ROXBURY E+ // ISA

LOCATION_CLIMATE

The project I chose are a series of townhomes located on 226-232 Highland Street in Roxbury. This area is within the historic Fort Hill area which is located on a formerly vacant city-owned site. In terms of climate, Boston is fairly typical to New England. For instance, Dry bulb temperature is around 26 degrees Fahrenheit in January, and rises to 74 degrees in July. In terms of relative humidity, the average for January is 60, and rises to 73 in August. To generalize, Boston has a "humid continental climate" with very cold winters of heavy snowfall, warm summer months and 40-60 inches worth of rain annually.

CLIMATE CONSULTANT

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	61	85	96	108	122	121	130	124	109	87	66	54	Btu/sq.ft
Direct Normal Radiation (Avg Hourly)	91	102	94	90	99	93	100	98	108	100	88	88	Btu/sq.ft
Diffuse Radiation (Avg Hourly)	30	42	46	52	53	53	59	57	47	40	32	26	Btu/sq.ft
Global Horiz Radiation (Max Hourly)	156	204	258	287	307	298	317	304	258	221	176	134	Btu/sq.ft
Direct Normal Radiation (Max Hourly)	284	285	309	293	293	255	277	278	283	294	282	242	Btu/sq.ft
Diffuse Radiation (Max Hourly)	72	114	116	161	155	140	154	146	129	101	95	66	Btu/sq.ft
Global Horiz Radiation (Avg Daily Total)	567	880	1143	1430	1766	1827	1923	1695	1349	946	636	484	Btu/sq.ft
Direct Normal Radiation (Avg Daily Total)	844	1048	1119	1200	1430	1414	1474	1341	1327	1073	847	794	Btu/sq.ft
Diffuse Radiation (Avg Daily Total)	279	435	542	684	780	812	881	790	586	441	316	235	Btu/sq.ft
Global Horiz Illumination (Avg Hourly)	1909	2686	3066	3441	3869	3843	4116	3904	3444	2735	2053	1667	footcandles
Direct Normal Illumination (Avg Hourly)	2378	2794	2667	2585	2873	2748	2924	2880	3089	2772	2339	2250	footcandles
Dry Bulb Temperature (Avg Monthly)	26	31	38	47	58	65	74	71	64	54	43	35	degrees F
Dew Point Temperature (Avg Monthly)	13	17	24	35	47	54	60	60	53	41	33	23	degrees F
Relative Humidity (Avg Monthly)	60	58	59	66	68	69	66	73	69	65	70	59	percent
Wind Direction (Monthly Mode)	290	290	310	220	300	220	290	200	240	230	0	270	degrees
Wind Speed (Avg Monthly)	12	13	13	14	12	11	11	11	10	11	10	13	mph
Ground Temperature (Avg Monthly of 3 Depths)	37	34	35	39	48	56	63	66	64	60	52	44	degrees F

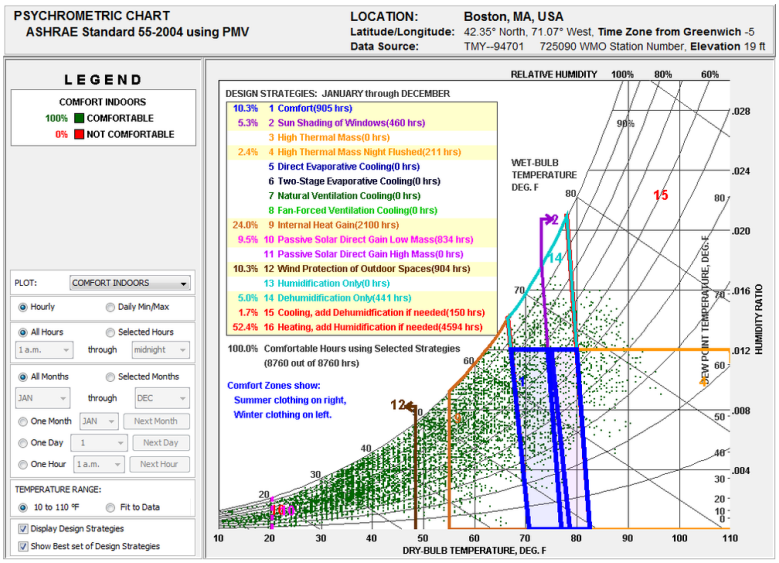
BACKGROUND

The townhomes were the premiere designs to be built under Boston's new E+ initiative to conduct net zero energy housing prototypes. ISA partnered with the Boston REdevelopement authority in collaboration with the Boston local developer, Ubanica.

DESIGN INTENT

The intent of the E+ homes were to be a replicable protype for family-oriented, energy efficien townhouse in an urban setting. Each townhouse is 1850 square feet that features 3 bedrooms and 2.5 bathrooms. Additional features include a private rear deck and a masterbedroom with 17 ft ceilings. ISA was aiming to contribute to the richness of the historical area with an affordable and environemntally sustainable design that was both context-sensitive and modern. They wanted to promote an urban lifestyle that encouraged energy-conscious decisions.

ENVIRONMENTAL DESIGN STRATEGY >> AFFECT TOWARDS HEAT FLOW



CRITICISM

"High-performance market-rate housing that seems to have been inspired by Passive House Standard design strategies. It is an elegantly designed, modest-scale project that fits well within the community. This net-zero project with super-insulated walls clearly pays attention to minimizing air infiltration and reducing energy usage in order to reduce the sizing of the renewables. It is done in a way that the entire photovoltaic array is nicely integrated into the architecture and does not dominate the building's look and feel. This project incorporates passive solar and solar electric systems. An example of both high performance and high style."
-AIA

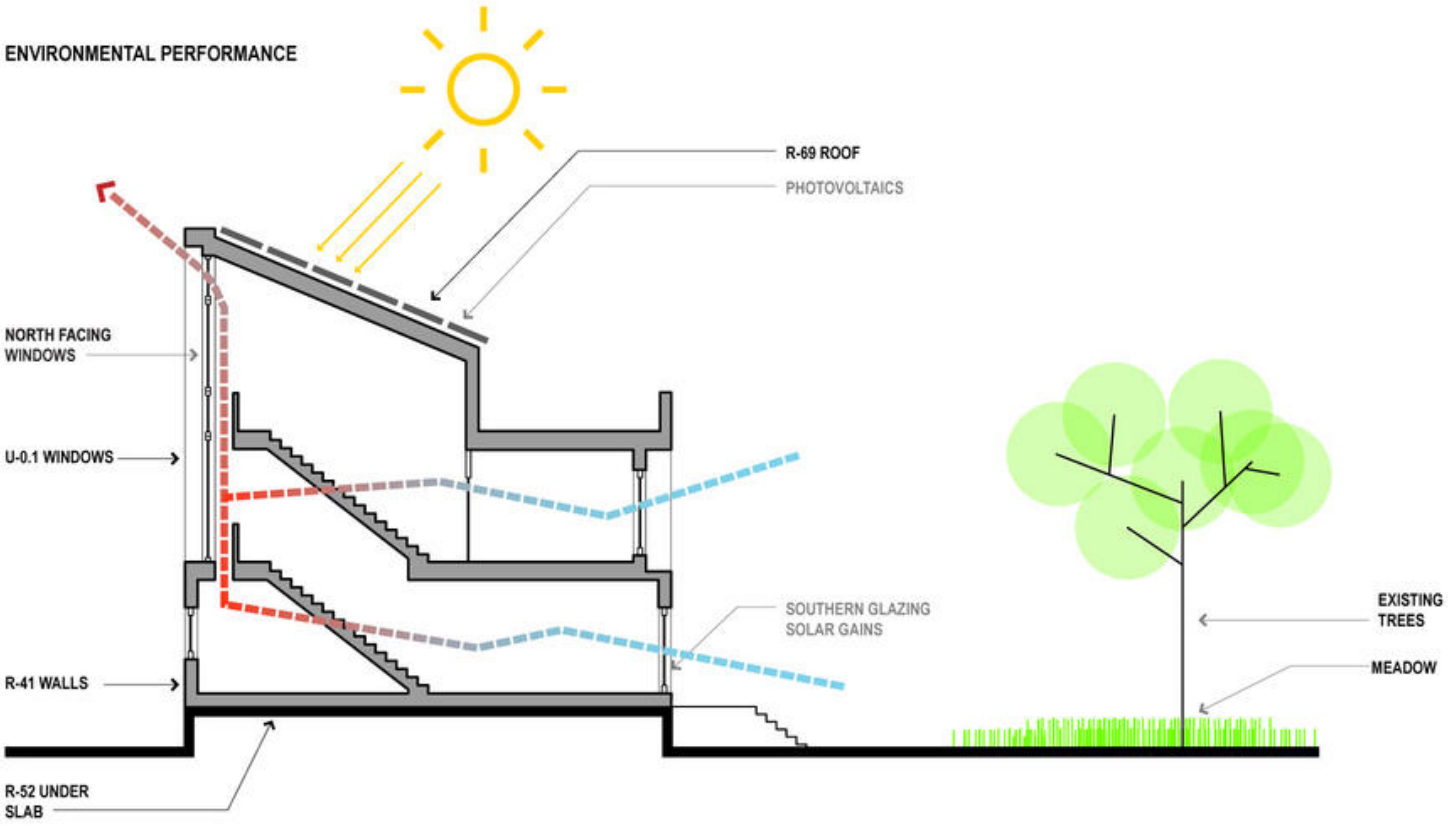
ROOF+FLOORS (highly sealed and insulated)
Minimizing Infiltration- By controlling the infiltration rate and purposeful ventilation, both comfort ad energy conservation is achieved,
Robust envelope insulation- batt insulation starts to sag, gaps start to develop between the studs and insulation, and cold air gets behind the insulation... which completely negates the insulation value.Modern insulation such as blown in polyisocyanate prevent any such settlement but also acts as an vapor barrier. The townhouse uses blown-in cellulose insulation.
The southward slope maximizes solar gain for photocoltaic panels.

STAIRS
Three level stairwell- will act as a chimney or thermal well, to promote stack effect. An active or passive system can be designed to take advantage of this natural phenomenon. During summer, heat will rise up through the staiwell, so hot air can be expelled from the top, either through gravity vent or through an exhaust fan, and draw in cooler air from lower floor windows. During winter, heat still rises, but now it can be reclaimed by using an active fan system to dive down this warm air to lower floors to heat.
Also, the stairs allow for light to make its way deep into the house.

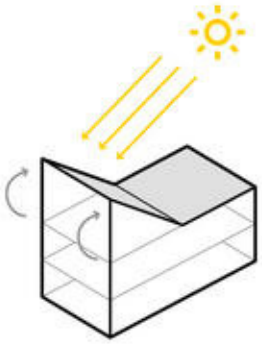
MECHANICAL (ductless mini-split HVAC system HRV)
Mini Splits- come as air conditioning or air-to-air heat pump. The air-to-air heat pump is only about 15% more than the straight AC system. Today's Japanese heat pump have COP (Coefficient of Performance) in the range of 3 to 4 meaning that for every KWh of energy it produces 2 to 4 times the heating value. Electric heat in US costs 2 to 3 times that of gas, so if COP is 2 to 3, heat pump's heating cost would be same as the gas heat, but at COP of 3 to 4, heat pump costs less than the gas heat. With such super-insulated homes, air-to-air heat pump offer a real attraction.
Heat recovery Ventilators (HRV)- heat exchanger recovers energy from exhaust and tempers outside air coming in for ventilation. In past, toilet exhaust, which contained heated or cooled air from interior to be exhausted with its integral energy totally lost to outdoors; meanwhile every unit of air exhausted is made up through infiltration of raw outside air which imposes heating/cooling load. An HRV would recover energy from toilet exhaust and use it to temper outside air. Modern HRV has heat recovery efficiency in the range of 40% to 80%.

PHOTOVOLTAIC
Photo Voltaic (PV)- PV converts solar energy directly into electricity. It is great for air conditioning since hottest sun results in highest electricity production when the air conditioning load is highest. Not necessarily so with other electrical loads, but thankfully the excess electrical generation can be sold back to utility company. The excess energy can also be stored in form of battery to be utilized later. Both the PV production and battery storage is in form of DC (Direct current), so when the need arises, it is converted to AC (alternating current) through an inverter.
Solar Thermal- is more efficient than PV but residential thermal load is limited. Year-round load is domestic hot water, but larger seasonal load is winter heating.
Natural lighting- northern exposure provides much more steady useful source of day lighting.

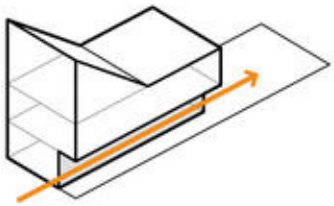
ENVIRONMENTAL PERFORMANCE



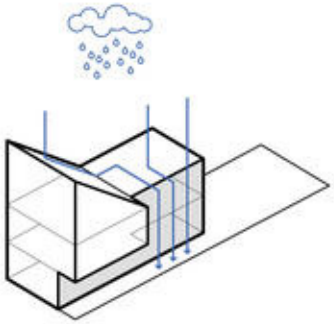
FIRST FLOOR PLAN
SCALE 1/8" = 1'-0"



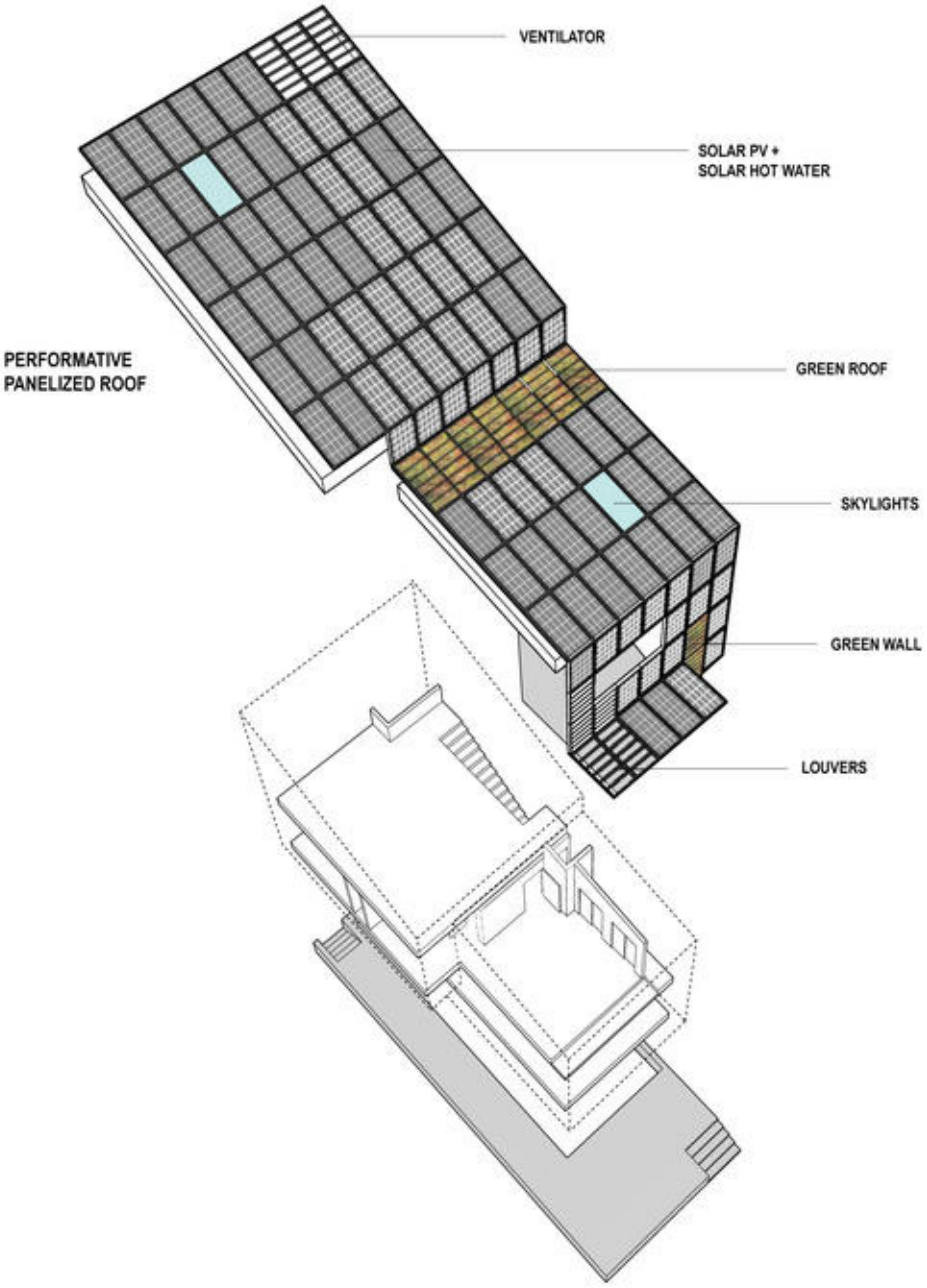
SOLAR



CIRCULATION



RAINWATER



PROPOSED PERFORMATIVE COMPONENTS

SOURCES

http://www.aiatopten.org/node/433
http://www.is-architects.com/roxbury-e/23ah3k9zpoqiss2tdl4svhyuo7jgyv