# 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**

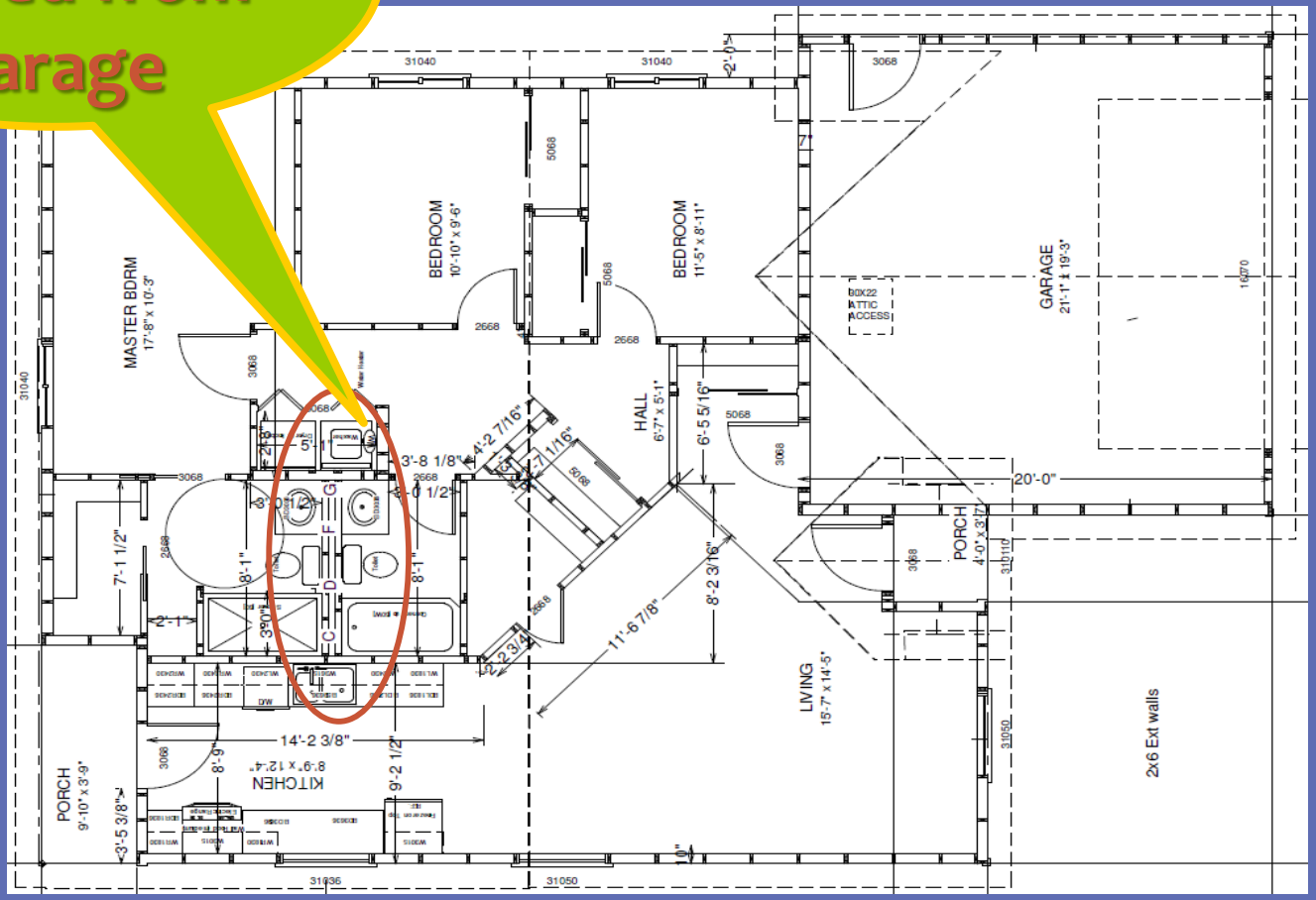
# DHW & Electrical Highlights

- Tankless gas water heater
  - EF.82 (EF .93 was recommended; budget prevailed)
- Extremely compact DHW layout
- 100% LED lighting
- Indicator lights on garage & porch light switches
- HVAC "System Off" switch near thermostat
  - eliminate standby loss during swing seasons
- Electric vehicle circuit in garage

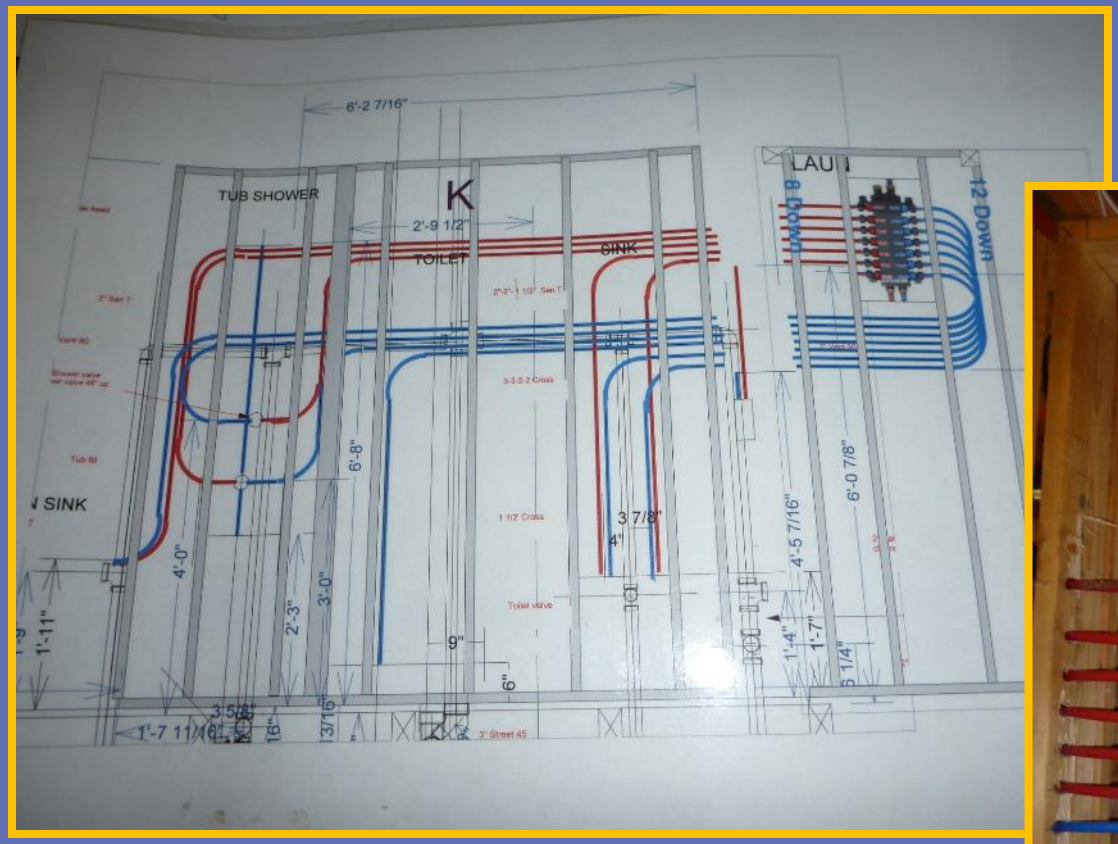
Longest hot water run = 12'

# Extremely Compact Hot Water Layout

water heater moved from garage

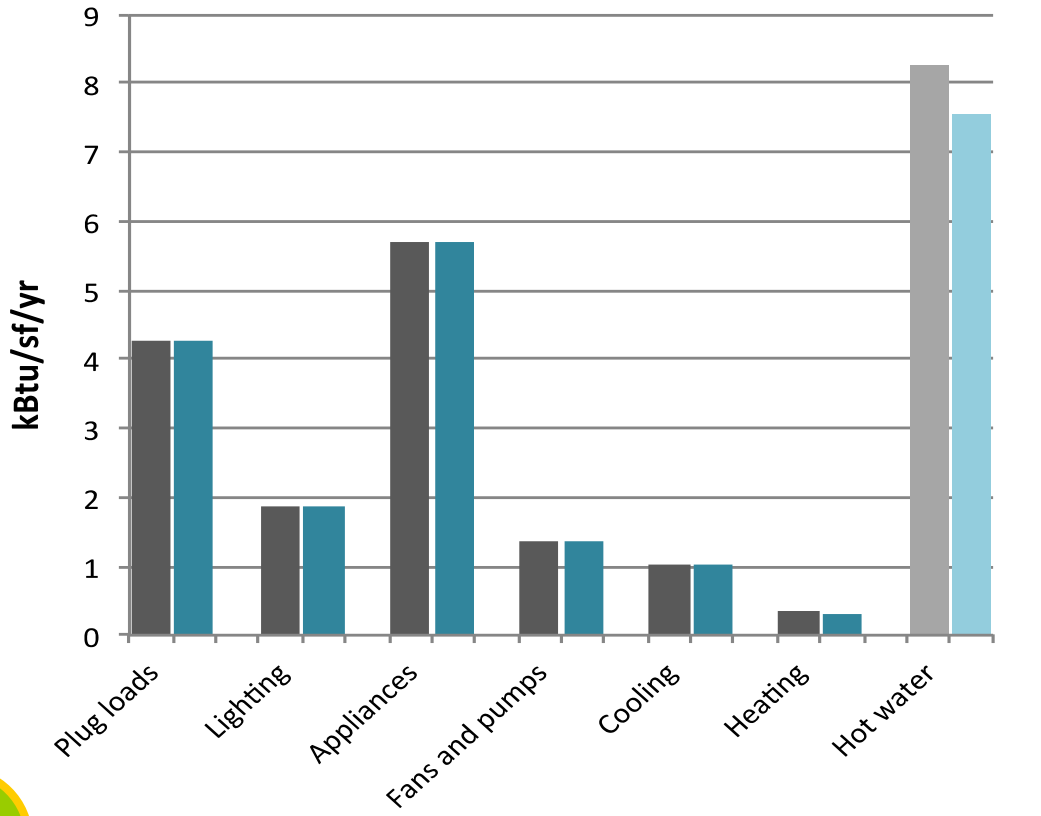


# Detailed DHW Schematic Provided




# DHW Impacts

- Water heater in conditioned space
- Reduced pipe runs
- Largest energy end use

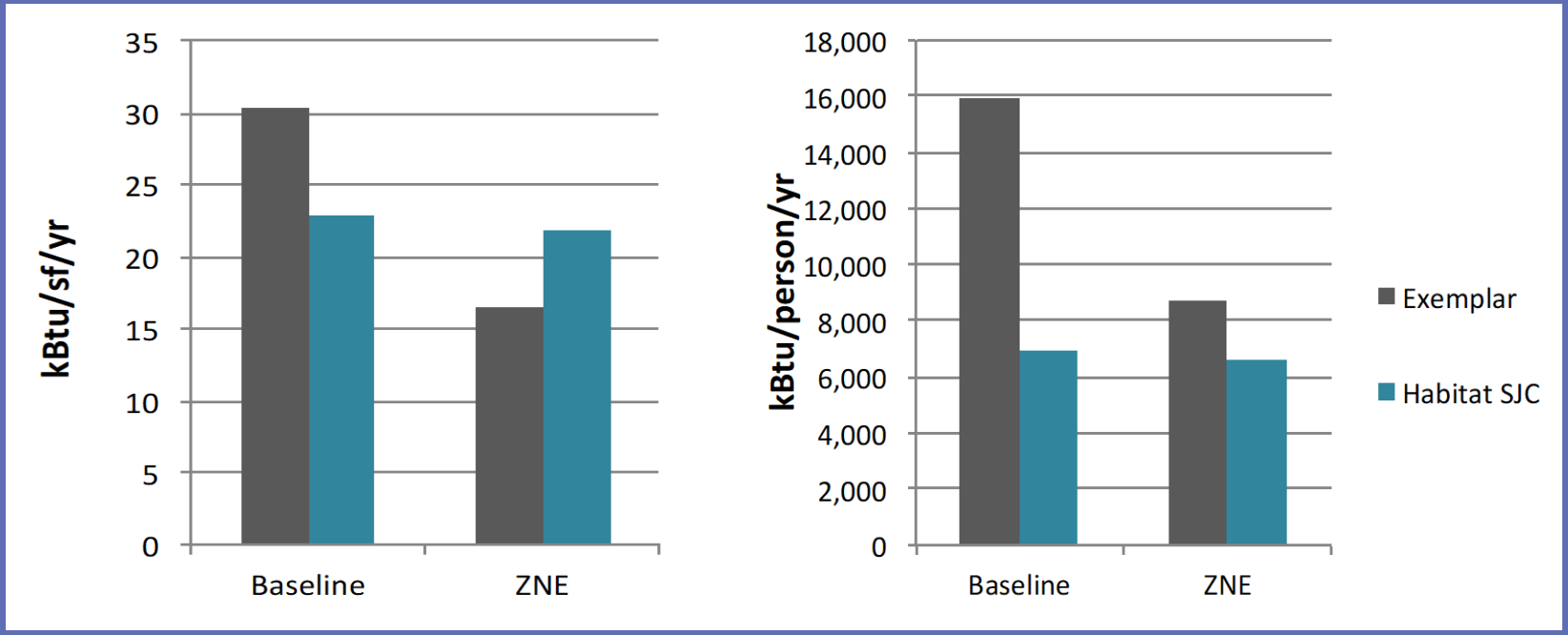



Graph: Resource Refocus LLC

**Changing to EF .93 *would have* provided >50% of ZNE measure savings**

# 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 increased some costs, reduced others

(selected features shown)

Offsets part of PV*

| 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 distribution | Standard | Compact | -$70 | -$400 |
| Lighting | 50-50 CFL + incand't | 100% LED | +$390 | |

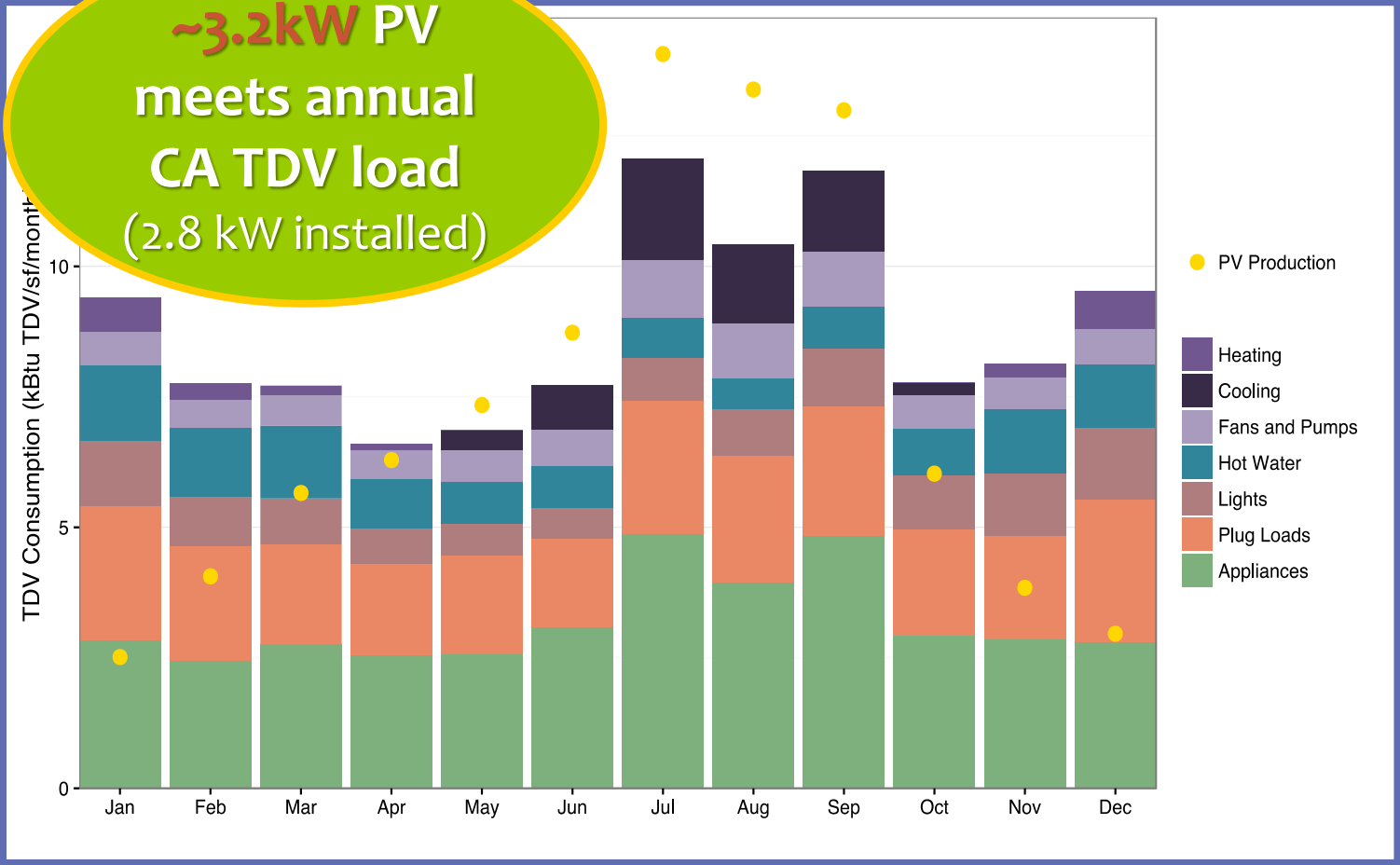
** Estimated at $25/hr

*Solar was included in original budget

# 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

except water heater

## Outcome #7:

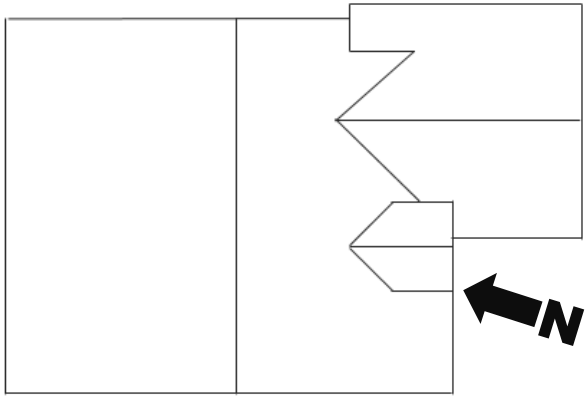
All future Habitat-SJ projects will include ZNE feature package

# Next-gen Improvements

- **New roof design**
  - Fits larger PV array
  - Better solar exposure – SW instead of SE
- **Upgraded water heater & appliances**

New project now underway

Next-gen roof design




Original roof design

4

# Getting to Zero **AFFORDABLY** *and* ***PROFITABLY***

Lessons Learned

# How do we get to zero affordably?

## BY DESIGN


Rocky Hill Co-Housing Community, Northampton, MA

**Ask the RIGHT question:**

**"What do we need to do differently to achieve ZERO without increasing costs?"**

**NOT**

**"How much extra will it cost to get to zero?"**

## Making Choices Instead of Paying Premiums for Greener Buildings

By Bruce Coldham

It is often presumed that "green" resourceful building involves a cost premium. This is not a universal truth. Though it is reasonable to assume that a superior product should come at a premium, good performance-enhancing design is more a matter of examining design goals and objectives with a view to redirecting investment. On this basis, a performance enhancement can be seen as favoring one option over another —a choice rather than a cost premium. Unfortunately, due to the rather extreme conservatism in the building industry, many choices are never made explicit. They are never discussed, never offered.

In this article I will address a particular residential opportunity for improving green resourceful building performance by means of conscious choice rather than cost premium. It involves improving the thermal envelope at the expense of committing to a central heating system. Let's begin with three questions:

1. Can compact, open-planned houses with well designed, well constructed, thermally-efficient building envelopes achieve a reasonable standard of comfort by relying solely on the natural convection air circulation within the house to distribute heat throughout the interior spaces?
2. Can a single space heater located in the first floor living space provide comfortable heating for the whole house?
3. Can the envelope upgrade cost be covered by savings generated by the elimination of the heating ducts/pipes and the associated fans/pumps?

The evidence of recent projects completed by our office is that we can confidently answer YES to each of these three questions.

With the savings from *not* investing in central heating, we are able to afford better windows (at least up to a U value

# Critical **Design** Considerations

- Mechanical product selection
  - Choose appropriate (low) capacity HVAC, ERVs
- Water heating strategy – electric favored *but …*
  - Inhibited by space constraints and
  - Utility rate structures that favor natural gas
- Enclosure approach
  - Fine-tune specs & details for optimum performance
- Aesthetics (“look”)
  - Make sure it’s attractive  & regionally appropriate

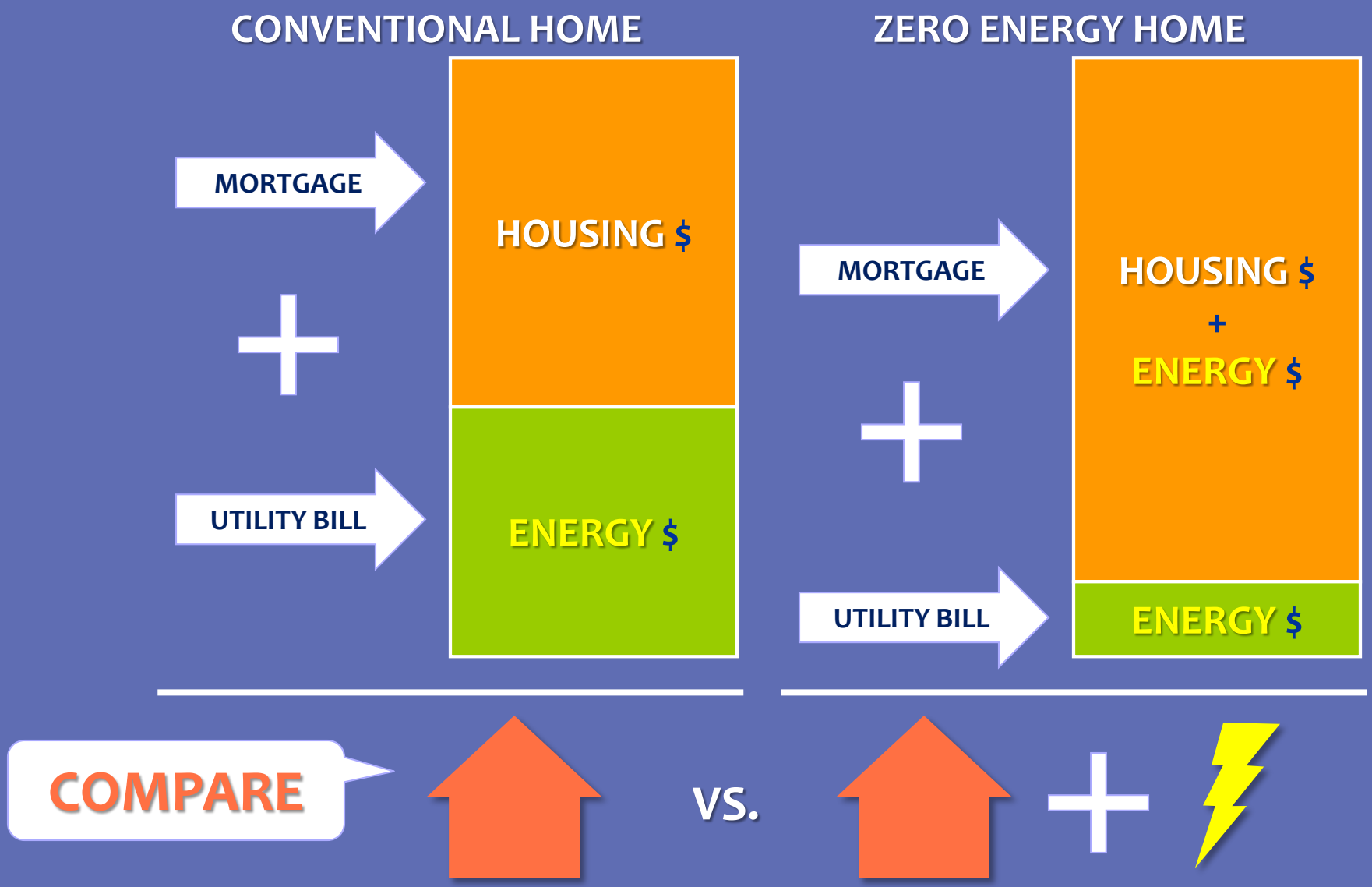
# Construction Focus Areas

- Trades execution
  - Make sure you have a great team
  - Ensure good coordination among trades
  - CHALLENGES: contractor lack of motivation & unwillingness to innovate
- Quality management
  - Active management is needed!
  - Use onsite verification (HERS, etc.)

# Innovation

- Experimentation
  - The basics are … **basic**, but …
  - Tinkering gets to the best solutions
- Collaboration
  - During design
  - With suppliers & manufacturers
  - During construction
  - With public agencies, for approval of new technologies
- Training
  - ZE practitioners are leaders and are teaching others

# Sales: it's about VALUE *not COST!*



# PROFITABILITY:
# selling VALUE is the last mile

**I ask customers to give me $100 more per month and I'll return $300 back to them in energy savings.**

Gene Myers, Thrive Home Builders

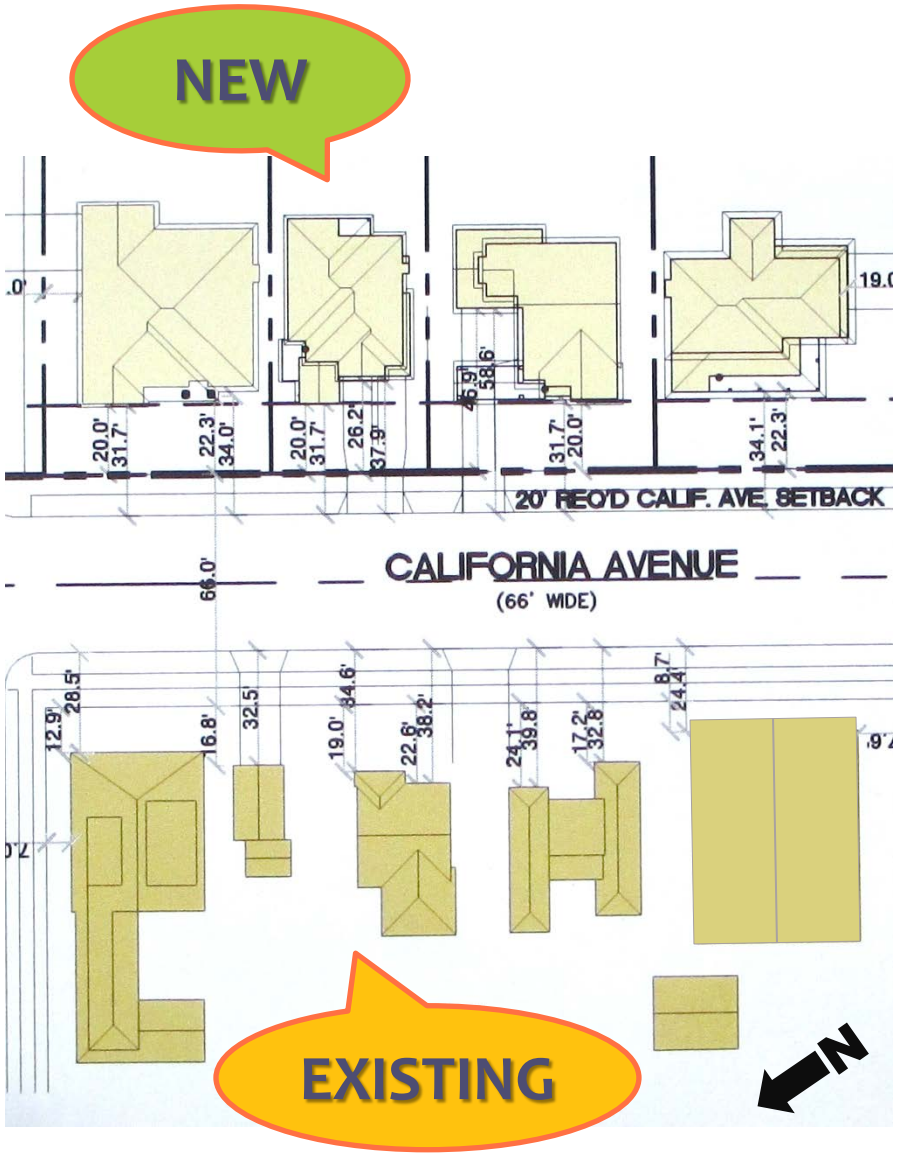
- Thrive Home Builders in Denver offered ZNE as an option; it didn't sell.
- Then they designed for ZNE from scratch and made it standard.
- Now their ZNE homes cost the same as their homes *without solar*.
- **Offering ZNE has given them unique access to premium properties.**

# What Would *You* CHANGE?

*

Discuss with your seatmate
Share your ideas

# Recommended Changes for ZNE?




NEW

# 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**

# Change happens *by design!*

*Thank you!*

- **2016 Inventory Report**
  http://netzeroenergycoalition.com/2016-zero-energy-inventory/
- **2017 Inventory Submission Form**
  http://netzeroenergycoalition.com/project-submission-form/
- **Case Study Database**
  http://netzeroenergycoalition.com/case-studies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