

S U S 2 0 1 8 THE ZERO-ENERGY HOME
INSTRUCTOR: DAVID FOLEY - FALL 2015
FINAL PROJECT / L O R I H A N C O C K



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INTRODUCTION

ZETA COMMUNITIES PRODUCES SMALL PREFABRICATED NET-ZERO STRUCTURES SUCH AS HOMES, MIXED-USE PROJECT, AND PUBLIC FACILITIES. THE STRUCTURE I WILL BE ADDRESSING IN THIS PROJECT IS THEIR OAKLAND, CALIFORNIA MODULAR TOWNHOUSE. THE TOWNHOUSE HAS 2 BEDROOMS AND 2 BATHROOMS IN AN 1,561 SQF LIVING SPACE COSTING \$165 PER SQUARE FOOT, EXCLUDING LAND, SITEWORK, AND FOUNDATION.

THE DESIGN TEAM INCLUDED ZETA COMMUNITIES; ARCHITECTS, DANIEL SMITH AND ASSOCIATES, LOCATED IN BERKELEY, CA; TIPPING MAR ENGINEERING; AND ENERGY/BUILDING SCIENCE CONSULTANT JOHN STRAUBE, FROM BUILDING SCIENCE CORPORATION IN SOMERVILLE, MA.

CERTIFICATIONS OF THE PROJECT INCLUDE LEED PLATINUM AT 99.5 POINTS, ENERGY STAR, DOE BUILDERS' CHALLENGE, EPA INDOOR AIRPLUS, AS WELL AS A 206 GREEN POINT RATING.

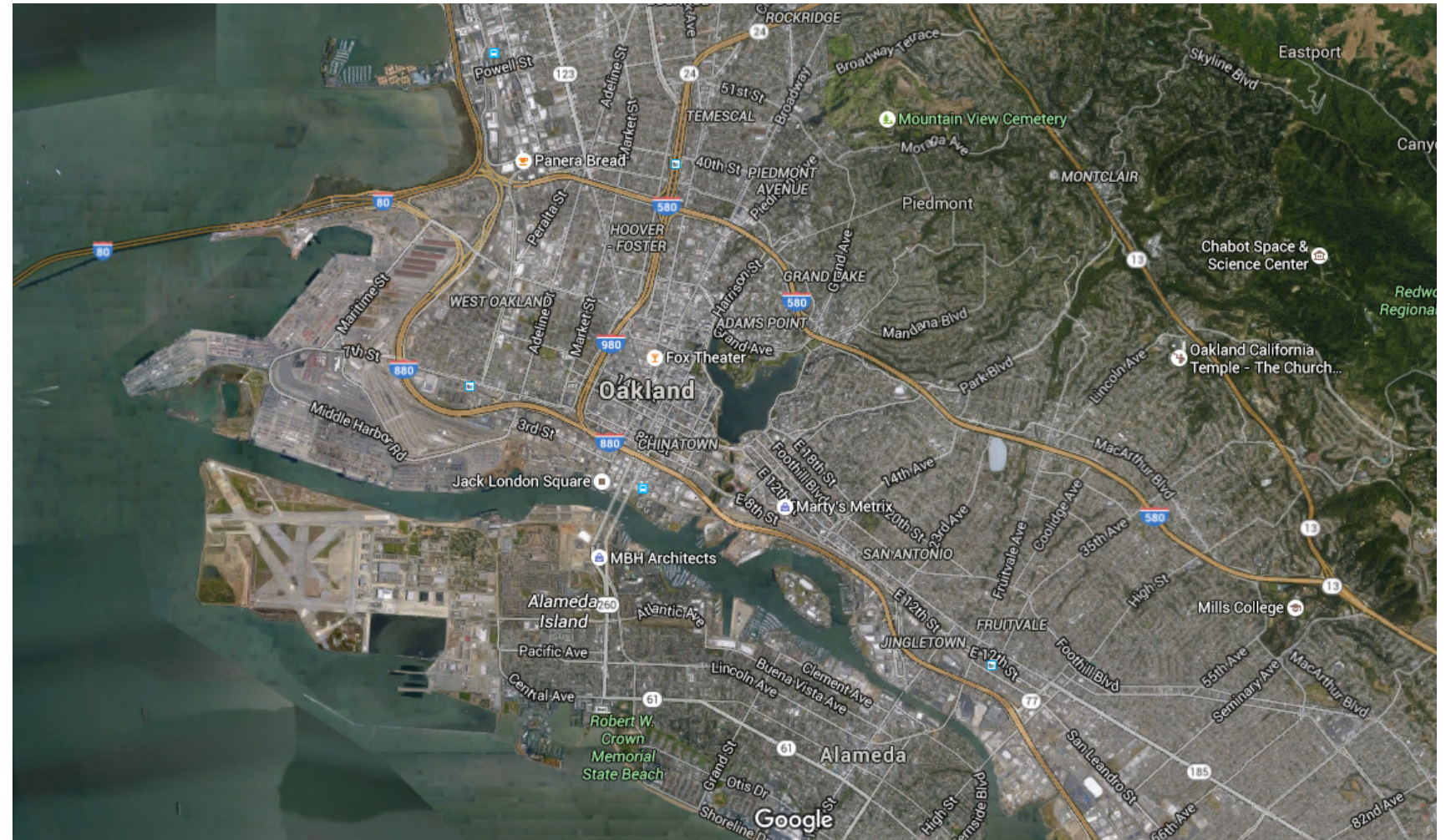


IMAGES AND INFORMATION FROM GREEN BUILDING ADVISOR: A NET-ZERO TOWNHOUSE IN OAKLAND

CLIMATE ANALYSIS

OVERVIEW

THE NET-ZERO TOWNHOUSE IS LOCATED EAST OF THE SAN FRANCISCO BAY IN OAKLAND, CALIFORNIA, WITH A BASIC LATITUDE OF 37.75 NORTH AND LONGITUDE OF 122.2 WEST. HEATING DEGREE DAYS FROM A BASE OF 65F IS 2909 AND COOLING DEGREE DAYS FROM A BASE OF 80F IS 128. DESIGN DAY DATA FOR 99% - WINTER IS 34F, AND 97.5% - WINTER IS 35F, WITH A RECORD LOW OF 14F. DESIGN DAY DATA FOR 1% - SUMMER IS 85F, AND 2.5% - SUMMER IS 80F, WITH A RECORD HIGH OF 114F. WINTERS ARE MODERATELY COLD AND SUMMERS ARE WARM AND DRY. RELATIVE HUMIDITY IS FAIRLY CONSISTENT, AROUND 60-80%, WITH A HIGHER HUMIDITY RATING IN THE MORNINGS, YEAR ROUND. WIND SPEED REACHES AN AVERAGE HIGH DURING THE MONTHS OF MAY AND JUNE OF 10 MPH AND A LOW OF 6 MPH DURING THE WINTER MONTHS.¹



1 CALIFORNIA CLIMATE ANALYSIS, PAGE 1

2 IMAGE FROM GOOGLE MAPS

CLIMATE DATA

LOCATION AND CLIMATE DETAILS:

CALIFORNIA CLIMATE ZONE 3

REFERENCE CITY: OAKLAND

LATITUDE: 37.75 N

LONGITUDE: 122.2 W

ELEVATION: 10 FT.

BASIC CLIMATE CONDITIONS:

SUMMER TEMPERATURE RANGE: 29F

RECORD HIGH TEMPERATURE: 114F

RECORD LOW TEMPERATURE: 14F

DESIGN DAY DATA:

WINTER 99% : 34F

WINTER 97.5% : 35F

SUMMER 1% : 85F

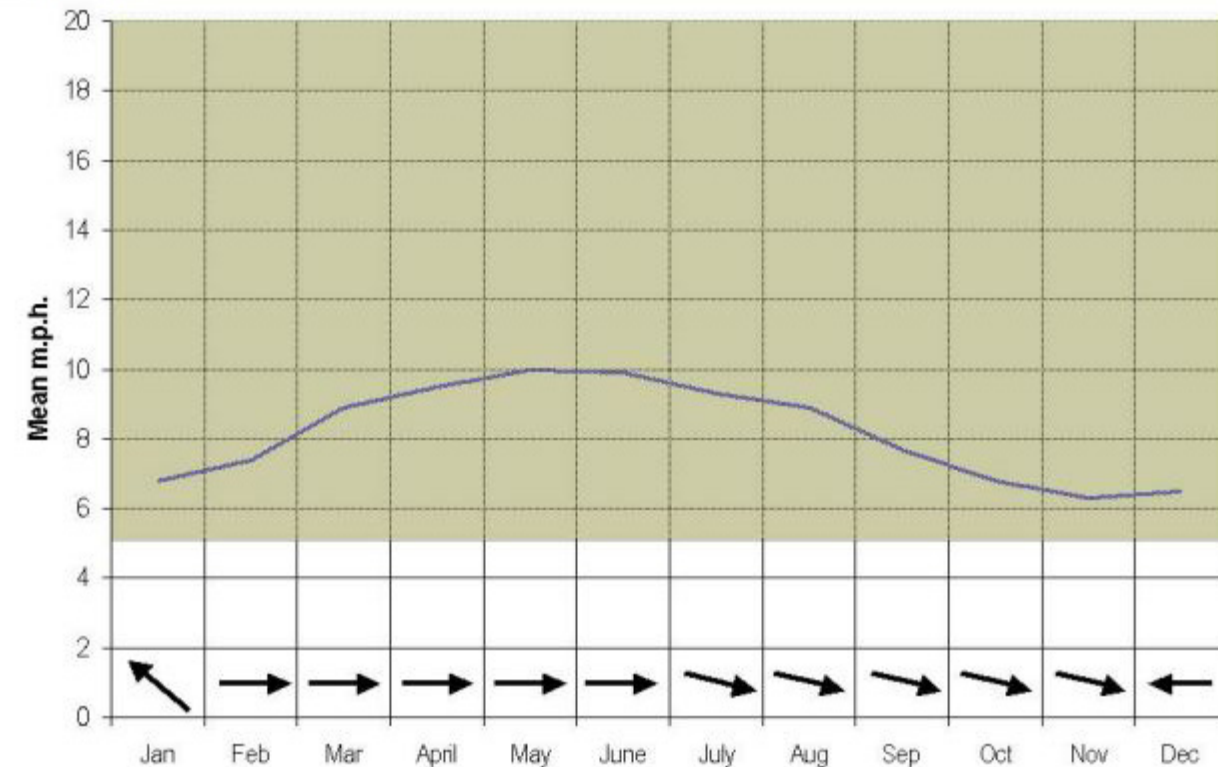
SUMMER 2.5 % : 80F

DEGREE DAYS:

HEATING DEGREE DAYS (BASE 65F): 2909

COOLING DEGREE DAYS (BASE 80F): 128

Wind Speed



Prevailing Wind Direction
Summer: WNW
Winter: E / W

Natural Ventilation is most effective when wind speed is 5 mph or greater.

Zone 3: Oakland
4 of 4

“THE CLIMATE OF ZONE 3 VARIES GREATLY WITH ELEVATION AND THE AMOUNT OF COASTAL INFLUENCE. AREAS WITH MORE COASTAL INFLUENCE EXPERIENCE MODERATE TEMPERATURES YEAR ROUND WITH PRECIPITATION IN THE WINTER AND FOG LIKELY FROM JUNE THROUGH MID-AUGUST. INLAND FROM THE BEACHES AND SEA CLIFFS, LOCAL GEOGRAPHY MAY REDUCE THE FOG COVER, LESSEN THE WINDS, AND BOOST SUMMER HEAT. WINTERS ARE MODERATELY COLD WITH MOST OF THE ANNUAL RAIN FALLING BETWEEN OCTOBER AND MARCH. WINTER SUNSHINE NEVERTHELESS IS PLENTIFUL. SUMMERS ARE WARM AND DRY, BUT THE NIGHTS ARE COOL. RAIN IS RARE DURING THE SUMMER MONTHS. A NEED FOR HEATING IS THE DOMINANT DESIGN CONCERN, BUT THE CLIMATE IS MILD ENOUGH THAT ENERGY CONSUMPTION IS RELATIVELY LOW.”

- ZONE 3: OAKLAND PAGE 1 OF 4,
CALIFORNIA CLIMATE ANALYSIS

CLIMATE DESIGN PRIORITIES

WINTER:

INSULATE
REDUCE INFILTRATION
PASSIVE SOLAR

SUMMER:

SHADE
ALLOW NATURAL VENTILATION

TITLE 24 REQUIREMENTS

PACKAGE:

CEILING INSULATION

C: R38

D: R30

WOOD FRAME WALLS

C: R25

D: R13

GLAZING U-VALUE

C: 0.42

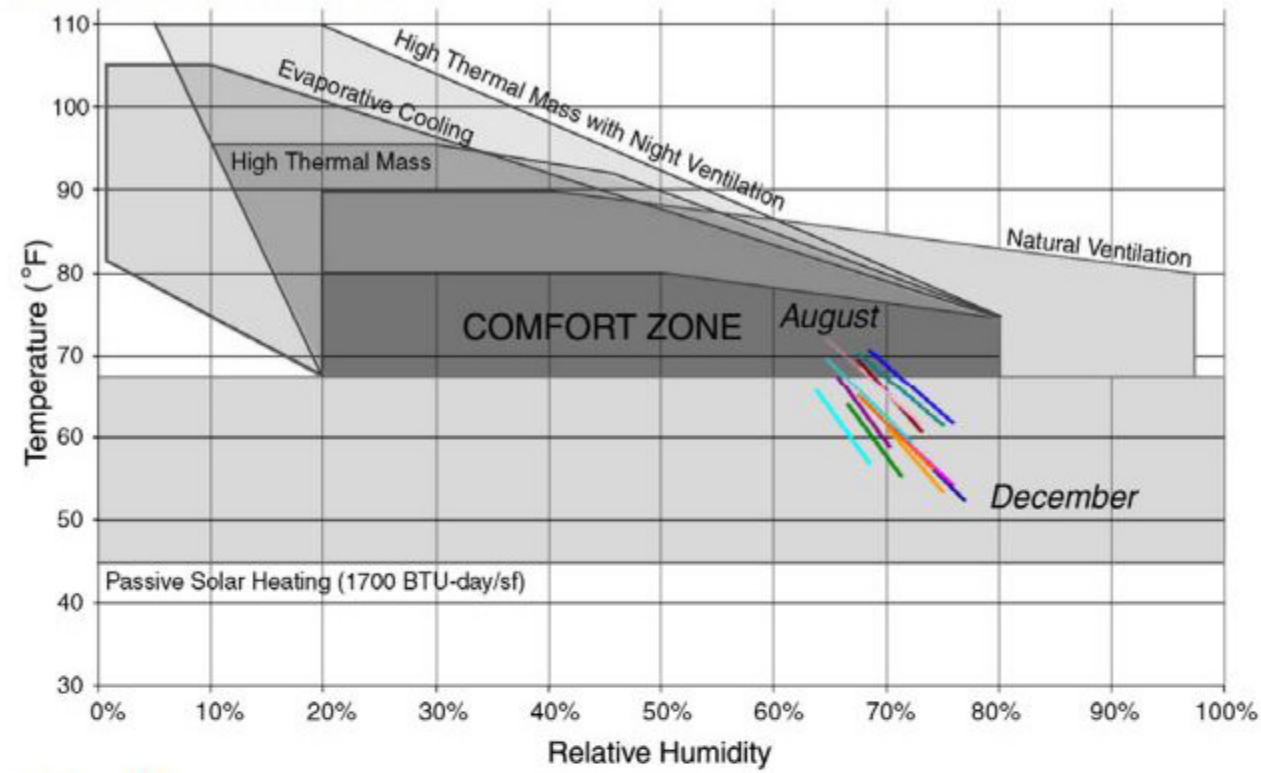
D: 0.67

MAXIMUM TOTAL AREA

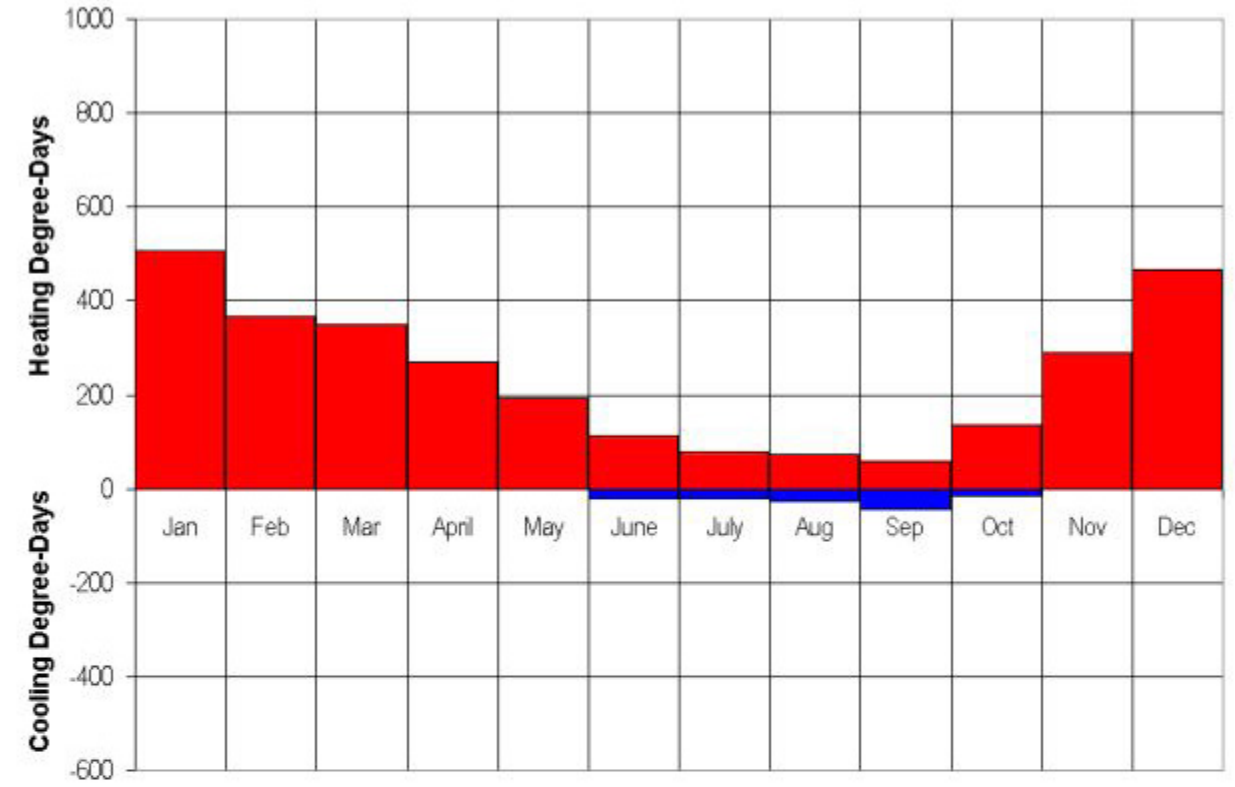
C: 14%

D: 20%

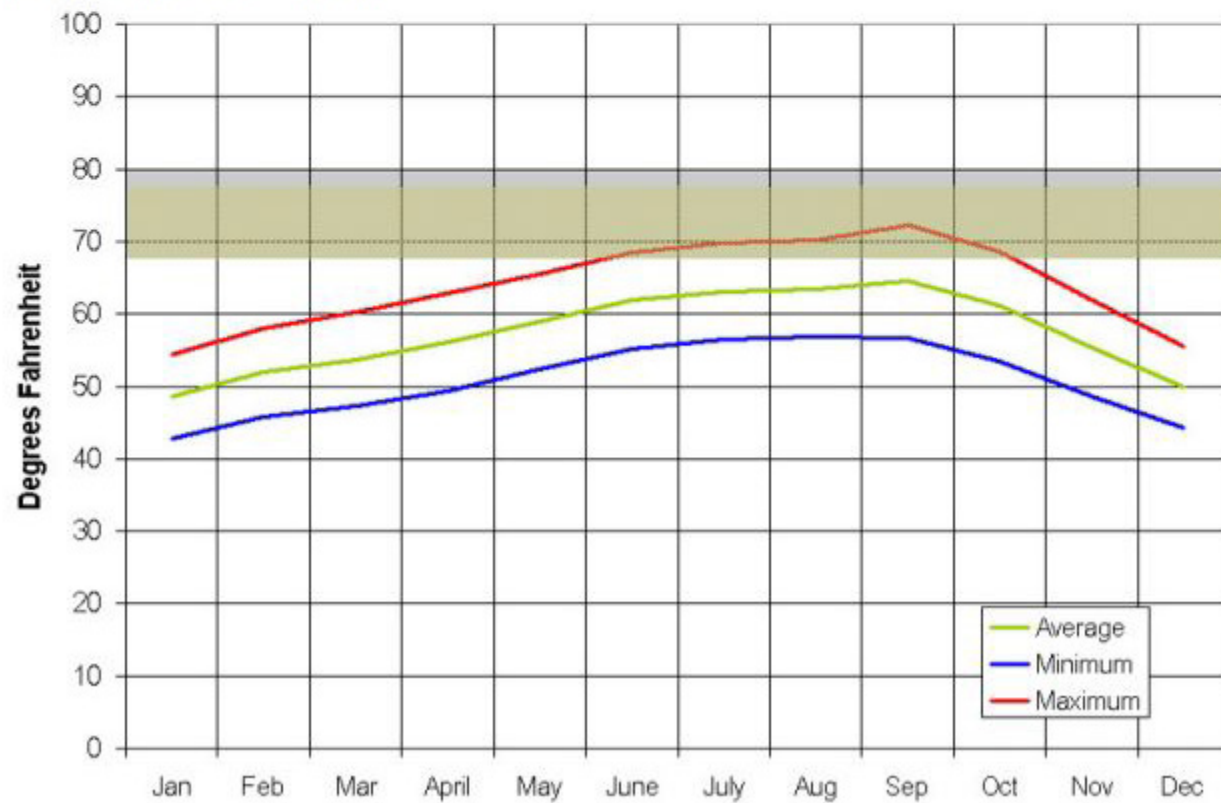
Bioclimatic Chart (Oakland)



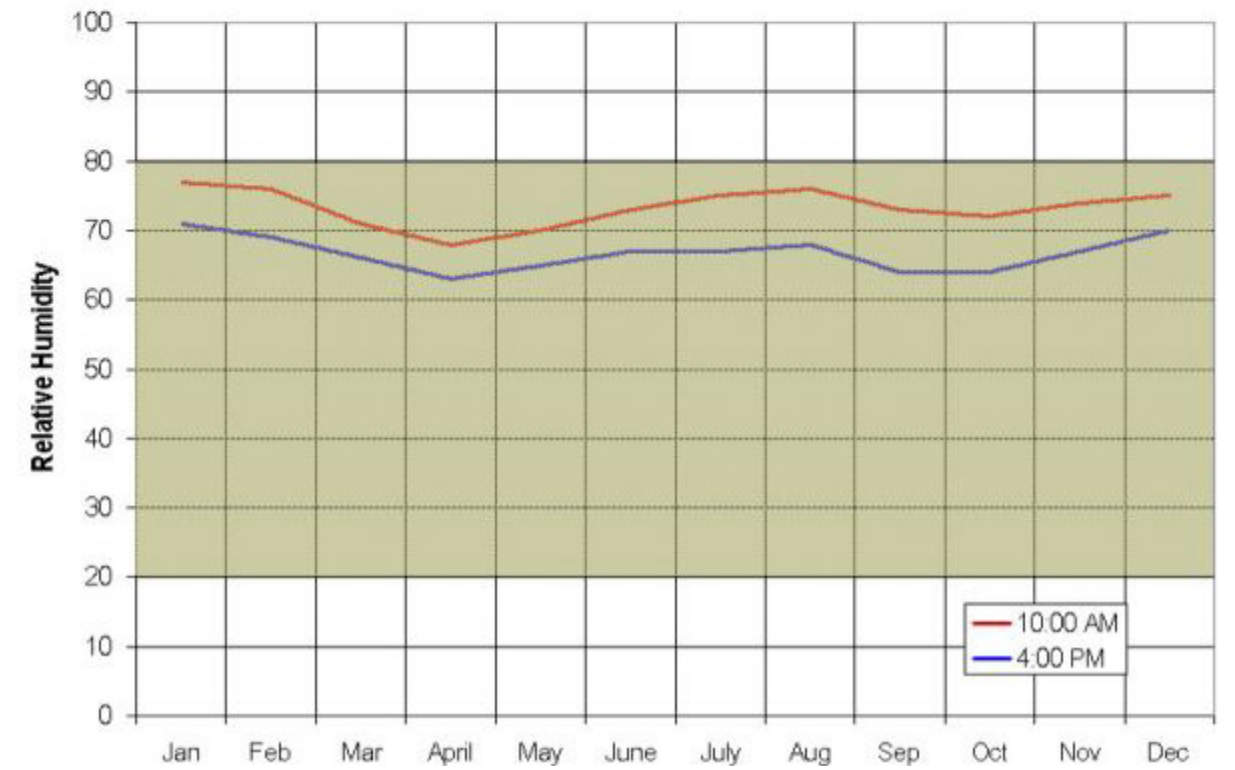
Degree Day (Base 65°)



Temperature (Typical Comfort Zone: 68-80°F)



Relative Humidity (Typical Comfort Zone: 20-80%)

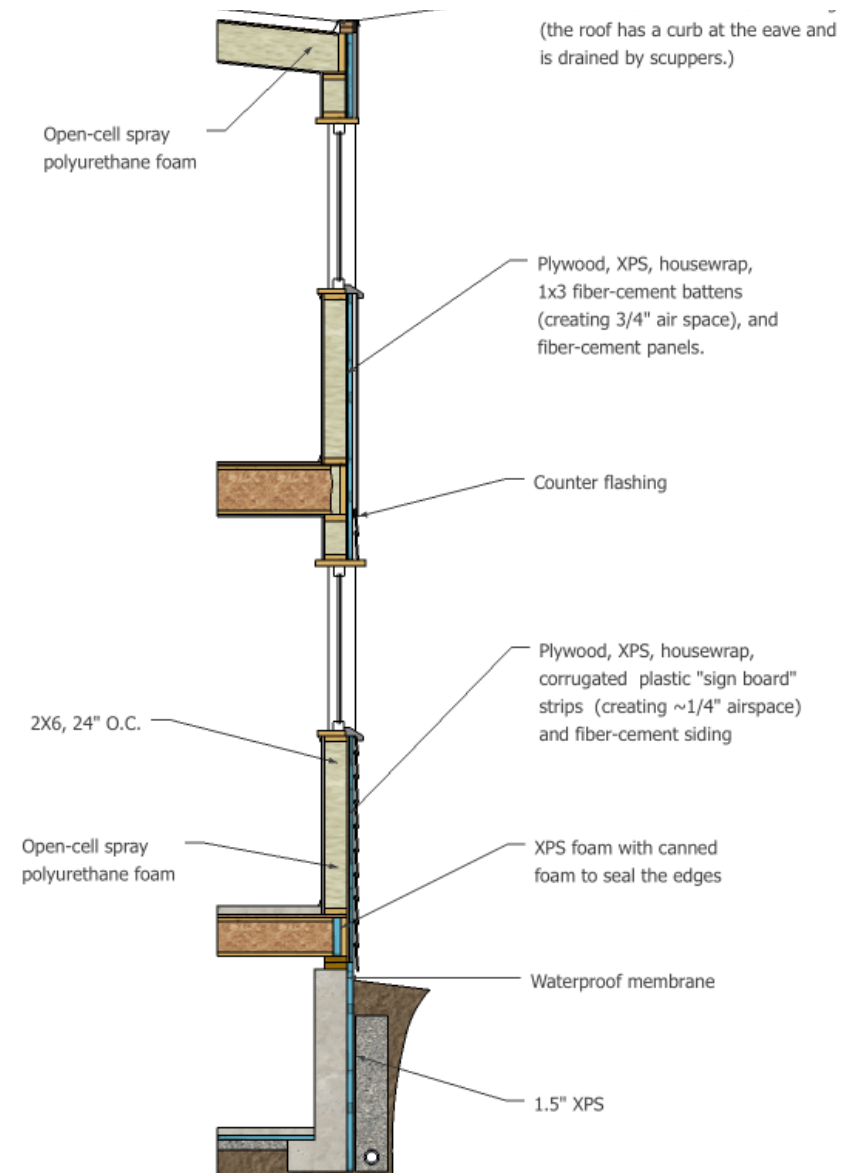


CONSTRUCTION

OVERVIEW

THE STRUCTURE IS COMPRISED OF FOUR PREFABRICATED MODELS THAT WERE ASSEMBLED ON SITE, ONTOP THE FOUNDATION WHICH IS A SEALED CONDITIONED CRAWL SPACE WITH 1 1/2" XPS INSULATION AT THE PERIMETER. THE DESIGN TEAM USED MINIMAL LUMBER TO REDUCE THERMAL BRIDGING WITH FACTORY FRAMED 2X6 OVE WITH 24-INCH CENTERS AND 2-STUD CORNERS. THE WALLS ARE INSULATED WITH A LOW-DENSITY POLYURETHANE SPRAY FOAM AND COTTON BATTS. EXTERIOR WALLS ALSO INCLUDE A CONTINUOUS 1" POLYSTYRENE FOAM (R-5 + R-19 ICYNENE.)

THE WINDOWS ARE "SERIOUS WINDOWS" WITH HEAT MIRROR GLAZING (U-0.23, SHGC 042). THE ROOF MODIFIED BITUMEN WITH CEILING INSULATION AT R-31 ICYNENE, AND THE SIDING IS FIBER-CEMENT.



CONSTRUCTION IMAGES



ENERGY CONSUMPTION

- ALL APPLIANCES ARE ENERGY STAR, INCLUDING MOST LIGHTING
- 5.4-kW PHOTOVOLTAIC SOLAR PANELS WITH AN EXPECTED OUTPUT 8,285 kWh PER YEAR
- THERE IS A TED 5000 ELECTRICITY READING DASHBOARD MOUNTED IN THE KITCHEN, HELPING MONITOR SEASONAL EFFICIENCY IN REAL-TIME
- THERE IS A DRAINWATER HEAT-RECOVERY SYSTEM
THE CRAWL SPACE HAS A 16 SEER/9.5 HSPF AIR-SOURCE HEAT PUMP
- THE AIR-SOURCE HEAT PUMP ALSO WORKS HELP AIR FLOW INTACT WITH THE CONCRETE-FLOORED CRAWL SPACE TO WORK AS A “THERMAL BASEMENT”
- THE MILD CLIMATE OF OAKLAND AND THE WELL-INSULATED AND AERATED STRUCTURE MINIMIZE COOLING IN THE WARMER SEASONS, WHICH THE HEAT PUMPS ALSO PROVIDE FOR
- A LARGE OUTSIDE AIR DUCT ALSO WORK TO FACILITATE NATURAL VENTILATION
- AIRIVA HE100 HEAT-RECOVERY VENTILATOR (HRV) IS CONNECTED TO THE BATHROOMS THROUGH EXHAUST DUCTS



INDOOR AIR QUALITY / WATER EFFICIENCY

INDOOR AIR QUALITY

- THEY USE AN ELECTRIC AIRTAP HEAT PUMP WATER HEATER (2.11 EF) AND AS STATED EARLIER, ALSO HAVE A DRAINWATER HEAT-RECOVERY SYSTEM
- THE HOME USES LOW-WATER-USE PLUMBING FIXTURES AS WELL AS DUAL-FLUSH TOILETS
- THE LANDSCAPE IS DESIGNED WITH DROUGHT-TOLERANT PLANTS ALSO, A PORTION OF THE ROOF WORKS AS A RAIN HARVESTING SYSTEM BY DRAINING TO A DRY WELL

WATER EFFICIENCY

- THEY USE AN ELECTRIC AIRTAP HEAT PUMP WATER HEATER (2.11 EF) AND AS STATED EARLIER, ALSO HAVE A DRAINWATER HEAT-RECOVERY SYSTEM
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CONCLUSION

IT WAS SURPRISING TO SEE JUST HOW SIMILAR AS A WHOLE THE ISSUES THE DESIGN TEAM AIMED TO ADDRESS IN THE OAKLAND TOWNHOUSE CONSISTED WITH THE COURSE-WORK OF THIS CLASS. MAYBE I COULD CREDIT THAT ENTIRELY TO JOHN STRAUBE, FROM BUILDING SCIENCE CORPORATION, BUT I ALSO FEEL THAT NET-ZERO NEEDS TO ADDRESS WHOLISTICALLY FROM ‘EVERYTHING THAT ENTERS IN’ AND ‘EVERYTHING THAT ENTERS OUT:’ ENERGY, AIR, WATER, ETC. AS THEY DID IN THE PROJECT AS AS WE ADDRESSED IN OUR CLASS.

THE DESIGN TEAM VERY CLEARLY WORKED COLLABORATIVELY THROUGHOUT THE PROJECT AND STARTED WITH A TIGHTLY WELL-INSULATED BUILDING ENCLOSURE BEFORE THEY ADDED ANY “THINGS” OR DEVICES. I ALSO APPRECIATED HOW THEY INCLUDED SELF-MONITORING CONTROLS, AS OCCUPANT BEHAVIOR IS ESSENTIAL TO ACHIEVING NET-ZERO, AS WELL AS INCORPORATING DROUGHT-TOLERANT PLANTS. AT

THE TIME THE STRUCTURE WAS COMPLETED IN 2009, ZETA COMMUNITIES COULD NOT HAVE PREDICTED THE EXTREME DROUGHT CALIFORNIA IS FACING TODAY. RESIDENTIAL LANDSCAPING IN THE LARGEST CONSUMER OF WATER FOR INDIVIDUAL HOMEOWNERS IN CALIFORNIA, SO THE DROUGHT-TOLERANT PLANTS ADDED IN 2009 COULD NOT BE MORE VALUABLE TODAY.