Zero-Net-Energy (ZNE) Home Design Basics

The case for all-electric Homes & Communities

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ZERO-NET-ENERGY (ZNE) HOME DESIGN BASICS
THE CASE FOR ALL-ELECTRIC HOMES & COMMUNITIES

Santa Rosa
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What IS “zero energy”? Why is it the goal?

ZNE emissions
energy costs all-electric
source energy site energy
Zero net energy
renewables offsets time-of-use

PROJECT BOUNDARY
TIME BOUNDARY
ZNE – By Force or Finesse?

Source: costofsolar.com
Zero-net energy logic

1. Minimize energy demand
   - Heating
   - Cooling (try to eliminate)

2. Optimize energy use
   - High-efficiency HVAC and DHW equipment
   - Energy-efficient lighting + appliances
   - Controls, monitoring, habits + feedback

3. Offset with renewable energy
What is heating demand?

Heat Losses - Heat Gains = HEATING DEMAND

Heat Losses:
- Ventilation
- Roof + Floor
- Air Leakage
- Windows + Walls

Heat Gains:
- Internal Gains: Hot Water, Lighting, Cooking, Plug Loads, Breathing!
- Solar Radiation
Envelope Design

- Compact, efficient shapes
- Lots of insulation
- Minimized thermal bridging
- Properly placed & shaded windows in moderation
- High-performance windows & doors
- Very good air tightness detailing
“Lots” of Insulation

Coastal California:
- R-23 whole assembly
- 1.5” rigid cork insulation
- fully-adhered water-resistant barrier (WRB)
- plywood sheathing
- 2x6 wood framing w/
- cellulose insulation
- drywall
Work WITH nature not against it

- Optimize shape & orientation
  - Passive solar gain & shading
  - Orient longer side along east-west axis
- Window configuration – control solar radiation
  - Majority of glazing on south
  - Less glazing on north
  - Thoughtful glazing on east & west
  - Thermal mass?
- Night flushing- nature’s AC
Build Tight and Ventilate Right

- Seal it up < 1 ACH_{50}
- Supply filtered fresh air
Minimization Results

- CA-Code Built Home - Heating and Cooling Loads
  - Apartments, 6 BTU/hr.ft$^2$ (~1.8 W/ft$^2$)
  - Single-family, 9 BTU/hr.ft$^2$ (~2.6 W/ft$^2$)
  - Remodeled house, 12 BTU/hr.ft$^2$ (~3.5 W/ft$^2$)

- Eliminate/minimize cooling
  - Good Design
  - Exterior and Site Shading
  - Night flushing & Ceiling fans
  - Behavior – close the drapes

Time to OPTIMIZE with ELECTRICITY!!!
California Grid Getting Cleaner

Heat Pumps for HVAC and DHW

- Lower GHG emissions
- Cost competitive: install and operation
- HP continue to increase in efficiency, Gas has no where to go.

MiniSplit Heat Pump

Heat Pump Water Heaters

Mitsubishi

Sanden – ECO₂

Stiebel- Accelera
Optimize: Electric Appliances

- Whirlpool – Heat Pump Dryer
- Samsung – Induction Cooktop
- Heat & Glo Gas Fireplace
The Duck Curve Caveat

Shift Electricity Use to Midday

- Lots of thermal energy for DHW and space cooling/heating
- Run heat pumps at midday - “charge” home’s thermal battery
- Distributed and Utility Renewables = cleanest electricity