Zero-Net-Energy (ZNE) Home Design Basics

The case for all-electric Homes & Communities

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II. Case Studies of custom zero-energy homes

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ADDITION / REMODEL

CUSTOM SITE BUILT

PREFAB / MODULAR
ZETA Communities Net-Zero Townhouse
Oakland, CA - Prototype, 2009

1776 sq.ft. (incl. 200 sq.ft garage)
5.4 kW rooftop solar PV
GC: Bill Malpas

Prefabrication as a means to achieve a well insulated, air-tight building envelope.

R&D and building monitoring as part of:

- Building America
- U.S. Department of Energy
- LEED Platinum
- U.S. Green Building Council
- Green Builder
- Green Builder Home of the Year Awards

www.greenbuildermag.com
Inside a ‘zero-energy’ home

A San Francisco company is planning to build multifamily townhomes, lofts and apartments that create as much energy as they use. Here is a look at some of the net zero energy methods and materials.

- **Solar panels**
  Convert energy from the sun into electricity

- **Heat recovery ventilator (HRV)**
  Provides controlled and natural ventilation for airtight building envelope

- **Energy Star appliances**

- **Wastewater heat recovery system**
  Preheats shower water

- **High-efficiency heat pump**
  Uses heat from outdoor air to heat the indoor air

- **High thermal performance windows**
  Four times more efficient than coated double-pane windows

- **Natural day-lighting**
  Solar orientation

- **Highly insulated**
  Walls, floors, roof, and basement

- **Automated controlling and monitoring system**
  Manages heating, cooling, ventilation and thermal storage

- **Thermal storage basement**
  High flyash concrete stores daytime heat and provides nighttime cooling

Note: Diagram represents an example of one type of net zero energy building.

Source: Zeta
Domestic hot water: AirTap heat-pump water heater (2.11 EF) backed up by 40-gal. electric water heater

Air & Water

Solar Energy Gain:
1. Sunlight enters the building via windows and the skylight.
2. Air warmed by the sun is drawn into the return air duct.
3. The warm air is circulated through the mini-basement, where the insulated concrete provides thermal mass, and stores the solar energy.
4. The air is circulated throughout the building periodically to even out temperature differences between spaces with high and low solar gain.
5. As the sun shines, photovoltaics on the roof spin the meter backwards, accruing energy "credit" for when supplemental mechanical systems are needed.

Night Time Passive Cooling:
1. Cool air is drawn into the house via the outside air intake duct.
2. Cool outside air is distributed throughout the house; warmer air rises towards the ceiling.
3. The skylight opening creates a natural chimney stack effect, drawing hot air out of the building.

Water Heating:
1. Cold water enters the building via municipal supply lines.
2. A waste water heat exchanger preheats supply water by extracting energy from hot water used for showers and sinks.
3. Water is stored in a 40-gallon tank, which utilizes an air to water heat pump to efficiently heat hot water for domestic use. Air for the heat pump is drawn in from the garage and is exhausted through the utility core and out the roof.

Space heat and cooling: Goodman 16 SEER/9.5 HSPF air-source heat pump

Heat recovery ventilator (HRV)

dsa architects
dsaarch.com

Domestic hot water: AirTap heat-pump water heater (2.11 EF) backed up by 40-gal. electric water heater
Energy Model

Projected Energy Consumption: 7852 kWh/year
Renewable Energy Production: 7882 kWh/year
Net Energy Use: 0 kWh/year

Produces as much energy as it uses over the course of a year.

-8000 kWh/yr to 0 kWh/yr
8000 kWh/yr

Home Energy Rating (HERS) performed by RESNET certified rater to measure projected energy efficiency of ZETA’s demonstration unit.

Actual energy use has closely matched the model calculations and can be provided in full by the 5.4kW rooftop PV system:

~7378 kWh/year produced vs. 7187 kWh/year consumed

The large portion of plug loads and lighting make actual energy use highly user-dependent, good controls & dashboard are helpful.
Actual Energy Use

![Graph showing actual energy use over time with various energy sources and counters.]

- **PV Output**
- **House MELs**
- **DHW Resistance**
- **DHW HP**
- **AHU**
- **Heating/Cooling**
- **HDD**
- **CDD**
Gold Country Solar Home
Amador County, 2008

2255 sq.ft. (6”-equiv.)
7.5kW rooftop solar PV + solar thermal collector
GC: Skillful Means
Passive Solar Design & Energy Modeling

P2spears - ANNUAL ENERGY USE

P2spears - SB high mass night vent
Passive Solar Design
High Thermal Mass
7.5kW rooftop solar PV
1 Gobi solar thermal collector
Ground-source heat pump
Radiant floor heating
(radiant cooling optional)
Natural / stack ventilation
Ceiling fans
Efficient Lighting + Appliances
Major Addition & Gut Remodel
Berkeley, CA – 2015

1560 sq.ft. (600 sq.ft. new)
5 kW rooftop solar PV
Net-positive energy
Gray water system
GC: Habel Construction
Net-positive annual energy production for EV-charging or refund.
- Rooftop PV System
- Southwest orientation is optimal for Time-of-Use metering.
- Split-system heat pump supplies single-zone ducted distribution
- HPDWH in garage
- HRV in attic serves 2.5 bathrooms, and provides whole house Ventilation as needed

- Natural ventilation
- LED lighting
- Induction stove
- Gray-water system
- Material salvage & re-use on site
Mid-Century Solar Addition & Remodel
El Cerrito, CA - 2017
GC: Berkeley Craftsmen
1844 sq.ft.
With 6 kW rooftop solar PV

- Multi-Zone Mini-Split
- Enhanced day-lighting
- Gray-water system
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