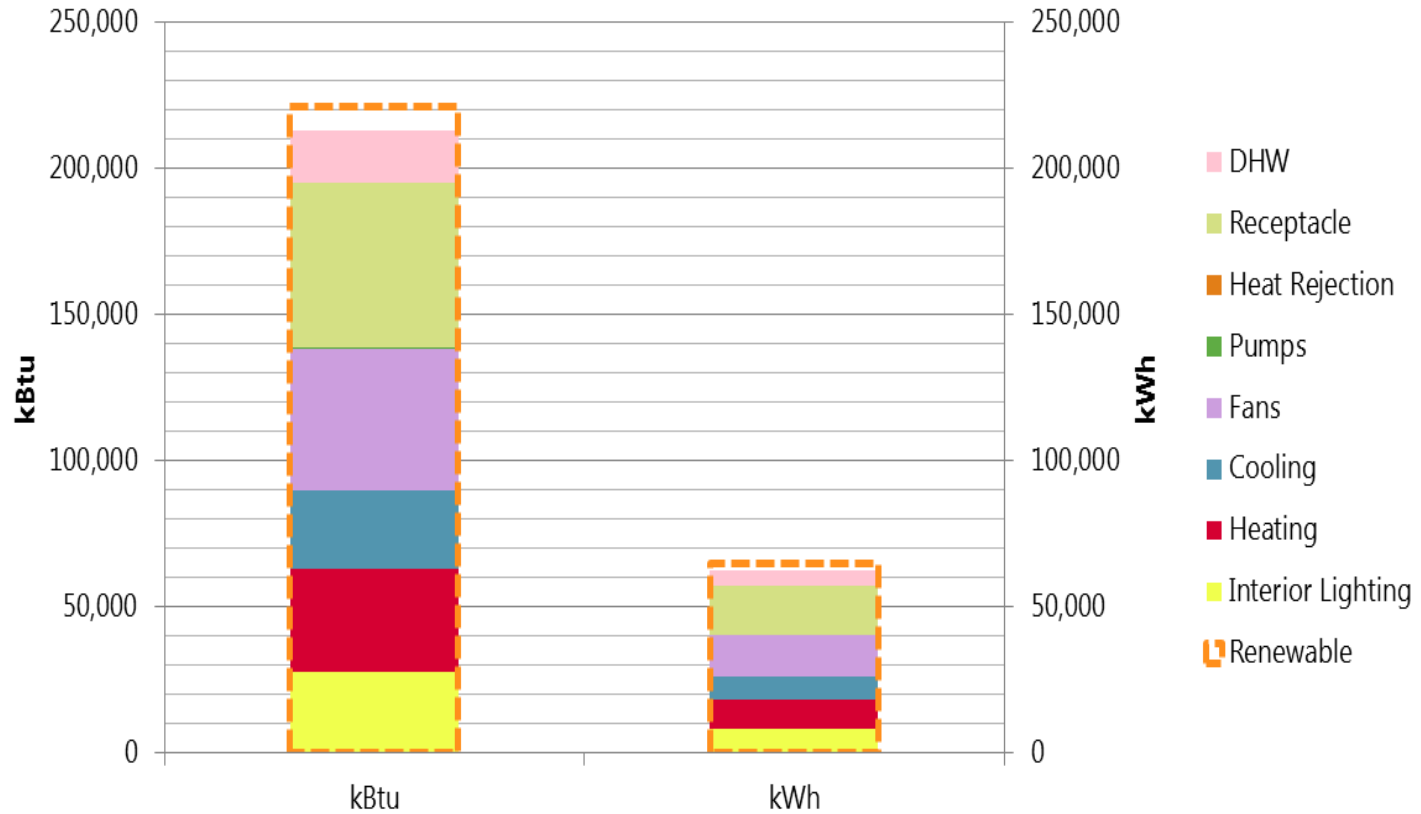
PHOTOVOLTAICS

Month	Generated kWh		Total kWh
	3:12 slope	12:12 slope	
Jan	-3,464	-1,232	-4,696
Feb	-2,929	-884	-3,813
Mar	-5,269	-1,447	-6,716
Apr	-4,799	-1,151	-5,950
May	-5,333	-1,202	-6,535
Jun	-5,245	-1,142	-6,387
Jul	-5,883	-1,298	-7,181
Aug	-5,891	-1,393	-7,284
Sep	-4,429	-1,146	-5,575
Oct	-3,035	-856	-3,891
Nov	-2,841	-919	-3,760
Dec	-2,295	-804	-3,099
Total	-51,413	-13,474	-64,887

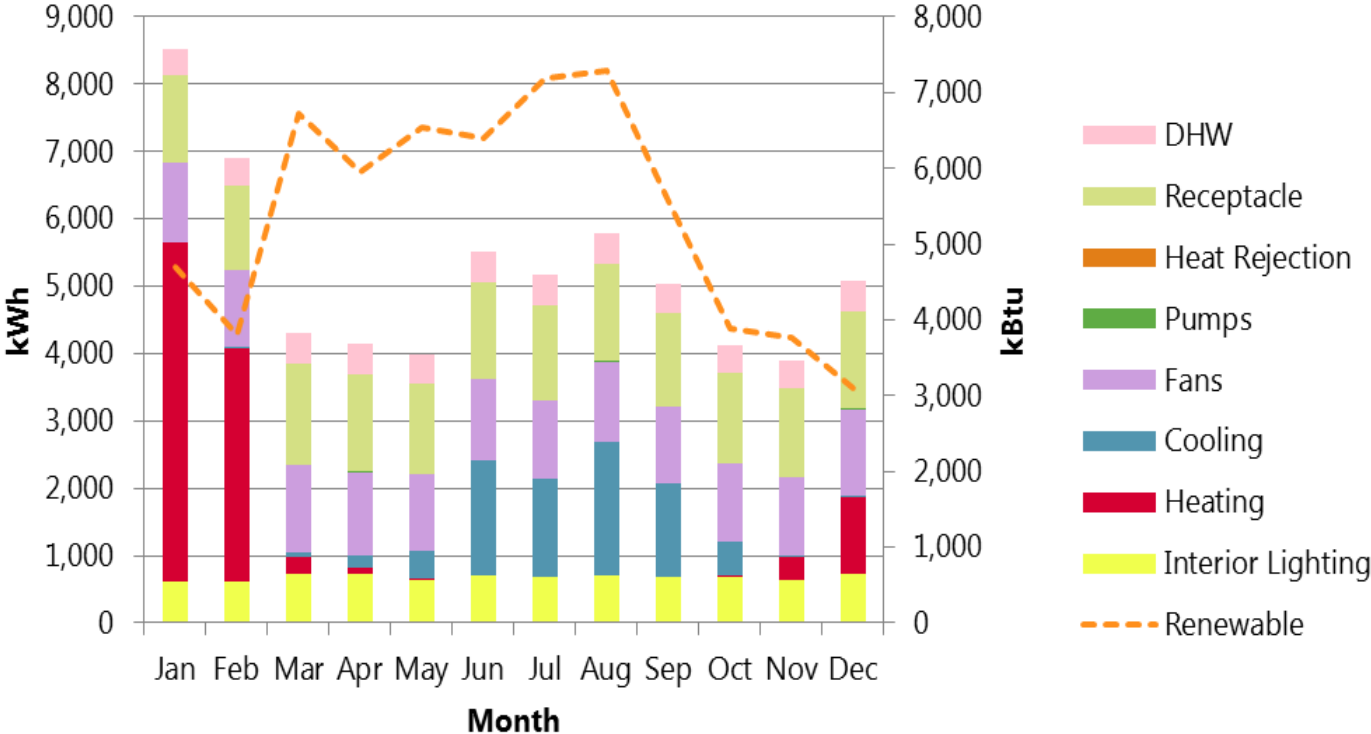


Note: PV generated electricity based on PV Watts Calculator

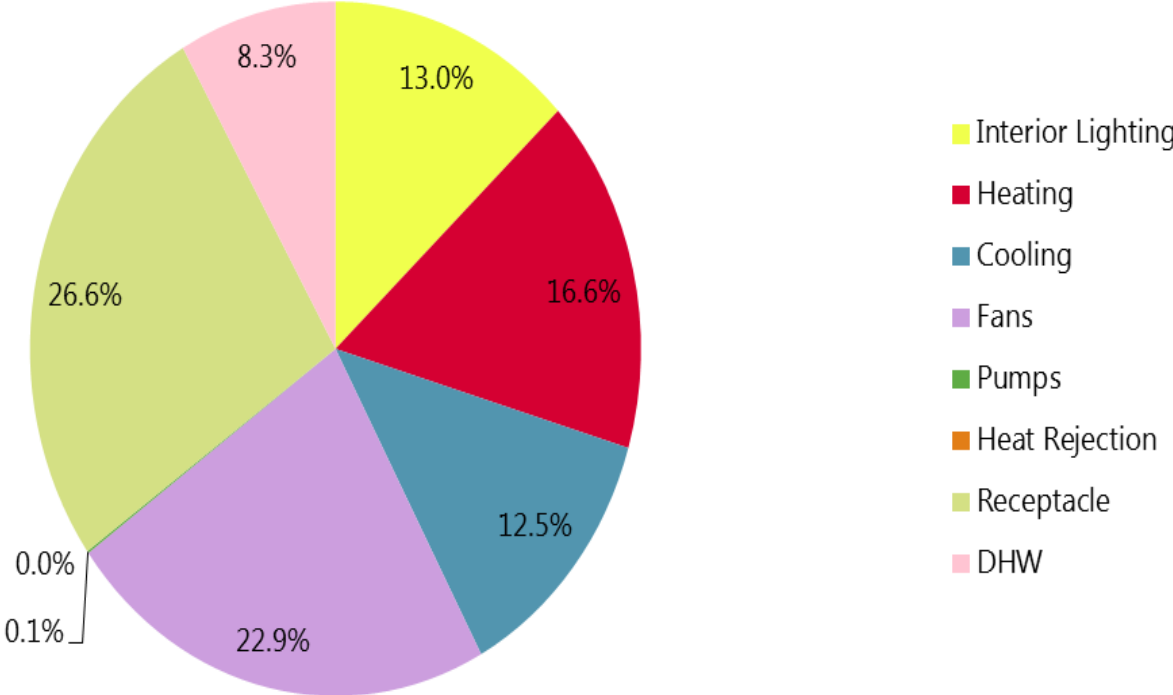
Proposed Building Design - Predicted Annual Energy Consumption



Predicted Monthly Energy End Use

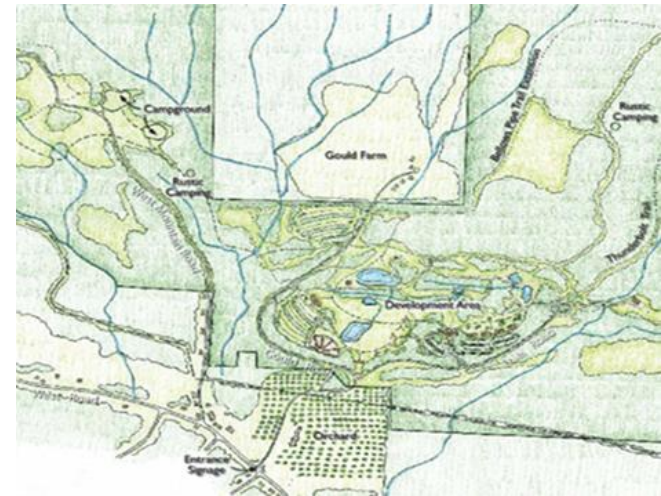


Proposed Building Design - Predicted Site Energy by End Use

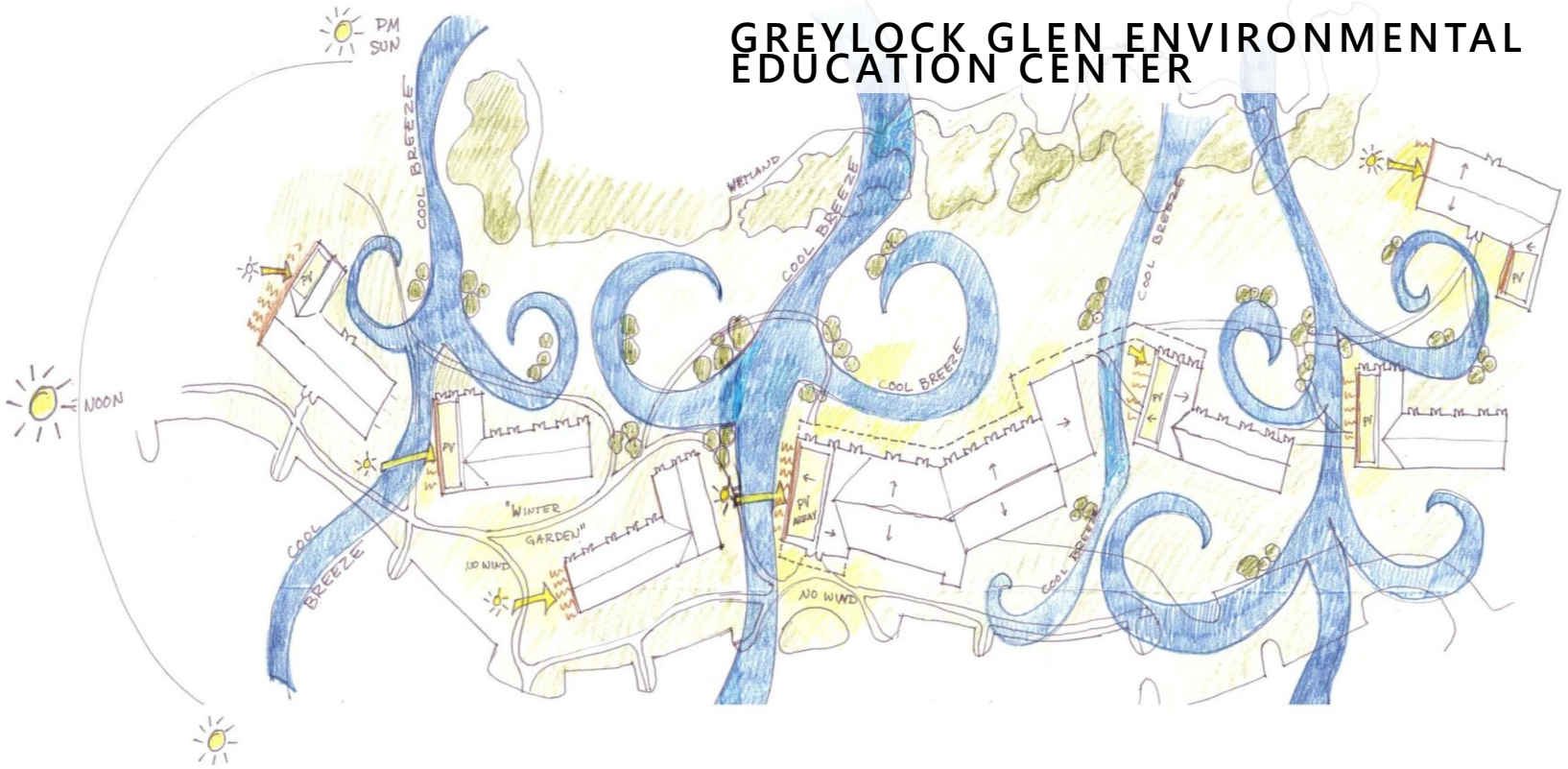


GREYLOCK GLEN ENVIRONMENTAL EDUCATION CENTER

- **Project Type**
 - Public/Commercial
 - Hospitality and entertainment
- **Location**
 - Adams, MA, USA
- **General Information**
 - ~117,000 sf
 - Program:
 - Golf course
 - Education/visitor's center
 - Outdoor amphitheater
 - Lodge with dining and meeting facilities (170 rooms)
 - Private overnight cabins
 - Campground
 - Expansion of hiking trails



GREYLOCK GLEN ENVIRONMENTAL EDUCATION CENTER



WIND
(COOLING AND VENTILATION)

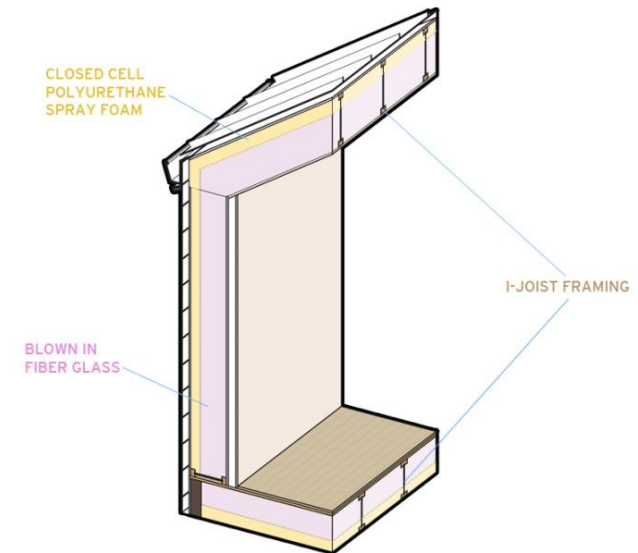
Buildings are oriented along the North South axis to take advantage of the cooling breezes from the East and West. As breezes move across the wetlands and wooded areas they are cooled. The Courtyards created between the buildings funnel the breezes through the site. Strategically placed trees channel the wind and create a cool microclimate. Outdoor rooms are cooled and shaded for more comfortable summer use.

SUN
(HEATING AND DAYLIGHT)

Buildings are oriented with the public atrium spaces facing +/- 10 degrees of South allowing for solar gain in the winter. South facing facades are shaded by deciduous trees and planting during the summer months. Thermal mass stores the heat from the sun and radiates it evenly throughout the day.

GREYLOCK GLEN: BUILDING ENVELOPE

- **Super Insulated Walls**
 - R-45 Walls, R-70 Roof
- **Triple pane low-e coated glazing with Argon, insulation in the sash and frame**
 - Minimum glazing thickness of 1 inch
 - Warm edge or similar glazing spacer
- **Air barrier with building envelope commissioning**
 - Maximum infiltration of 0.15 air changes per hour
- **Slab and below grade walls/Foundation thermal breaks**
 - R-10



GREYLOCK GLEN: BUILDING ENVELOPE

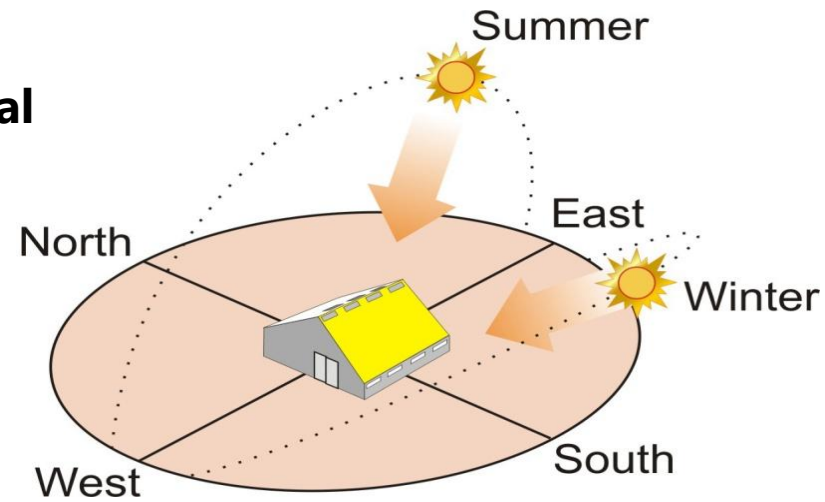
Shading

- Consider use of insulating shades, louvers or shutters on windows with large areas during non-daylight hours to prevent heat loss.
 - Operable exterior panels or interior mechanical shades in a track.
- Consider using horizontal louver systems on the south facing windows and vertical louvers on the east and west fenestration

GREYLOCK GLEN: BUILDING ENVELOPE AND ORIENTATION

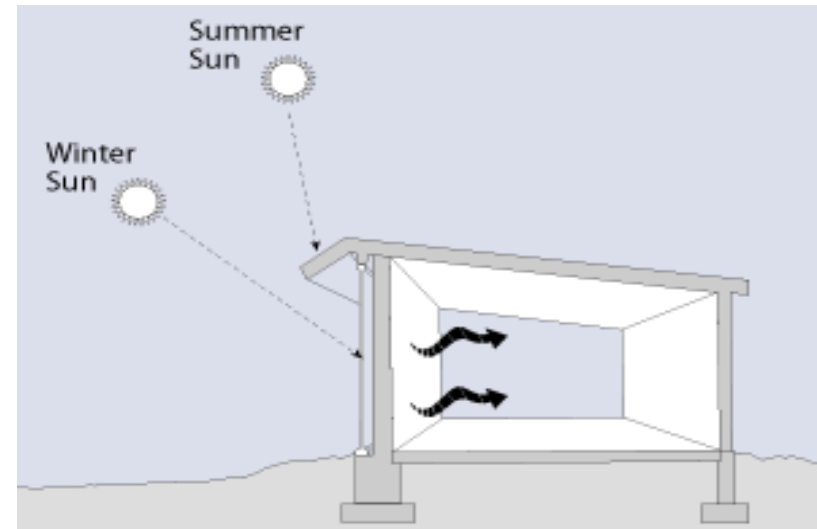
- **Roof**
 - High albedo or vegetated roofs
 - Refer to LEED v2.2 SS Credit 7.2 Heat Island Effect: Roof for guidelines
 - High solar reflectance index (SRI)
 - Refer to ASTM Standard E1980-01 – Standard Practice for Calculating Solar Reflectance Index

- **Long axis east-west orientation is optimal**



GREYLOCK GLEN: PASSIVE HEATING

- **Utilize thermal mass in the floors and walls to act as solar collectors**
 - Distributes heat throughout the course of the day and night, preventing temperature swings
- **Reduce glazing to the north, east and west.**
 - Area of south facing glazing should be approximately 30% of the floor area being heated by the sun
- **South-facing trombe walls**



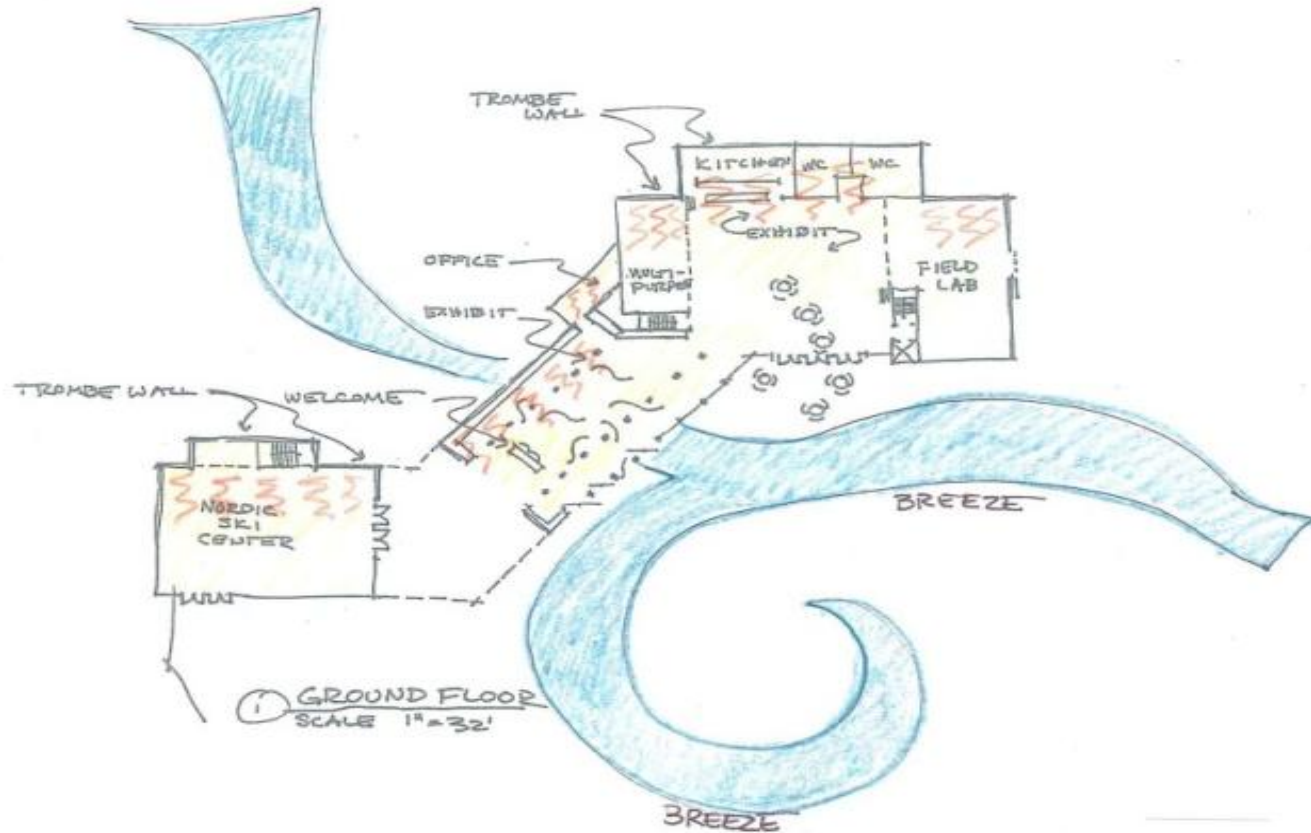
GREYLOCK GLEN: PASSIVE COOLING/NATURAL VENT.

Hybrid Natural Ventilation System:

- **Operable Windows**
- **Building massing arranged to channel breezes across vegetation and into the building**
- **Interior transoms allow cross and stack ventilation to occur across partition walls**
- **Double height spaces exhausted at the top (stack effect)**
- **Exterior Shading, overhangs, or trellis help cool air before it enters building**
- **Bypass the mechanical ventilation with energy recovery system**
 - Bring in outdoor air when it is within comfort range
- **Narrow building footprint will allow to take advantage of cross ventilation**

GREYLOCK GLEN: PASSIVE COOLING/NATURAL VENTILATION

Hybrid Natural Ventilation System:

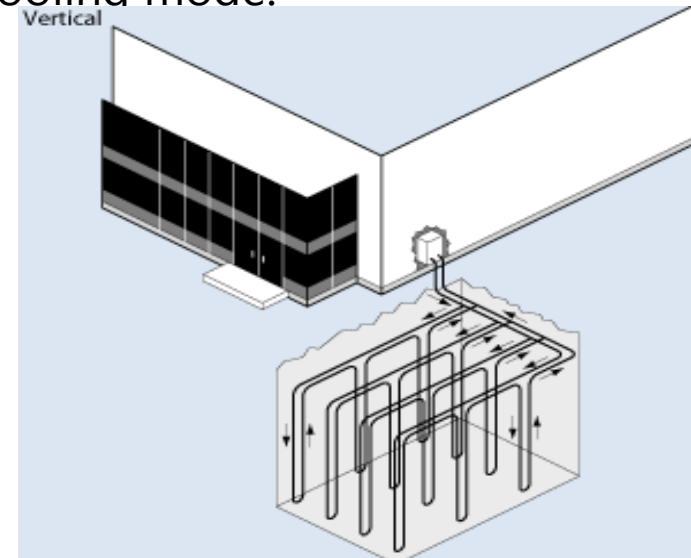


GREYLOCK GLEN: HVAC

Heating and Cooling Systems:

Combination of water-to-air and water-to-water GSHPs EER=18, variable speed pumping, premium motors, low pressure drop

- **GSHP wells: 250-400 ft. deep, 15-20 ft. grid, 1.5 wells/ton**
 - Summer Indoor: 75F / 50-55% RH setpoint in cooling mode.
 - Winter Indoor: 70F setpoint in heating mode



GREYLOCK GLEN: HVAC

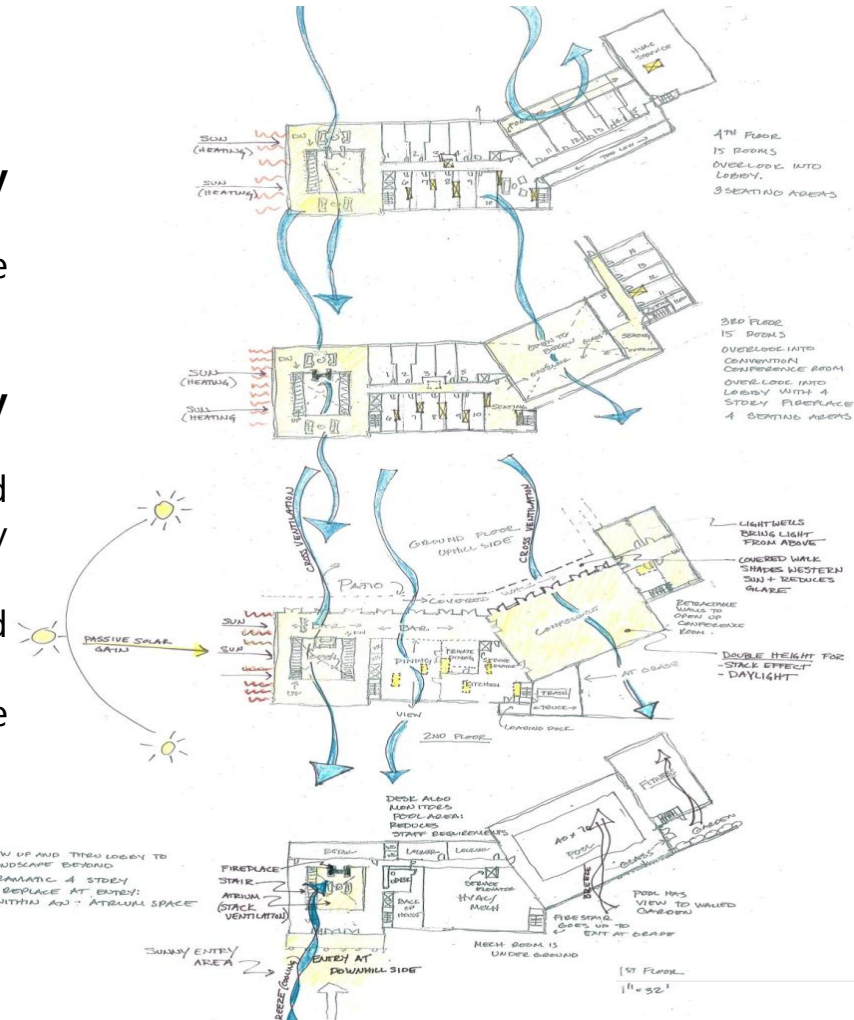
Ventilation:

Preheat the incoming outside air with energy recovery systems

- Allows most of the heat in the exhausted air to be recaptured and transferred to the incoming air

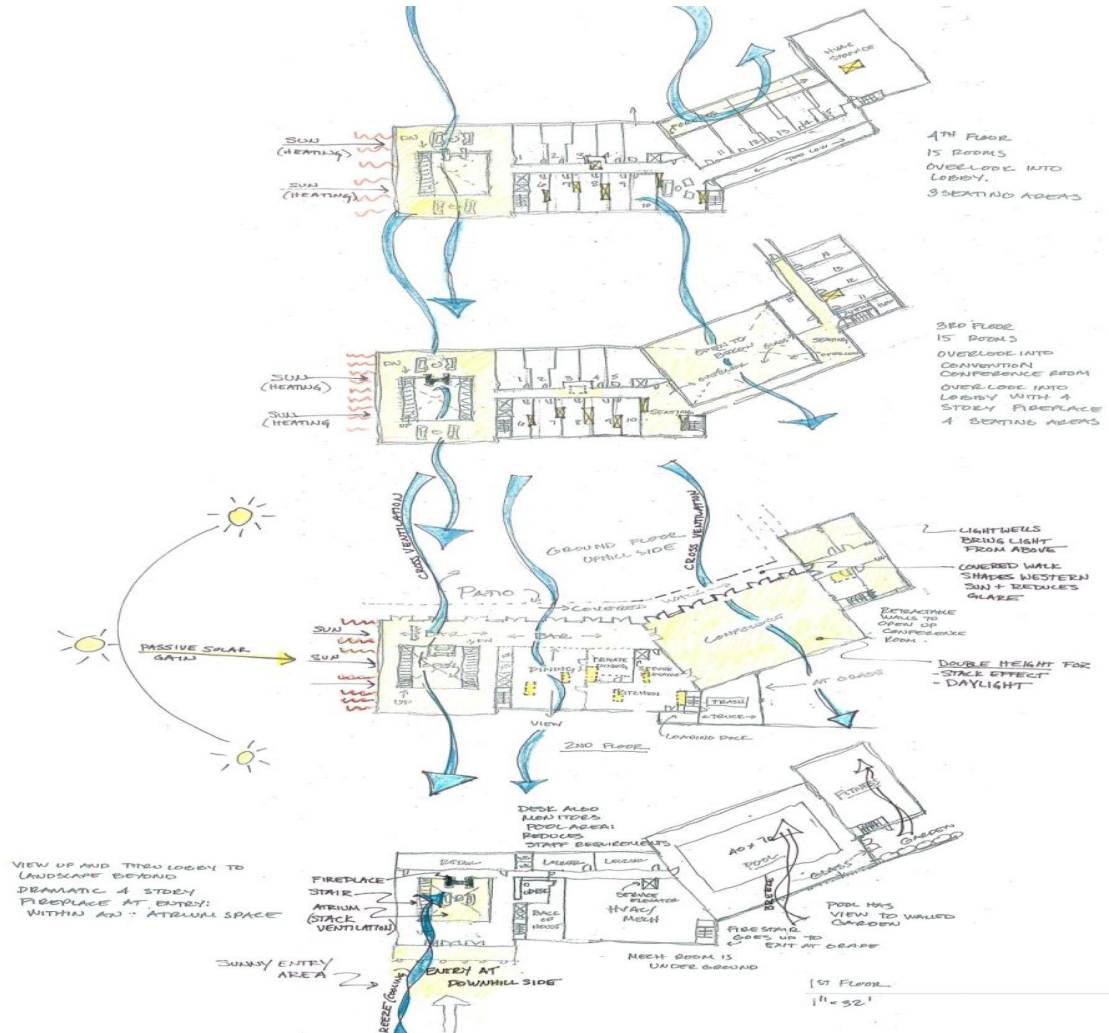
Mechanical ventilation with a desiccant coated-energy recovery wheel

- Optimizes indoor air quality by providing the required outdoor air ventilation exchanger while significantly reducing the heating and cooling load
- Decouples the heating and cooling ventilation load from the building
- Provides a constant source of ventilation air to the building occupants



GREYLOCK GLEN: HVAC

Ventilation:



GREYLOCK GLEN: ELECTRICAL LOADS

Reduced Electrical Lighting Load – Daylighting:

- **Daylight sensors with Daylighting zones oriented parallel to daylight openings on daylight sensors**
- **High clerestory windows with louvers, light shelves or shading**
 - Evenly distribute light and reduce glare
- **Prismatic or light diffusing glazing with high Light Diffusing Power (LDP)**
 - Evenly distribute light and eliminate hot spots
- **Lightwells**
- **Translucent interior folding partition walls**
 - Improve light distribution
 - Allow daylight into interior spaces
 - Allow for room darkening as required by program

GREYLOCK GLEN: RENEWABLE ENERGY

Photovoltaic:

- **Solar thermal systems for heating and domestic HW**
- **Possible satellite energy farm**
 - Replace the tree shaded parking area with a trellised, PV covered parking area
 - Integrate the energy farm into the sculpture garden or other program area
 - Provides more flexibility to the building orientation and footprint while providing an educational, and easily maintained and operated renewable energy area

Wind Turbines:

- **2-3 wind turbines**
- **Wind study/feasibility assessment needs to be done**



GREYLOCK GLEN



ACADEMY FOR GLOBAL CITIZENSHIP

Project Type

- Pre K-12 (150 students)

Location

- Chicago, IL, USA

General Information

- 60,000 sf
- Program:

Learning studios
Agricultural plots
Orchards
Greenhouses

- Will meet Living Building Challenge Standards
- Net-positive energy building
- Carbon-neutral site



SITE

limits to growth

The proposed site is currently a green field, largely asphalt and concrete paving. LBC encourages the redevelopment of this type of site. AGC proposes to transform the largely inflexible site into a living center of the community with a harmonious blend of healthy plant, animal and human habitats.

contamination/remediation

Soils testing will be conducted and remediation strategies determined prior to site restoration and implementation of habitats. This remediation strategies may be preferred over extensive excavation and mechanical removal of contaminants.

urban agriculture

LBC requires that a minimum of 10% (approximately 1 acre) of the developed site be dedicated to food production. AGC has envisioned that a minimum of 1 acre dedicated to agriculture, including vegetable gardens, orchards, and green houses that are devoted for school children.

natural habitats

LBC requires that a equal amount of land be set aside in perpetuity as a habitat exchange. Half of the proposed site will be restored as wetlands, prairie and forest, for use by a variety of animal species and for the educational benefit and enjoyment of the AGC students and the surrounding community.

community connections / transportation

LBC requires that the project promote safe first biking. AGC has already implemented the walking school bus initiative with parent volunteers. The proposed site is also close to an existing city transit hub to further reduce the number of vehicles trip required to get to the school. AGC aims to work with the neighborhood and to promote the addition of bicycles and pedestrian crossings within the community to further the safe and easy access to the new school site.

MATERIALS

no use of red list materials

The LBC contains your team to make a successful materials inventory that is non-toxic, transparent and socially equitable. The AGC team will work to design materials that are safe for all species through life and help to foster a positive impact on human and ecosystem health. None of the red list materials will be used on the project, these include: asbestos, cadmium, chlorinated paraffins, chlorofluorocarbons (CFCs), chloroprene (neoprene), formaldehyde, halogenated flame retardants, hydrochlorofluorocarbons (HCFCs), lead, mercury, perchloroethylene and pesticides, phthalates, poly(vinyl chloride) (PVC), wood treatments containing arsenic, azobis, or pentachlorophenol.

embodied carbon footprint offset

The LBC requires that the project team account for the total footprint of embodied carbon (eCO₂e) from its construction and projected replacement parts through a one-time carbon offset tied to the project boundary. The AGC team will help to establish a thorough understanding of how to minimize the carbon footprint during the construction process, and help to reduce the cost of the carbon offset of the project.

advocate for responsible industry

The LBC requires that the project be an advocate for the creation and adoption of third-party verified standards for sustainable resource extraction and fair labor practices. All wood specified for the project must come from Forest Stewardship Council (FSC) certified sources, from salvaged sources, or from the intentional harvest of timber trees for the purpose of clearing the area for construction. The AGC team will work with local contractors and suppliers to help ensure that these requirements are met and that the sustainable resource market is improved in the region as a result of this project.

place-based material selections

The LBC requires that materials are appropriately sourced to promote place-based solutions and to contribute to the economic of the regional economy. The AGC team will work to specify in materials and services that are within the bioregion boundaries required by the LBC, further connecting the project to the local and regional context that will make it an outstanding example of mid-western sustainability at work.

conservation and reuse

The LBC requires that project teams strive to reduce or eliminate the production of waste during the design, construction, operation and end of life in order to conserve natural resources. The AGC team will comply with these requirements and produce materials conservation plan that reduce project impacts on our resources in each phase of the project, these include appropriate product specifications during the design phase, product optimization and collection of reused materials during the construction phase, consumable and durable collection plan during the operations phase, and an subjective reuse and deconstruction plan for the end of life phase of the project.



WATER

contamination/remediation connections to the aquifer

Aquifer water testing will be conducted and remediation strategies determined prior to site restoration and implementation of habitats. If ground water contamination is present, steps will be taken to use an open-loop geothermal system integrated with the facility's heating and cooling systems that will be mutually beneficial.

on-site collection

81,550 gal/month probable average. LBC requires that all project water needs be met with onsite water collection and treatment. Water will be collected on-site with roof structures and stored for building use in above ground and in-ground cisterns. Preliminary calculations show that an average of 61,550 gal/month can be collected from a roof area of about 30,000 sf. The wettest month August will provide 70,270 gallons (0.22 inch) with a 70,000 x 0.22 gal of 0.095, the driest month February will provide 24,011 gallon (1.26 months) 20,009 x 0.62 x 0.05. These calculations indicate that there will likely be more than enough water collected onsite to accommodate the building and site needs, including agricultural, animal and human uses.

reduced water use

22,610 gal/month probable usage. Preliminary water use calculations show that water supplied plumbing fixtures including lavatories and sinks will use 22,000 gal/month (310,074 gallons/year) x 1,250 days = 4 of days used in only a 136 days/month). The calculations for flushing plumbing fixtures included toilets (gal/year) x 250 days = 30 days/month). This means that 22,610 total gallons per month are anticipated for building occupant use. These calculations do not set account for kitchen equipment or agricultural and animal needs on the site. Calculations indicate that low-flow fixtures will be specified throughout the facility.

on-site treatment

LBC requires that all waste water be treated on-site before being returned back into the natural water cycle. The AGC project proposes to use rain gardens, bioswales, and infiltration beds for onsite storm water storage and slow release into the natural water system. These Best Management Practices will also provide natural habitats for many plant and animal species, as well as opportunities for the students of the school and the community.

storm water management

LBC requires that all storm water runoff is contained and treated on site before being released back into the natural water cycle. The AGC project proposes to use rain gardens, bioswales, and infiltration beds for onsite storm water storage and slow release into the natural water system. These Best Management Practices will also provide natural habitats for many plant and animal species, as well as opportunities for the students of the school and the community.

EQUITY

human scale and humane places

The LBC requires that the project be designed to create human-scaled rather than automobile-oriented places, or that the experience brings out the best in humanity and promotes culture and integration. The AGC team will work to gauge the impacts of the design and development of the site while embracing the humanity of the entire community, working to make decisions the project and value the natural environment while providing a civilized and humane place for all.

democracy and social justice

The LBC requires that all primary transportation, roads and non-building infrastructure that are considered essential. Roadways must be equally accessible to all members of the public regardless of age, disability, race and socioeconomic class including the homeless, with reasonable steps taken to ensure that all people can benefit from the project's construction.

rights to nature

The LBC requires that the project team seek access to, use, and improve the quality of, both air, sunlight and natural waterways the agency member or adjacent developments.

BEAUTY

design features

The LBC recognizes the need for beauty as a precursor to caring enough to preserve, conserve and care for the greater good. The AGC team will work to include many beautiful design elements throughout the site including high quality materials, thoughtful human scale and the celebration of culture, spirit and place, to foster community appreciation of the world that we inhabit and to measure the best generational outcomes to create a healthy relationship with the natural world.

inspirational and educational features

The LBC urges that the project be inspirational and educational. The performance and operation of the project must be provided to the public to share successful outcomes and to inspire others to make changes. The AGC team will ensure that many of the sustainable features of the project are visible and explained to the community and students. The AGC school will function as a community resource and open educational environment for all ages, students, parents, grandparents and more. The building will be open to the public for tours and educational discussions at least once per year to further the sustainability building education of the surrounding community.



ENERGY

reduced energy usage

LBC requires that all site produce the required energy on site to achieve annual net-zero energy consumption. Preliminary energy models have shown that low energy use can be achieved and the AGC team has set a targeted energy use of 25 kWh/yr/ft² based on best-practice energy models. Total annual energy use is estimated at 1,500,000 kWh. The strategies implemented in the energy modeling exercise are as follows:

- **good solar orientation** - minimize east and west, optimize north and south exposure
- **increased insulation in walls and roof** - target R-48 for roofs, R-38 for walls, max 40% glazing R-144
- **good use of daylight** - light all spaces during day hours - optimize and lighting with auto and step lighting
- **geothermal well field and GSHP** - closed loop system/minimal fluid circulation - use of natural ventilation to temper, sources and displacement ventilation in common hot and cold zones
- **water thermal hot water heaters**
- **energy efficient kitchen equipment**
- **reduced plug loads**, including kill switches to power off entire zones when not in use

photo voltaic array calculations

In order to generate the majority of the project needs, the AGC team has run preliminary PV array calculations. A 485 x 315 PV array, would be required to offset the anticipated energy consumption of the building annually. The current market conditions suggest that PV needs invest for approximately \$1,000 per kW. An anticipated cost for 485 kW array is \$485 million dollars. A kW array is approximately 100-120 square feet, so roughly 48,500 - 58,200 square feet would be required.

wind turbines

To augment the PV array power production, turbines will be installed at Administration to benefit and community members. AGC proposes 6 to 8 kW wind turbines, each could produce approximately 4,000 kWh annually. Total annual energy production from these would range between 24,000 and 48,000 kWh. These will help to push the project in the net-positive energy goal, provide main-gate power for low solar months, and generate power during each hour.

human power generation

To augment the PV array power production, turbines will be installed at Administration to benefit and community members. AGC proposes 6 to 8 kW wind turbines, each could produce approximately 4,000 kWh annually. Total annual energy production from these would range between 24,000 and 48,000 kWh. These will help to push the project in the net-positive energy goal, provide main-gate power for low solar months, and generate power during each hour.

HEALTH

natural ventilation and daylight

The LBC promotes a sustainable, healthy, productive and healthy indoor environment. Every occupied space must have operable windows that provide that inhabitants access to fresh air and daylight. The AGC team will work together to ensure that every space provides a comfortable and naturally healthy indoor environment, ensuring the maximum physical and psychological well-being for the inhabitants of the school spaces.

good indoor air quality

The LBC requires that specific air quality related strategies be incorporated into the building design. The AGC team will work to ensure that all of these are included in the building design.

- Entrances must have an external and internal dirt and moisture control to separate air space.
- All kitchens, bathrooms, copy rooms, janitorial closets and chemical storage spaces must be completely ventilated and exhaust directly to outside air.
- Ventilation rates must be designed to meet levels of ASHRAE 62.2-2007 and equipment must be installed to monitor levels of carbon dioxide, temperature and humidity.
- Smoking must be prohibited within the project boundary.

biophilia

The LBC requires that biophilia be provided within the site and building project. The AGC team will help to ensure the transformation of our human-nature relationship, providing natural features, use of inspiring natural shapes and forms, and including our natural processes and patterns.



ACADEMY FOR GLOBAL CITIZENSHIP

a. Limits to Growth

Surrounded by contaminated lands from a history of heavy industry, AGC has the unique opportunity to transform brownfields into fields of green. AGC will select and transform a lifeless and distressed site into a thriving community center containing a harmonious blend of healthy plant, animal, and human habitats.

b. Renewable Energy

Using clean and renewable resources, AGC will harness the power of the sun, the heat of the earth and the strength of the wind to produce more energy than we will need to operate. Renewable energy sources will also serve as demonstration tools for students and community members. These will help to push the project towards its net-positive energy goal and will realize the AGC value of "doing good".

c. Human Scale and Humane Places

LBC requires that the project be designed to create human-scaled rather than automobile-scaled places. The AGC team will work to gauge the impacts of the design and development of the site while embracing the humanity of the entire community, working to make decisions that protect and restore the natural environment while also providing a civilized and humane place for all.

d. Urban Architecture

LBC requires that a minimum of 10% (approximately 1 acre) of the developed site be dedicated to food production. AGC intends to incorporate a minimum of 3 acres of urban agriculture, including vegetable gardens, orchards and greenhouses.



i. Water Cleansing

If ground water contamination is present (after testing), steps will be taken to use an open-loop geothermal system integrated with the aquifer to begin a filtering and cleansing process.

h. Embodied Carbon Footprint Offset

The AGC team will help to establish a thorough understanding of how to minimize the carbon footprint during the construction process, and help to reduce the cost of the carbon offset to the owner and account for LBC requirements.

g. Biophilia

The AGC team will help to ensure the transformation of our human-nature relationship, promoting natural features, use of inspiring natural shapes and forms, and celebrating our natural processes and patterns.

f. On-site Water Collection

LBC requires that all project water needs be met with on-site water collection and treatment. Water will be collected on-site with roof structures and stored for building use in above ground and in-ground cisterns.

e. Educational and Inspirational Services

AGC will function as a community resource and educational environment for all ages – students, families and community members alike. As a learning laboratory, the building will be open to the public for tours and educational discussions.

ACADEMY FOR GLOBAL CITIZENSHIP



ACADEMY FOR GLOBAL CITIZENSHIP: BUILDING ENVELOPE

Super Insulated Walls

Roof: R-48

- Greenroof
- Skylights (20% of area glazed)
- Flat

East and West walls: R-36

- Opaque
- 12" thick cip concrete
- No glazing

North and South walls: R-48

- 60% opaque
- 12" thick cip concrete
- 40% glazing
 - R-3.84

Underslab Insulation

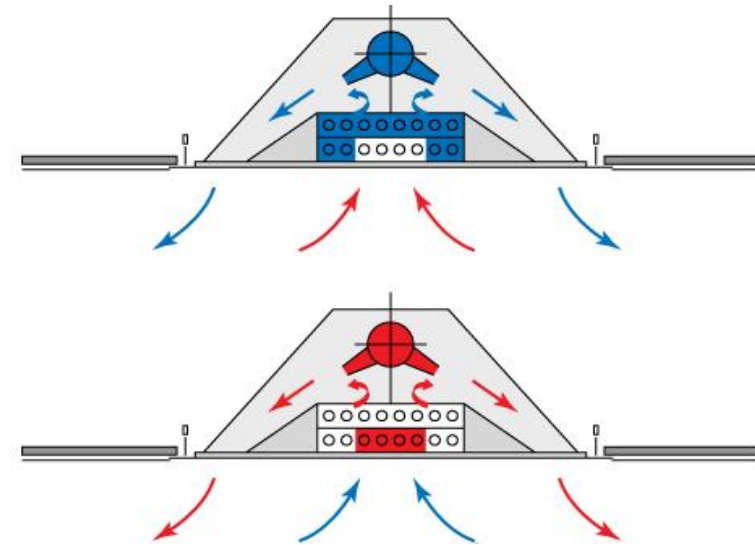
- R-10



ACADEMY FOR GLOBAL CITIZENSHIP: HVAC

Heating and Cooling Systems:

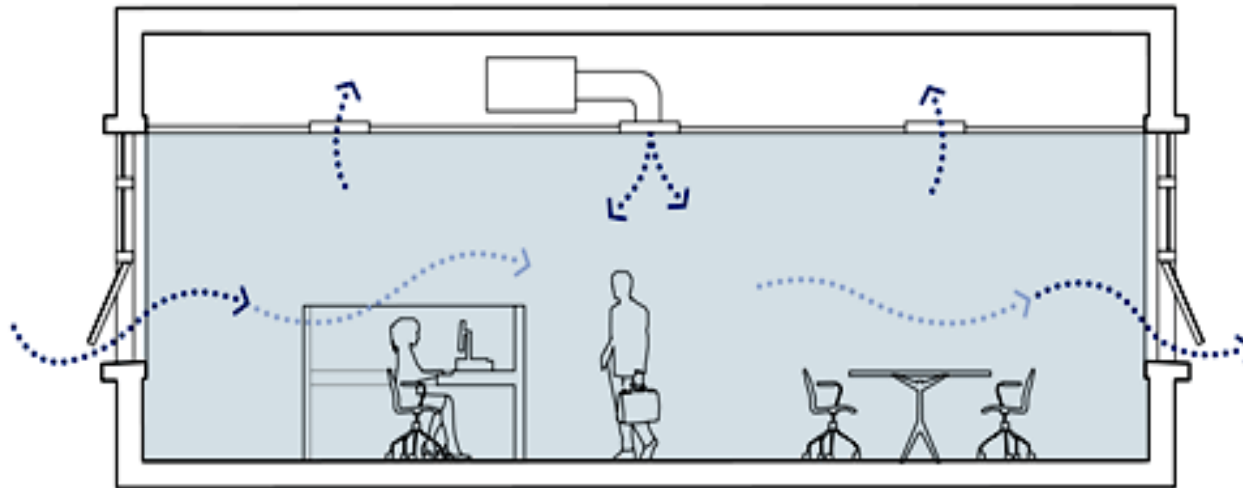
- **GSHP: Closed loop system**
- **Mechanical System:**
 - DT coils in ERU's
 - Geothermal heat pumps attached to the ERU's
 - Chilled beams
- **Energy Recovery on make-up air systems during non natural ventilation hours**



ACADEMY FOR GLOBAL CITIZENSHIP: HVAC

Ventilation

- **Fan systems – Low pressure, ECM motors (0.00019 kW/CFM), zone distribution**
- **Displacement ventilation**
- **Mixed Mode/Natural Ventilation**



ACADEMY FOR GLOBAL CITIZENSHIP: RENEWABLE ENERGY

Photovoltaic

- **485 kW PV array required to offset the anticipated annual energy consumption**
- **Estimate 48,500-58,200 sf of roof area required**

Wind Turbines

- **4kW wind turbines (4-6)**
 - Assume 4,000 kWh/yr per turbine
 - Total annual energy production ranges between 16,000-24,000 kWh
 - Provide power for low solar months
 - Generate power during dark hours

Solar domestic HW heating

ACADEMY FOR GLOBAL CITIZENSHIP: BEYOND NET ZERO

- **Performance and operation data will be provided to the public to share successful solutions and to motivate others to make changes**
- **Many of the sustainable features are visible and explained to the community and students**
- **School will function as a community resource and an educational environment**
- **Building will be open for public tours and educational discussions at least once per year to further the sustainable building education of the surrounding community**



ACADEMY FOR GLOBAL CITIZENSHIP: BEYOND NET ZERO

- Wind turbines will be installed as demonstration to students and community members
- Composting
- Waste water wetlands
- Stormwater management
 - Rain gardens
 - Porous parking lots



This concludes The American Institute of Architects
Continuing Education Systems Course

