Embracing Limits

Jack London Gateway

900 Market Street Oakland, CA 94607

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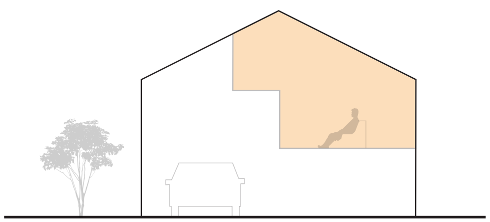
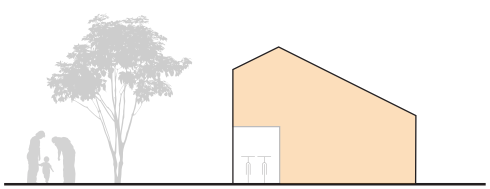
Part 1: Design introduction

Part 2: Energy performance

Part 1: Design Proposal

Introduction

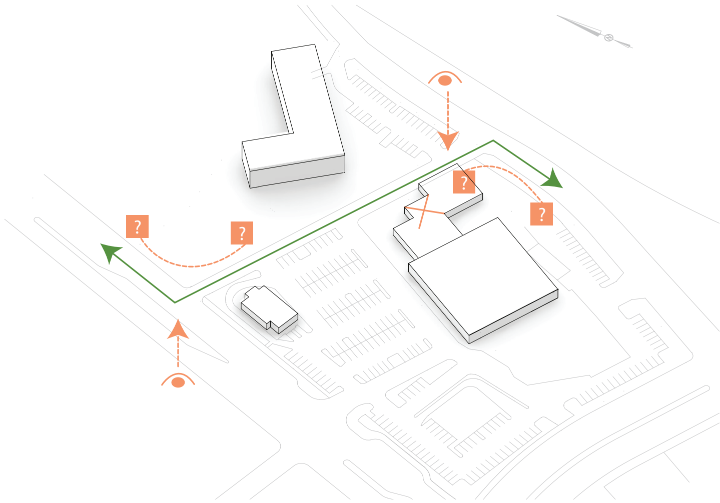


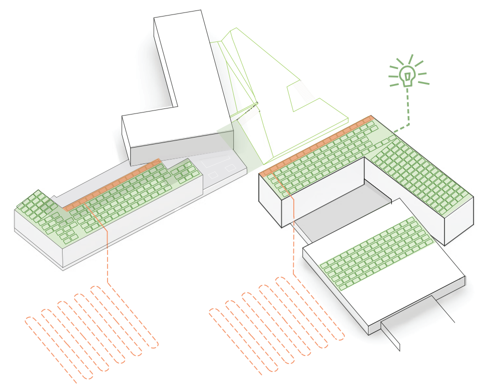


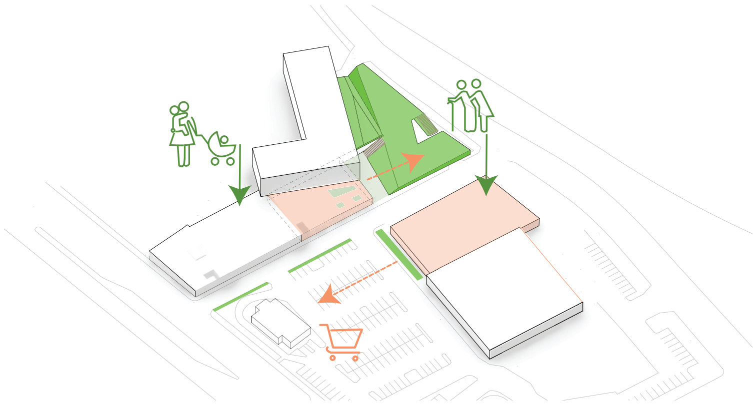
Technology, especially the INTERNET, encourages people to believe the world's resources are unlimited and that infinite consumption will make our lives better. The proposed design examines an alternative to such a commonly held belief system. Our design suggests that contentment can be achieved by embracing limits. We envision developing a modern and interdependent village. One that will supply it's own energy as well as provide basic/necessary services for the residents and for the community at large.

Energy Self Sufficiency:
The project achieves Zero Net Energy through conservation and advanced technology. Efforts to conserve begin at the building cell level. The rooms are compact. Leaving less distance between units in order to create more space for outdoor communal areas. Thus the energy that would have been used to heat and cool excess surplus space becomes unnecessary. The units are developed based on a 11'-6" module which allows for flexibility and layout variations. The concept is also adaptable to prefabrication. Through passive design this high-performance building absorbs solar energy to heat it in the winter and breathes in fresh air to cool it in the summer. The supplemental energy is provided through highly efficient roof photo-voltaic arrays, a solar thermal collector and a ground source heat pump.

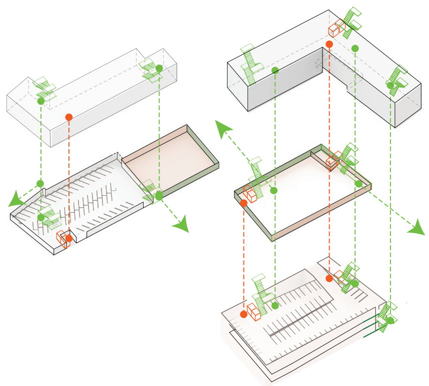
Site strategies

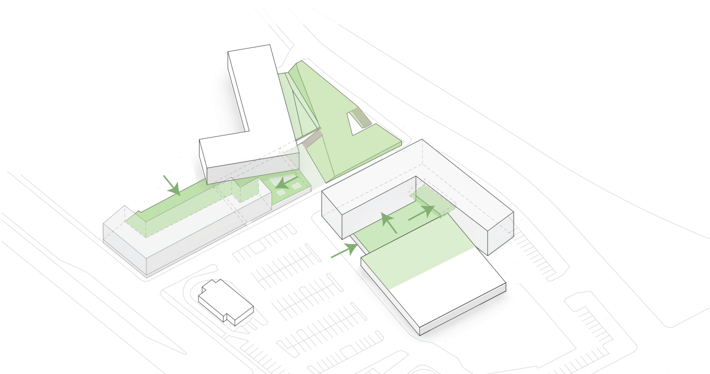


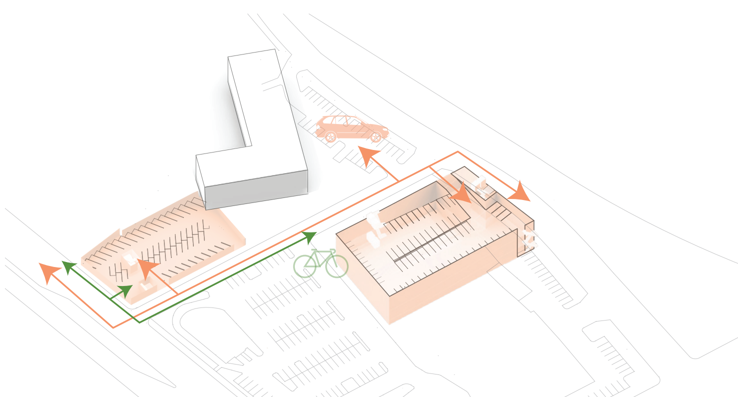




Service self sufficiency:
The buildings rest on the edges of the property enhancing the streetscape thereby welcoming shoppers and residents to the new development. This strategy also helps shelter the open spaces from street noise and the elements. The new building on parcel one defines the northern edge of the shopping center with pedestrian friendly walkway and bike lanes. Basic services are provided on-site allowing residents more time to spend with family and to participate in the community activities. A grocery store is located on top of the underground parking garage for the convenience of customers and residents above parcel two. The childcare facility proposed on the east - south side of parcel one will offer sunlight and easy access to the outdoor playground.







URBAN FABRIC

The two buildings are located at the two ends of the alley dividing the two parcels. The divider now becomes a connector between Brush and Market Street. The pedestrian friendly street attracts new customers to the shopping center and also serves local residents. People can walk and bicycle to basic services including the new grocery store and childcare.

OPEN SPACES

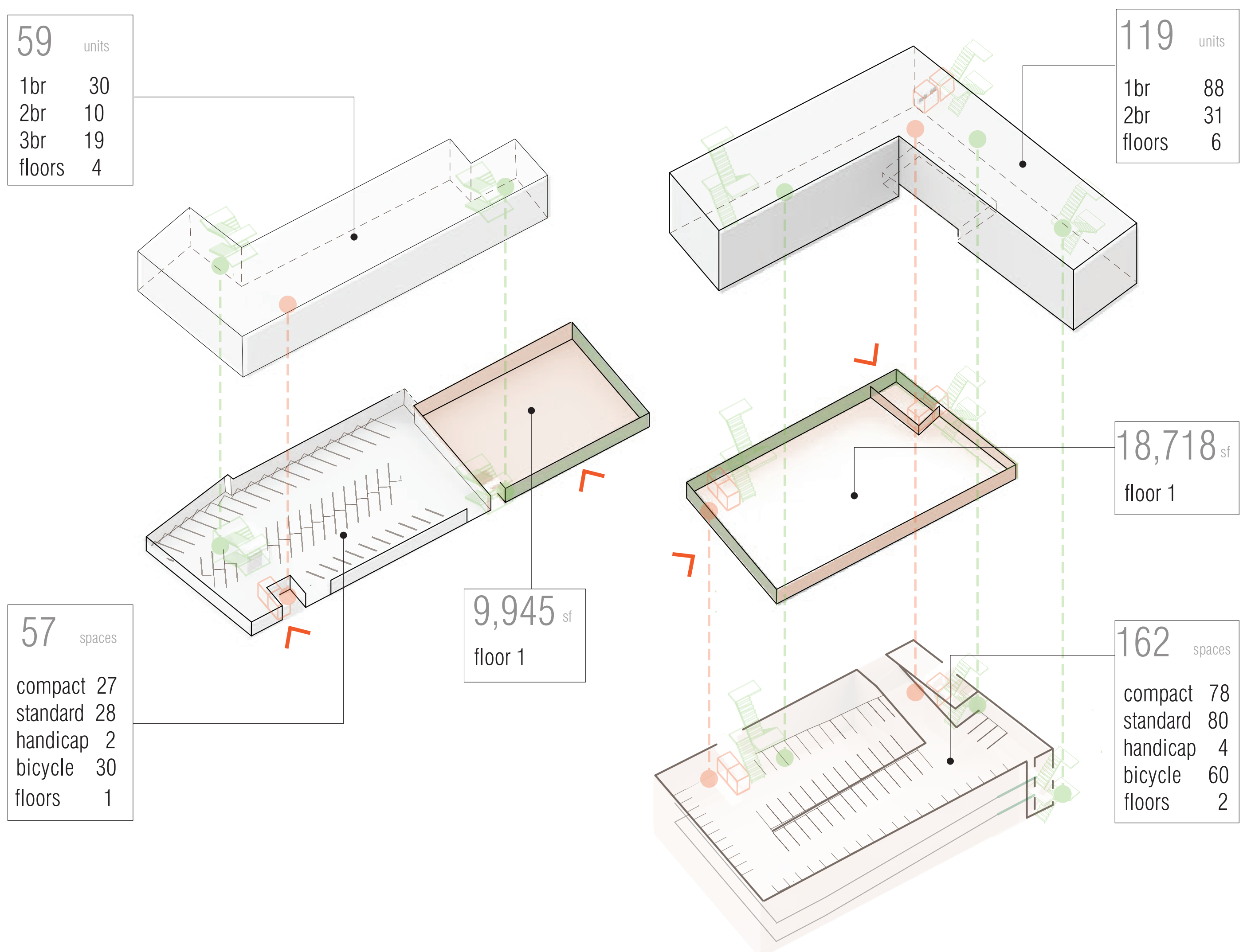
Each residential building is provided with open spaces on the second level sheltered from the street noise and pollution. A new park is proposed on top of the parking of the senior housing center to provide a gathering space for the community. It is safe from traffic and receives ample sunlight.

BUILDINGS

Parcel 1 affordable residential building anchors the northwest corner of the shopping center and creates a friendly edge for pedestrians and bicyclists. The building is located on the south edge to allow plenty of sunlight entering the senior housing garden. The proposed childcare facility is pulled toward the center where it is safe from traffic and has access to an outdoor playground and the newly created park. The ground floor parking garage is shared between the residents and the facility staffs.

Parcel 2 market rate apartment building is located on the northeast corner to signify the entrance to the new development. The west wing reinforces the street edge while provide great view toward the city and the bay. The north wing shapes the new park and open to the garden on the south. The building sits above a grocery store and two level underground parking structure serving customers and residents above.

Program

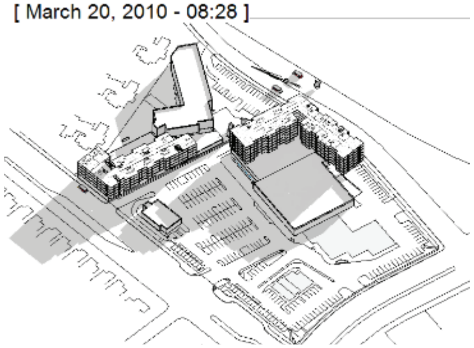


59 units
1br 30
2br 10
3br 19
floors 4
119 units
1br 88
2br 31
floors 6
18,718 sf
floor 1
9,945 sf
floor 1
57 spaces
compact 27
standard 28
handicap 2
bicycle 30
floors 1
162 spaces
compact 78
standard 80
handicap 4
bicycle 60
floors 2

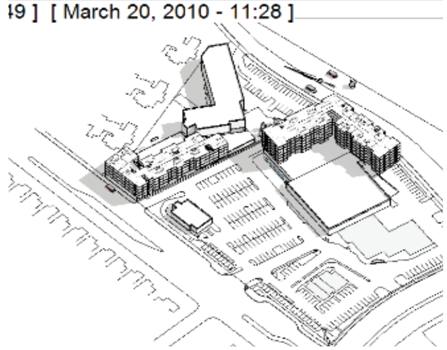
Environment analysis

Shadow site study

[March 20, 2010 - 08:28]



49] [March 20, 2010 - 11:28]



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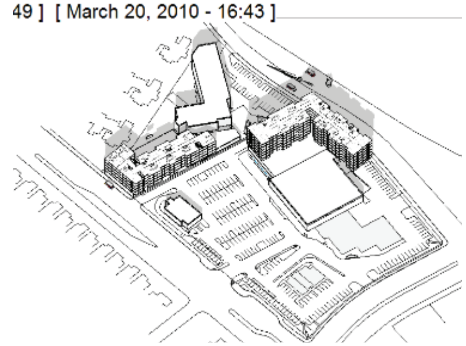
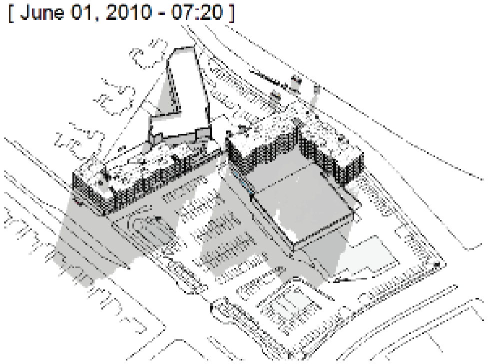


[June 01, 2010 - 07:20]



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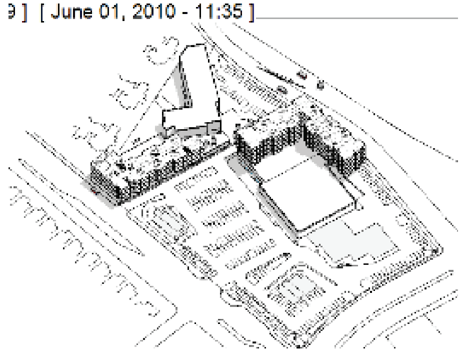

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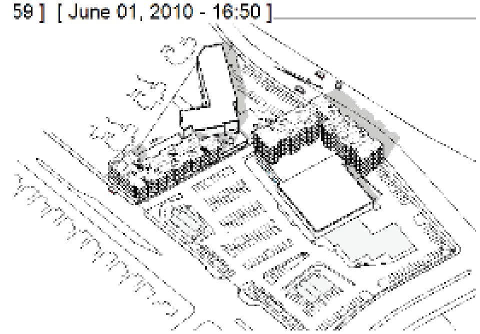
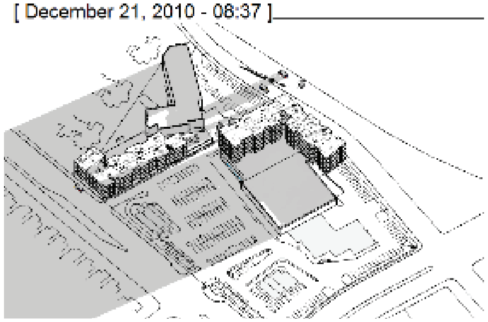
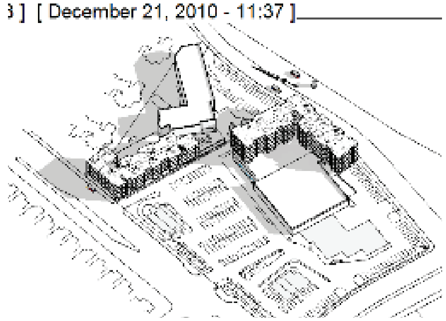


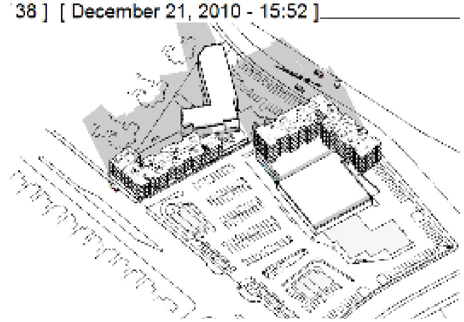
[December 21, 2010 - 08:37]



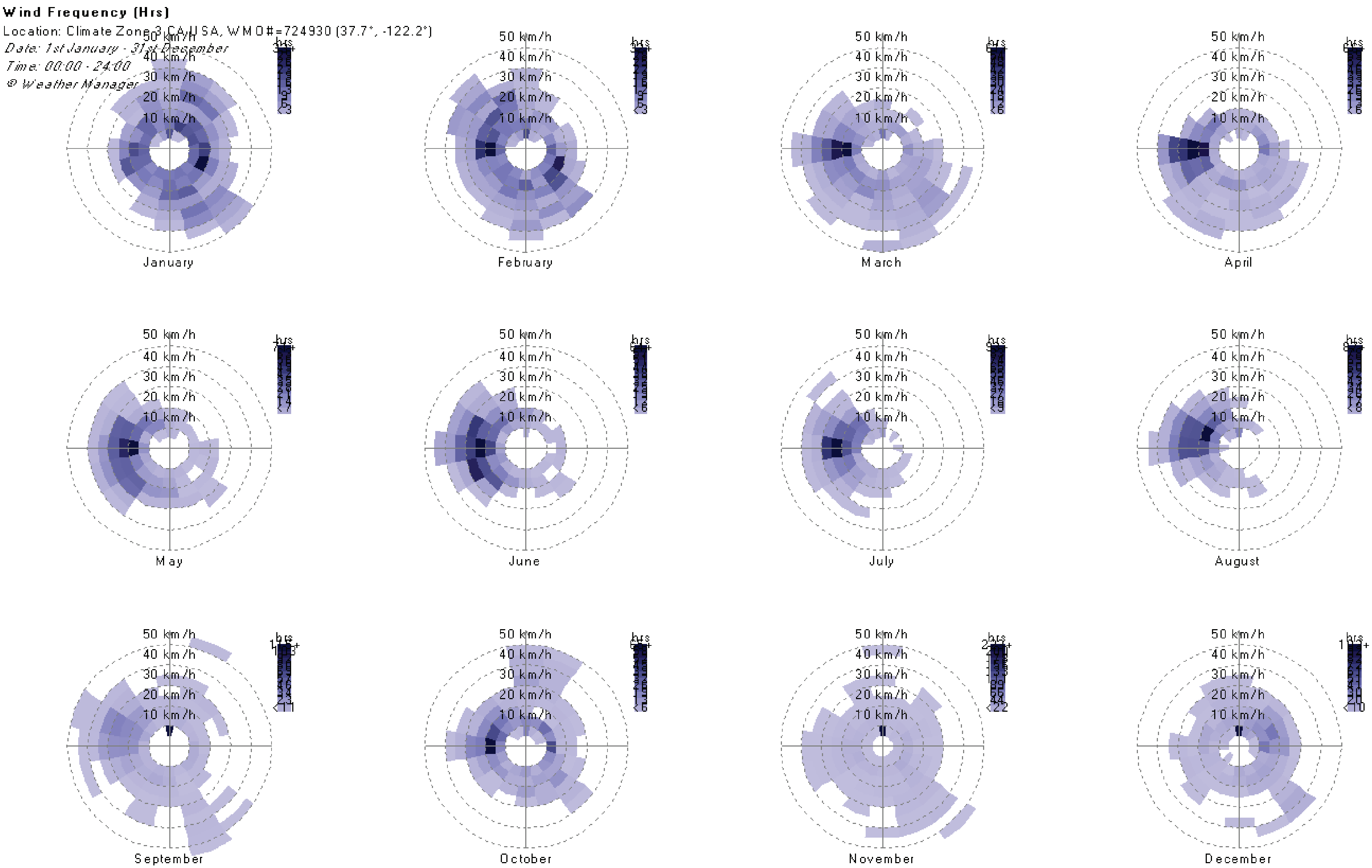
3] [December 21, 2010 - 11:37]



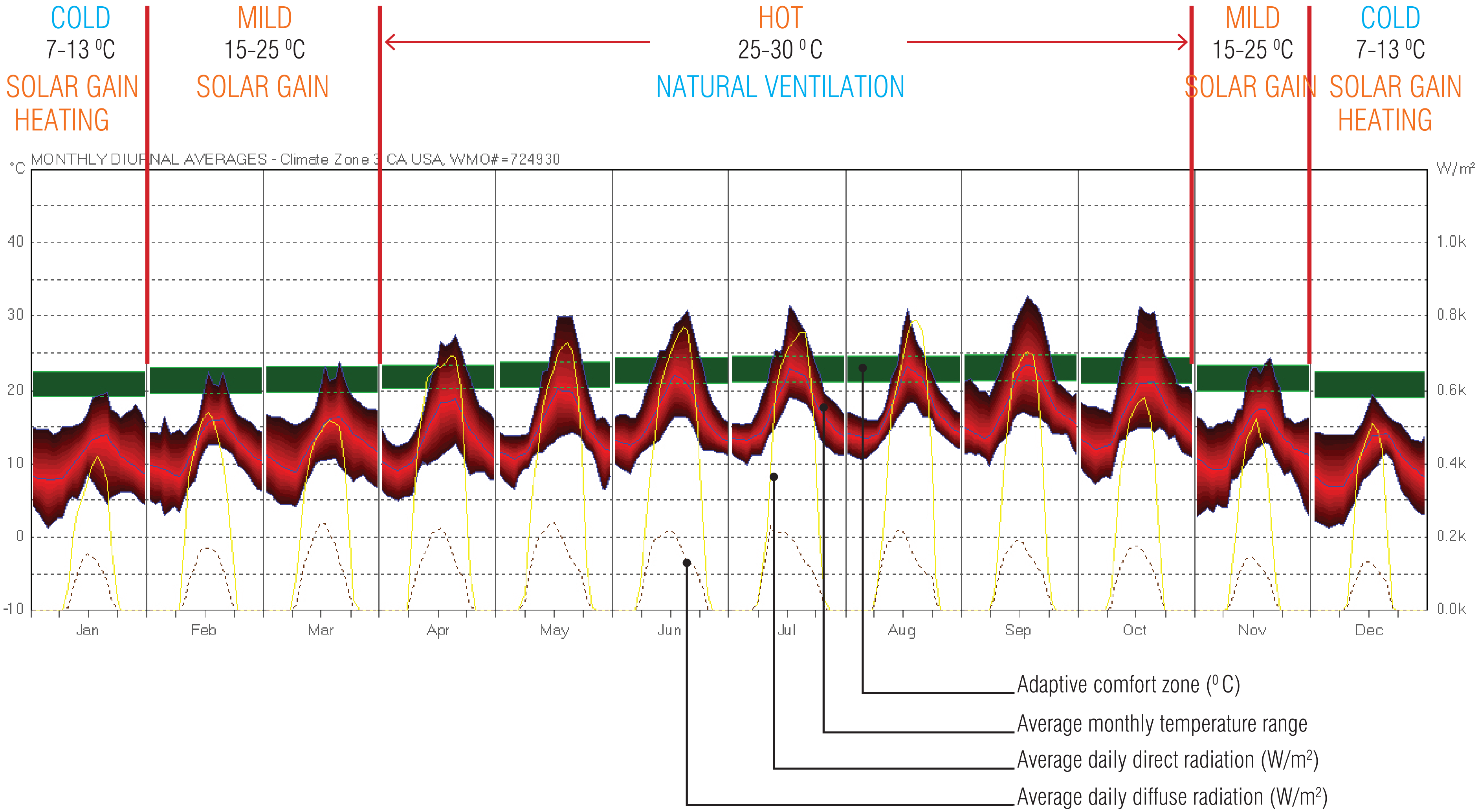
38] [December 21, 2010 - 15:52]

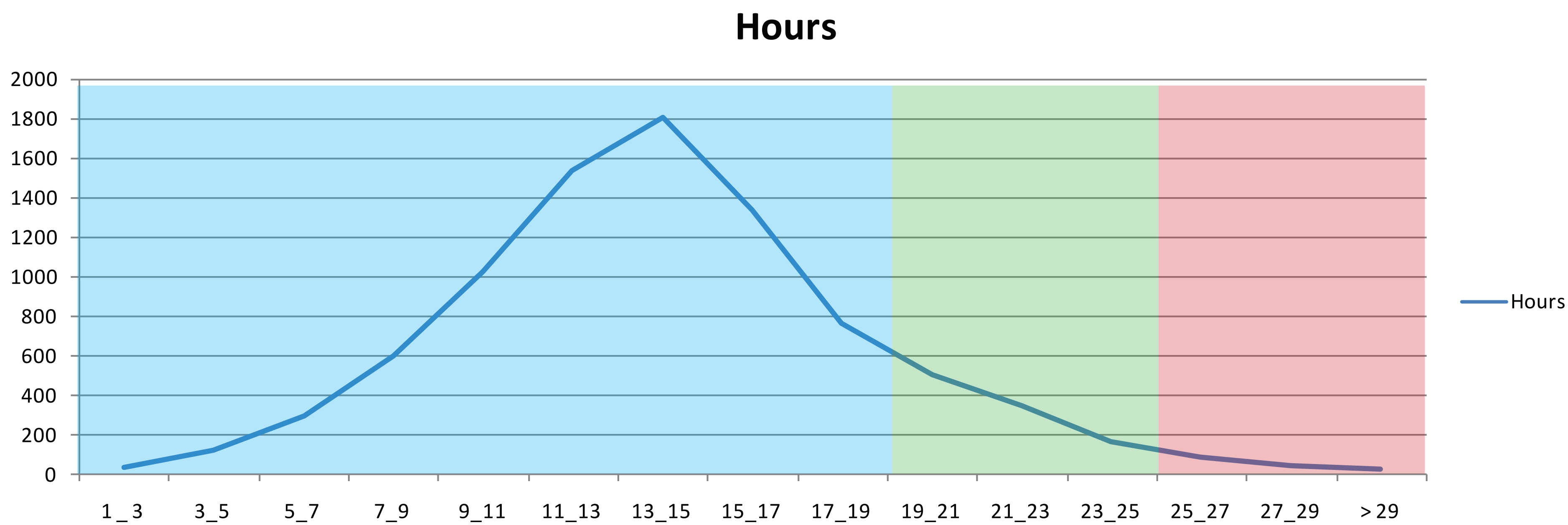


Prevailing winds

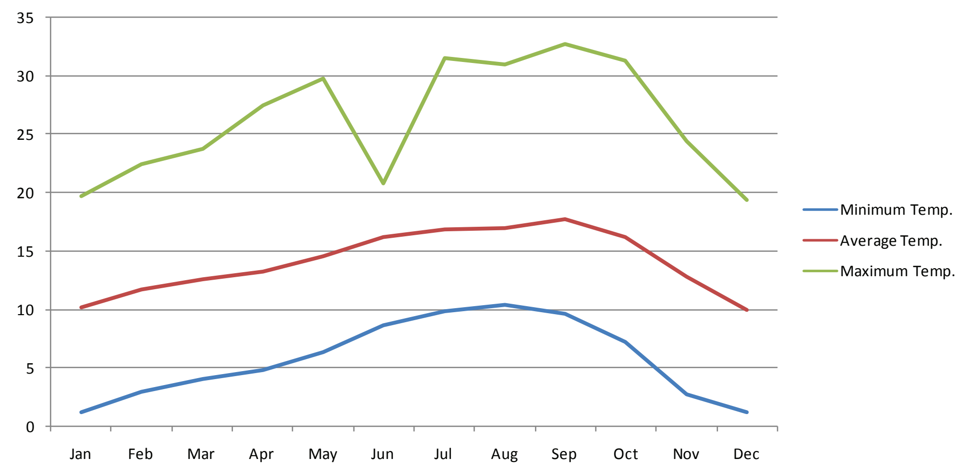


Thermal comfort





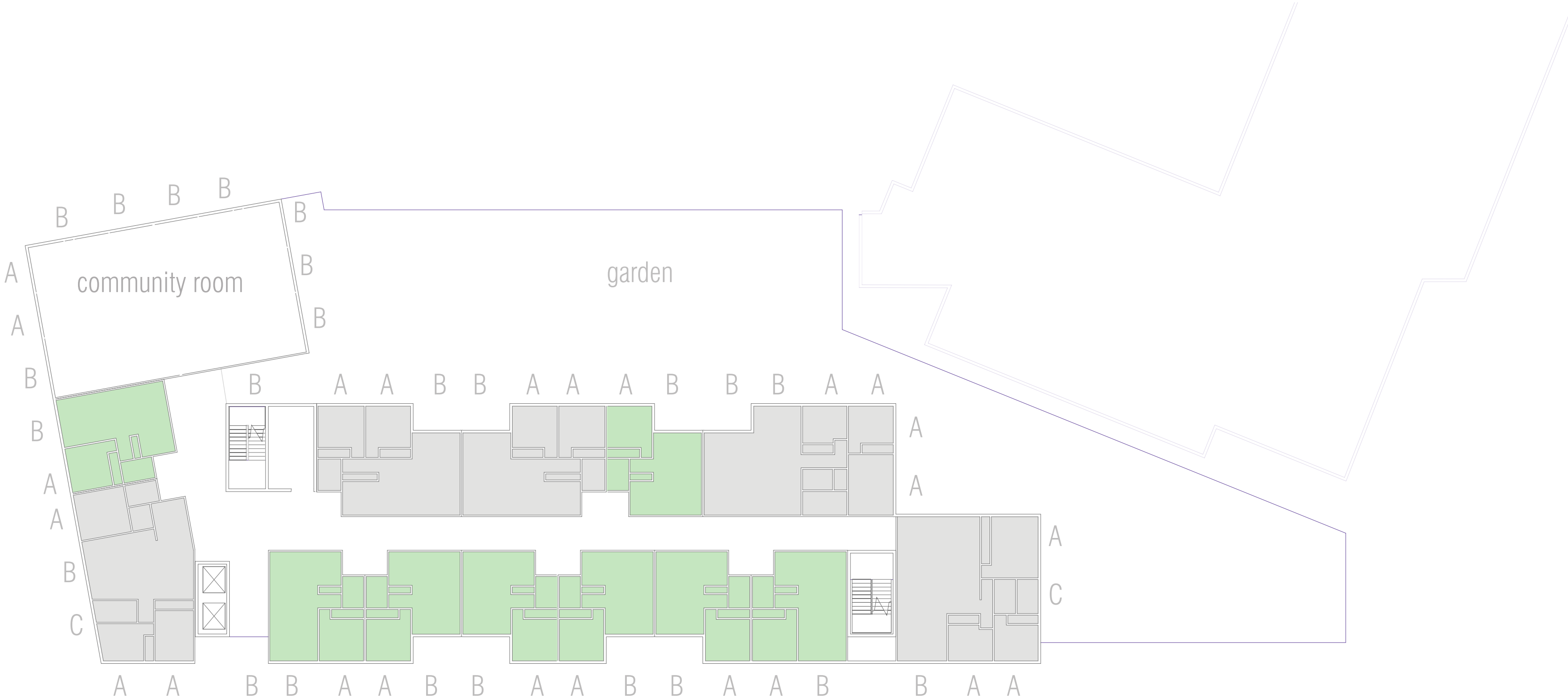
Air temperature frequency distribution



Monthly temperature

Part 2: Energy Performance

2A window to wall ratio



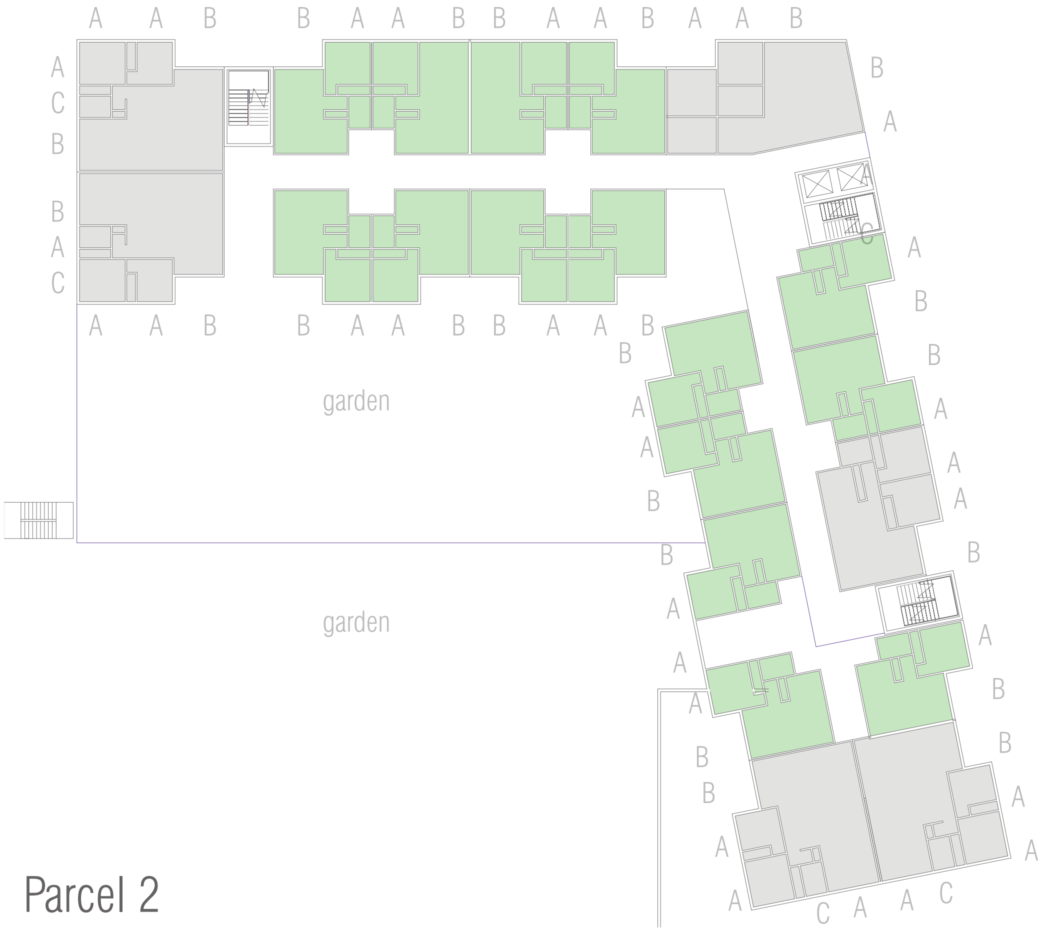
Parcel 1

	glazing	wall	ratio
north	2,736	10,272	0.27
east	1,876	5,622	0.33
south	4,264	11,075	0.39
west	1,272	5,481	0.23
parcel 1	10,148	32,450	0.31

Through our research a window to wall ratio of 0.27 provide a good balance between daylighting and heat loss. The energy model generated by Open studio and Ecotect also proved that it worked well for the project (see more diagrams and calculations in section 2E and System Performance on page 34). Due to commercial spaces on the ground floor the ratio is higher than the target number on some facades.

Window module A = 3'-0" x 7'-0"
Window module B = 9'-0" x 7'-0"
Window module C = 2'-0" x 4'-0"

2B window and shading



Parcel 2

	glazing	wall	ratio
north	3,512	13,414	0.26
east	3,619	13,763	0.26
south	4,680	13,911	0.34
west	5,294	13,250	0.40
parcel 2	17,105	54,338	0.31

Since the design window to wall ratio is relatively low, we think tripple glaze windows and doors with low U-factor are cost effective. They will save significant energy over the life of the building. The glazing also help cut down the noise of the nearby freeways. A typical bedroom window includes a tilt and turn panel on top of a tempered hoper window. This setting allow flexibility for natural ventilation.

The winter and summer are not severe, we propose a neutral SHGC at 0.30 and high VLT at 0.55. (see page 22-23 for window details)

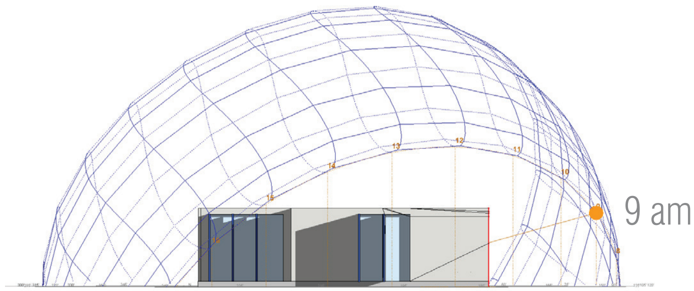
propose glazing for both parcels

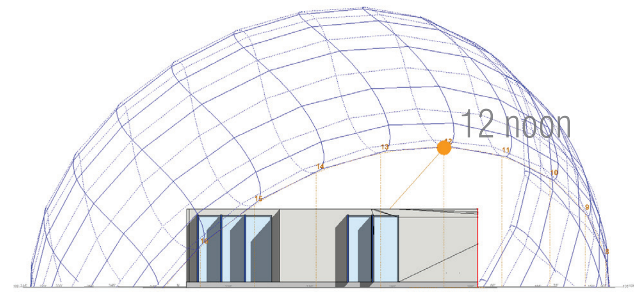
	U-factor	SHGC	VLT
north	0.27	0.30	0.55
east	0.27	0.30	0.55
south	0.27	0.30	0.55
west	0.27	0.30	0.55

Shading studies

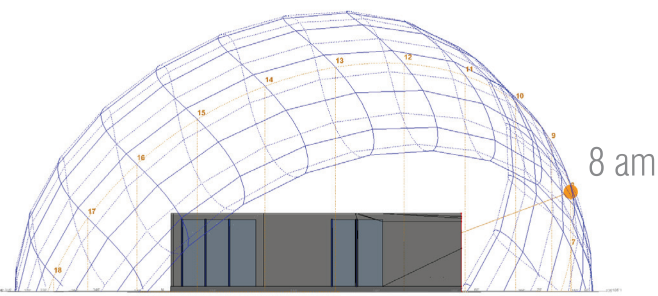
South Elevation

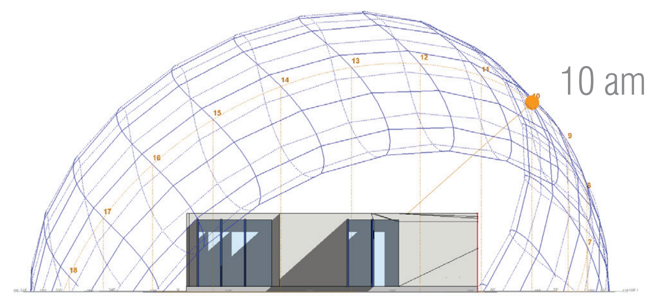
December 21



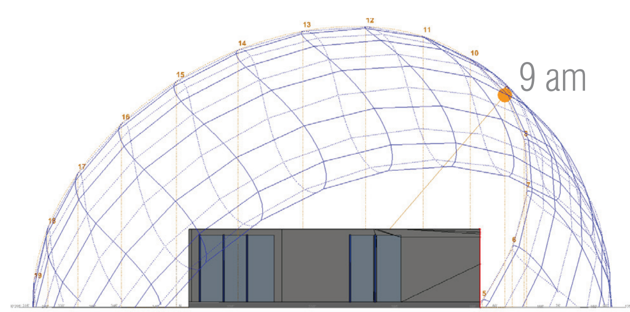


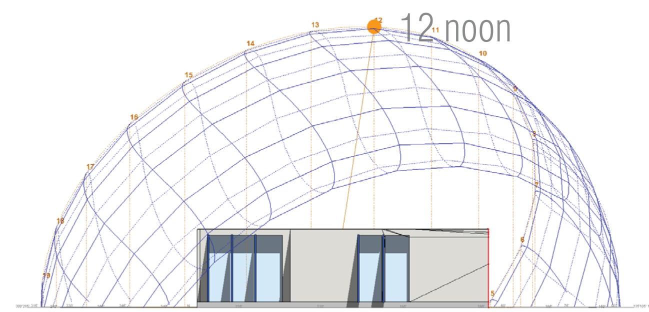
March/September 21

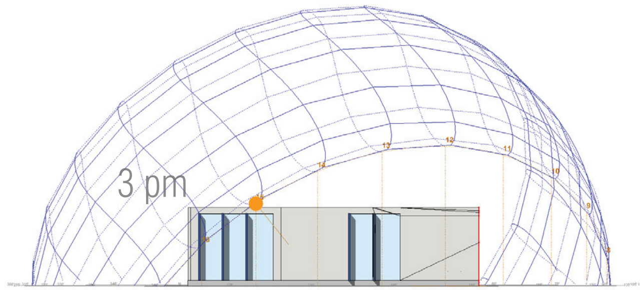


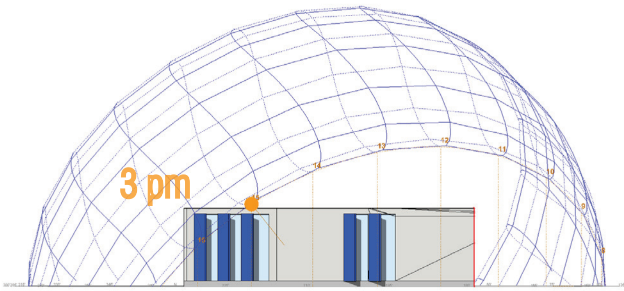


June 21

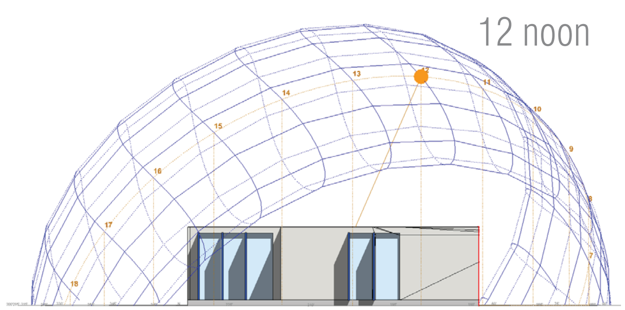


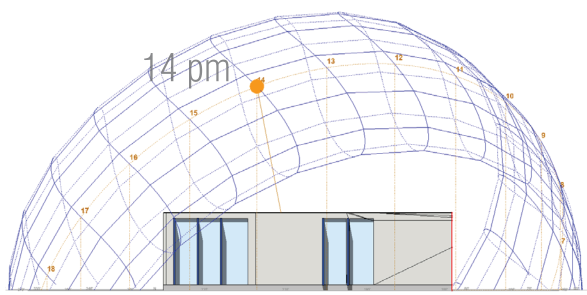


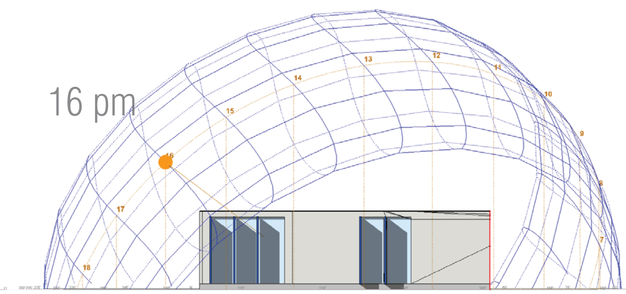


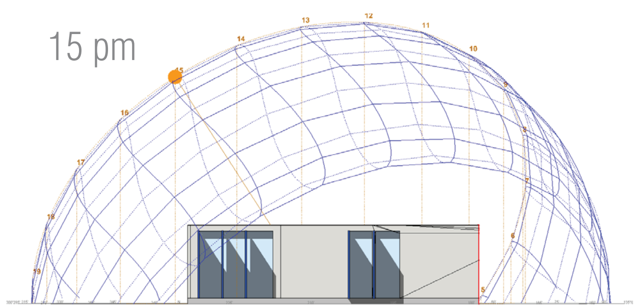


Users can adjust the panels to appropriate angle to perform
the best shading. The angle studied in this diagram only is :60 degree opened





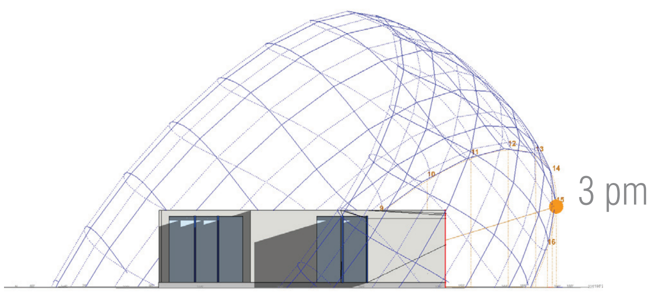




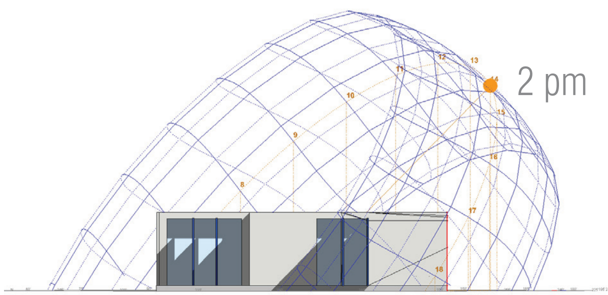
Users can adjust the panels to appropriate angle to perform
the best shading. The angle studied here is : 90 degree opened.

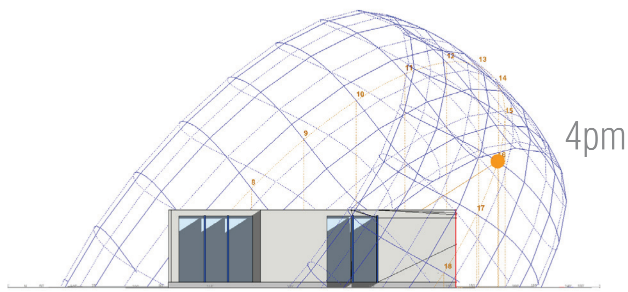
This model was generated by Ecotect 2011

West Elevation

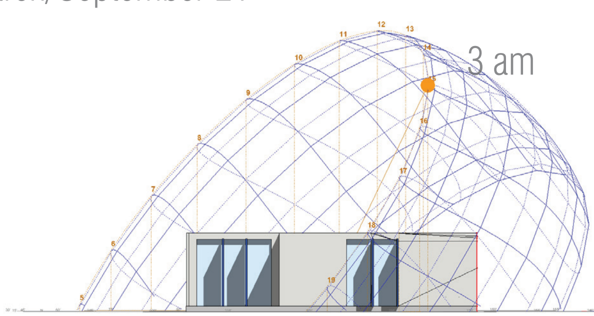


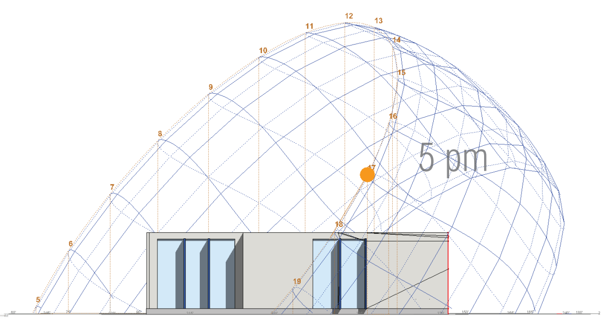
December 21

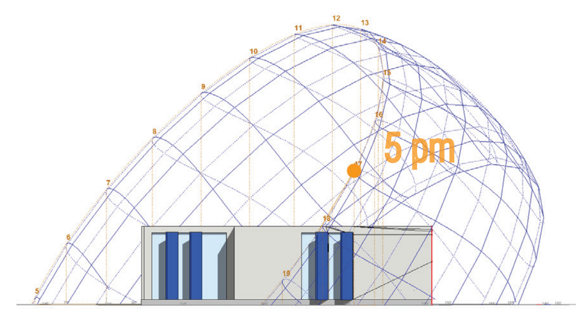




March/September 21







June 21

Examining on 90 degree of shading panel opened

Examining on 60 degree of shading panel opened

2C Building enclosure details

Typical wall section through parcel 1

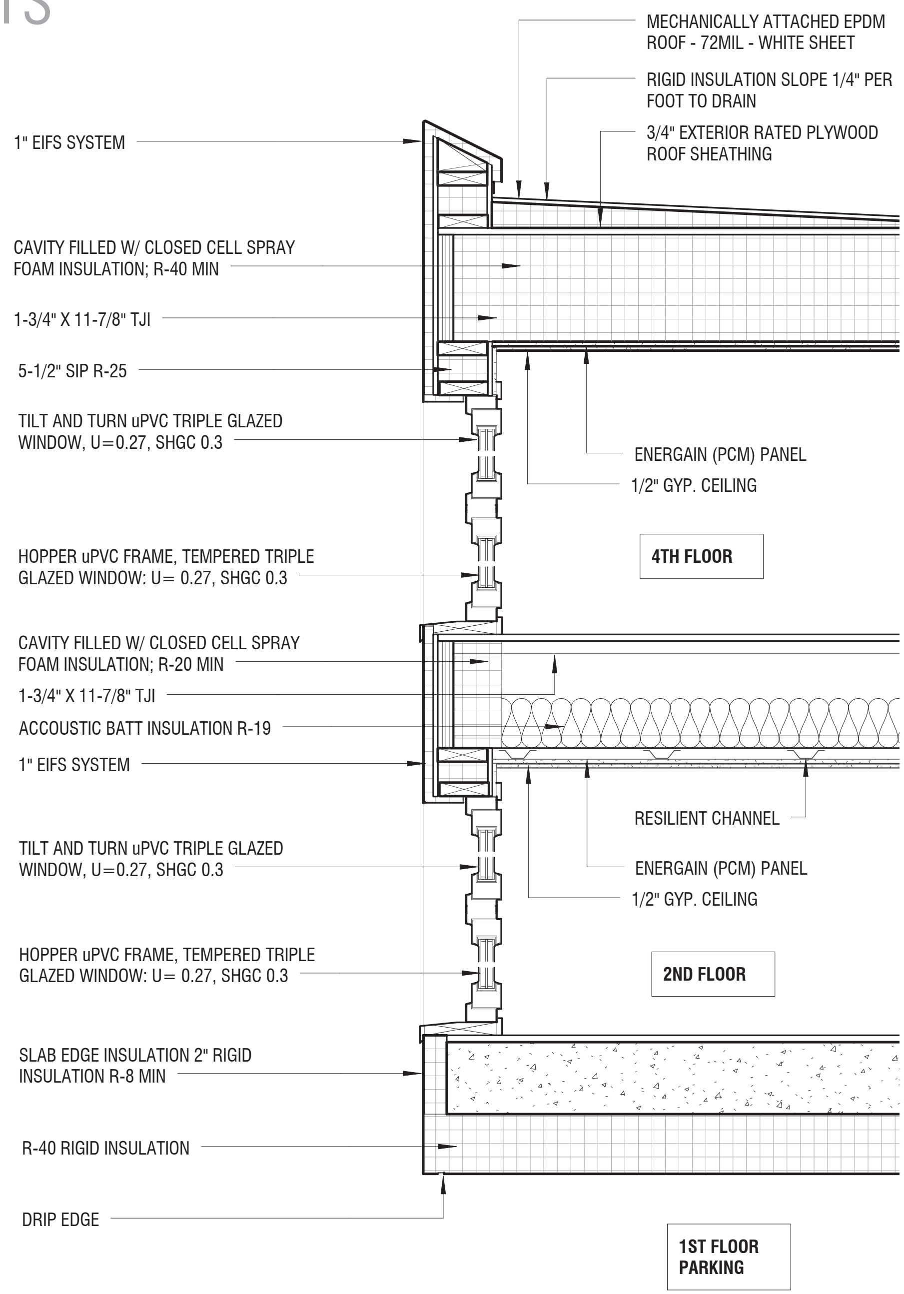
RESIDENTIAL ENVELOPE ASSEMBLY
(outside to inside)

WALL (R-25)
1" EIFS SYSTEM
waterproofing membrane
5-1/2" SIP wall
1/2" drywall

ROOF (R-40)
mechanically attached EPDM, 72 mil white sheet
Rigid insulation (2 in min) slope 1/4" per foot to drain
3/4" exterior plywood roof sheathing
1-3/4" x 11-7/8" TJI @ 16" O.C. with cavity filled with closed cell spray
3/4" phase change material board
1/2" drywall ceiling

FLOOR (interior between units)
(top to bottom)
3/4" bamboo floor
1/4" recycled rubber sound isolation mat
3/4" OSB subfloor
1-3/4" x 11-7/8" TJI joist at 16" O.C.
1" resilient channel
3/4" phase change material board
1/2" drywall ceiling

FLOOR (2nd level above garage) R-40
(top to bottom)
3/4" bamboo floor
3/4" OSB subfloor
concrete slab
8" rigid insulation EIFS



scale 1/2" = 1'-0"

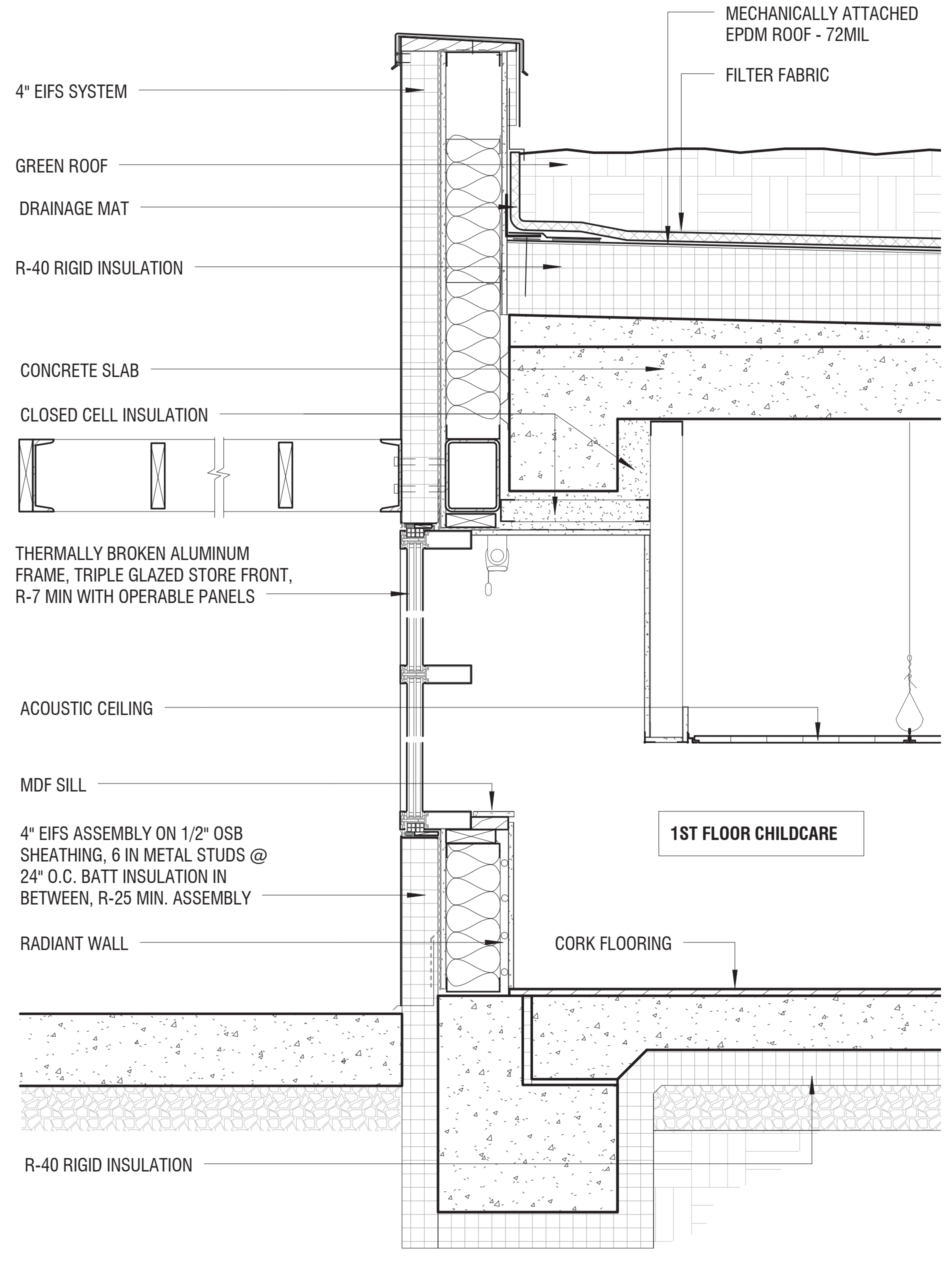
Wall section through childcare

COMMERCIAL ENVELOPE ASSEMBLY
(outside to inside)

WALL (R-25)
4" EIFS SYSTEM
waterproofing membrane
6" metal stud @ 16" O.C. cavity filled with batt insulation
1/2" drywall

ROOF (R-40)
green roof
drainage mat
mechanically attached EPDM, 72 mil white sheet
Rigid insulation (8 in min) slope 1/4" per foot to drain
concrete slab
1/2" drywall drop ceiling

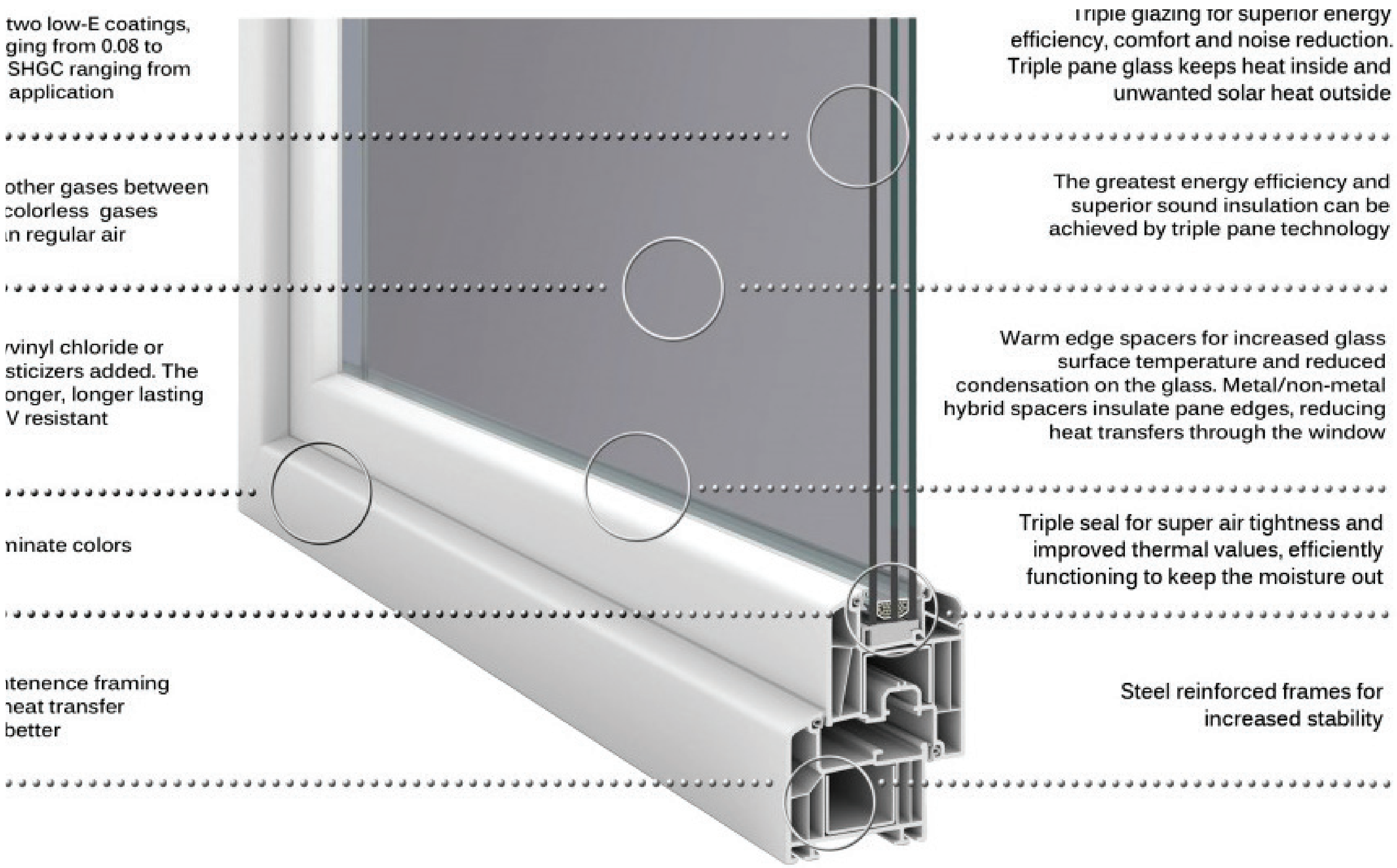
FLOOR R-40
(top to bottom)
cork floor
3/4" OSB subfloor
concrete slab
8" rigid insulation EIFS



scale 1/2" = 1'-0"

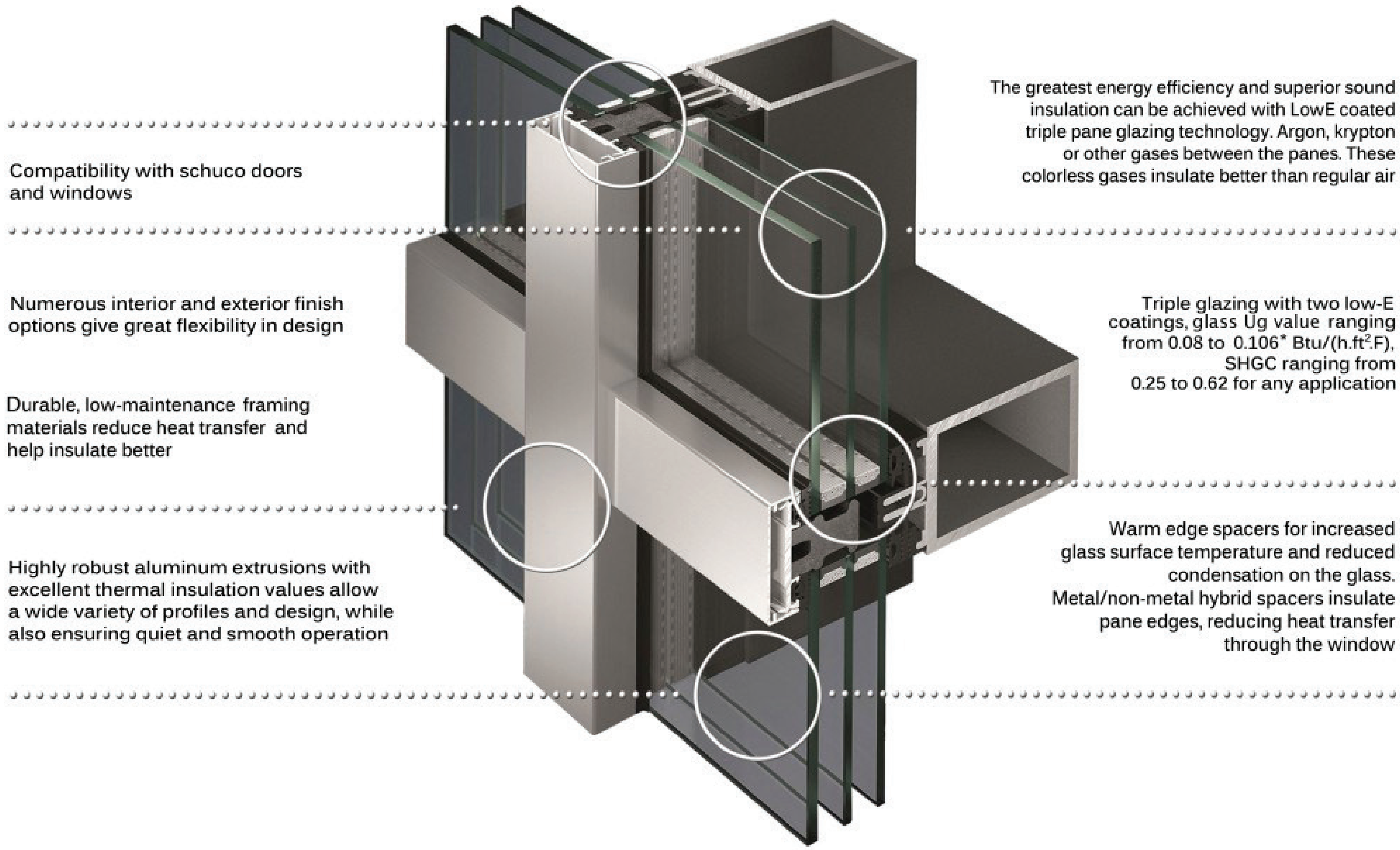
2C building enclosure details

Residential window system



source: Intus window

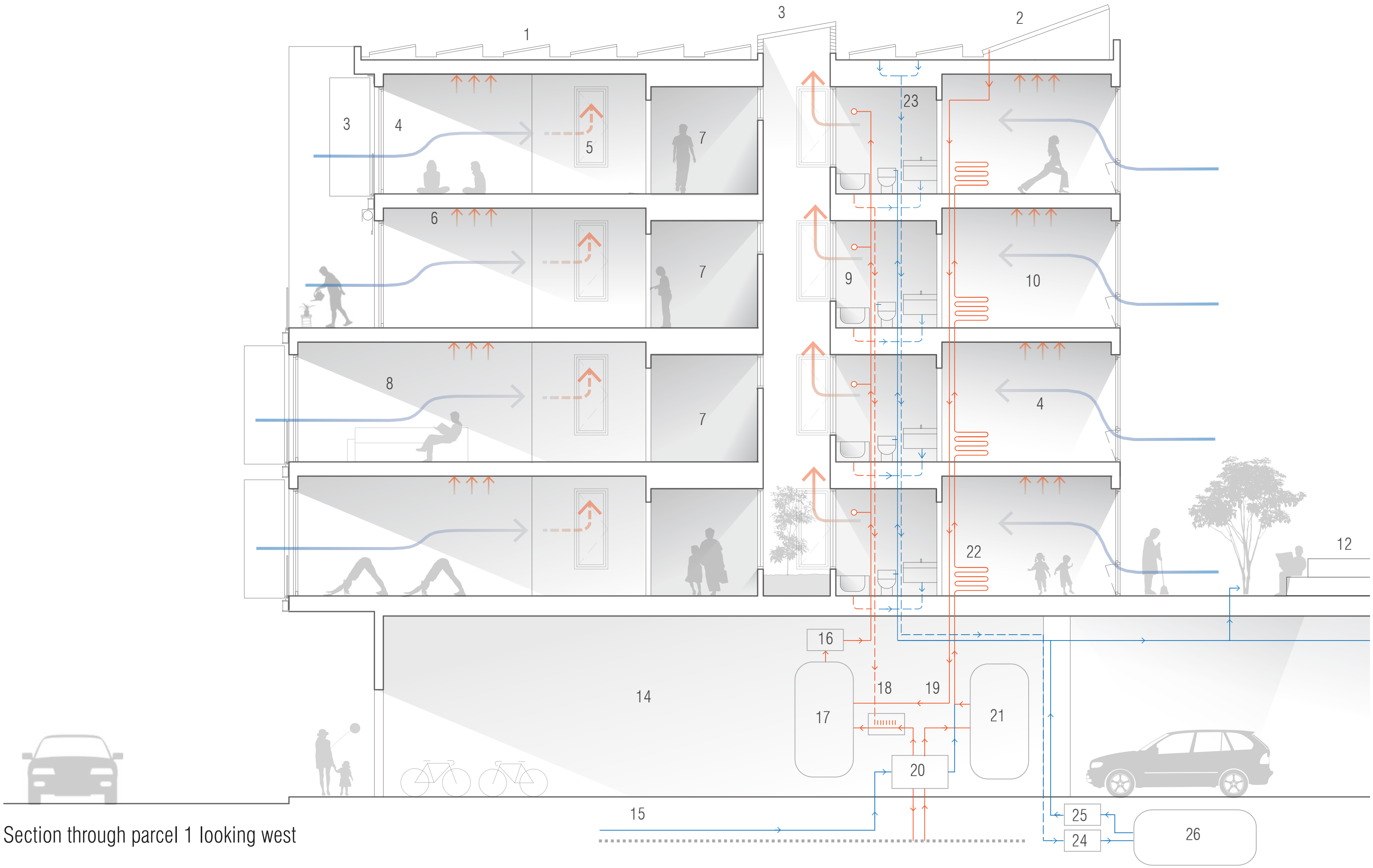
Commercial storefront system



source: Intus window

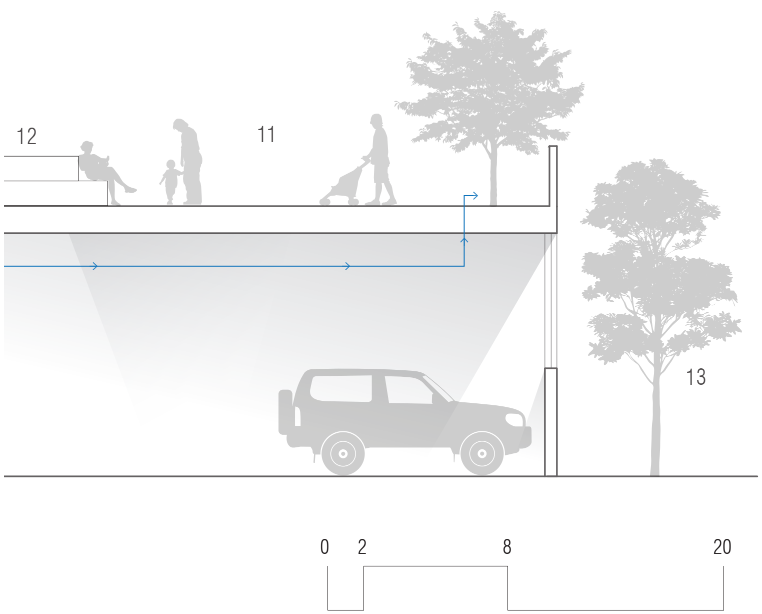
2D Heating and cooling system

System overview



Section through parcel 1 looking west

1 photovoltaics
2 solar thermal collector for dhw
3 operable perforrated metal shadding device
4 intake fresh air
5 exhaust air through kitchen
6 phase change material ceiling
7 corridor
8 living room
9 bathroom
10 bedroom
11 community garden at podium level
12 lightwell to garage
13 existing senior center garden
14 garage for residents
15 water supply
16 on-demand circulation pump
17 domestic hot water boiler
18 hot water heat recovery system
19 hot water from solar thermal collector
20 ground source heat pump with summer bypass
21 water heating boiler
22 radiant wall
23 gray water recovery
24 filter system
25 circulation pump
26 gray water cistern



Heating
source: ground source heat pump with backup gas boiler
delivery: on demand recirculating pump. Each floor has a separate loop with storage tank and pump.
end unit: radiant wall

Ventilation
passive ventilation through the lightwell. Phase Change Material is installed on ceilings to reduce the temperature swing.

Cooling
source: ground source heat pump
end unit: radiant wall
this is intended to be backed up for the hottest days.

Domestic hot water
source: solar thermal collector with supplement gas boiler
delivery: on demand recirculating pump
heat recovery: heat from shower will be captured to pre-heat incoming water to reduce enery by up to 30%.

Refrigeration
Exhaust heat from the grocery store refrigeration is capture to pre-heat incoming water for service hot water use.

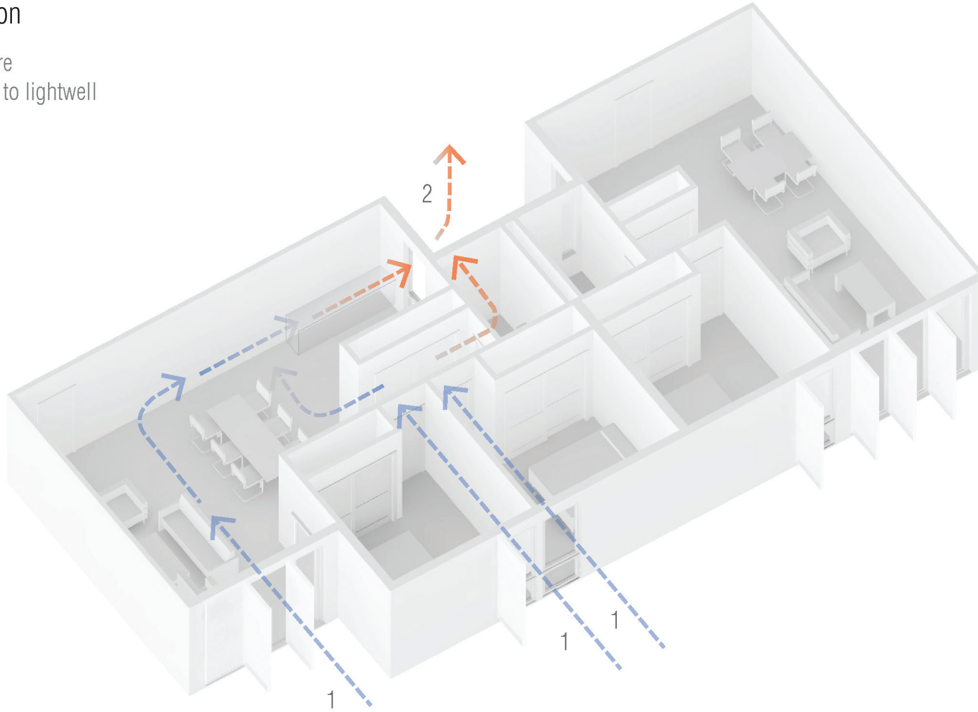
2E Residential unit system

Typical two bedroom unit systems on parcel 1

(see more diagrams and calculations of natural ventilation on page 26)

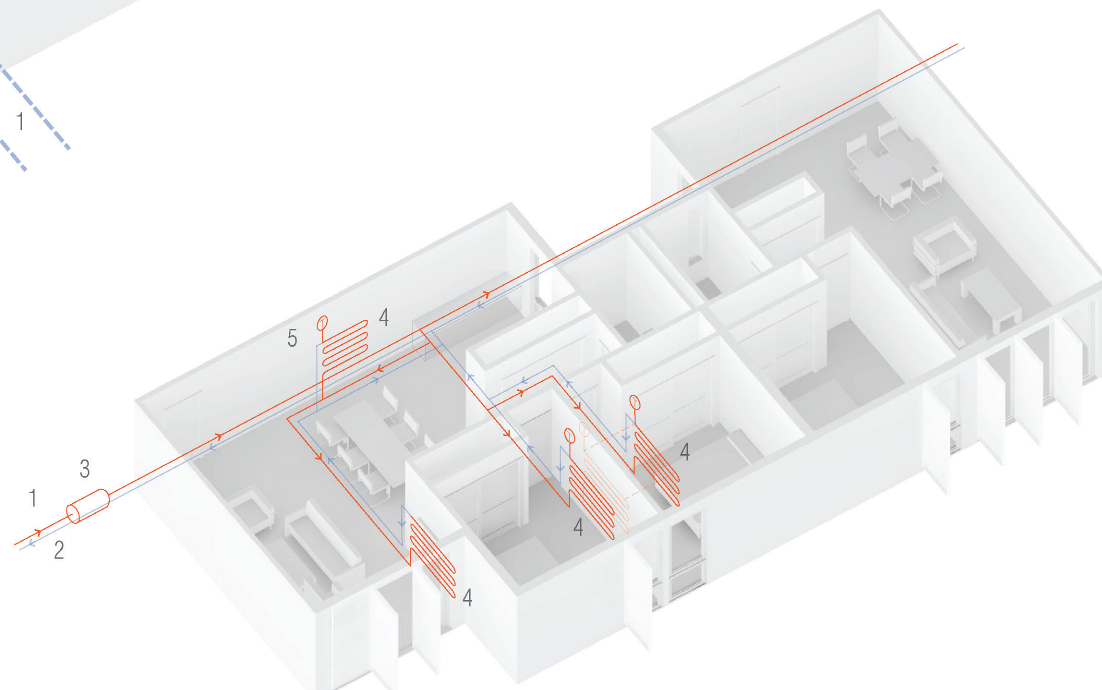
Natural ventilation

1 incoming fresh are
2 warm air exhaust to lightwell



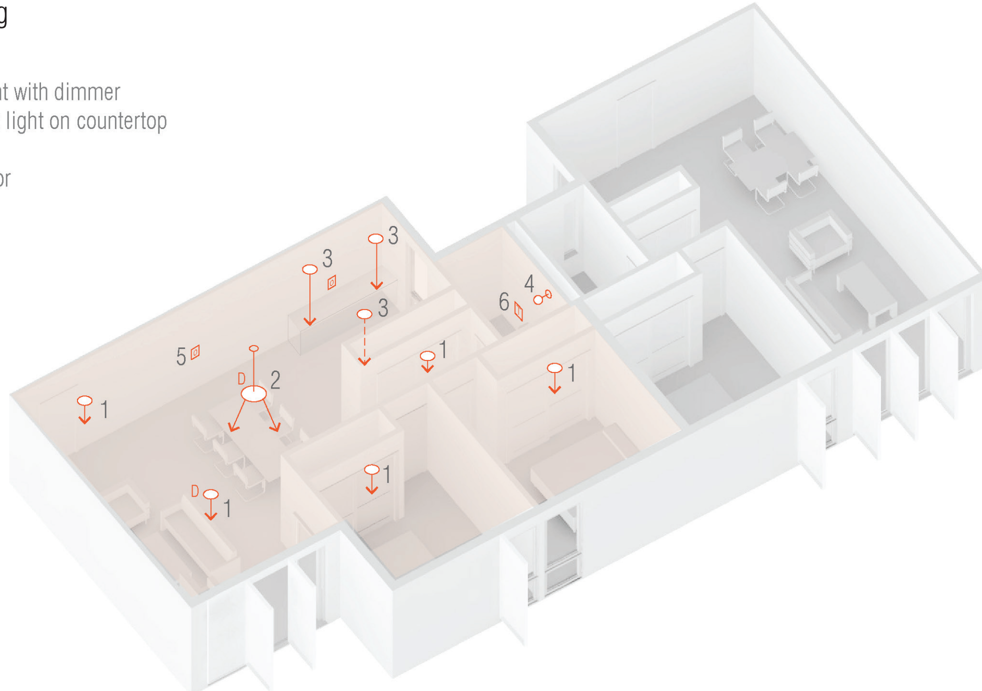
Heating and cooling

1 supply hot/cold water from ground source heat pump plant
2 return water to plant
3 on-demand recirculating pump
4 in-wall radiant
5 zone control thermostat

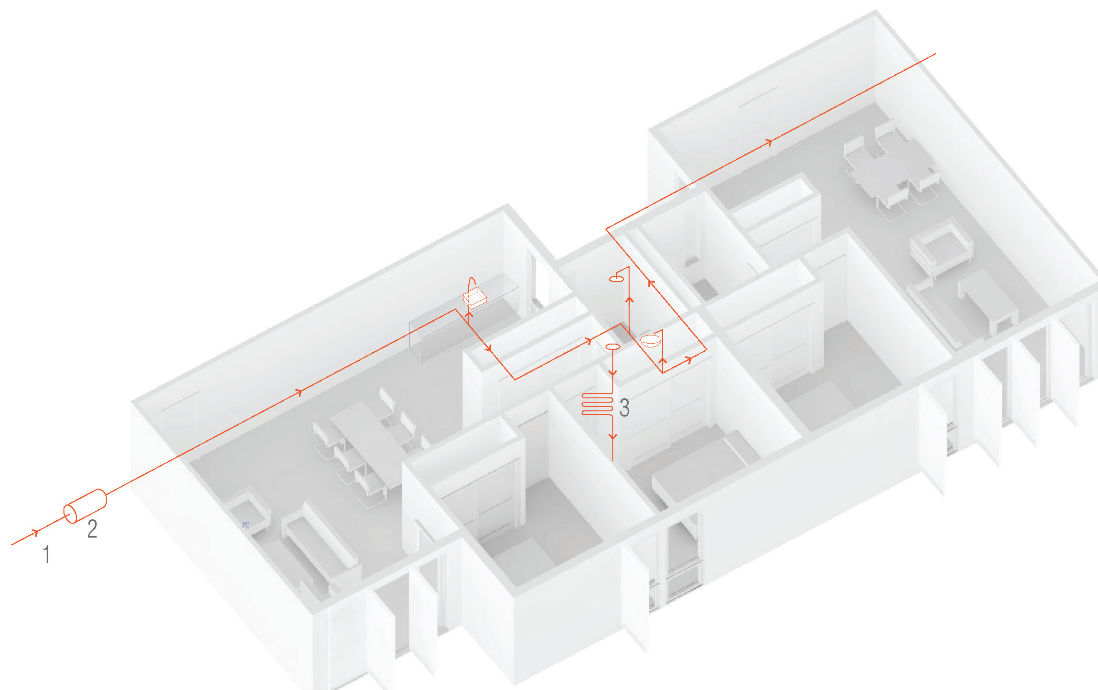


Artificial lighting

1 LED down light
2 LED pendant light with dimmer
3 LED kitchen spot light on countertop
4 LED mirror light
5 occupancy sensor
6 timer



(see more diagrams and calculations of natural lighting on page 28)

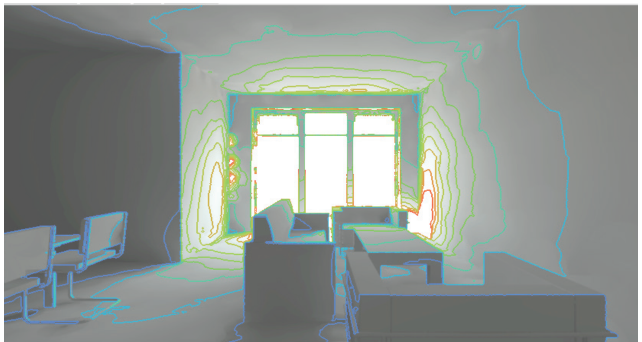


Domestic hot water

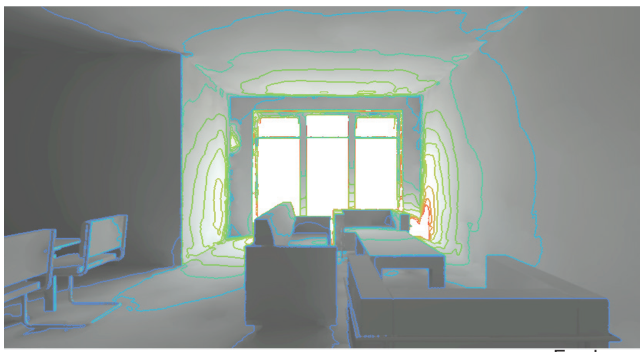
1 hot water from boiler
2 demand inititated circulating pump
3 to waste water heat recovery system

2E Residential unit system

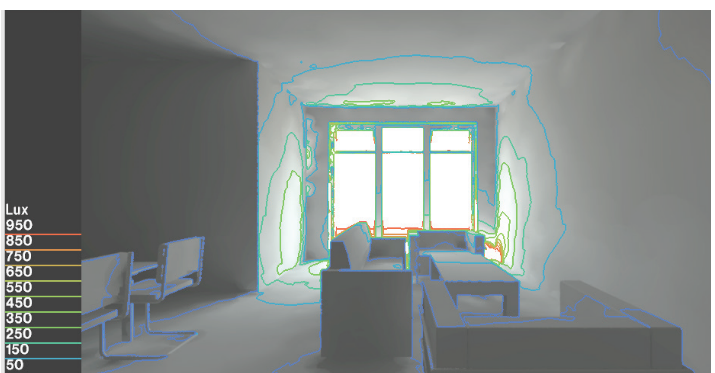
Daylight performance



Summer solstice

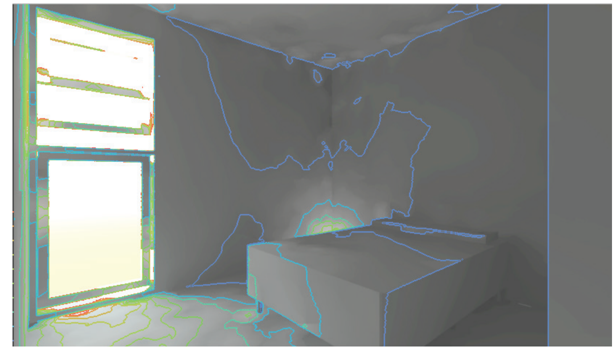


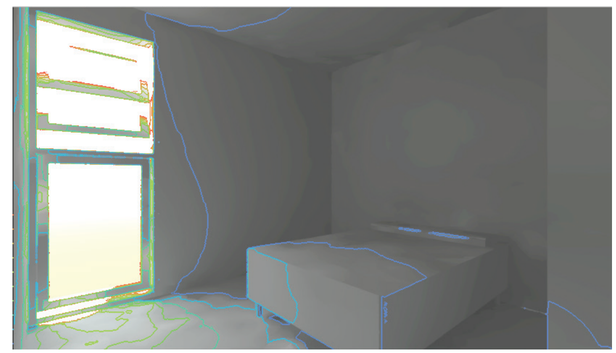
Equinox

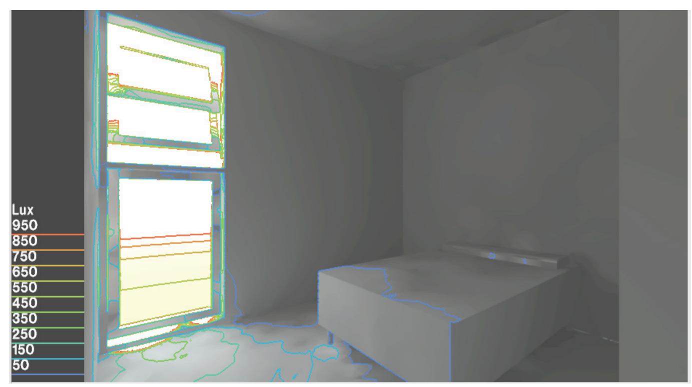


Winter solstice

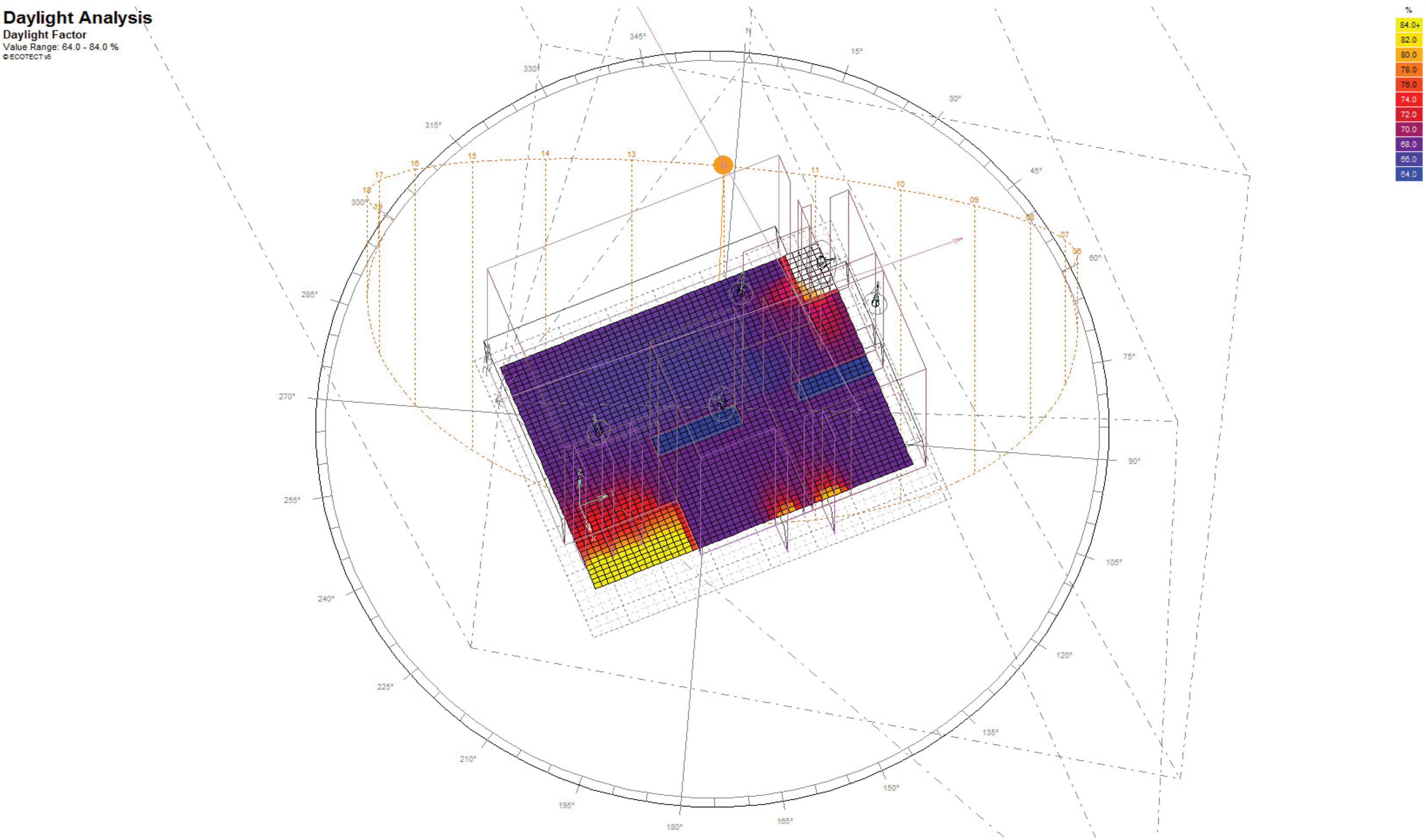
Living room model for daylight performance generated by Ecotect 2011







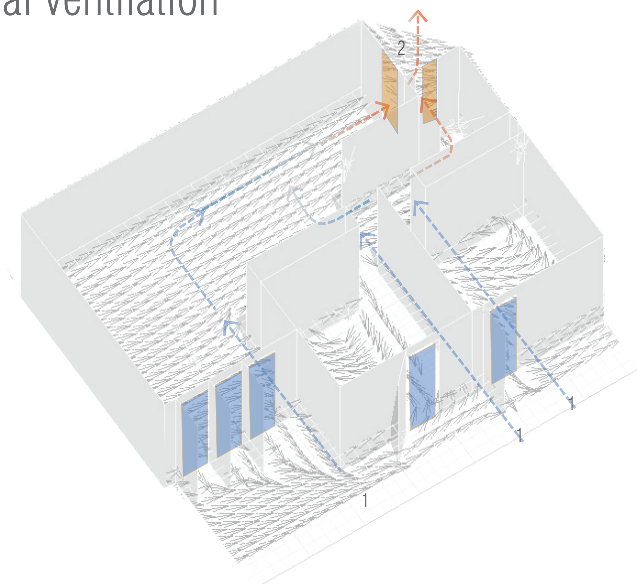
Bedroom model for daylight performance generated by Ecotect 2011

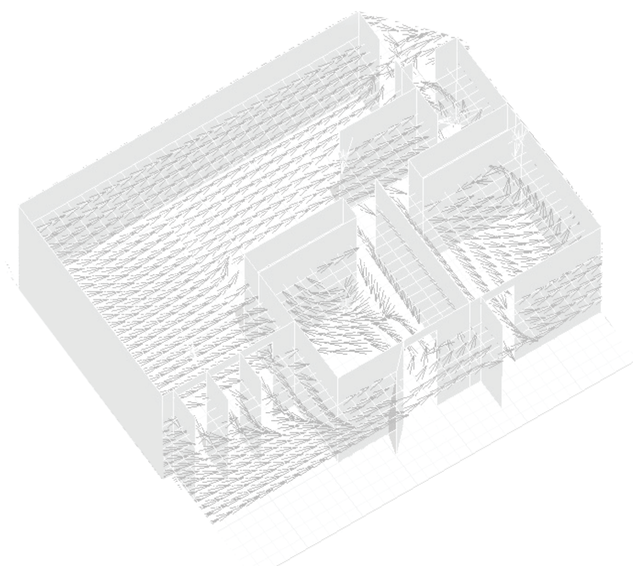


Typical unit - model for daylight performance generated by Ecotect 2011 on date July 21 12 noon

2E Residential unit system

Natural ventilation





Wind analysis generated by Ecotect 2011 and Winair 1.4b

The natural ventilation study was based on the calculation tool of OPTIMASS ventilation (Camilo Diaz, Brian Ford & Associate) (metric unit system) and of Winair - Ecotect. The outlet design within in each unit is capable to regulate the air flow and temperature during summer.

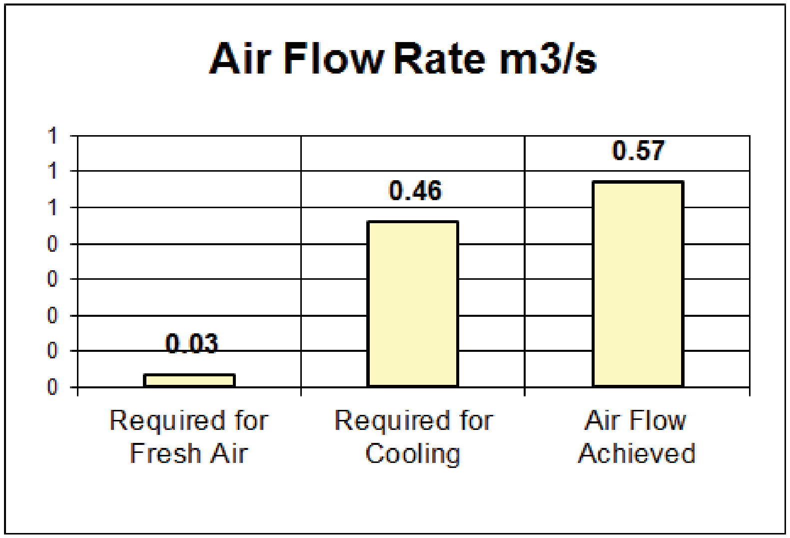
For midrise building, the stack height is considered $h_{neutral}$

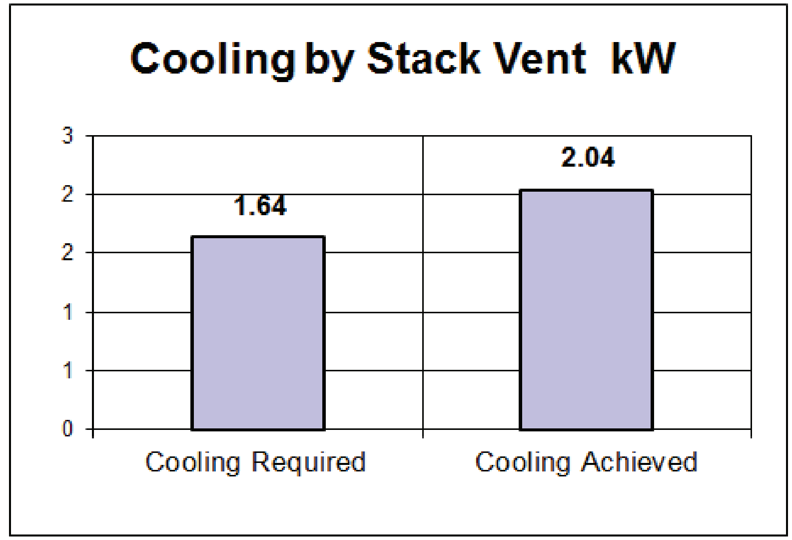
h	=	height of observation (m)
$h_{neutral}$	=	height of neutral pressure level (m) = h/2
T	=	absolute temp (K) (subscripts i = inside and o = outside)

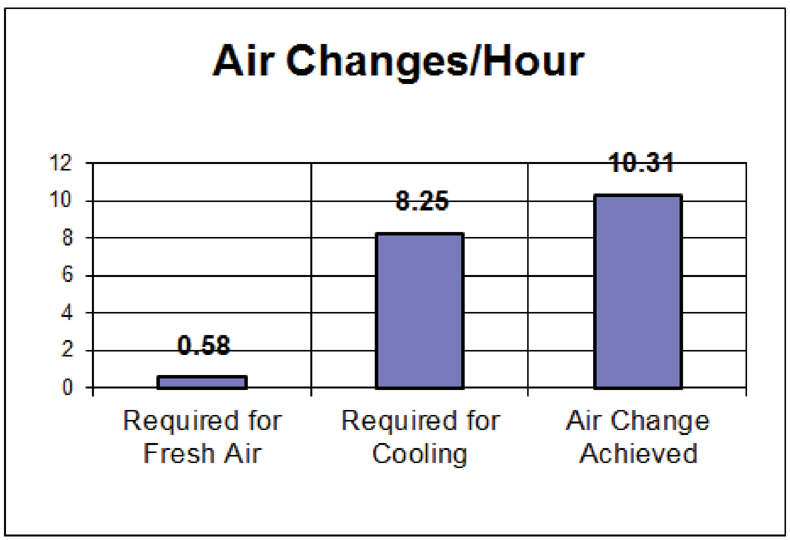
Unit Summary

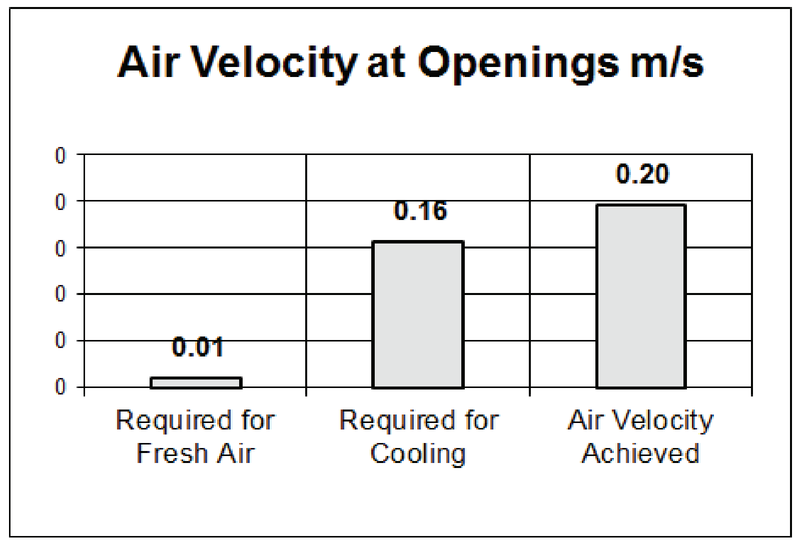
Floor Area	71.5	m2	770	f2
Ceiling Height	2.8	m	9	f
Volume	200.2	m3	7063	f3
Structural Area Inlet	9.75	m2	105 = 5*module A	f2
Structural Area Outlet	2	m2	20.5 = 2.5*5+2*4	f2
Stack Height	4.5	m	9	
Free Area Factor Inlet	30	%		
Free Area Factor Outlet	50	%		
Net Free Area Inlet	2.925	m2		
Net Free Area Outlet	1	m2		

Heat Gain Summary	W/m2 Floor Area	kW
Equipment	9.0	0.64
Lighting	6.5	0.46
Number of Occupants	4	
Gains by People	4.9	0.35
Total Internal Gains	20.4	1.46
Direct Solar Gains	2.45	0.18
Conductive Solar Gains	0.00	0.00
Total Solar Gains	2.45	0.18
Total Heat Gains	22.9	1.64
Temperature Difference (C)	3.0	





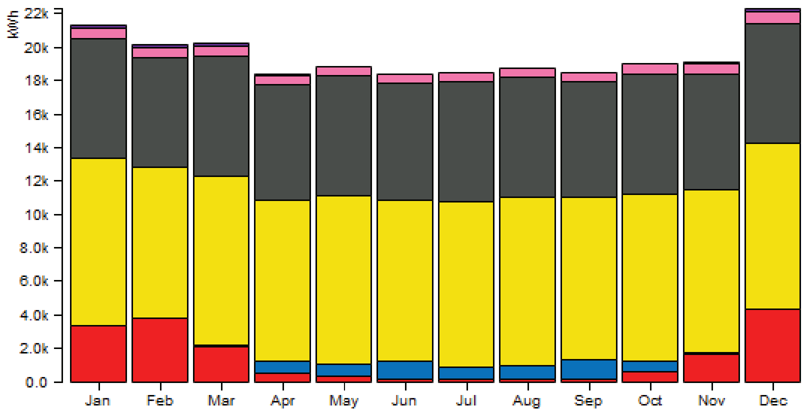




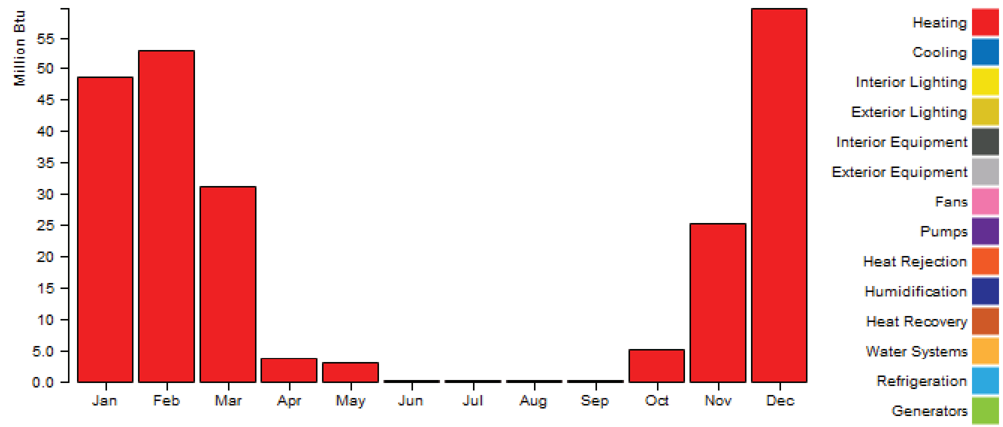
Calculations and diagrams generated by OPTIMASS ventilation (Camilo Diaz, Brian Ford & Associate)

System performance

parcel 1



Electric consumption (kwh)



Natural gas consumption (mbtu)

Electric consumption (kwh)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cooling	11.403	—	86.807	268.129	1,111.378	1,887.619	1,400.172	2,069.469	2,385.931	259.321	130.954	—	9,611.183
Interior Lighting	10,185.889	9,210.472	10,265.861	9,754.111	10,265.861	9,914.056	9,069.139	9,130.361	9,834.083	10,185.889	9,914.056	10,105.889	117,835.667
Interior Equipment	9,191.75	8,308.5	9,240.333	8,832.528	9,240.333	8,929.722	7,878.5	7,919	8,881.139	9,191.75	8,929.722	9,143.139	105,686.416
Fans	1,343.078	1,235.342	1,396.944	1,274.844	1,396.944	1,343.078	1,328.711	1,396.944	1,328.711	1,343.078	1,343.078	1,328.711	16,059.463
Pumps	313.089	345.292	206.199	58.783	101.558	166.903	159.68	179.181	143.339	54.723	128.963	368.444	2,226.154
Total	21,045.209	19,099.606	21,196.144	20,188.395	22,116.074	22,241.378	19,836.202	20,694.955	22,573.203	21,034.761	20,446.773	20,946.183	251,418.883

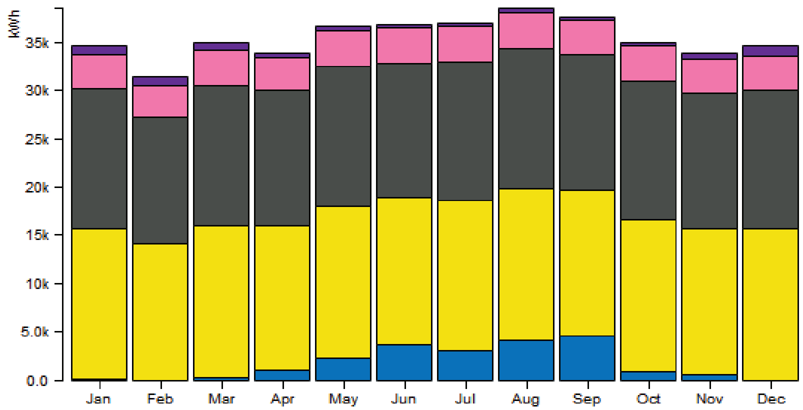
Natural gas consumption (mbtu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating	24.22	31.704	10.179	0.672	0.166	0.013	0.148	0.255	0.007	1.08	8.297	36.935	113.676
Total	24.220	31.704	10.179	0.672	0.166	0.013	0.148	0.255	0.007	1.080	8.297	36.935	113.676

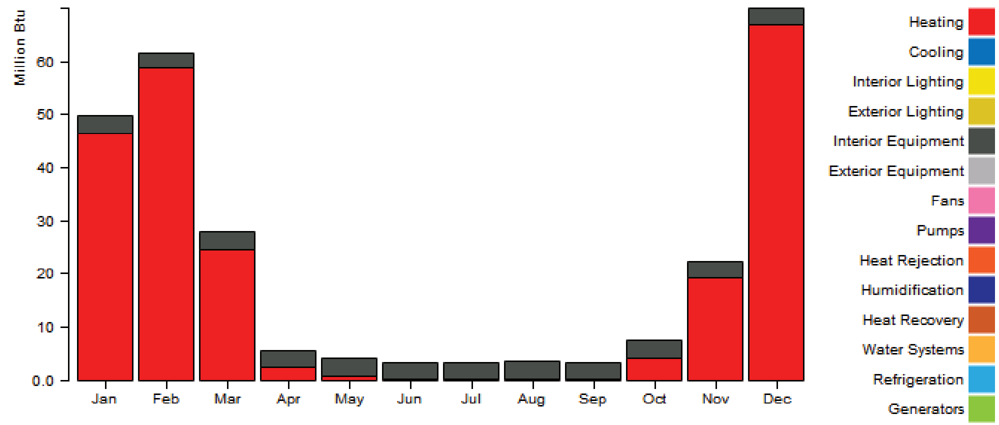
The energy model was setup on EnergyPlus and OpenStudio. For simplicity, the simultated system was a radiant heating and cooling with DOAS HVAC system. The fuel for the boiler is natural gas. The model did not include phase change material (pcm) and natural ventilation. We believe that with natural ventilation and addition of pcm, the buildings will be cool without the assistant of a mechanical system.

	area	energy	per area	DHW	EUI	Total
Space/ unit	sf	kbtu	kbtu/sf	kbtu/yr	kbtu/sf/yr	kbtu/yr
residential	59166	664,865	11.24	399,059	17.99	1,063,924
commercial	9945	306,685	30.86	6,841	31.55	313,526
parcel 1	69111	971,550	14.07	405,900	19.94	1,377,451

parcel 2



Electric consumption (kwh)



Natural gas consumption (mbtu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cooling	77.809	—	261.3	951.014	2,288.447	3,648.361	3,012.528	4,171.667	4,580.194	926.919	517.256	—	20,435.495
Interior Lighting	15,644.25	14,170.056	15,739.472	15,096.861	15,739.472	15,216.333	15,620	15,739.472	15,192.083	15,644.25	15,216.333	15,620	184,638.582
Interior Equipment	14,450.194	13,069.667	14,499.167	13,954.611	14,499.167	14,022.667	14,431.111	14,499.167	14,003.556	14,450.194	14,022.667	14,431.111	170,333.279
Fans	3,623.528	3,332.861	3,768.861	3,439.444	3,768.861	3,623.528	3,584.778	3,768.861	3,584.778	3,623.528	3,623.528	3,584.778	43,327.334
Pumps	955.883	923.261	757.158	435.161	464.569	440.108	410.011	399.808	357.778	409.961	563.911	1,014.303	7,131.912
Total	34,751.664	31,495.845	35,025.958	33,877.091	36,760.516	36,950.997	37,058.428	38,578.975	37,718.389	35,054.852	33,943.695	34,650.192	425,866.602

Natural gas consumption (mbtu)

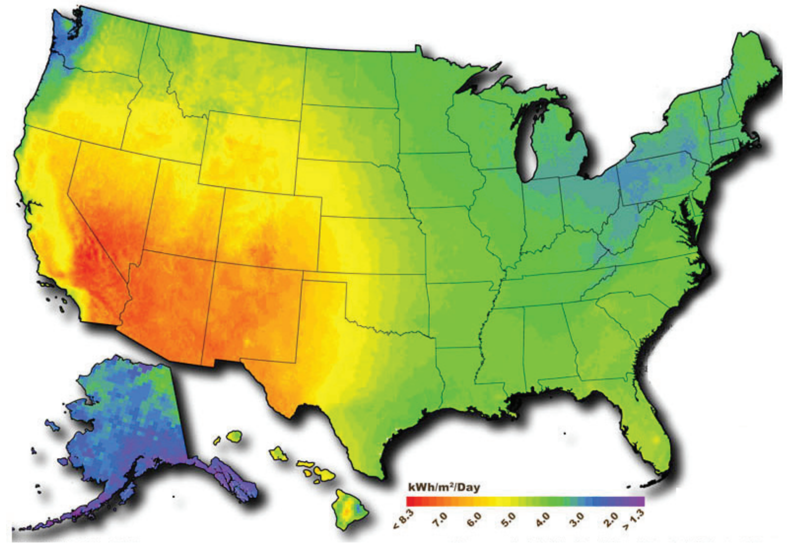
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Heating	46.422	58.623	24.639	2.36	0.81	0.077	0.099	0.268	0.058	4.201	19.099	66.756	223.412
Interior Equipment	3.219	2.919	3.251	3.095	3.251	3.141	3.206	3.251	3.128	3.219	3.141	3.206	38.027
Total	49.641	61.542	27.890	5.455	4.061	3.218	3.305	3.519	3.186	7.420	22.240	69.962	261.439

	area	energy	per area	DHW	EUI	Total
space/ unit	sf	kbtu/yr	kbtu/sf/yr	kbtu/yr	kbtu/sf/yr	kbtu/yr
residential	91612	1,040,703	11.37	604,289	17.96	1,644,993
commercial	18718	672,950	35.98	21,891	37.14	694,841
parcel 2	110330	1,713,653	15.55	626,181	21.23	2,339,834

With the addition of waste water heat recovery and movable shading devices, the energy consumption should be further reduced.

2F renewable energy

Potential resources



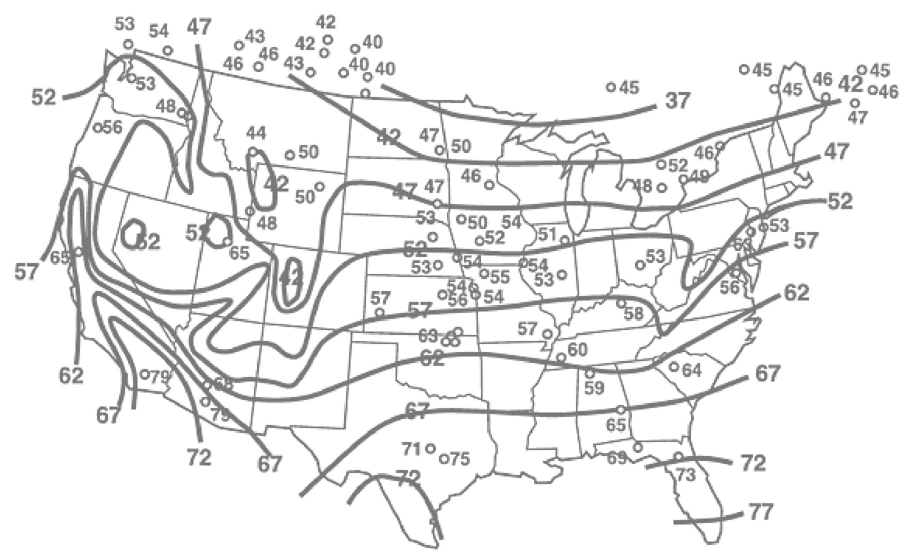
Source: National Renewable Energy Lab

Wind: with an average wind speed of 8 mph, the site is not ideal for wind turbines. Noise of turbines also a concern for a medium density residential area.

Solar Thermal: with the average radiation at 5.61 kWh/m² (1), solar energy has great potential in Oakland. With high efficiency, solar thermal payback time is relatively short. Due to the short and mild winter, we only size solar thermal system for domestic hot water.

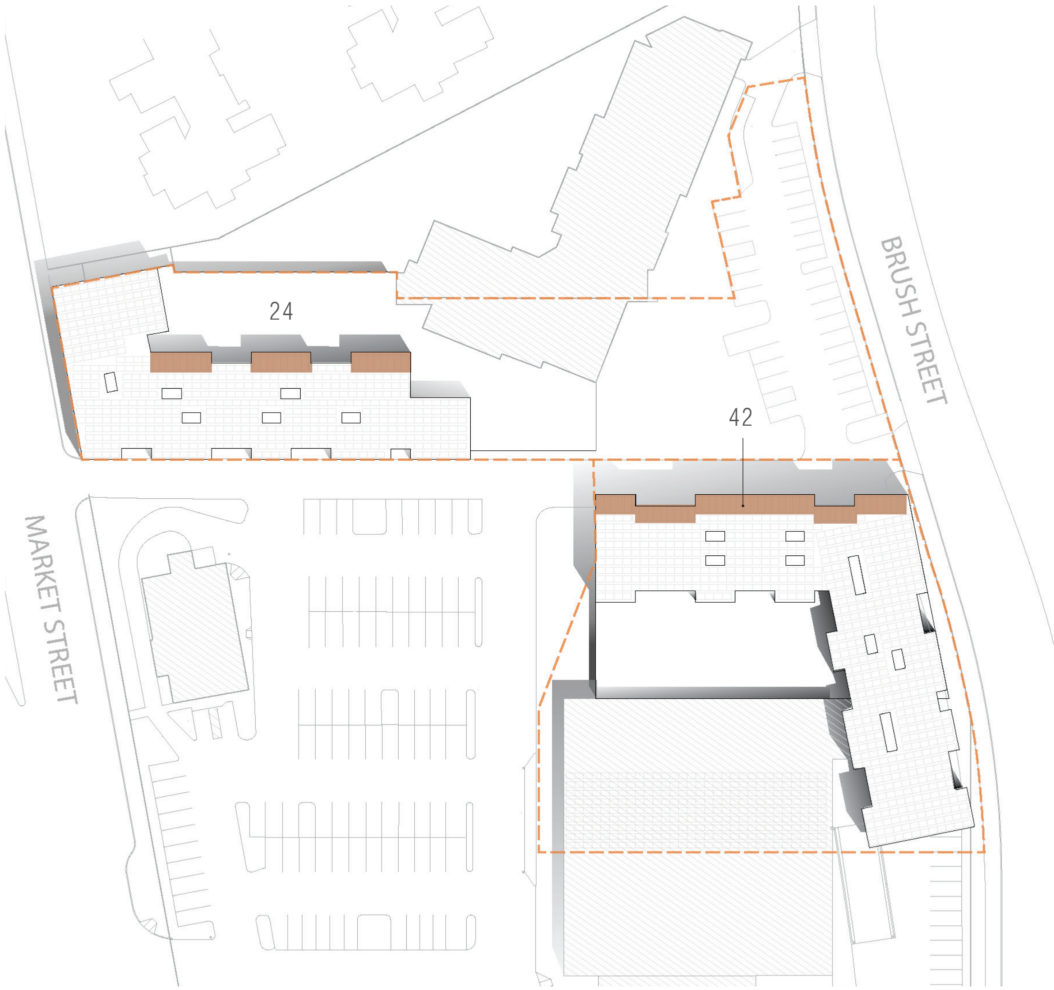
Photovoltaics: with grid-tie installation, photovoltaics is the most flexible renewable energy source.

Geothermal: potentially provides both heating and cooling. Since the site excavation is already required for the ground-up construction, the installation cost is significantly reduced.



Mean annual earth temperature observations at individual stations, superimposed on well-water temperature contours.
source: build it solar

Solar thermal



Panel specifications

Type: glazed flat glass
Model: Heliodyne Gobi 410 003
Dimension: 4’ x 10’
Area: 40 sf
Production: 46 kbtu/panel/dy (SRCC)

Energy produced

E = N x p

N: number of panels
p: panel performance (kbtu/day)

System production	Parcel 1	Parcel 2
number of panels	24	42
daily production (kbtu/yr)	1,104	1932
yearly production (kbtu/yr)	402,960	705,180

Solar Thermal arrays are laid out as a a single row on the northern edges to maximize roof space for the photovoltaics system.

2F Renewable energy

Photovoltaics

Panel specifications

Type: monocrytaline (Sunpower)
Model: Sunpower X21-345
Dimension: 3'-6" x 5'-0" area: 17.5 sf
Efficiency: 21.5 %
Nominal power: 345w

Energy produced

$E = A \times r \times H \times PR$

E: energy produced (kbtu)
A: system pv area (sf)
r: solar panel efficiency (%)
H: annual average radiation (5.61 kWh/m^2 for Oakland)
PR: performance ratio (use 0.75)

System production	Parcel 1	Parcel 2 upper	Parcel 2 lower
number of panels	520	610	330
yearly production (kbtu/yr)	888,175	1,031,975	558,282

In order to maximize the number of panels on the roof area, the panels are laid out in landscape mode and tilted 10 degree toward the south.

Geothermal

We propose 4.0 COP closed loop ground source heat pump heat pump for both parcels. 75% of the modeled heating requirement will be replaced by geothermal energy, and 25% is electricity.

System production	Parcel 1	Parcel 2
district heating model (kbtu/yr)	287.347	1,007,708
geothermal energy (75%) (kbtu/yr)	215,510	755,781
electricity heat pump (25%) (kbtu/yr)	71,837	251,927

2F summary

Approaching net zero energy

renewable ktbu/yr	photovoltaics ktbu/yr	solar thermal ktbu/yr	geothermal ktbu/yr	total ktbu/yr
parcel 1	888,175	402,960	71,837	1,362,972
parcel 2	1590257	705,180	251,927	2,547,364

target	area sf	target EUI kbtu/sf	total target kbtu
residential	59,166	19.6	1,159,648
commercial	9,945	22	218,790
parcel 1	69111		1,378,438
residential	91,612	19.6	1,795,586
commercial	18,718	73.3	1,372,060
parcel 2	110330		3,167,647

summary	renewable ktbu/yr	energy modeled ktbu/yr	energy target ktbu/yr
parcel 1	1,362,972	1,377,451	1,378,438
parcel 2	2,547,364	2,339,834	3,167,647

Comparing to the target prepared by ARUP, parcel 1 reached Zero Net Energy, while parcel 2 still has a gap due to the energy intensive of the grocery store. The load should reduce significantly with energy saving strategies that not included in the simulation. These include natural ventilation, phase change material and waste water heat recovery. The gap can be easity closed by enlarging the ground source heat pump system and/or the photovoltaics array on the roof of the existing shopping center.

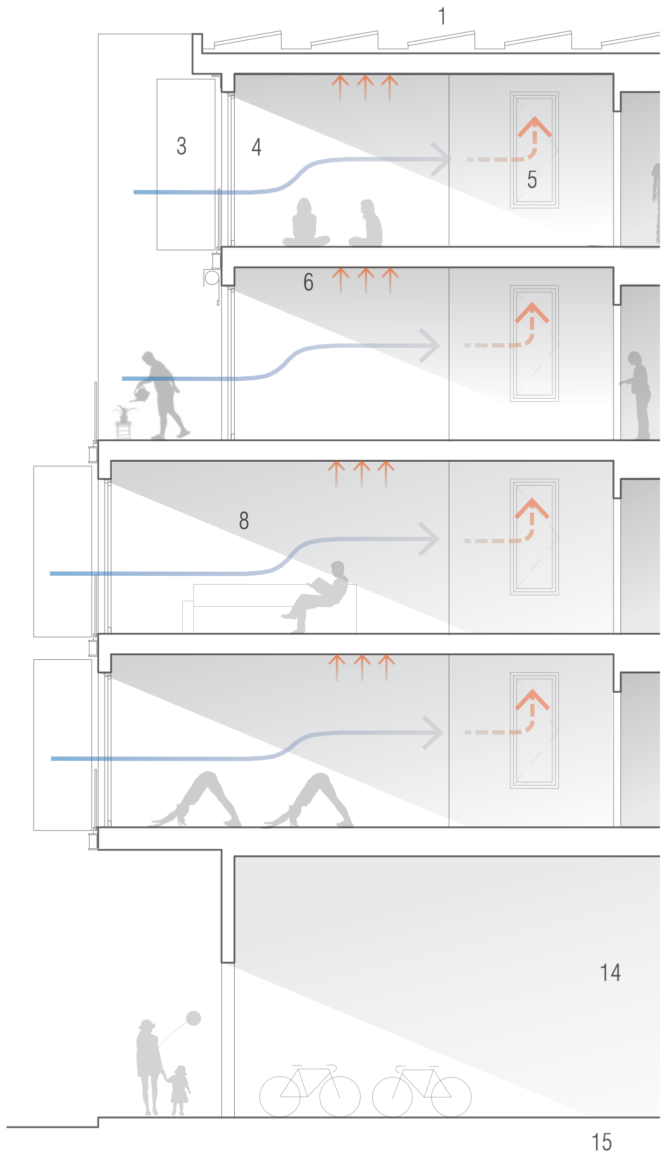
2G occupant behavior

The project begins with a small unit with small rooms and little storage space. The limitation discourages inhabitants from acquiring extraneous things which are the major waste of energy.

It makes the inhabitant aware of the surrounding. Open the windows for fresh air, changing the shade angle in responding to the sun angle. The inhabitant is also reminded of the nature through natural materials such as bamboo floor, reclaimed wood wall, green facade or simple furniture, natural light and breeze, shadow and shade and so on. An appreciate for nature is developed.

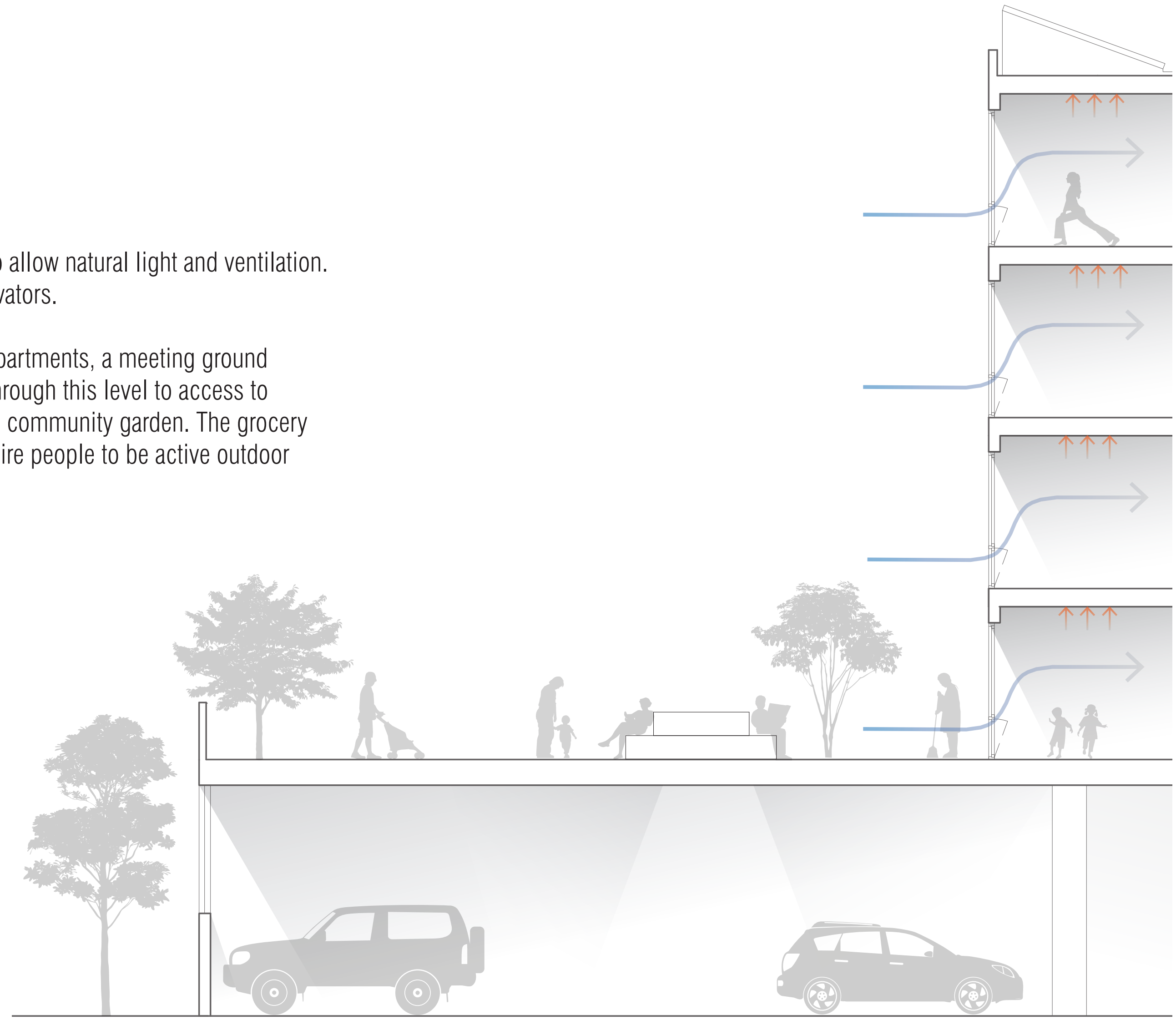
Ultimately, the success of the solution depends largely on the user, who will develop healthy habits in routine and who will increasingly become more sensitive to internal and external environmental conditions, to decide on the appropriate time or angle to perform the ventilation or shading.

Kitchen was set in a neat corner with natural light during the day. Enhanced by warm spot lights, the space encourages people to a healthy attitude toward food. The living room and dinning room is free open as a multi-functional room allowing interaction between family members.



Generously sized stairs are located on the perimeter to allow natural light and ventilation. They encourage residents to walk instead of using elevators.

The elevated open space serve as a front yard of the apartments, a meeting ground to foster a strong community. Residents would pass through this level to access to essential services such as community center, laundry, community garden. The grocery store is only three flies of stair below. The garden inspire people to be active outdoor and connected with other fellow residents.



The small communities of residents are also encouraged to interact with each other. An elevated park is proposed on top of the existing parcel 1 parking lot. The park is an ideal place for senior residents to be interact with children at the childcare facility that do not only add joy to senior people's golden years but also keep them mentally sharp. The children playground was layout to receive sufficient sun light throughout the day. Located at the junction, the childcare has a good balance of privacy and exposure. While being safe, it brings joyful energy to the community.

Streetscape and landscape are both set nicely for drivers, pedestrians and cyclists. The street activities in return will strengthen the bond among all facilities on the site. When people either walk down to the street, sit on the lawn at park, work in the community garden, go shop at the local grocery store or play with children, they are nurturing a living organism - the Home.

We hope that the limit of energy and spaces will open up a new way of living. With less time spent on car and consuming, the more efficient lifestyle will allow the dwellers abundant time for themselves and their families to make a better community.