ZERO COMMUNITY

IPRO 323

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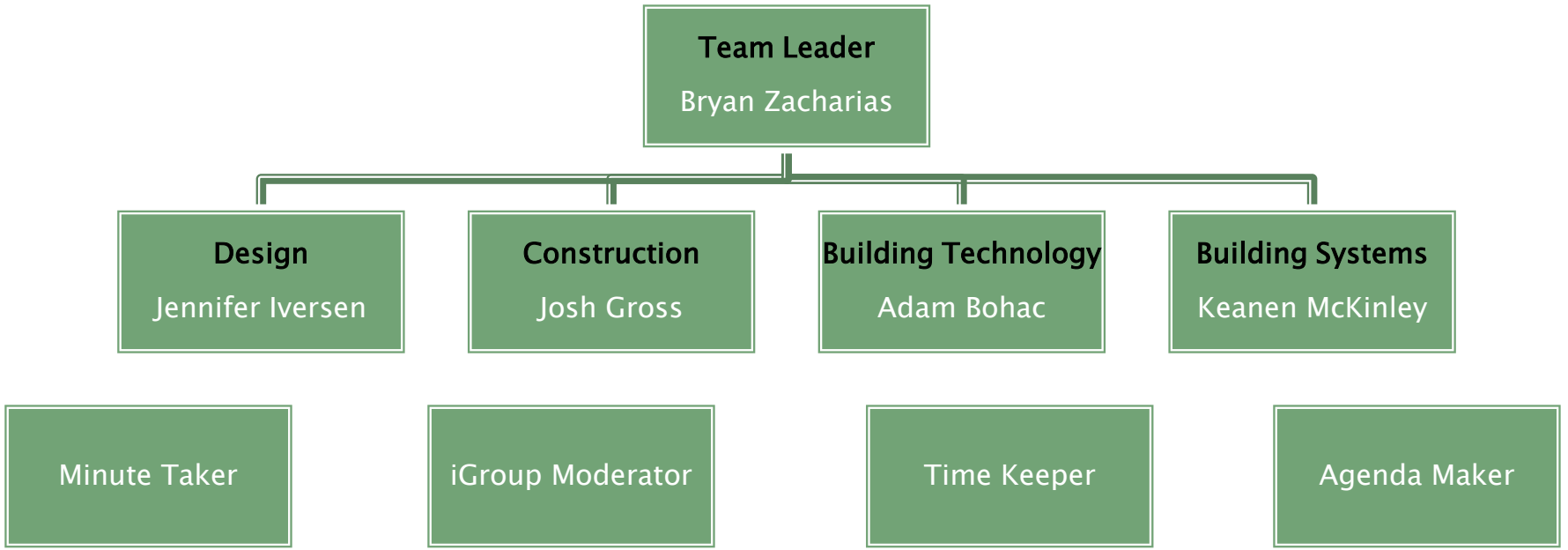
Mission

- Create a zero energy housing module which can expand to an entire community
- Encourage Chicago suburbs to reassess standards
- Influence sustainable planning of future communities

Team Development

- First semester for IPRO 323
- Create research base
- Team Organization
  - Team Leader
  - Subgroups
  - Individual Roles

Team Structure



Team Performance

- No project history
- Goals
  - Use new and existing technology to create a home that had zero net energy consumption
  - Design homes in a replicable module that can expand to an entire community
  - Make homes more efficient and comfortable
  - Examine established zoning and building regulations
  - Establish new guidelines for planning innovative sustainable communities
  - Document and present findings to Chicago area suburbs

Project Work

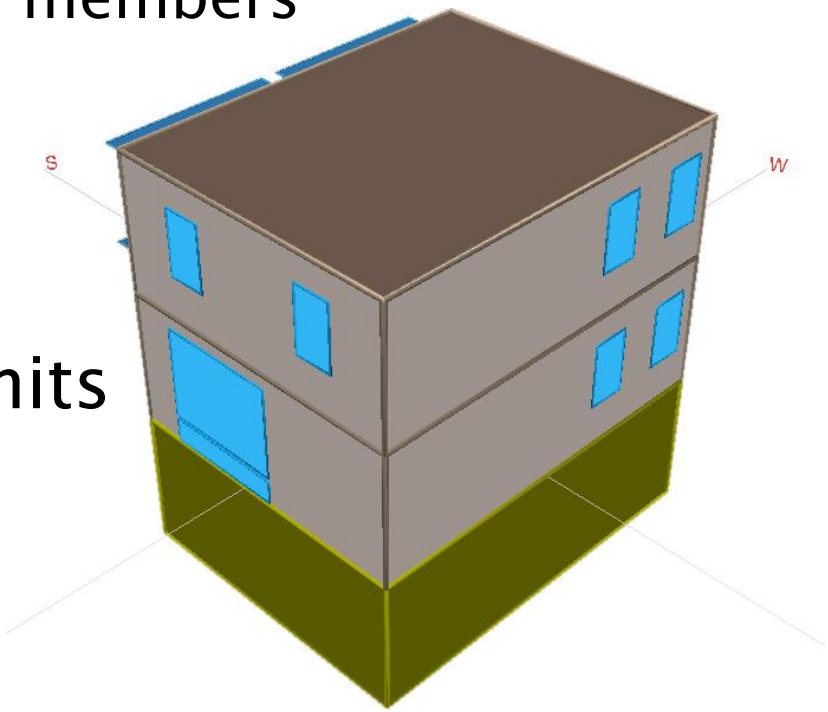
- Collaboration of each subgroup
- Demographics
- Average vs. Prototype Home
- Criteria
  - LEED
  - Energy Star

Problem Solving Techniques

- Problems
  - Multitude of systems
  - Using credible sources
  - Simulating solutions
  - Sharing information
  - Efficiency v. Price
- Solutions
  - Google Docs
  - eQUEST
  - Standardization of units

Specific Techniques

- Google Docs
  - Lists all systems by subgroup
  - Reduces overlapping research
  - Accessible to all group members
- Simulating solutions
  - eQUEST
    - Compare to average
    - Compare systems
- Standardization of units
  - Compare costs
    - Monetary
    - Energy



Problem Solving

- Cooperative process
  - All subgroups participate equally
  - Subgroups constantly advise one another
- Design for efficiency
  - Process based upon sustainability
  - Emphasis on reducing energy use
- Feedback loop
  - Solution is refined and reanalyzed with new information

PROCESS AT A GLANCE

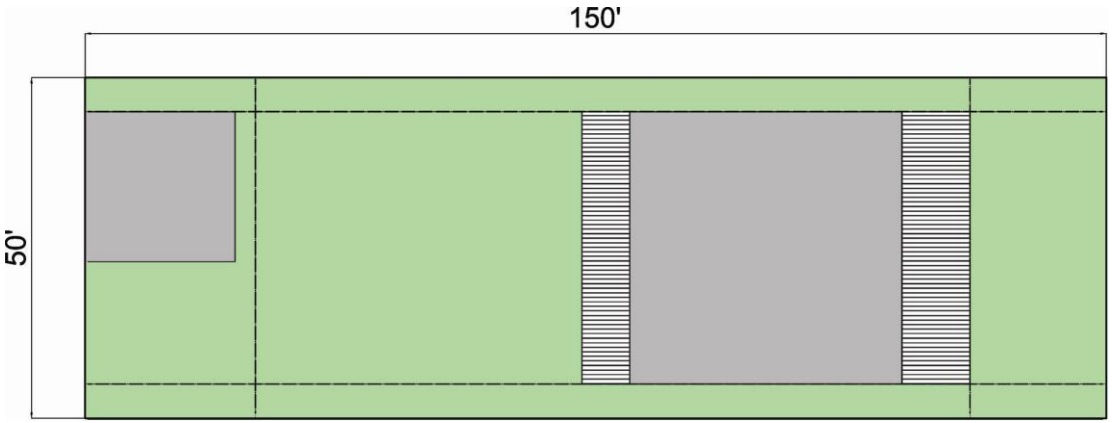
Demographics

Statistic	Oak Park	Evanston
Average Household Size	2.26	2.27
Average Family Size	3.06	3.03
Median Age	36	32
Median Income/Household	$74,614	$69,303
Median Income/Family	$103,840	$102,580
Per Capita Income	$36,340	$33,645
Children Under 18	29.5%	25.4
Married Couples	42.1%	40.4
Population	52,524	74,239
Families	12, 970	15,952

Zoning Analysis

Requirement	Oak Park	Evanston
Zoning District	R-5/ 2-family	R-4/ 2-family
Minimum Lot Size	5,000/ duplex	2,500/d.u.
Max Building Height	35 feet	35 feet or 2.5 stories
Max Impervious	65%	55%
Front Setback	20 feet	27 feet
Side Setback	5 feet	5 feet
Rear Setback	25 feet	25 feet

Similar Code



Average Home

- 3,000 square feet
- 2-Stories
- Wood-Stud construction
- Poorly insulated
- Small windows
- Inefficient use of space
- Does not take advantage of natural light or ventilation
- Antiquated mechanical systems and appliances

Prototype Site Concept

Typical block

- Narrow lots
- North-South alleys
- Restricted solar access
- Less daylight

Proposed Checkerboard

- Repurposed alley
- Large shared green space
- Increased solar access
- Improved ventilation

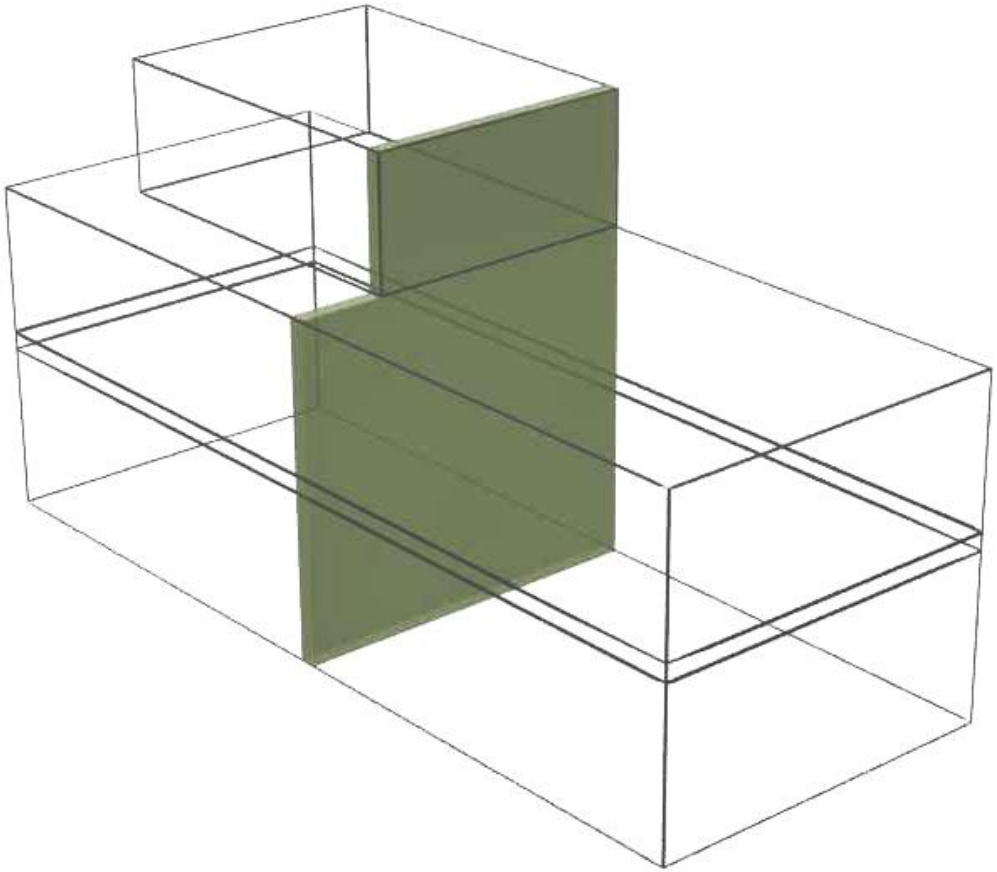
Module Planning…

Higher density with more green space

Full Site Planning…

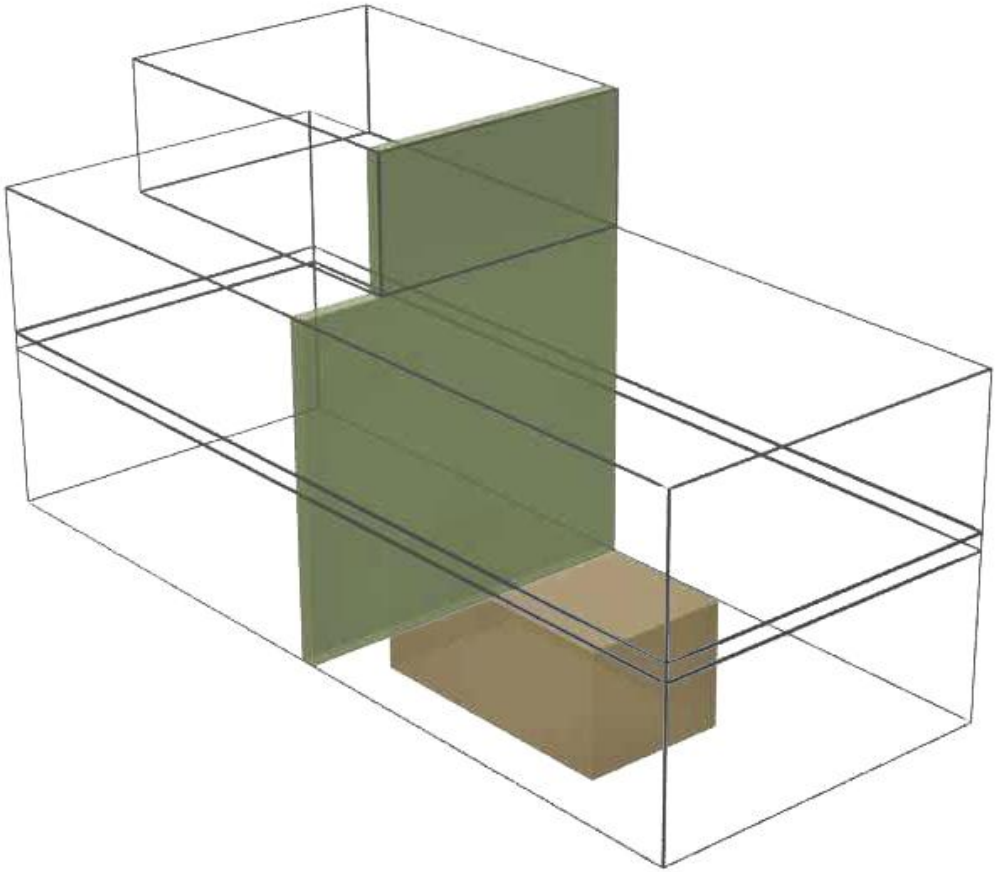
Enhanced CommunIITy through shared site features and green space

Prototype – Building Massing



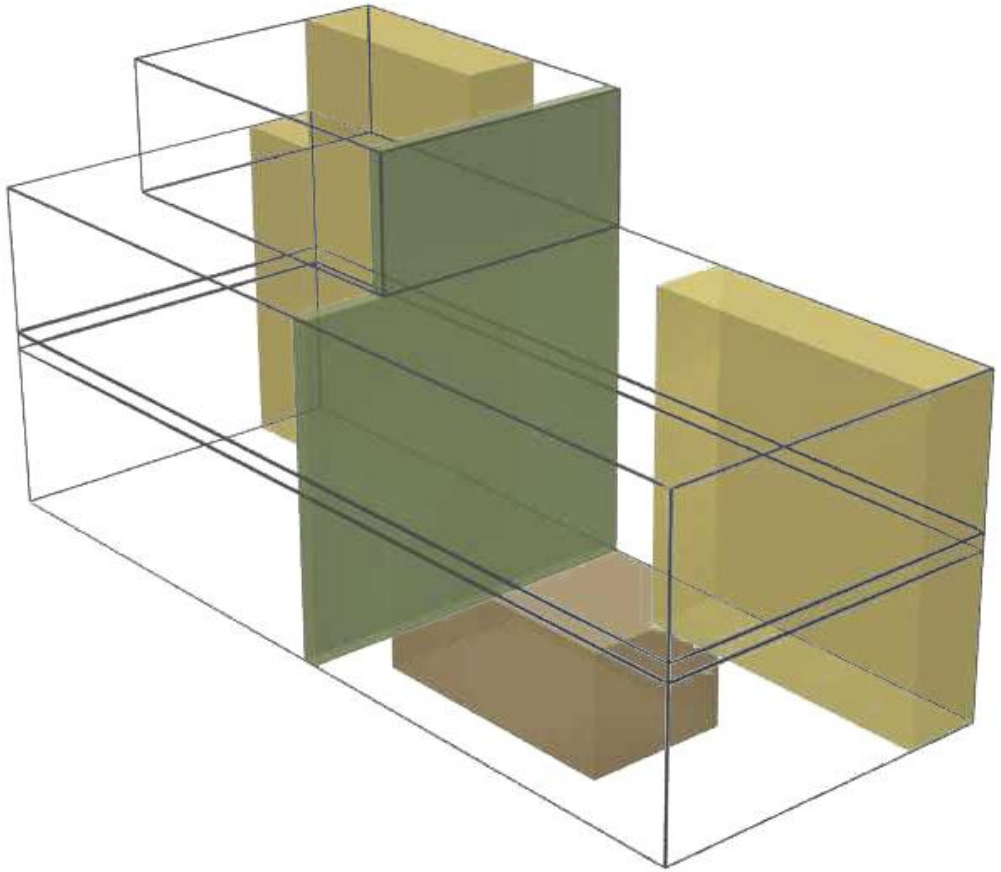
Shared Plumbing Wall

Prototype – Building Massing



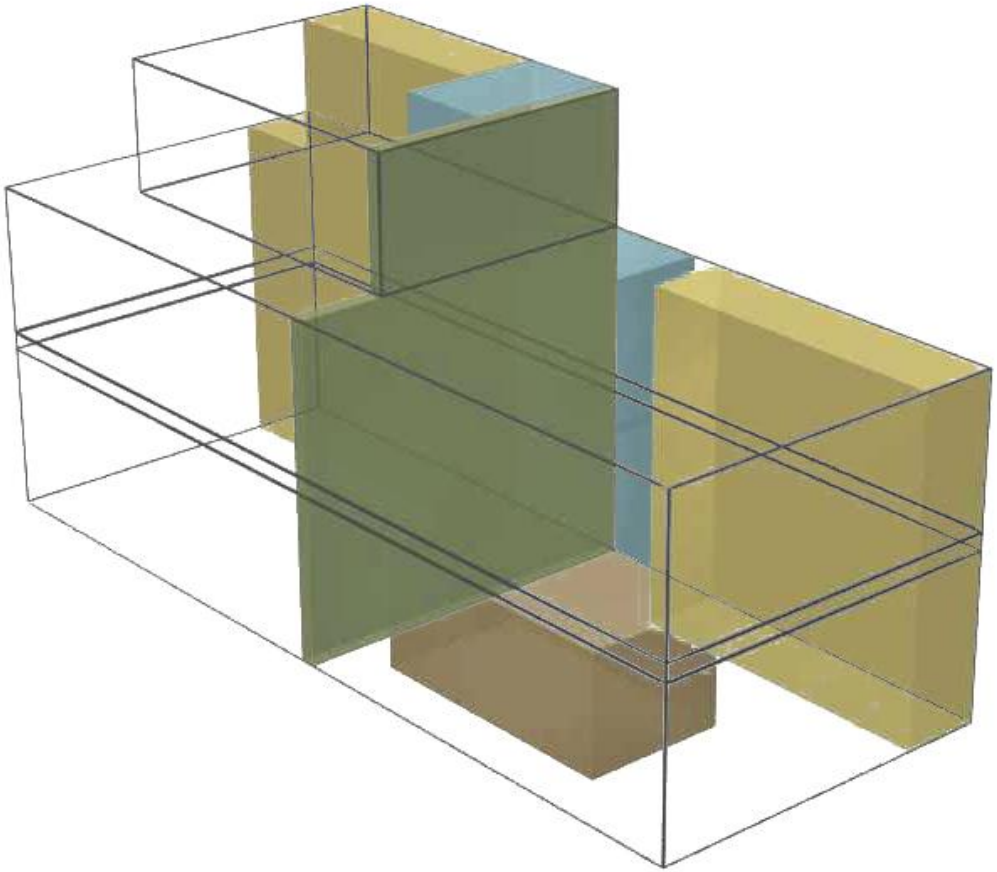
Common Basement

Prototype – Building Massing



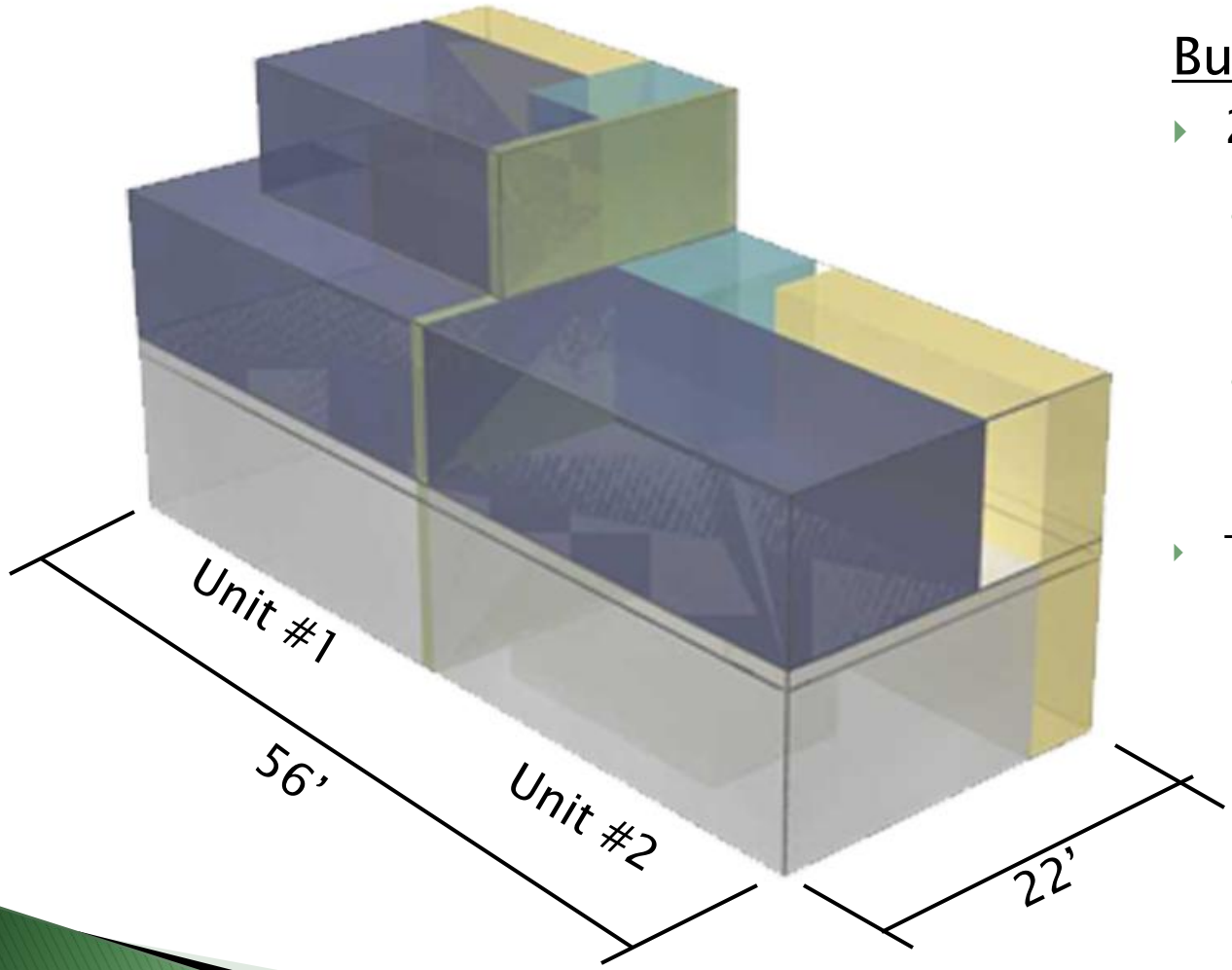
Circulation and Stack Ventilation

Prototype – Building Massing



Bathrooms

Prototype – Building Massing



Building Stats

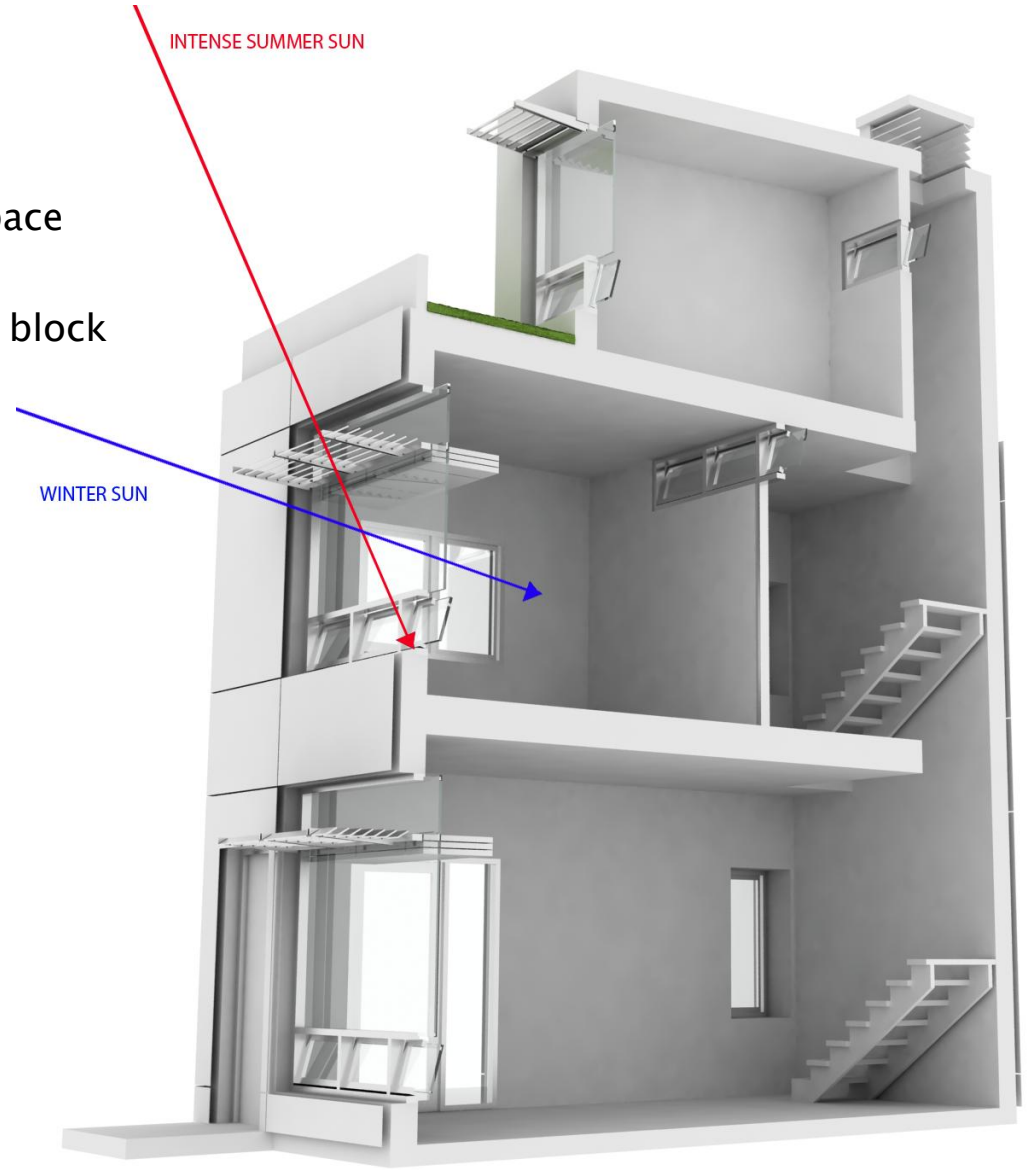
- 2 Dwelling units
  - 2 Bedroom

    @ 1500 sqft
  - 3 Bedroom

    @ 2000 sqft
- Total 3500 sqft

PASSIVE SYSTEMS:

- Solar Gain:
  - Winter – sunlight enters space
  - Summer – shading devices block intense sun

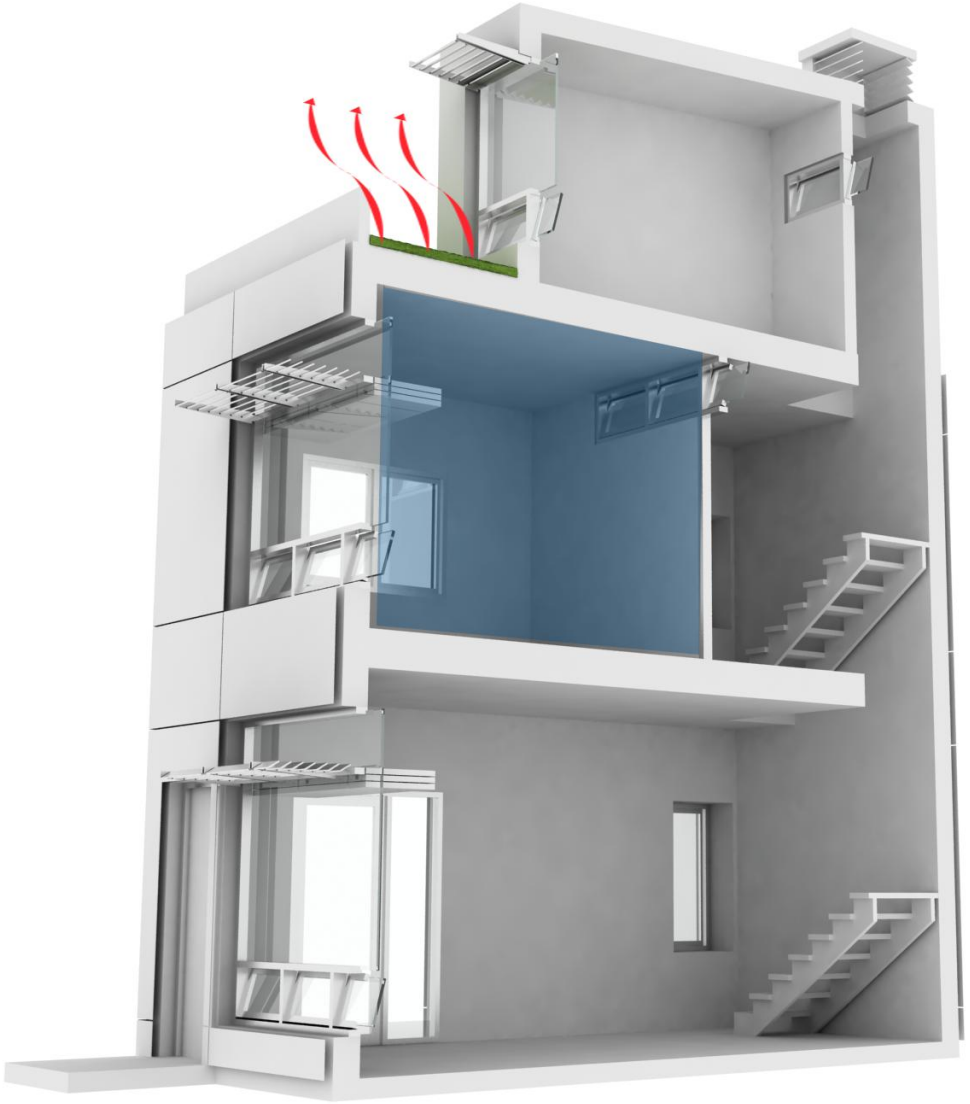


PASSIVE SYSTEMS:

- Ventilation:
  - Operable windows near floor
  - Clear-stories in bedrooms
  - Open-riser stair
  - Damper at top of stair

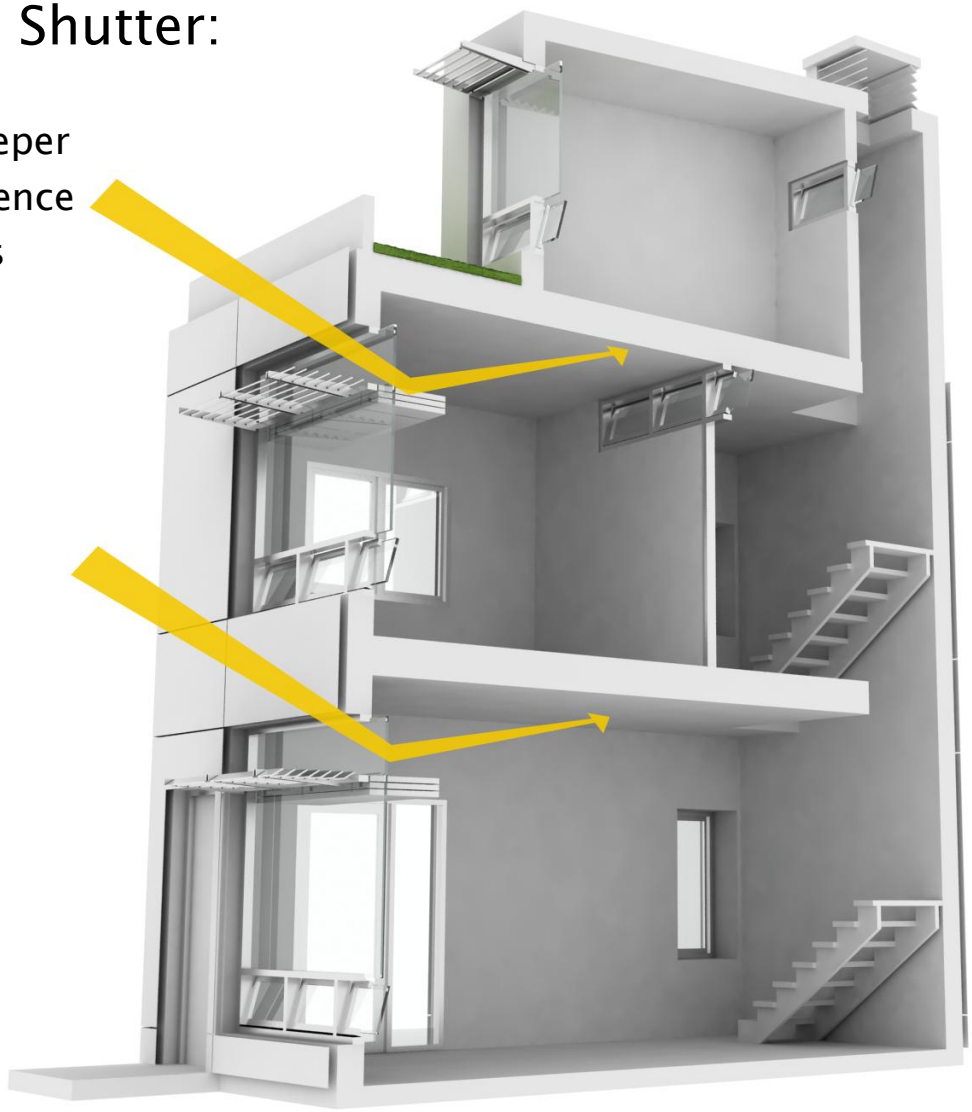
PASSIVE SYSTEMS:

- Green Roof:
  - Evaporative cooling



PASSIVE SYSTEMS:

- Light-shelf/Insulating Shutter:
  - Day: natural light brought deeper into rooms, reducing dependence on electric lighting, LED bulbs used when needed
  - Night: shutter covers glass to reduce heat loss



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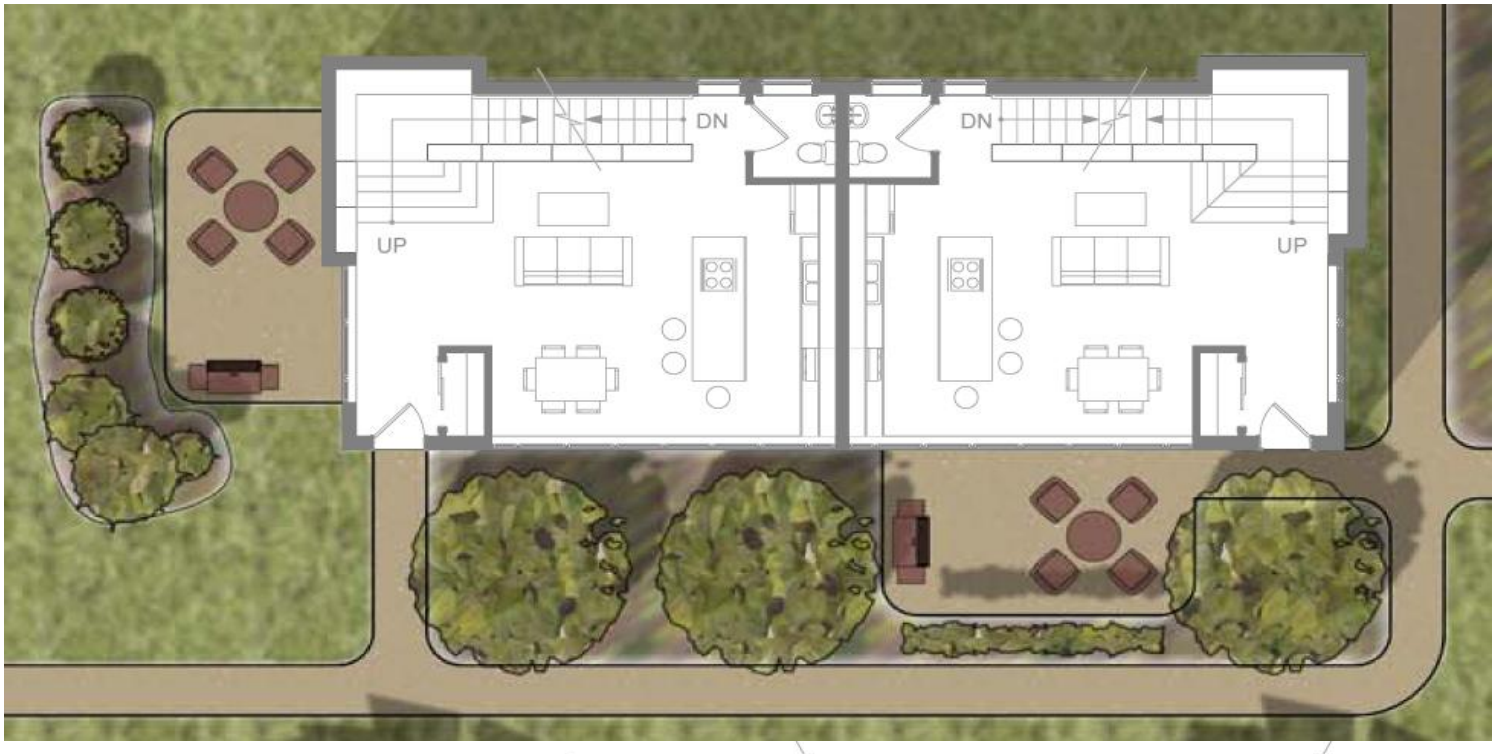
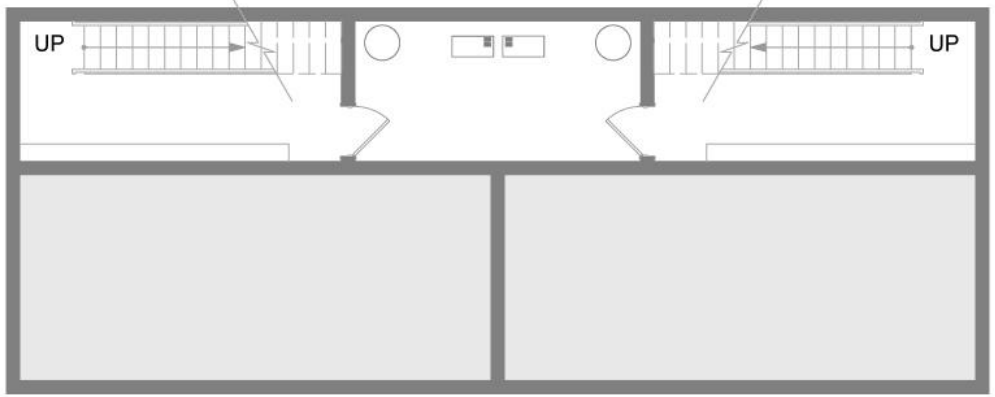
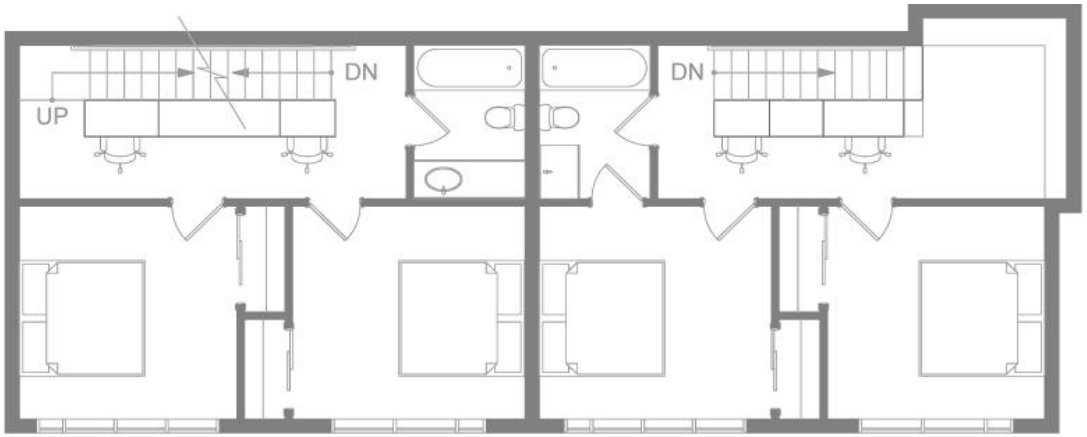
Floor Plans





Basement 490 SF

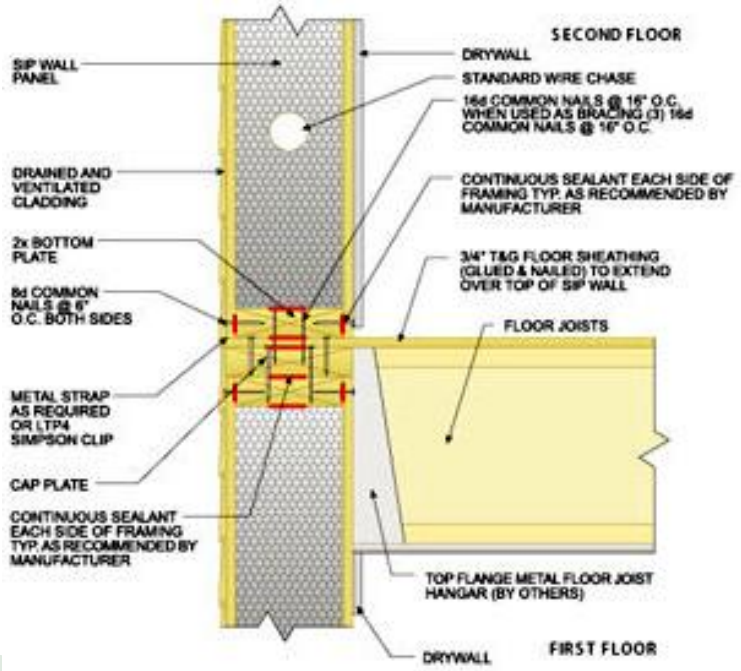
Floor Plans



Second Floor Plan 1259 SF

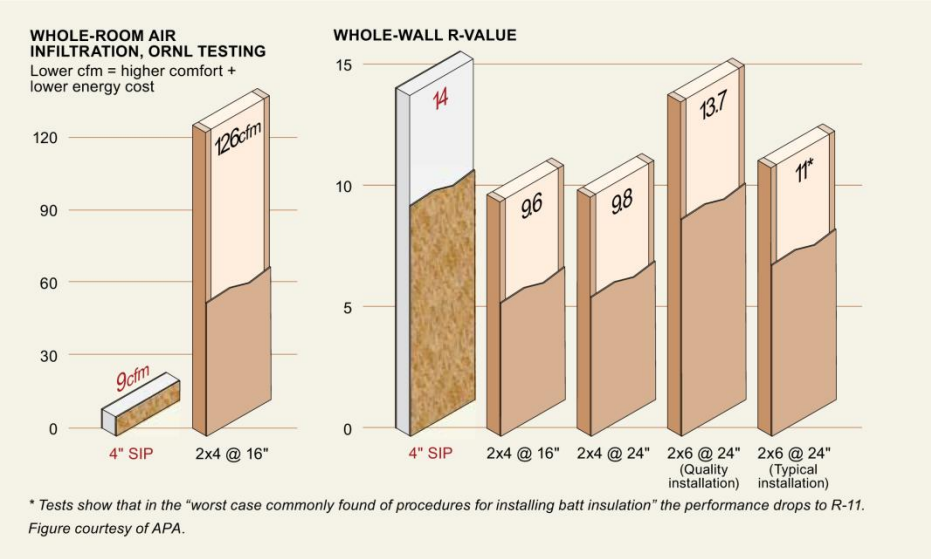
Third Floor Plan 375 SF

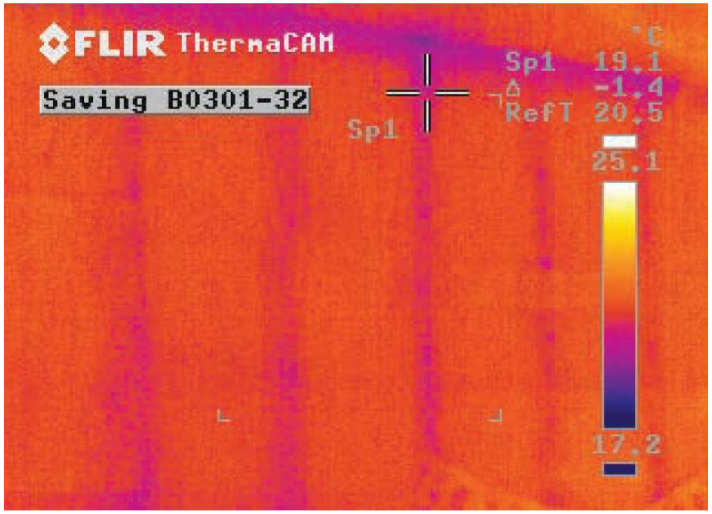
Structural Insulated Panels (SIPs)



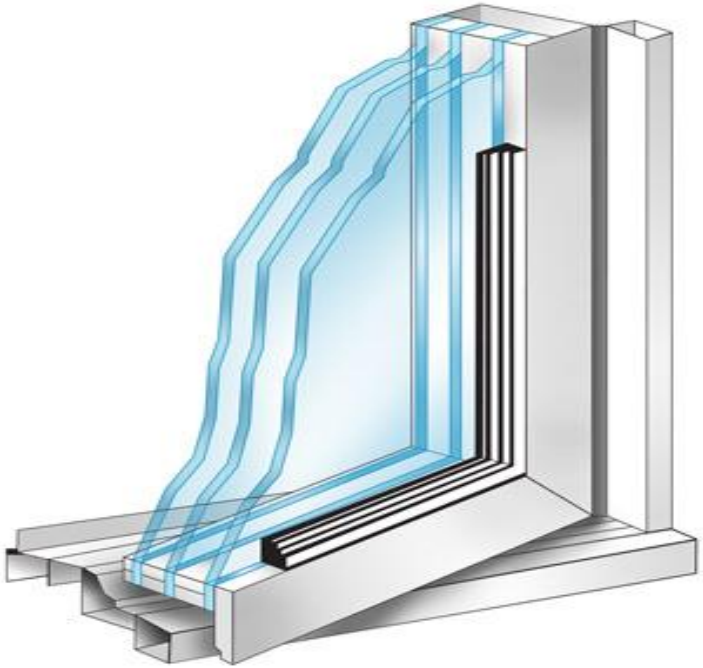
Structural Insulated Panels (SIPs)

- High R-Value
- Low air infiltration
- Can provide 50% annual energy savings
- Improves indoor air quality
- Reduces construction waste
- Made from sustainable, low cost, materials
- Requires 24% less energy to produce than fiberglass insulation





Gas-Filled Windows



- Low-E gas reduces heat transfer
- Applicable to standard windows
- Non-toxic, transparent, odorless
- Argon: low cost (~$0.12/ft^3)

	Average Home Single Pane	Prototype Home Triple Pane Argon
Heat Transfer (kW)	**7313**	**29**
Yearly Cost	**$6,854.00**	**$27.18**

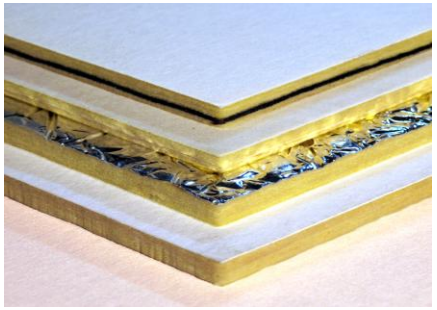
Reduces heat transfer by ~99% →→→ $$$

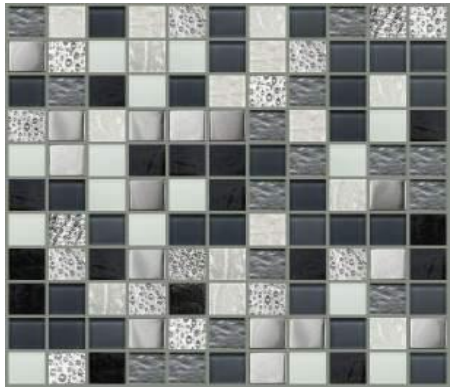
Green Roof

- Reduces water runoff
- Reduces heat island
- Protects roofing from sun and environment increasing roof life
- Reduces heat gain from sun
- Cools building due to evapo-transpiration
- Attractive

Sustainable Finishes

- Use recycled or naturally abundant materials
- Require less energy to produce
- Improve indoor air quality





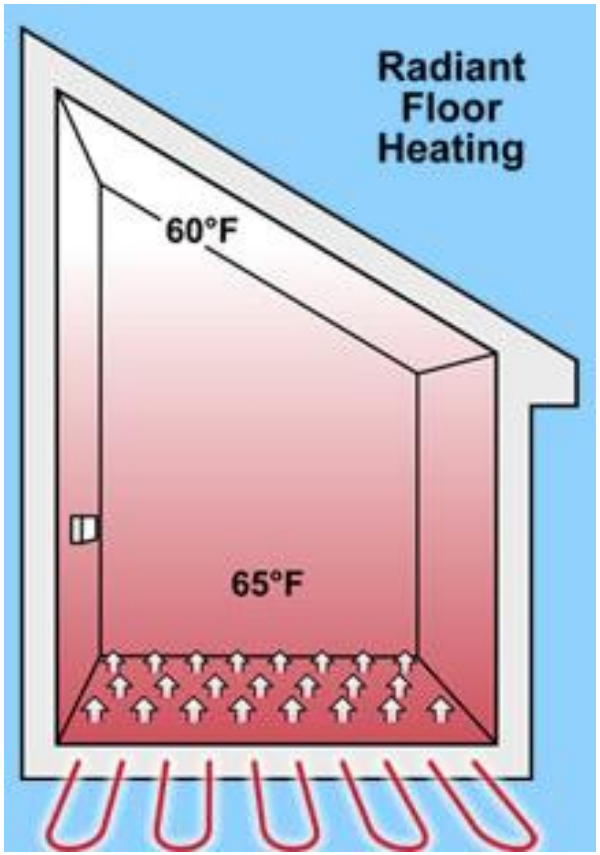
Active Systems Utilized

- Geothermal Heat Pump
- Radiant Floors
- Grey Water System
- Solar Thermal
- Photovoltaic Panels

Geothermal

- Vertical Loop
  - Disturbs less surface area
  - Ideal for densely populated areas
- Drilled 150-300 ft deep
  - Low maintenance cost
  - Protection from weather and vandalism
- Temperatures are more stable

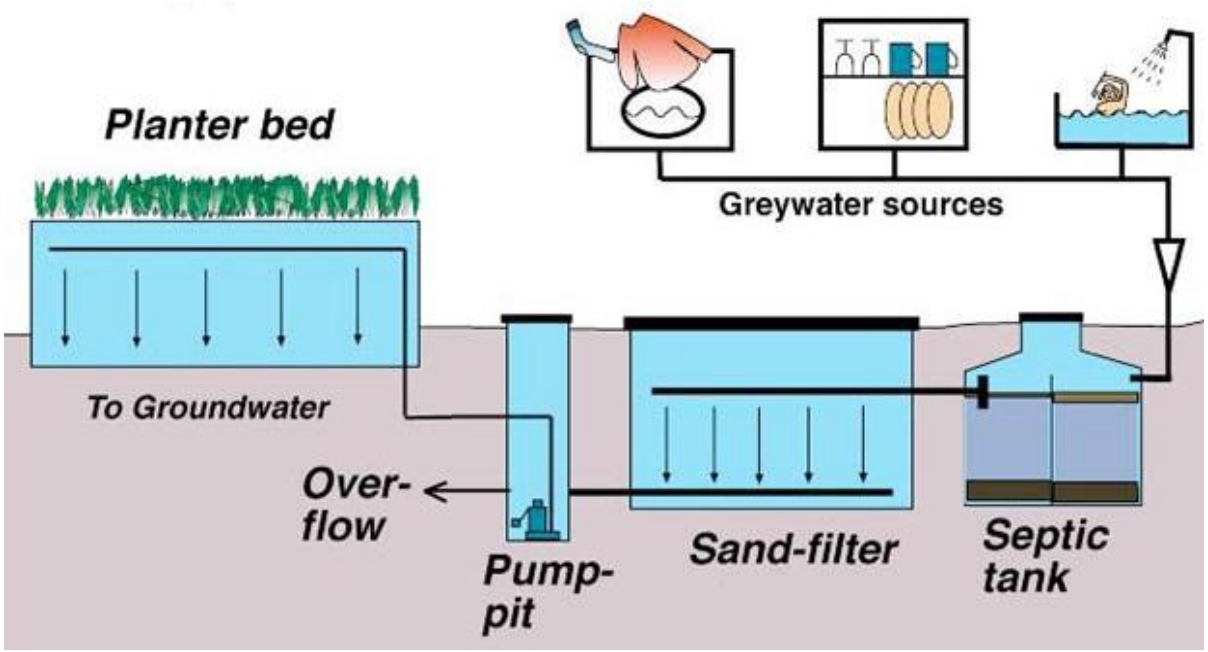
Radiant Floors



- Better than Forced Air Heating
  - Doesn't use air as a heating medium
  - Directly heats objects
- Perceived temperature is higher
- Heating components are built directly into the flooring
- Works on the principle that heat rises

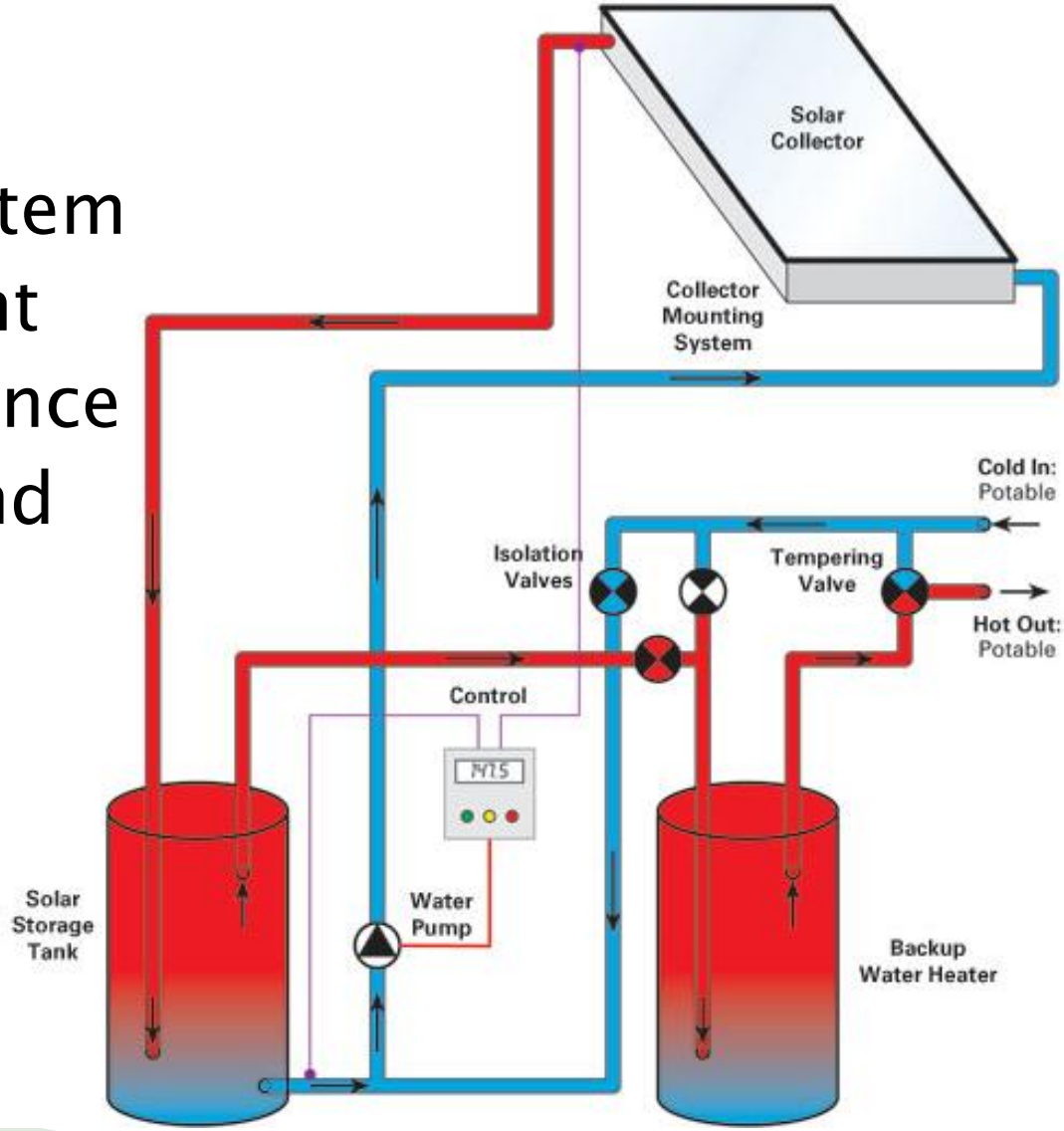
Grey Water Systems

- Reduces water waste
- Not to be confused with “black water”



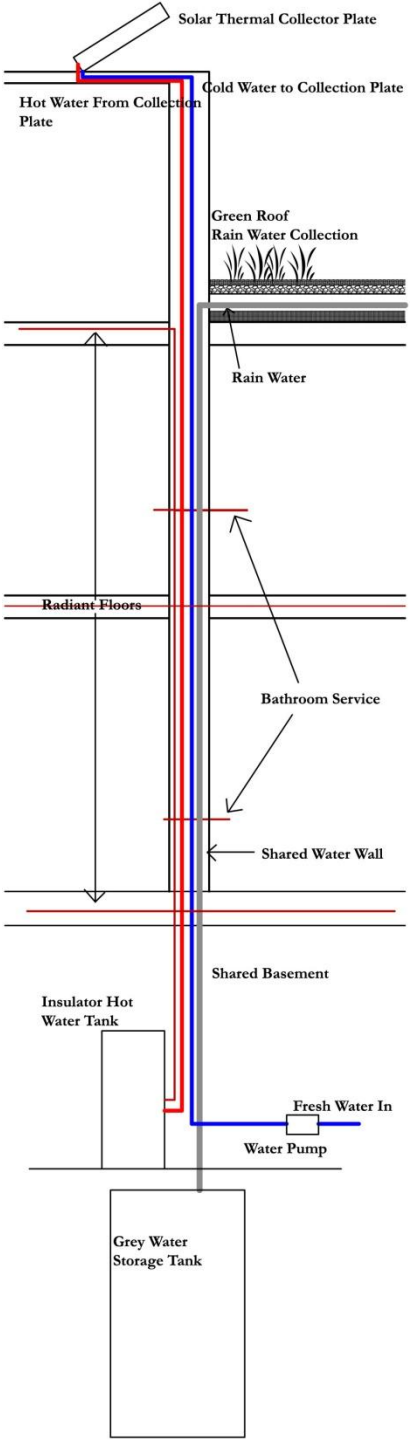
Solar Thermal

- Closed loop drainback system
- Freeze tolerant
- Low maintenance
- Low profile and lightweight

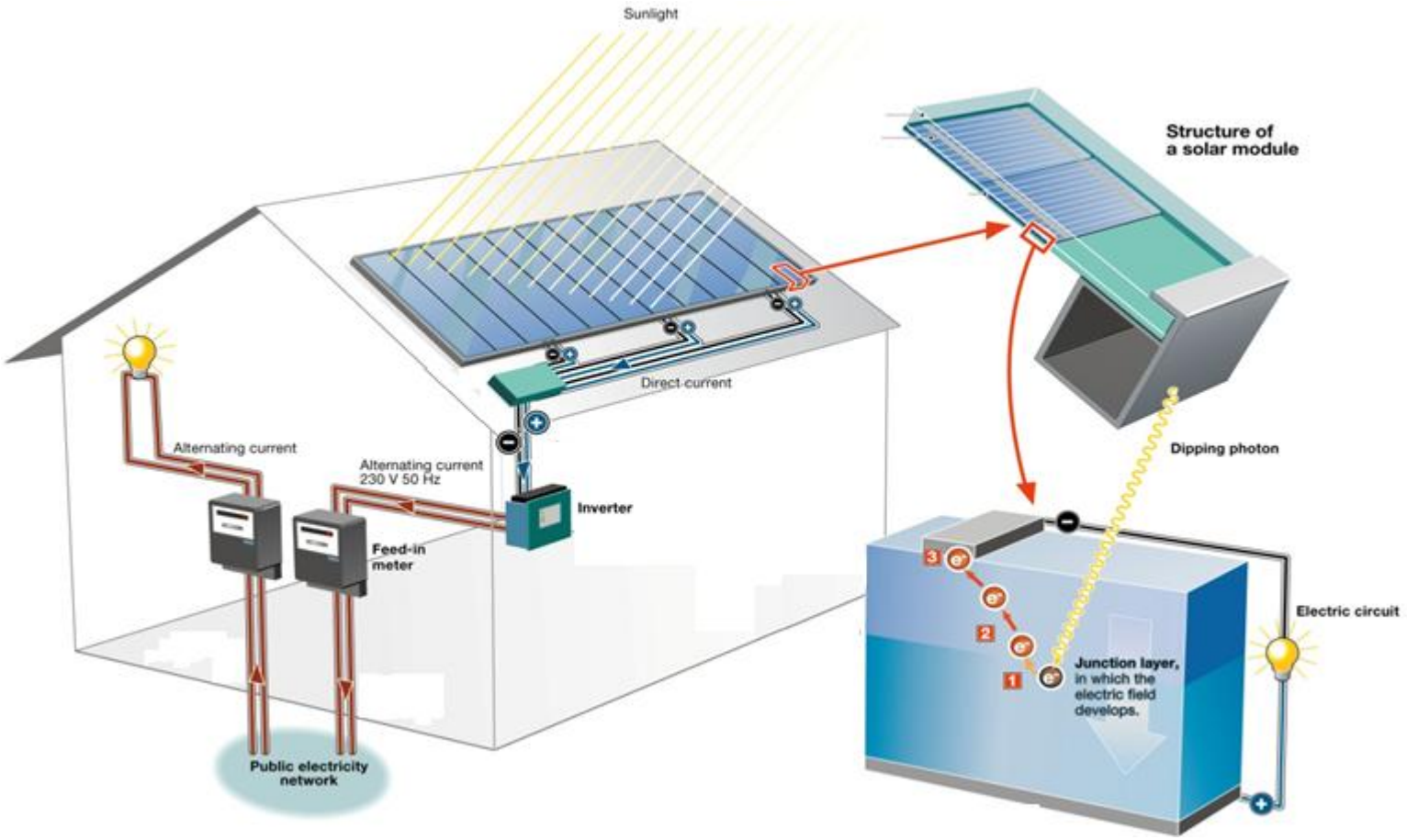


Shared Wall

- Shared wet wall
- Hot water collected
  - Water
  - Spaces
- Green roof filters rain
  - Grey water
  - Landscaping
- Integrated systems reduce waste



Photovoltaic Panels



PV System Flowchart

PV Panels
Installed on the carport roof, tied together in series for inverter input volatge range

$25026.00

PV OUTPUT:
10080 W max
230-500 VDC
53.3A max

DC DISCONNECT
For maintenance and safety

$263.00

GRID-TIE INVERTER
Converts DC to AC

Acts as a controller
Uses maximum power point tracking for greatest efficiency.

Does not allow reverse current flow.

Outputs power in phase with ComEd

$7000.00

INVERTER OUTPUT:
240 VAC
47.5A max output
10080 W max output
7257 max kw/hr per month

AC DISCONNECT
For maintenance and safety

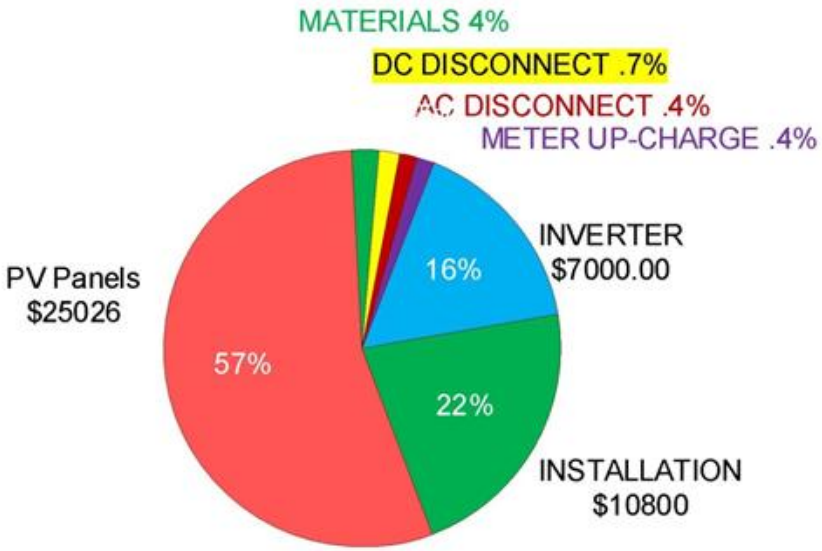
$197.00

NET METER

Will track net power in both directions.

Upcharge from ComEd $50.00

PV Economics



TOTAL COST =
$42566.00

MONTHLY PRODUCTION

(210 W ea. unit) x
(48 units)x
(10/24 hours of sunlight)x
(720 hrs/mo)

= 3019 KW*hr per month

MONTHLY ELECTRIC BILL SAVINGS

($.107 Kw*hr) x
(3019 Kw*hr)

= $323.03 per month

PAYBACK TIME

($42566.00) /
($323.03 per mo.)x
(12 mo/year)

~ 11 years

Average Home

TOTAL YEARLY ELECTRIC CONSUMPTION

21,200 kWh

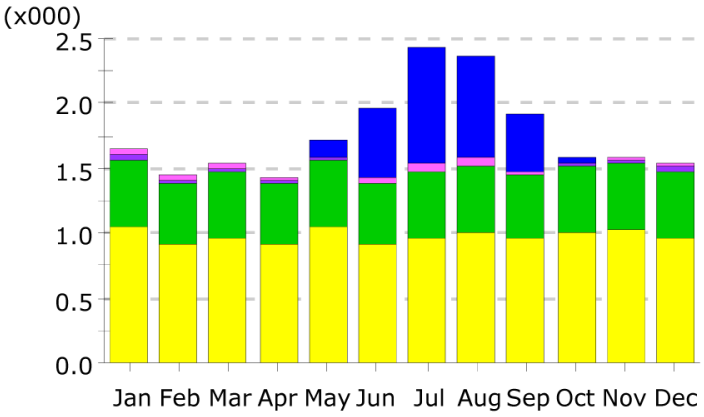
TOTAL YEARLY GAS CONSUMPTION

26,400 kWh (converted from Btu)

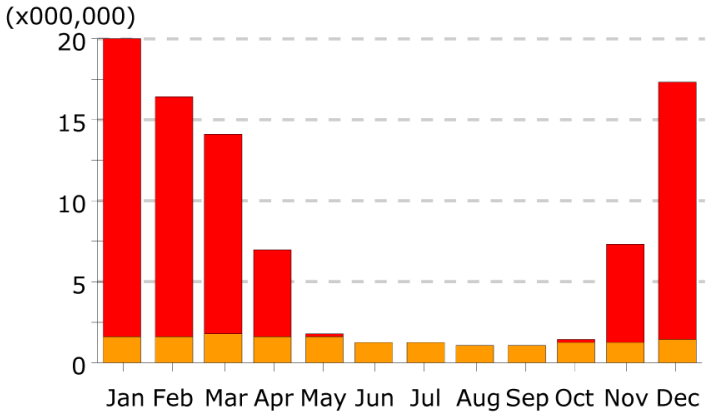
GRAND TOTAL

47,600 kWh

Electric Consumption (kWh)



Gas Consumption (Btu)



Area Lighting
Task Lighting
Misc. Equipment
Exterior Usage
Pumps & Aux.
Ventilation Fans
Water Heating
Ht Pump Supp.
Space Heating
Refrigeration
Heat Rejection
Space Cooling

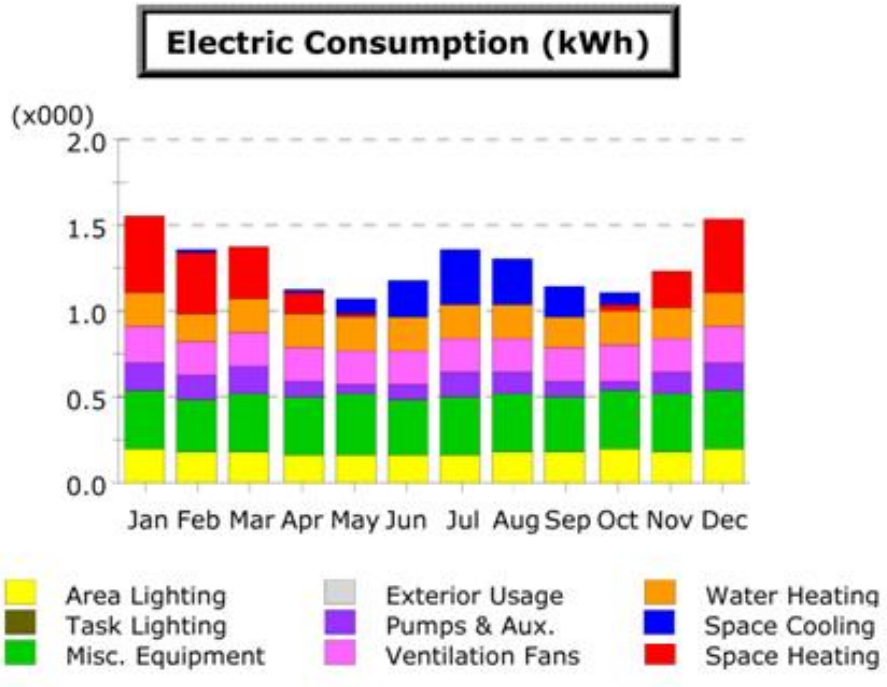
Prototype Energy Consumption

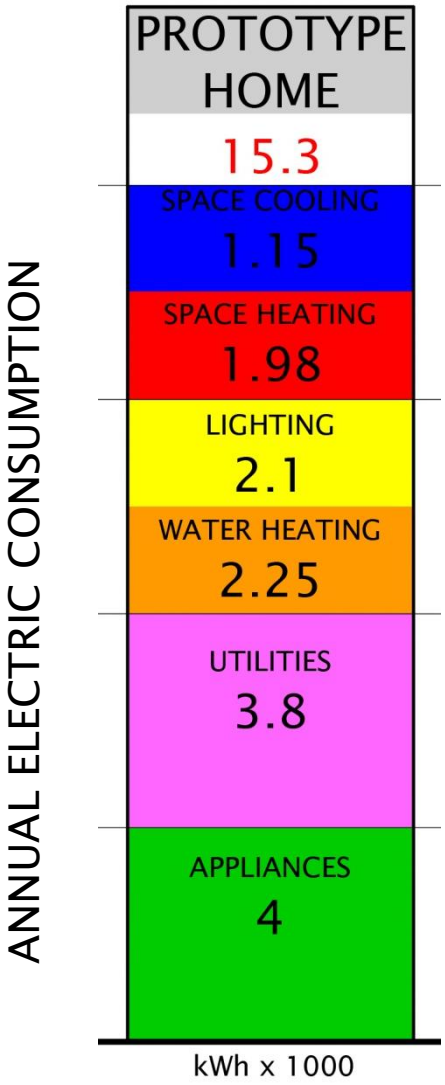
ANNUAL ELECTRIC CONSUMPTION

15,300 kWh

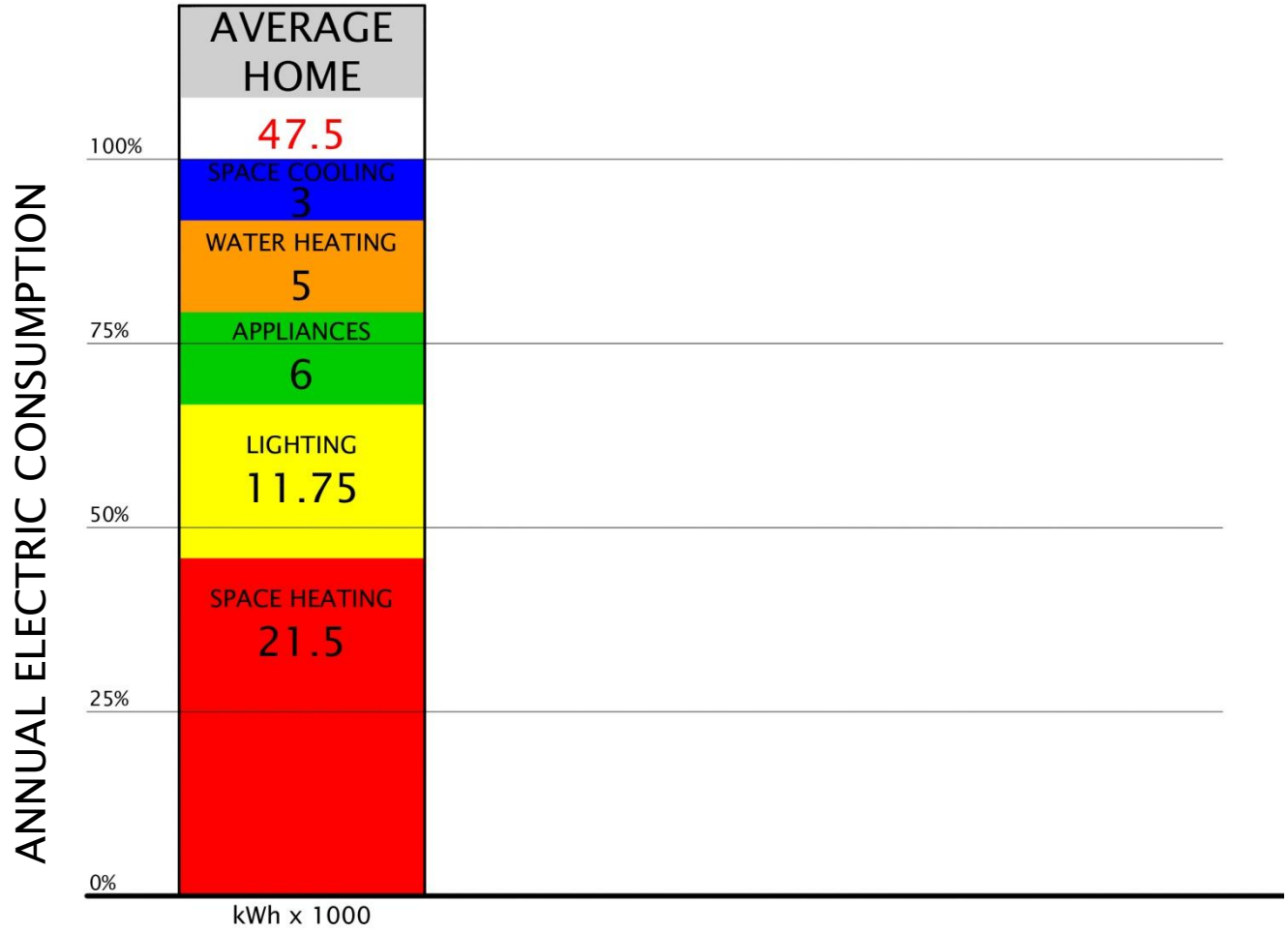
ANNUAL GAS CONSUMPTION

0 kWh (converted from Btu)





Energy Comparison



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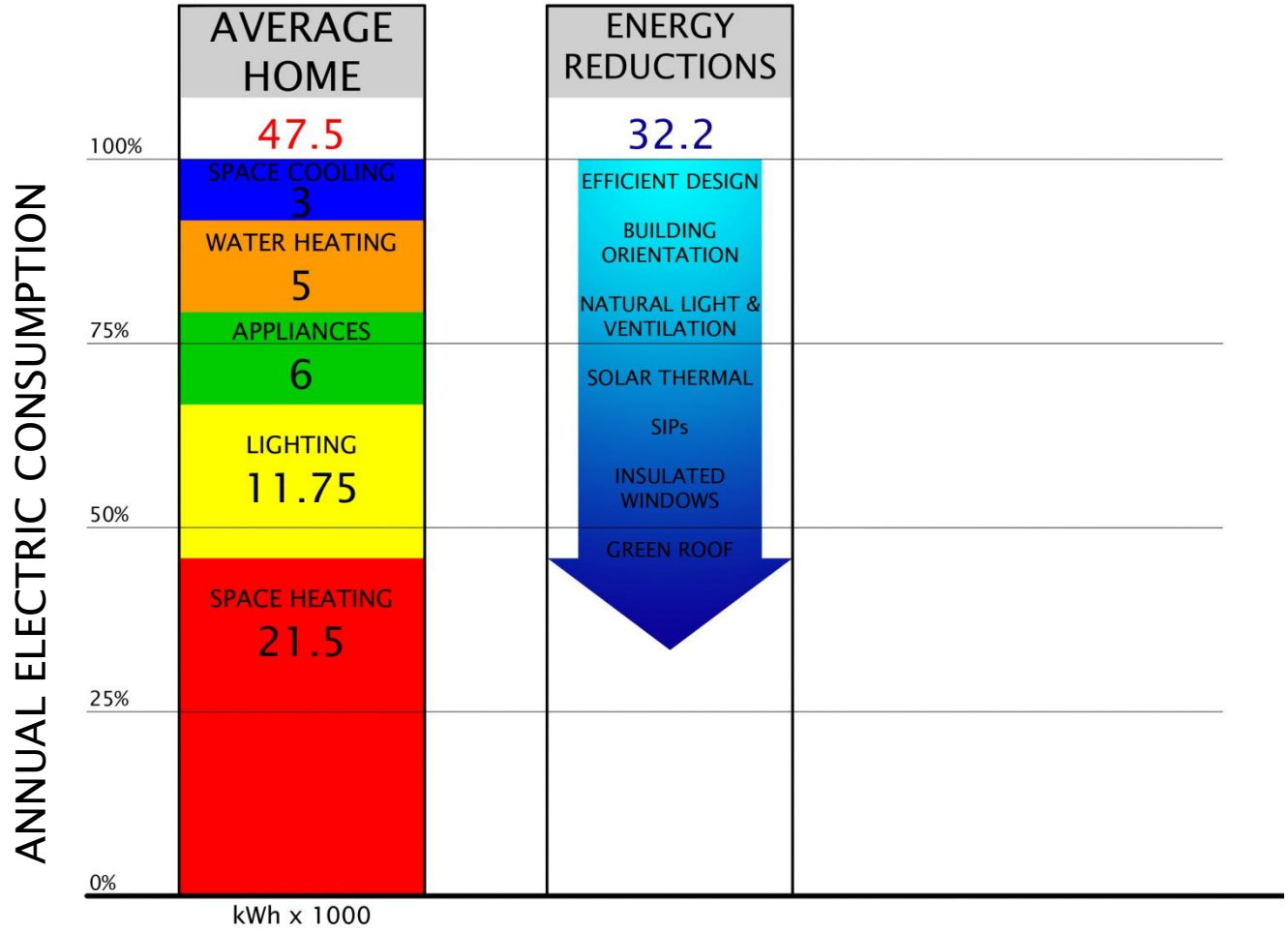

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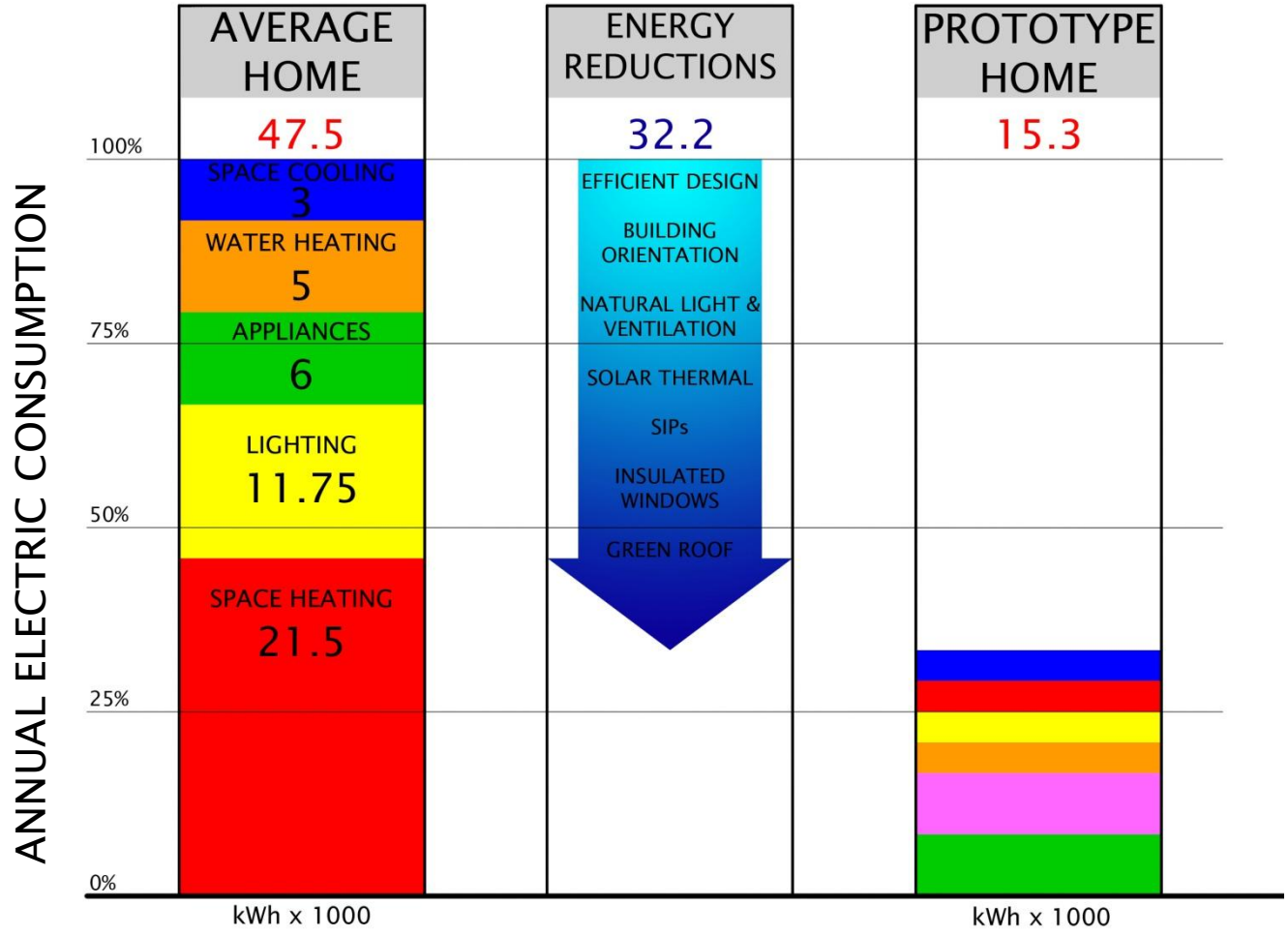
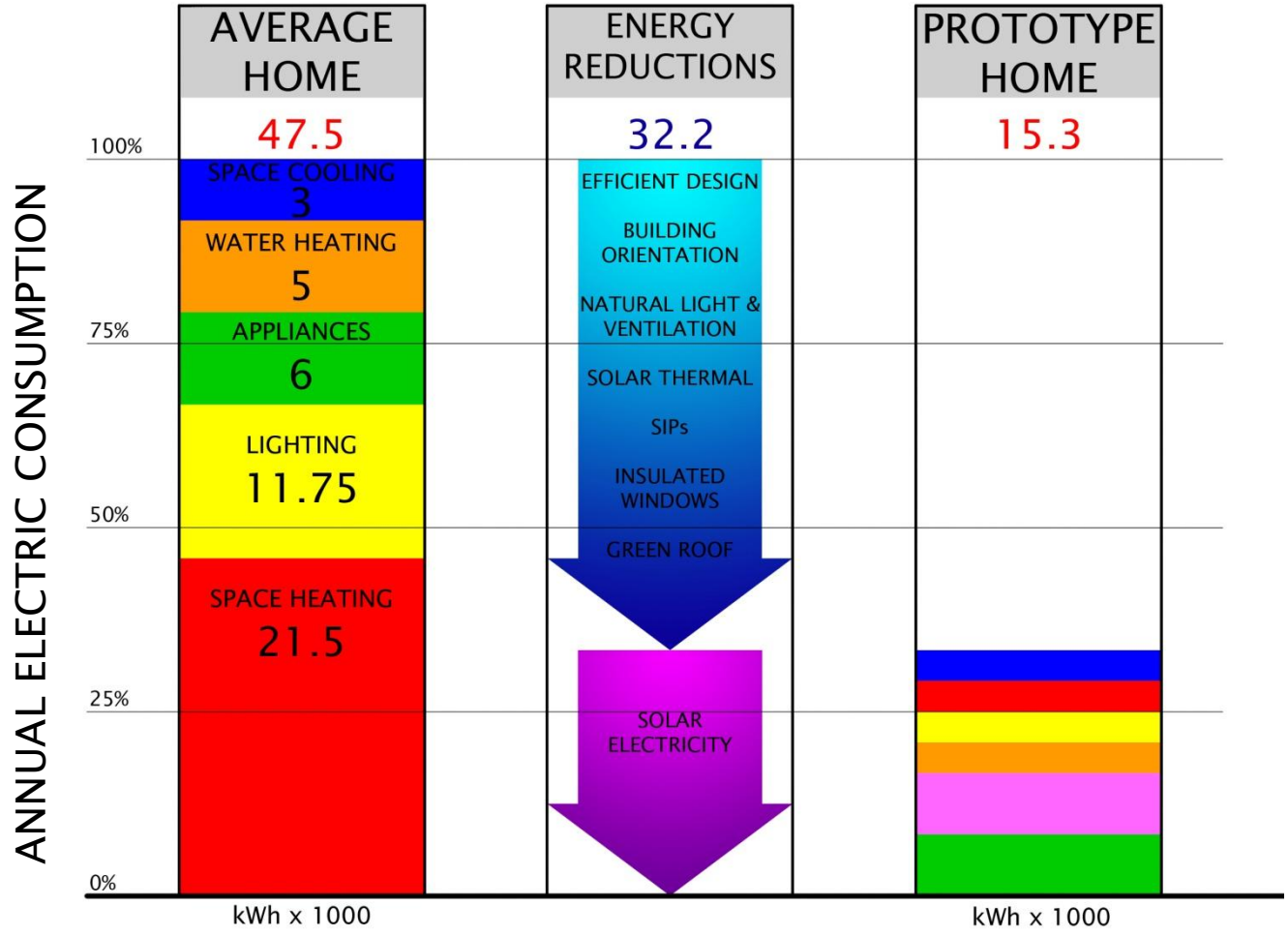


Energy Comparison



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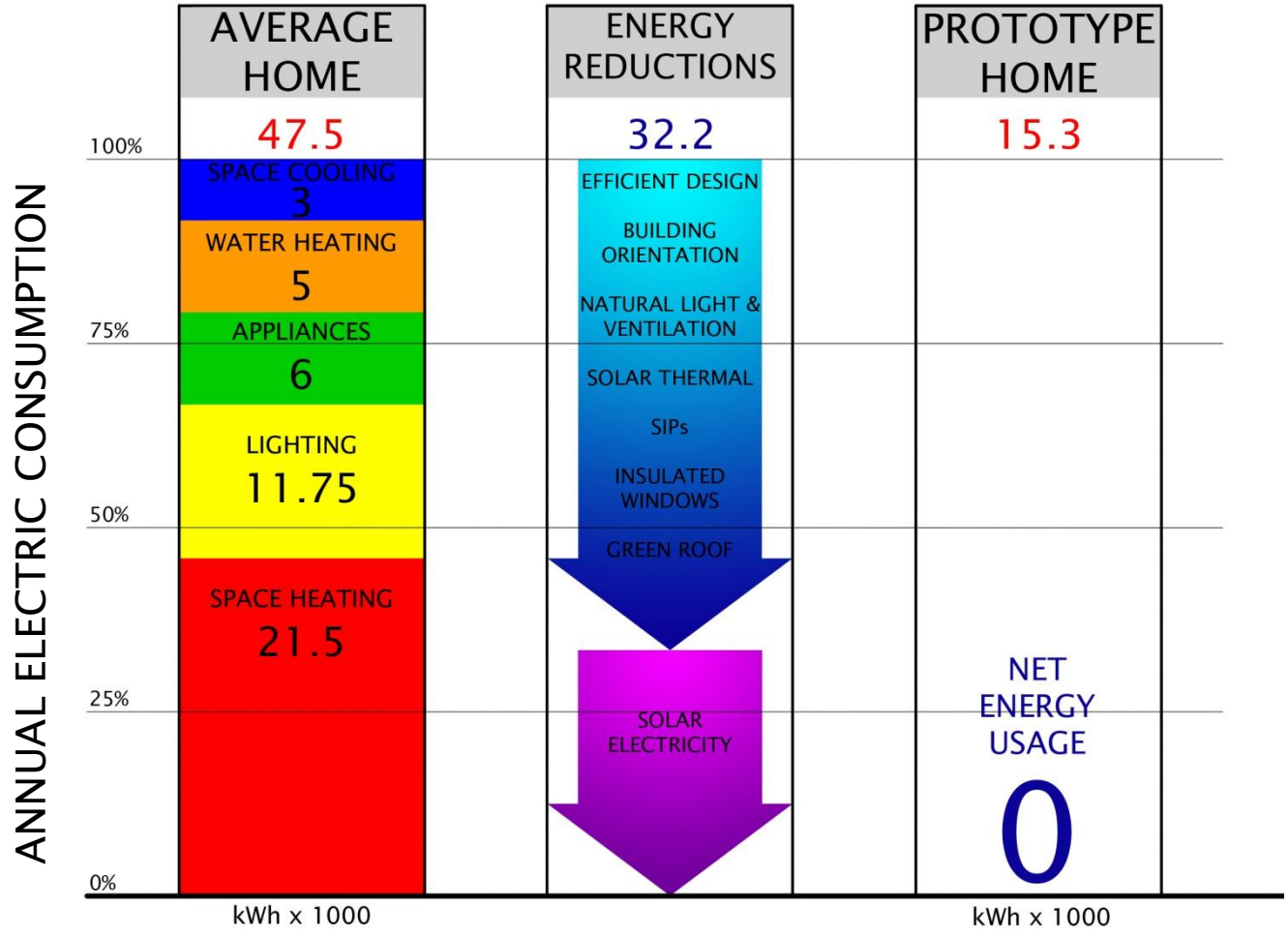


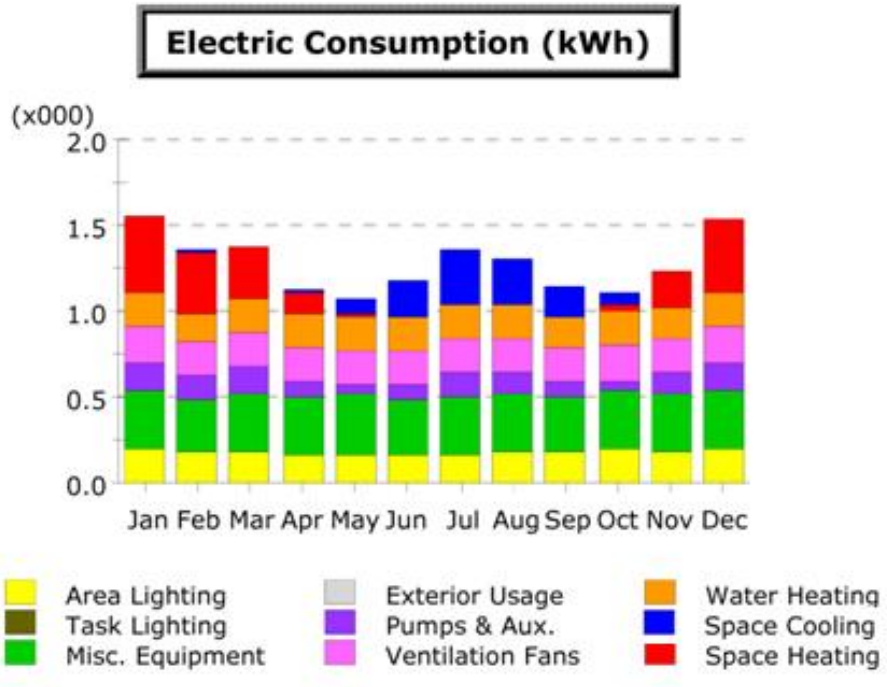
Prototype Energy Consumption

ANNUAL ELECTRIC CONSMPTION

15,300 kWh

ANNUAL GAS CONSUMPTION

0 kWh (converted from Btu)



AVERAGE VS. PROTOTYPE

AVERAGE ANNUAL USAGE

47,600 kWh

PROTOTYPE ANNUAL USAGE

15,300 kWh

SAVINGS

32,300 kWh

@ $0.107

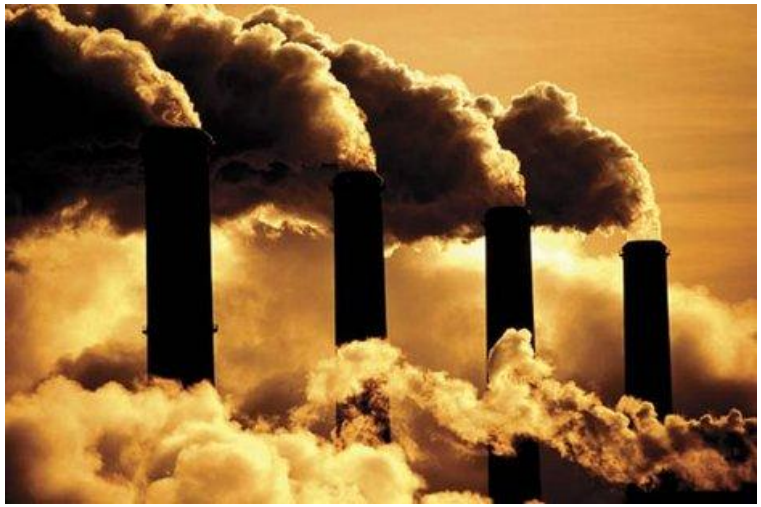
$3,456/year

OVER A 30 YEAR MORTGAGE

$188,611

Carbon Offset

One pound of coal produces 1.22 kWh



COAL SAVED BY PROTOTYPE

kWh SAVED

32,300

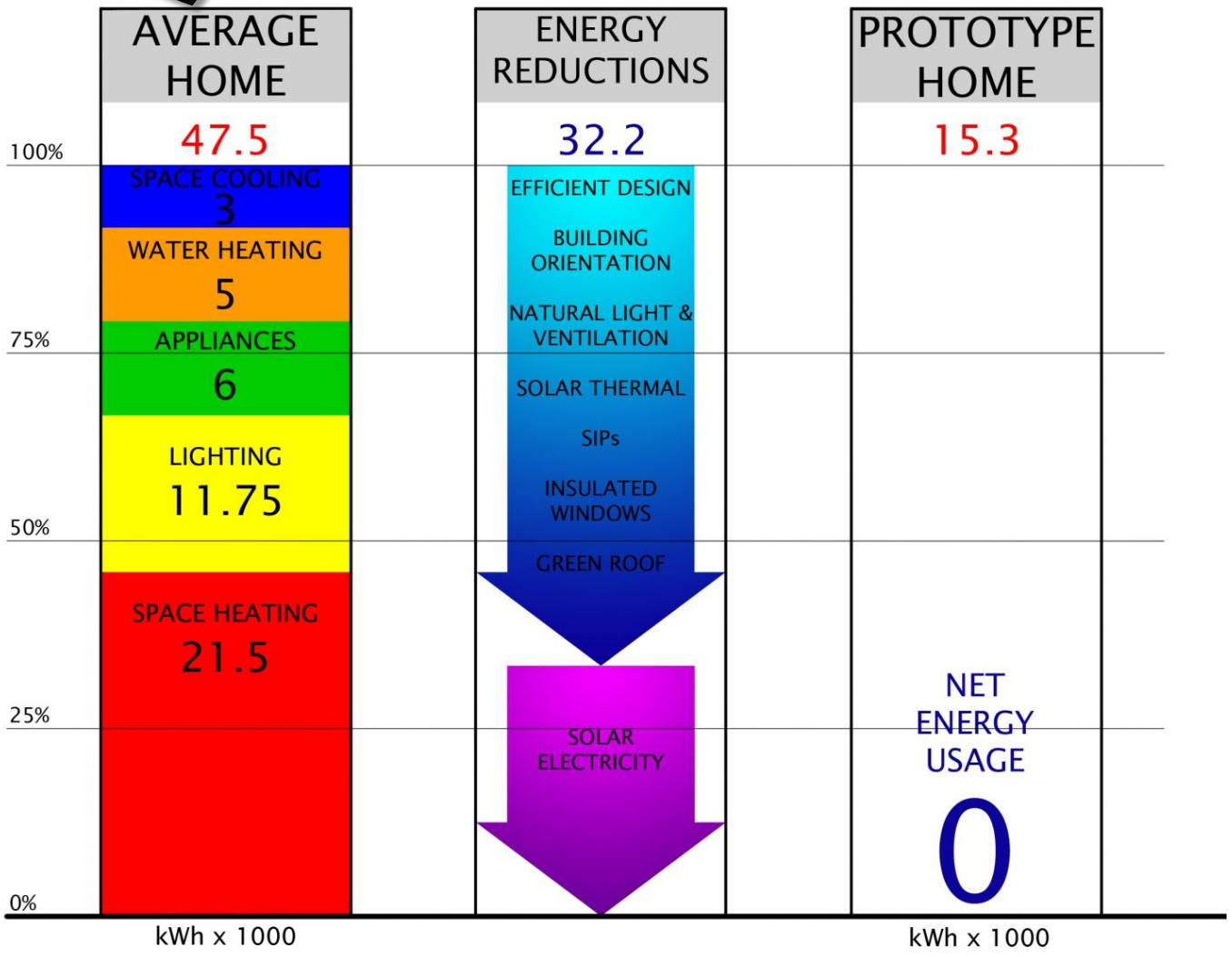
/1.22 POUNDS OF COAL

26,475 lbs coal/ year

Conclusion

- Multidisciplinary approach
- Design for efficiency
- Enhance green space and community
- Reduce infrastructure costs
- Reduce energy consumption
- Produce all energy on site (no gas)
- Use sustainable materials and methods
- Greatly reduce carbon emissions

QUESTIONS?


AVERAGE HOME
47.5
SPACE COOLING
3
WATER HEATING
5
APPLIANCES
6
LIGHTING
11.75
SPACE HEATING
21.5
100%
75%
50%
25%
0%
kWh x 1000
ENERGY REDUCTIONS
32.2
EFFICIENT DESIGN
BUILDING ORIENTATION
NATURAL LIGHT & VENTILATION
SOLAR THERMAL
SIPs
INSULATED WINDOWS
GREEN ROOF
SOLAR ELECTRICITY
PROTOTYPE HOME
15.3
NET ENERGY USAGE
0
kWh x 1000