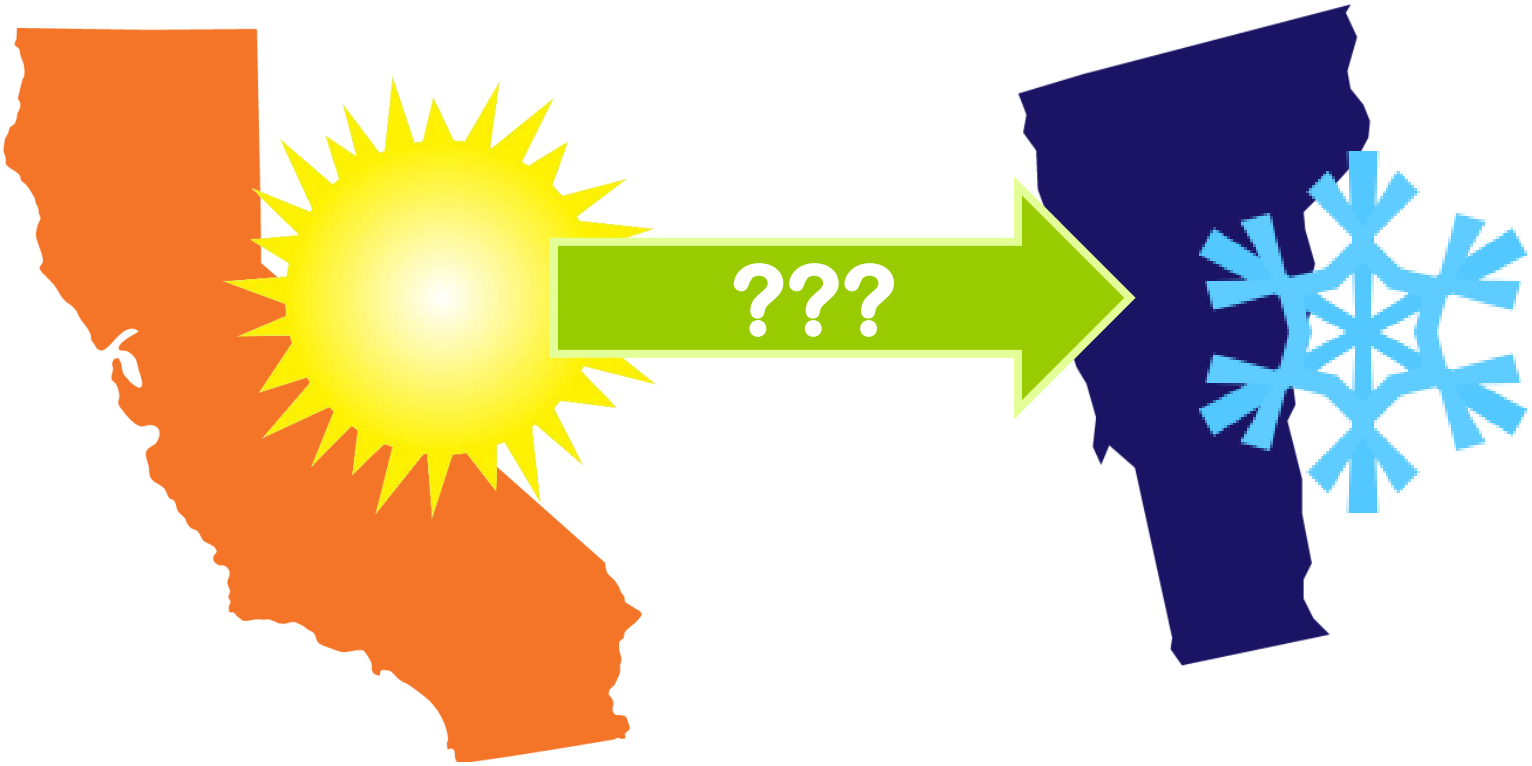
What Can Sunny California

Teach the Chilly Northeast?



ANN V EDMINSTER
AVE DESIGN AVEnues LLC

Photos courtesy of Rick Chitwood,
Chitwood Energy Management

What Can Sunny California

Teach the Chilly Northeast?

- Introduction
- Enclosure
- HVAC
- DHW & Electrical
- Outcomes
- Conclusions

What Can Sunny California

Teach the Chilly Northeast?

- Introduction

Central Valley Subdivision

Stockton, California

Pacific Gas & Electric Co. ZNE Production Builder Demonstration Project

Developer: **Habitat for Humanity of San Joaquin County**

Consultants: **Ann Edminster, Rick Chitwood, Steve Easley**

Project Objectives

- Help production builders achieve ZNE, affordably
- Identify ways to reduce barriers to the design, construction, and operation of ZNE homes in California
- Inform PG&E's future program offerings

Project Overview

BASICS

- 1,200 sq. ft.
- 3 bedrooms + 2 baths
- Occupied by a family of 4, late May 2016

ENCLOSURE

- Extensive advanced framing
- Air sealing & infiltration testing

HVAC

- Equipment in conditioned space
- HVAC sized based on field research
- Balanced ventilation

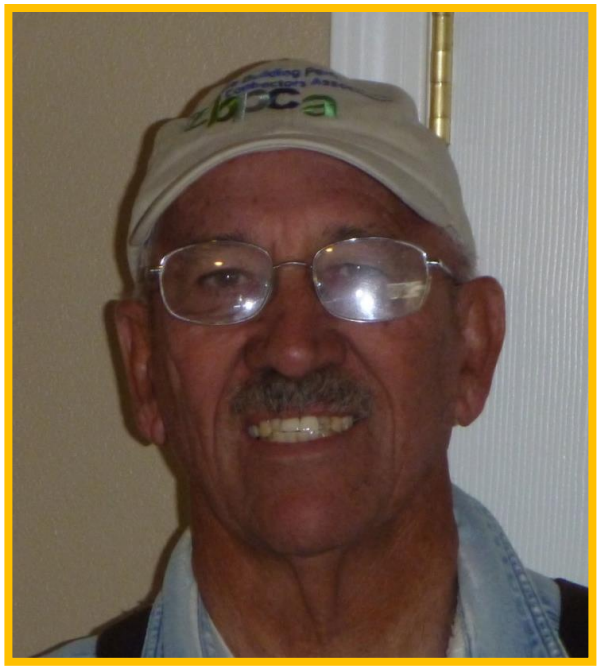
DHW

- Highly efficient equipment & layout

Stockton, CA
Climate Zone 3
CA Climate Zone 12
HDD 2,702
CDD 1,470

Burlington, VT
HDD 7,288
CDD 411

Project Team



George Koertzen
Habitat for Humanity
Project Manager

- X decades, construction experience
- 7 yrs, modular housing manufacturing production manager
- 2 yrs, panel plant owner
- 6 days ZNE education classes

Unskilled Workers
Student trainees
Homeowners
(sweat equity)

What Can Sunny California

Teach the Chilly Northeast?

- Introduction
- **Enclosure**

Enclosure Highlights

- R-42 attic insulation
- R-21 walls & floor
- R-5 rigid insulation on walls
- Careful air sealing
- Windows U.28, SHGC .20
- No plumbing in exterior walls
- **MANY** advanced framing measures

Advanced Framing →

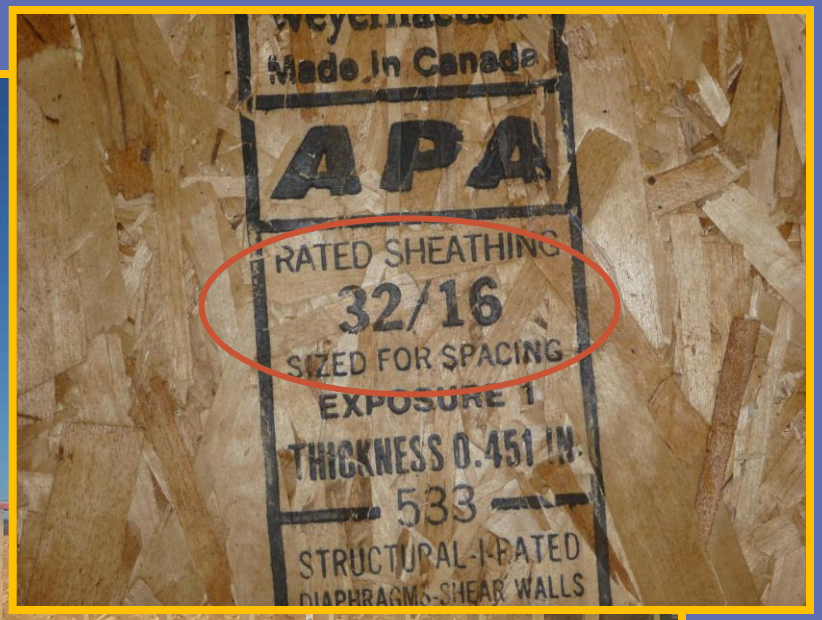
- 24” OC
- Single top plates
- Windows fit framing
  (no up-charge for custom size)

35.5% Framing Factor (Sacramento 2014)

12.5% Framing Factor

60-ft LVLs, no lapping needed

Less than 50% CA avg



Steel C-channel joins horizontal OSB & guides stud placement

2-Stud Corners

Installed with screws to allow removal for insulation installation

Engineered Headers

No Extra Framing At Exterior Wall Intersections

- All studs shown on plans

Drywall Clips

- Less cracking
- Less lumber
- Less labor

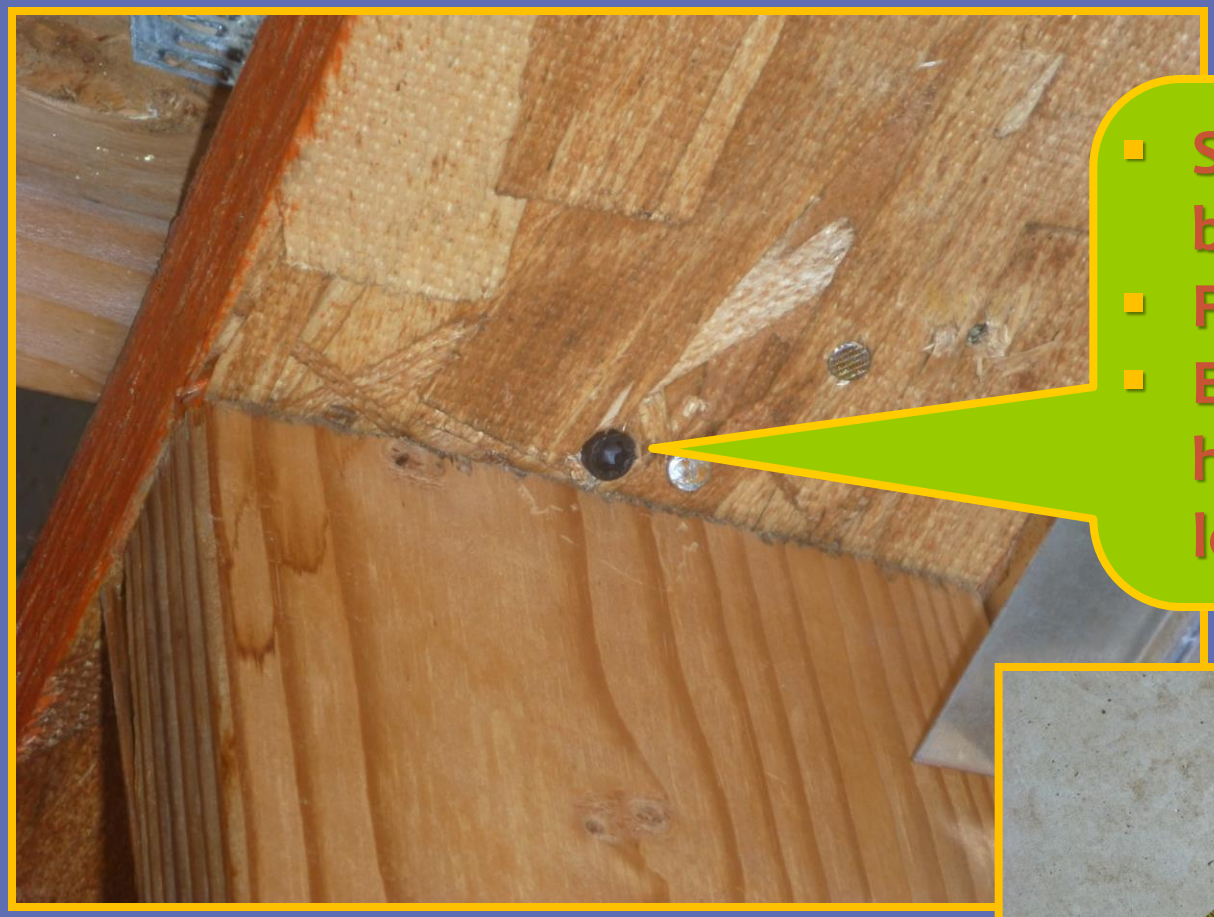
Gable-end Truss Assembly

Lookouts, fascia, roof & gable-end sheathing, venting, house wrap – all done on the ground

Porch overhang eliminates need for support post

No harness work needed
(harness required on 4:12 roof within 3 ft. of gable end)


Less blocking
Reduced thermal bridging
Raised-heel trusses; OSB spliced below top plate at C-channel



- Stronger than H1 bracket
- Faster to install
- Eliminates hard-to-seal air leakage path

Simpson SDWC Truss Hold-down Screw

All Wiring At Studs & Plates

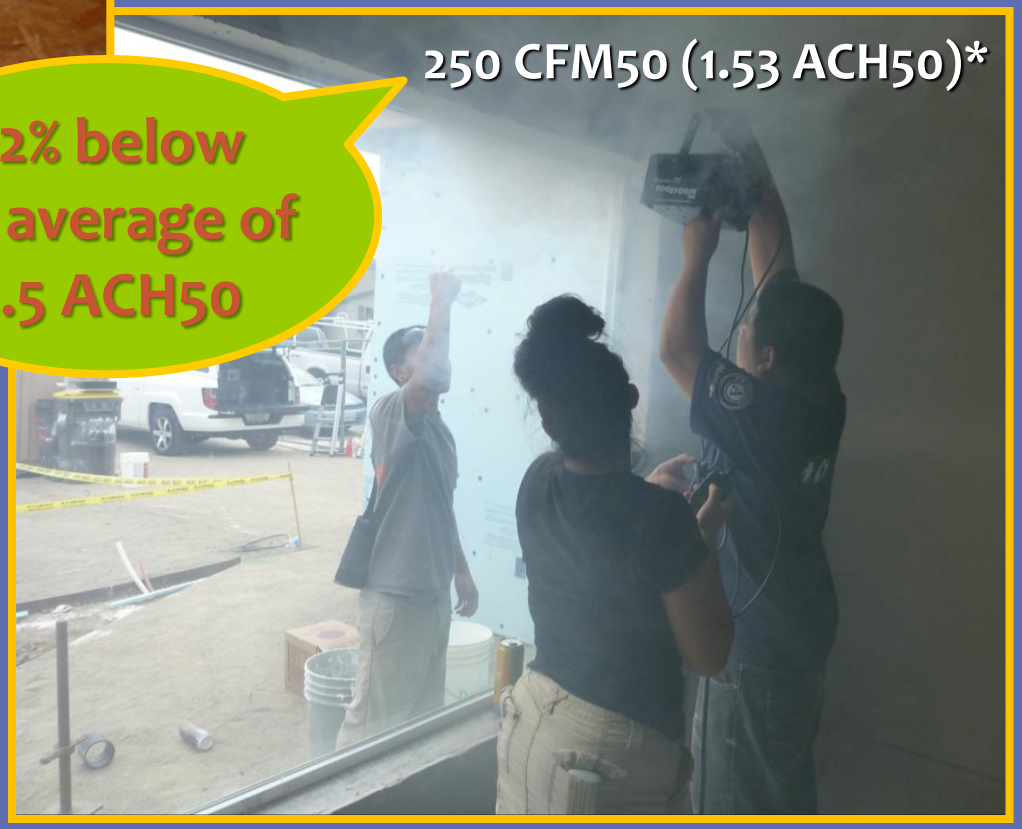
Infiltration Reduction Strategies

- Hatches don't penetrate insulated assemblies
- Fixed windows at appropriate locations
- No recessed lights

Air Sealing

- Preliminary blower door after ceiling drywall
- Smoke testing

72% below CA average of 5.5 ACH50



House 1	House 8	House 9	House 10
776 CFM50	572 CFM50	469 CFM50	250 CFM50
4.75 ACH50	3.6 ACH50	2.9 ACH50	1.53 ACH50

* Temporary doors sealed at preliminary; not sealed at final.

What Can Sunny California

Teach the Chilly Northeast?

- Introduction
- Enclosure
- **HVAC**

HVAC Highlights

- **Air handler in conditioned space**
- **Ducts in conditioned space**
- **Ducted ¾-ton mini-split heat pump**
  - SEER 24.5, HSPF 12.5
- **2 ERVs supply continuous fresh air**
- **High-performance bath exhaust fans**
  - Humidity & occupancy controls
- **Installation quality assurance** (measured performance)

7 ft hallway soffit for ducts & mini-split

Smallest Available HVAC Used

¾-ton mini-split heat pump

Industry Standard	House 10	PG&E Redding Project*
500-800 sf/ton	1,600 sf/ton	2,400 sf/ton

* A larger home than House 10, in a hotter climate

- Sizing based on extensive field testing funded by CA Energy Commission
- All available equipment is too large for small low-load CA homes – House 10 load is 6,000 Btu/hr or ½ ton

Low-pressure Duct Design (minimizes static pressure to keep fan watt draw very low)

- Double-deflection supply grilles with air-foil blades
- Straight supply boots
- Short supply ducts
- Oversized supply ducts
- Oversized return grille (20” x 30”)
- A filter grille that will accept a 2-inch-thick filter

Installation Quality Assurance & Commissioning

- ZERO commissioning = industry standard
- Diagnostic testing ensures proper performance
- Commissioning site visit by consultants confirmed all HVAC equipment performed to spec

NOTABLE!

CA Energy Commission-funded research on 240 new HVAC systems found 100% failed to meet manufacturers' static pressure requirements

What Can Sunny California

Teach the Chilly Northeast?

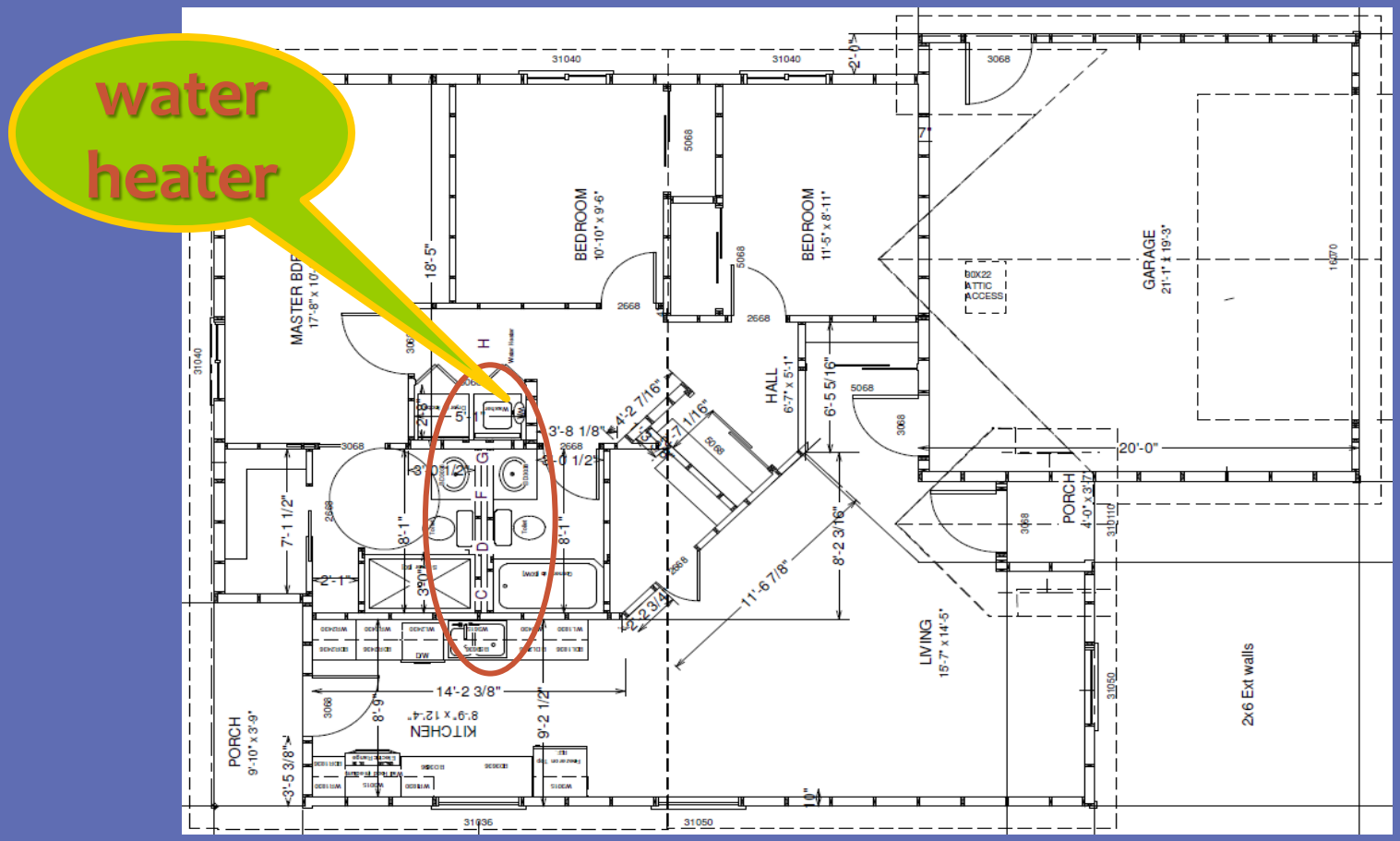
- Introduction
- Enclosure
- HVAC
- **DHW & Electrical**

DHW & Electrical Highlights

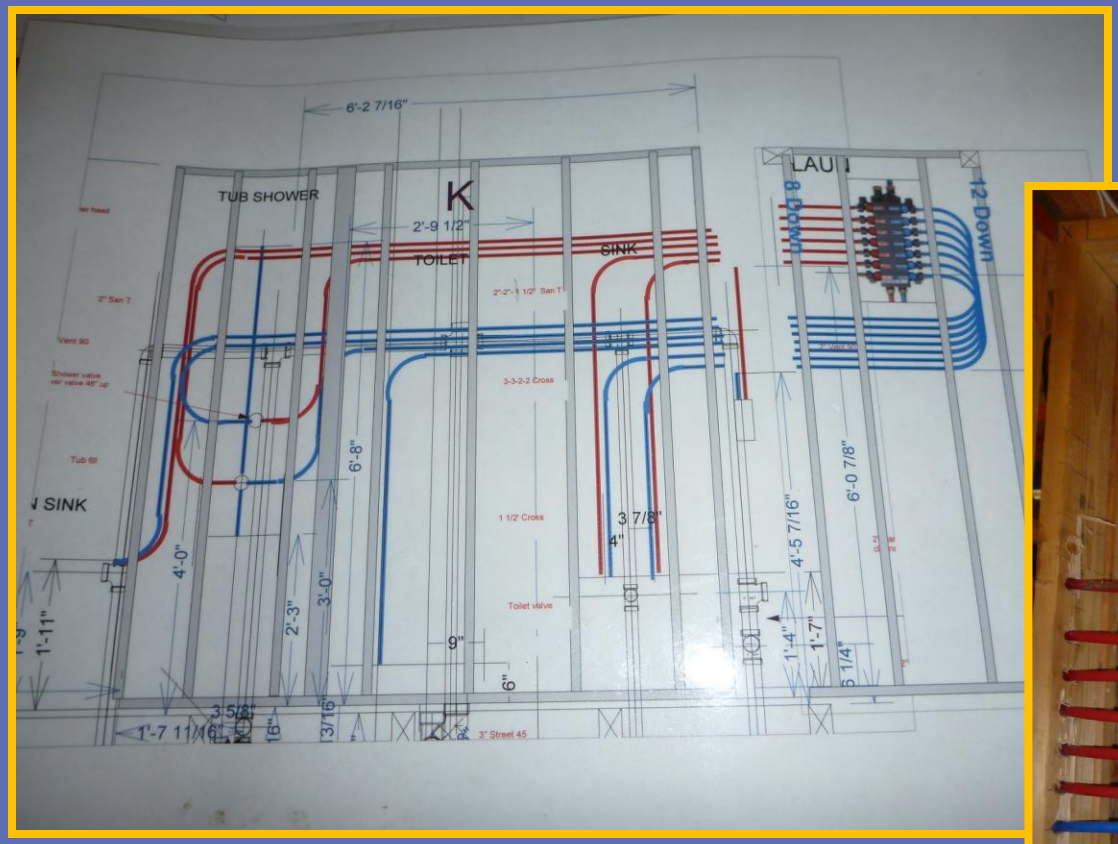
- Condensing tankless gas water heater
  - EF.93
- Extremely compact DHW layout
- 100% LED lighting
- Indicator lights on garage & porch light switches
- HVAC "System Off" switch near thermostat to eliminate vampire loss during swing seasons
- Electric vehicle circuit in garage

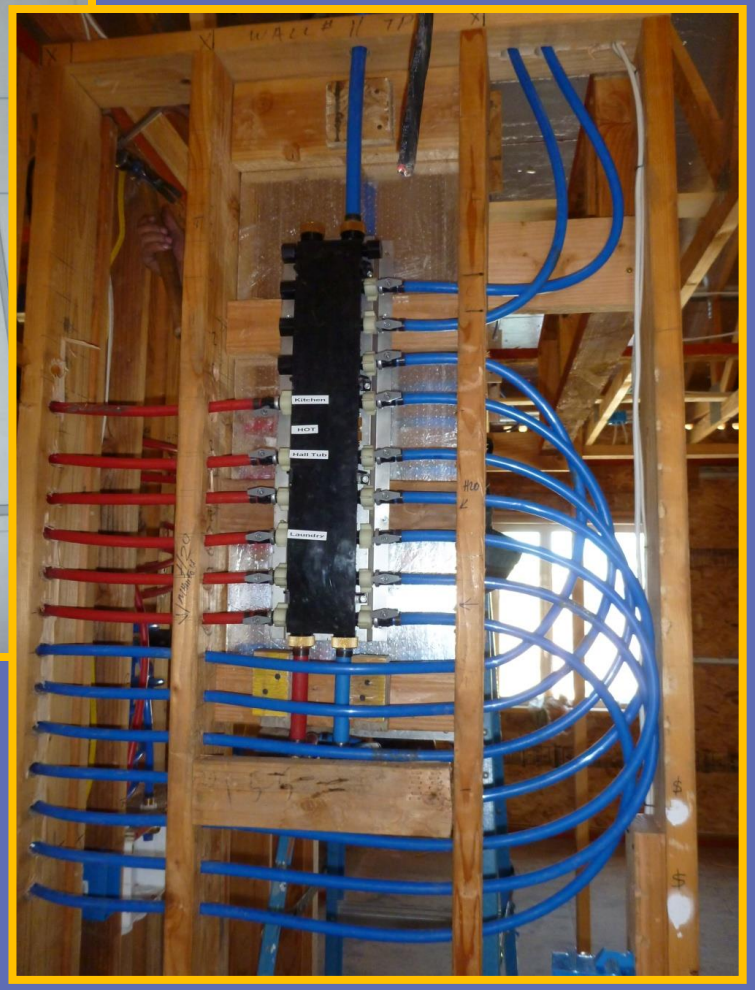
Longest hot water run = 12'

Extremely Compact DHW Layout



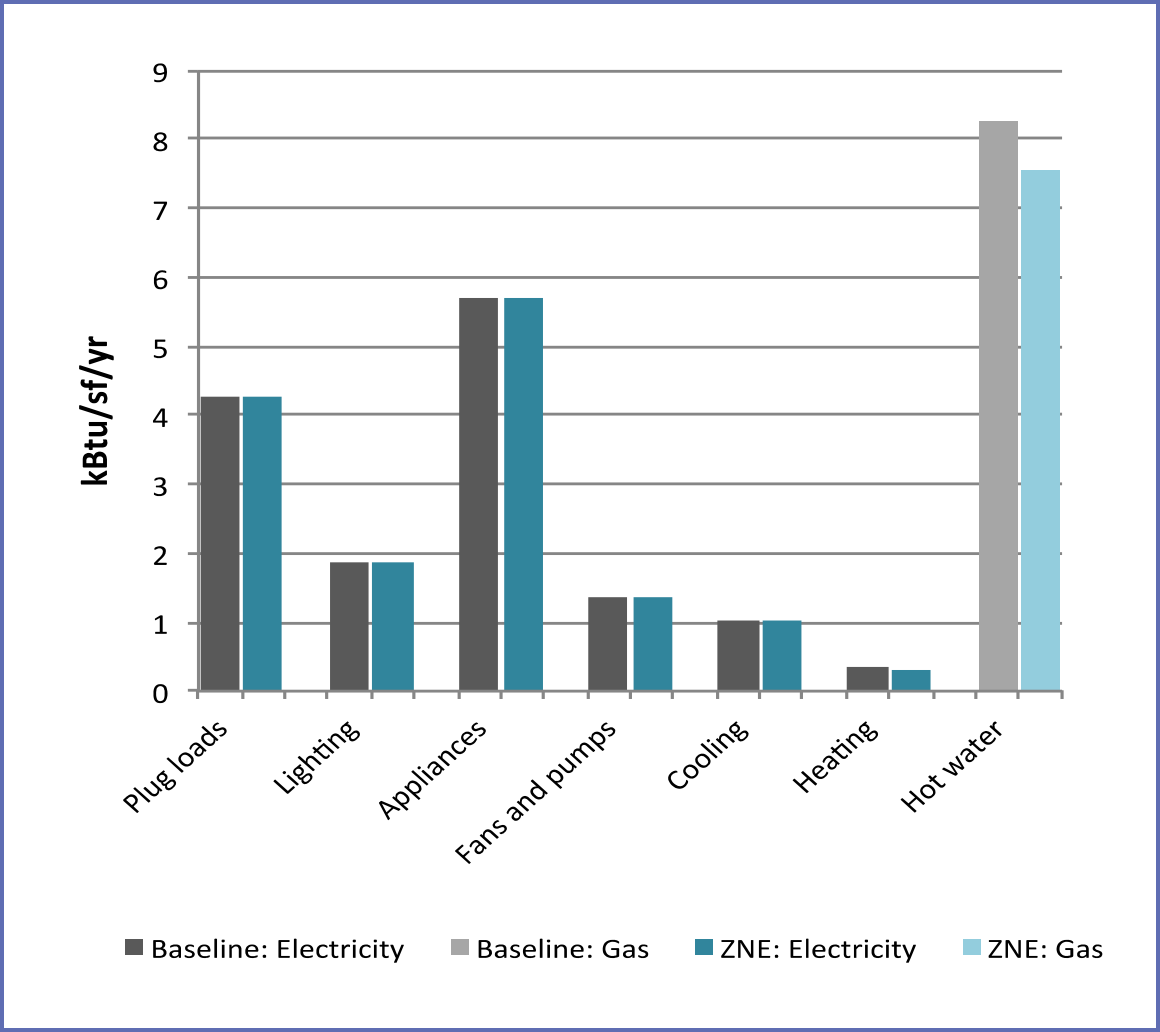
Detailed DHW Schematic Provided





DHW Impacts

- Largest energy end use
- >50% of ZNE measure savings
  - Water heater in conditioned space
  - Reduced pipe runs



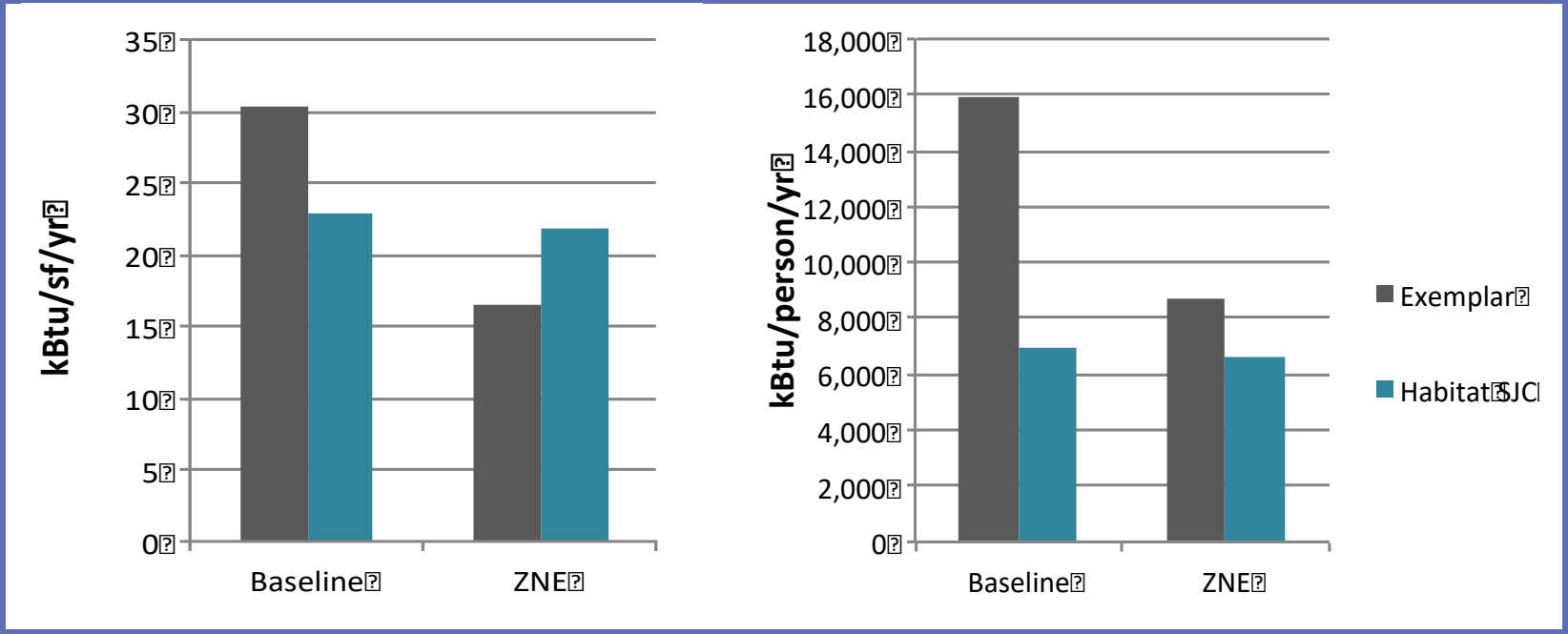
Graph: Resource Refocus LLC

What Can Sunny California *Teach the Chilly Northeast?*

- Introduction
- Enclosure
- HVAC
- DHW & Electrical
- **Outcomes**

Outcome #1: EUI 21.8 kBtu/sf-yr

- **Higher than CA exemplar** (ZNE feasibility study, Arup 2012) *but*
- **23% lower based on occupancy** (bedrooms + 1)
  - House 10 = 1,229 sf, exemplar = 2,100 sf



Graphs: Resource Refocus LLC

Outcome #2: $3,000 Cost Reduction

ZNE measures added to some costs, reduced others

(selected features shown)

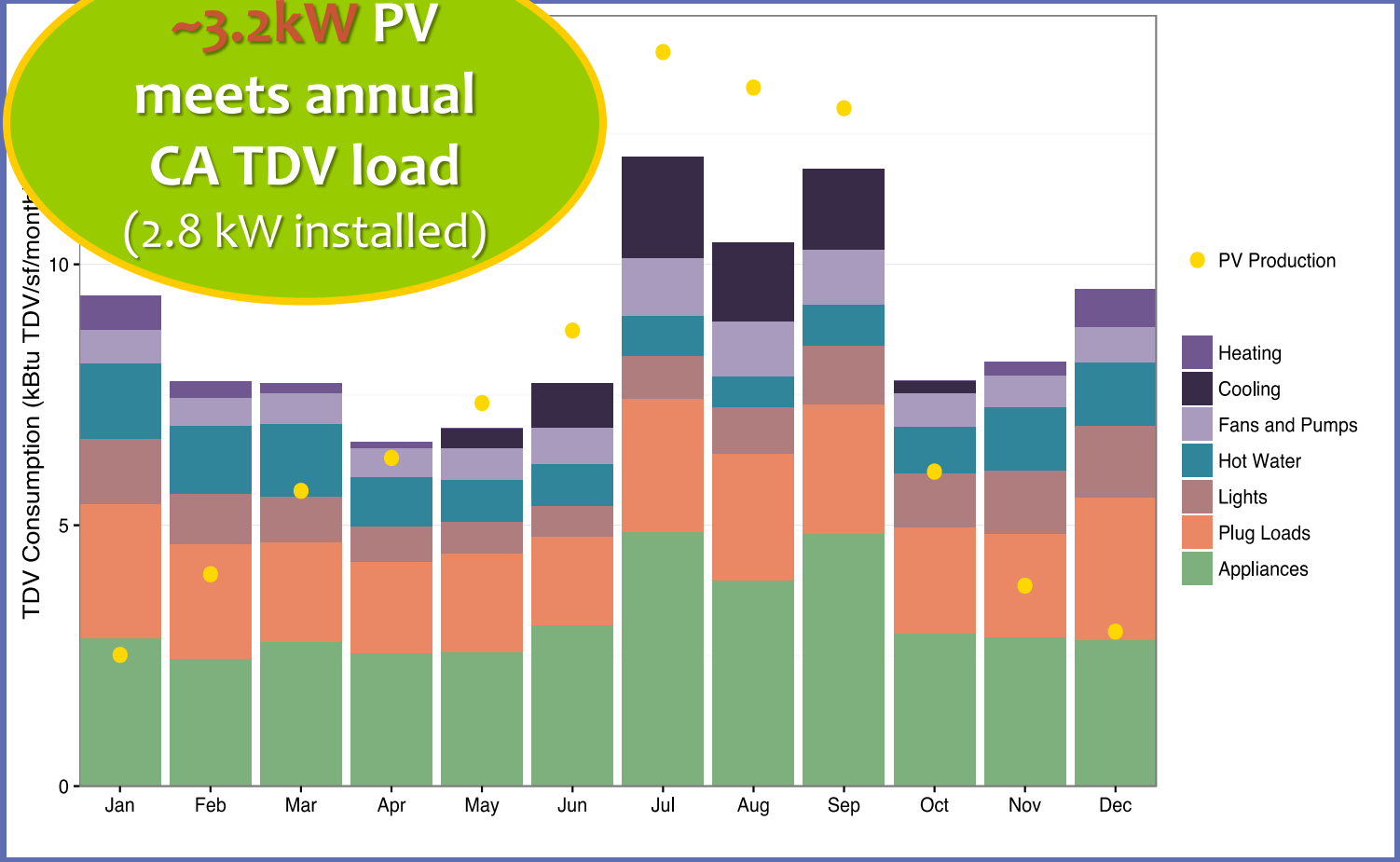
Feature	Before	After	Materials	Labor*
Framing	2x4 @ 16" o.c.	2x6 @ 24" o.c.		-$300
Wall insulation	R-11	R-21		-$100
Air leakage	4.75 ACH50	1.53 ACH50	+$400	+$800
HVAC	A/C + gas furnace	¾-ton mini-split		-$2,000
Ducts	Standard	Compact	-$100	-$500
DHW dist'n	Standard	Compact	-$70	-$400
Lighting	50-50 CFL + incandescent	100% LED	+$390	

* Labor estimated at $25/hr

Outcome #3: Near-ZNE Performance

(using CA ZNE-TDV definition)

~3.2kW PV meets annual CA TDV load (2.8 kW installed)



Graph: Resource Refocus LLC

Outcome #4:

50% Lumber Savings

Outcome #5:

Infiltration Reduced 68%

Outcome #6:

All Equipment Efficiencies Increased

Outcome #7:

All Future Habitat-SJ Projects Will Include ZNE Feature Package

What Can Sunny California

Teach the Chilly Northeast?

- Introduction
- Enclosure
- HVAC
- DHW & Other
- Outcomes
- **Conclusions**

Conclusions: ZNE Success Factors

- **Top-level organizational commitment**
- **Focus on integration and cross-trade synergies *during design***
- **Instruction for all team members**
  - Energy efficiency principles & practices (classroom)
  - Quality installation (hands-on demonstration)
- **High level of attention to detail**

Throughout:
- **Design**
- **Construction**
- **Commissioning**

What's the Ideal Integrated Team?

The fewest people with the required skills & attributes: commitment, creativity, experience, engagement

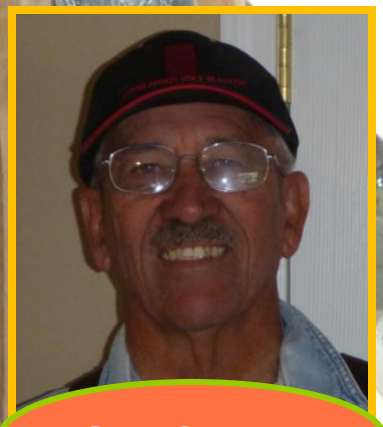

PLUMBING


ARCHITECTURE


INSULATION

CONSTRUCTION MANAGEMENT


MECHANICAL


STRUCTURAL


ELECTRICAL


AIR SEALING