IPRO 317

Net Zero Zero Energy Home
1114 W. Roscoe Ave. Chicago, Il

Problem:
To design a net zero energy, zero carbon emission, high efficiency green home at a competitive cost relative to neighboring units.

Background:
This IPRO was sponsored by Mr. Jimmy Eng who presented the group with the problem of designing a zero energy home. Homes today are still being built with the same construction techniques that have been in use for hundreds of years, and yet this architecture is temporary rarely surviving fifty years before it would need to be torn down and rebuilt. All over the world groups are trying to solve the problem everyone around the world is experiencing of limited natural resources and land. This IPRO took a step closer to finding the solutions this semester.

Objective:
Our goal was to design a three-unit condominium building on a specific 100 ft. by 25 ft. Chicago-style lot with the following conditions in mind:

- "non-disposable" design with a minimum three hundred year design life.
- lower maintenance fees over the lifespan of the building
- maximum physical and psychological comfort
- zero energy use and zero carbon emission
- looking beyond existing building codes and technologies
- cost of construction be comparable to similar sized structures in the area ($1.7 million construction cost for a three flat building)

Methodology:
The IPRO team was split into multiple subgroups under subgroup team leaders to accomplish specified goals throughout the course of the semester. Information from existing green technologies, literature, and journals pertaining to the strength of materials, as well as other relevant design information available, were gathered and used as part of our research. Each team consulted with experts in the fields when needed to supplement their research. Throughout the course of our research and investigations, a variety of different software was used to aid in our design. Equest (Energy Modeling Software) was used to estimate and analyze the overall energy usage of the building. MathCAD assisted in any structural calculations that needed to be done as well as calculating the overall R-values for the building. AutoCAD was utilized to draft all elements of the building, which include architectural and structural components. Revit and ArchiCAD were also used for 3D modeling and architectural problem solving. Additionally, the building was designed in accordance with the Chicago Building Code. Other codes accepted by the city of Chicago were used as well.

Case Studies

CASE STUDY # 1

Smith House (Passihaus)
Urbana, Illinois

Edward Sindelar Builders
Katrin Klingenberg and Nicolas Smith Architects

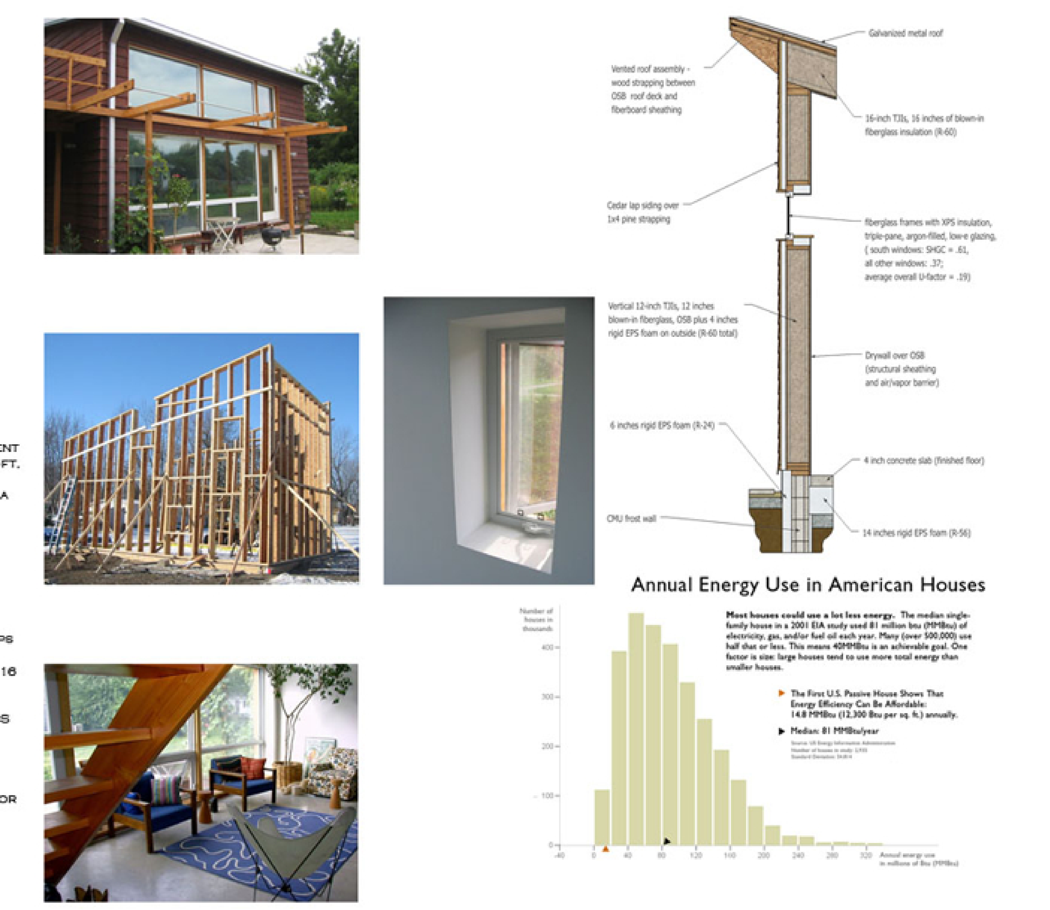
2 bedrooms and 1 bath
1,200 sq. ft.
Cost = $94 per sq. ft.
Annual Energy Use = 14.8MMBtu

Indoor Air Quality:
HRV constantly exchanges air
Linseed oil floor finish
Water-based sealant on the concrete floors
Non-VOC wall paints
Solid wood countertops

Water:
Toilets and laundry will eventually be fed by a rainwater colleciton system

Energy:
Cooling: HRV with 1,000 watt electric resistance heating element coupled to an 8 inch diameter x 100 ft. long earth tube buried 6ft. below grade.
Water Heating: A tankless water heater with spare conduit for a solar thermal system to be installed later.
Superinsulation:
Foundation = R – 56 + R – 24
4 in. concrete slab over 14 in. EPS foam surrounded by a Concrete-block foundation wall covered in 6 in. of EPS foam
Walls = R – 60
Vertical 12 in. I-joists with 12 in. blown-in-fiberglass insulation + 4 in. EPS foam over the exterior to bridge gaps
Roof = R – 60
16 in. I-joists with vent channels above the sheathing and 16 in. of blown-in-fiberglass insulation
Windows = U - .19
Triple-pane, argon filled low-e, fiberglass frames with XPS insulation

Materials:
Durable, recyclable galvanized-steel roof
CMU frost wall + on-grade concrete slab are material and labor efficient
Recycled tub, fixtures and medicine cabinets
100% regionally sourced wood (fir, pine, and cedar)
Recycled slate cladding on the foundation
Recyclable blown-in-fiberglass insulation



CASE STUDY # 2

Duluth, MN

J and R Sundberg Builders
Wagner Zaun Architecture

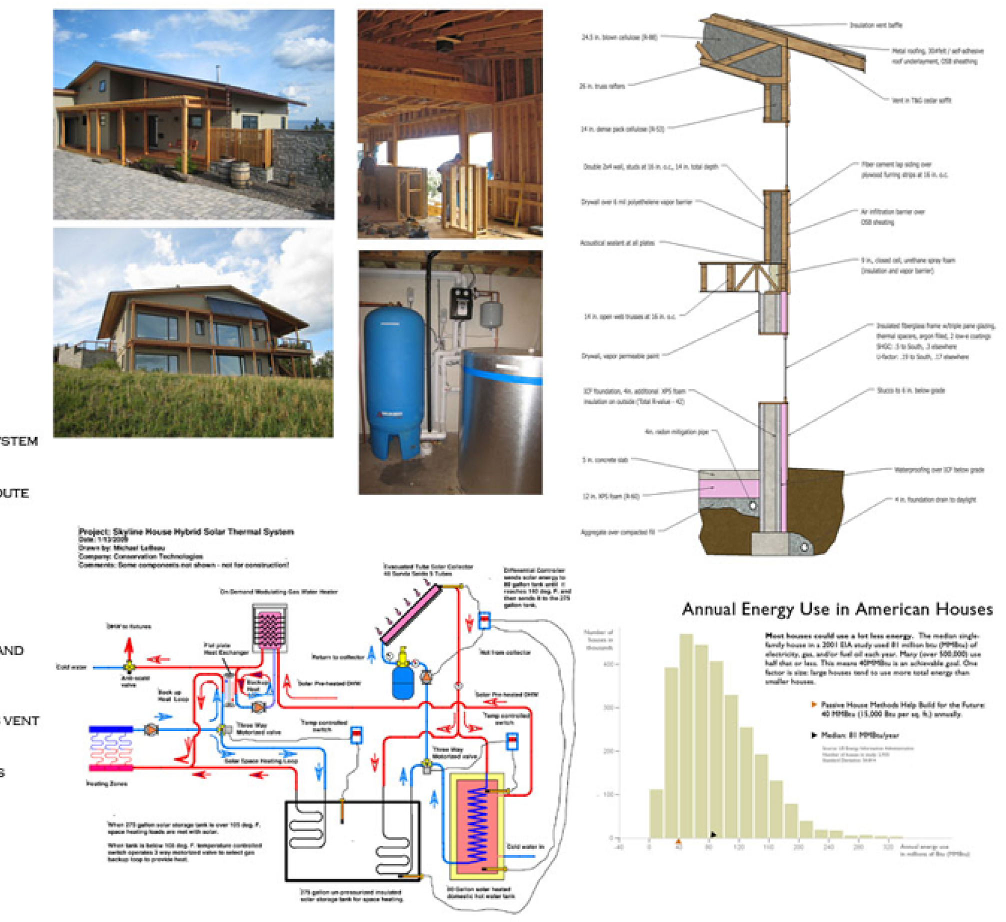
3 bedrooms and 2 bath
2,660 sq. ft.
Cost = $94 per sq. ft.
Annual Energy Use = 19.4 MMBtu

Indoor Air Quality:
Whole-house HRV
No carpeting

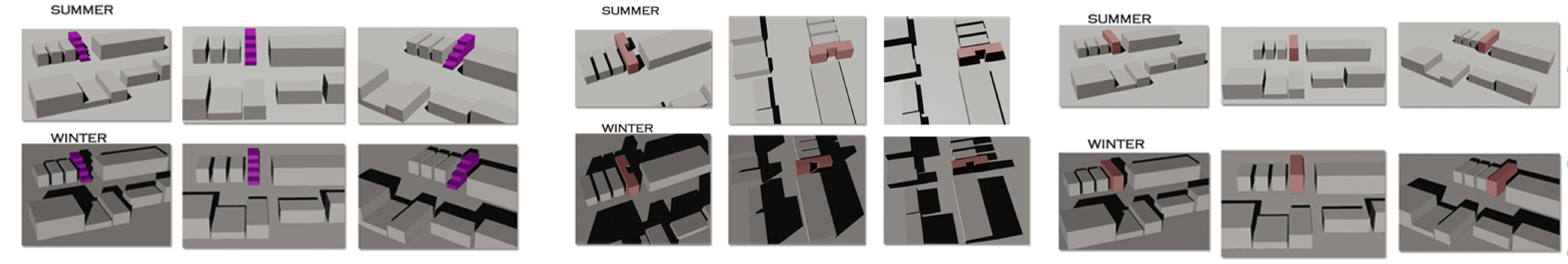
Water:
Dual-flush toilets
Low-flow faucets
Rain barrels for roof water collection
Bathrooms are stacked close to the mechanical room

Energy:
Heating and cooling: evacuated tube solar collection system with a 275 gallon insulated tank.
Radiant heating
EPA-rated wood stove with a dedicated combustion air route
Back up heating from a gas-fired Takagi
No air conditioning
Superinsulation:
Foundation = R – 40 + R – 60
ICF with 8 in. poured walls + 4 in. XPS exterior insulation
5 in. concrete slab over 12 in. XPS
Walls = R – 53
14 in. thick with wood 2x4's, ½ in. of exterior OSB, and ½ in. Interior gypsum. The interior is stuffed with dense-pack cellulose insulation
Roof = R – 88
26 in. deep parallel chord trusses with continuous vent chutes and 24 ½ in. of blown cellulose insulation
Windows = U - .17/.19
Triple-pane, argon filled low-e, insulated fiberglass frames with thermal spacers

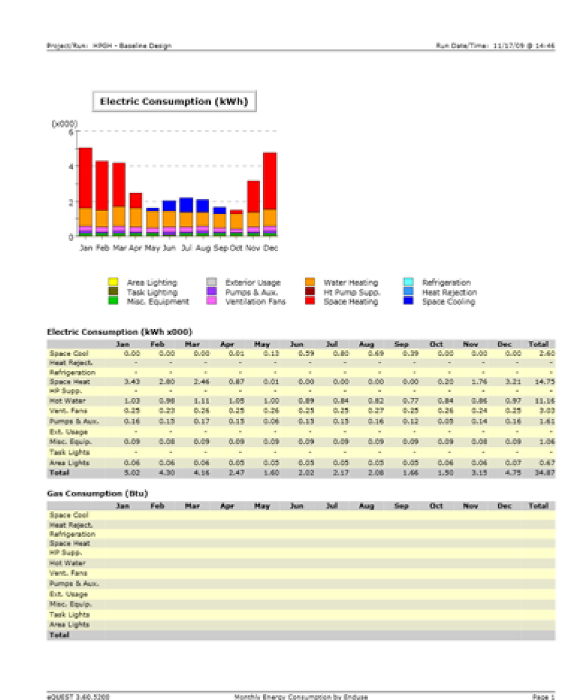
Materials:
Bamboo flooring on the main level
Water-based concrete stain on the lower floor
Cellulose insulation
Standing seam metal roof

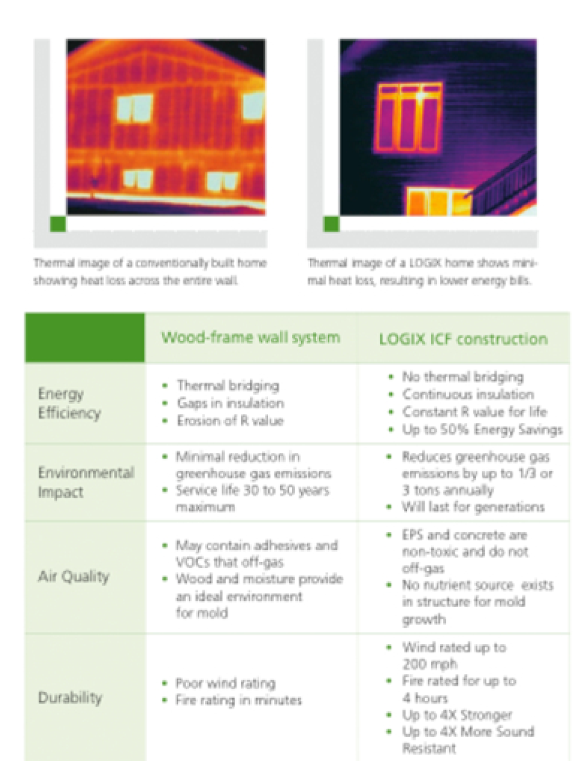


Site Analysis

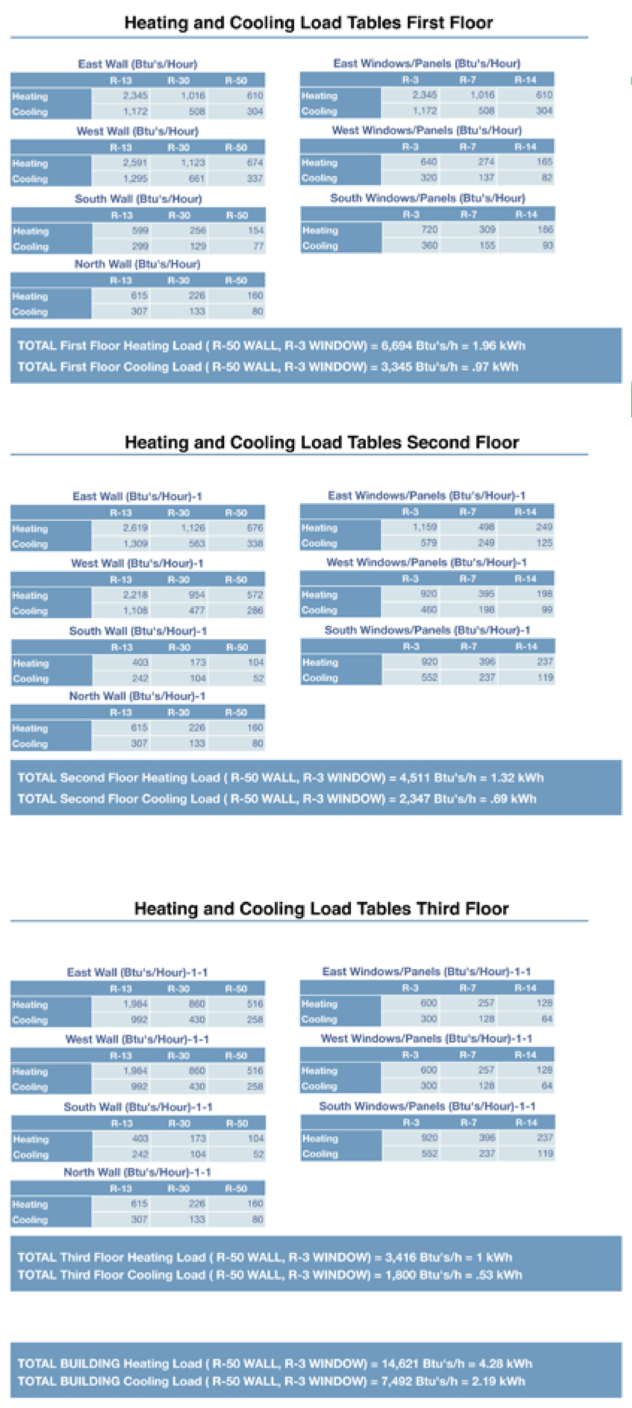


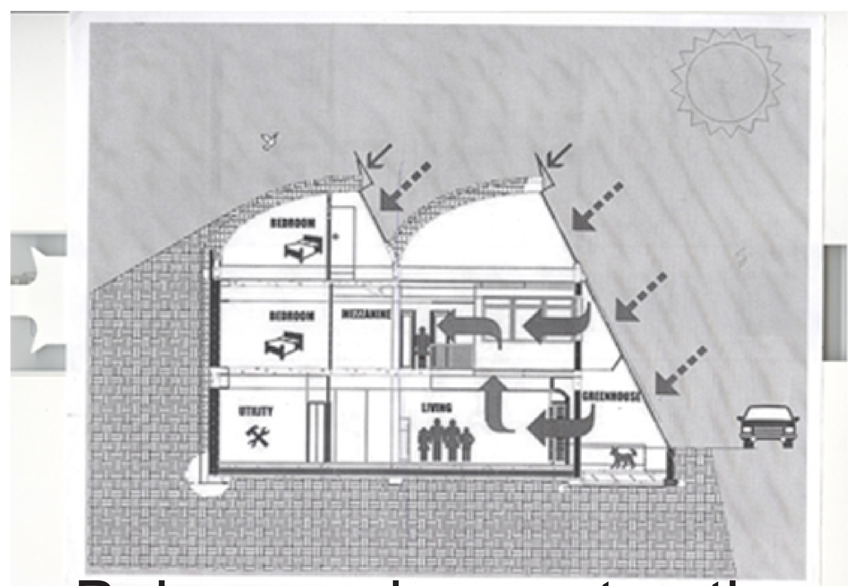
Research



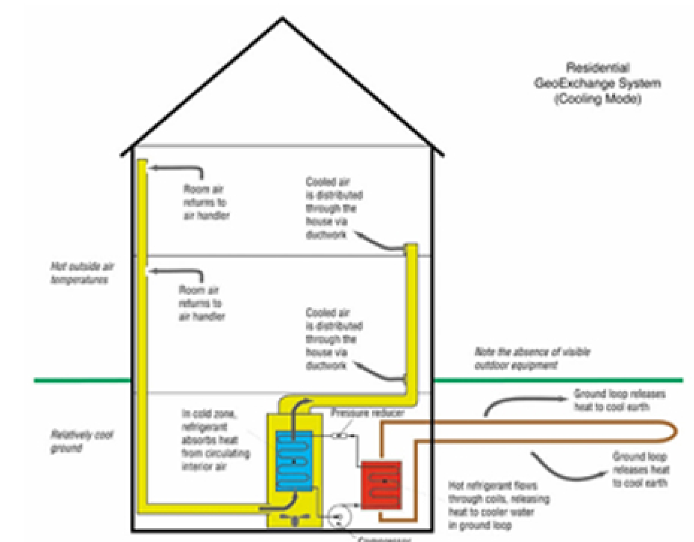


Logix was the decided company for furthered research regarding Insulated Concrete Forms (ICF) for the central layers of the exterior walls (Please reference the ICF on the table). These ICFs are very durable, thus aiding in meeting our goal of durability. The ICFs do not loose their R-value over time which means that the thermal envelope created for the housing unit will be consistent over time. Unlike over insulating a wood-framed building and creating a 'sick home,' the Logix walls provide no environment for mold growth. This means that the home is green, healthy and durable.

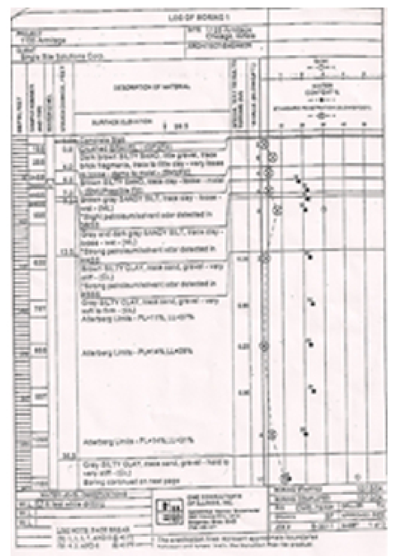




Below grade construction



Geothermal



Soil Test

Zoning Map

Load Tables