Modern trend in efficient house construction

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The First Consumer Hydrogen House

This is the first commercially produced fully-permitted, solar-hydrogen, off-grid residence completed in Pennington, NJ in 2015 by Mike Strizki. Now it is practical for the average consumer. Anyone can converted their own house into Hydrogen house.

Features

- 40kw Solar installation
- 20kw Backup power
- Electrolyzer to generate hydrogen
- Hydrogen fuel cell
- Accepted by local residential building regulations

This solar-hydrogen home provides power for all of the amenities required in a typical, modern home, such as a full kitchen, laundry, bathrooms, hot tub, and multimedia home entertainment systems.

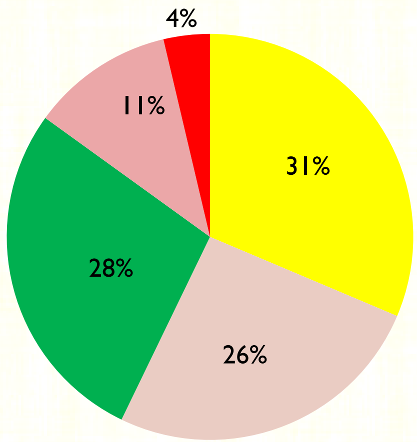
How it all began

The global economic crisis 1974 was the first stimulus for talking of energy saving in construction. First energy saving ideas appeared in the middle of the 70-ies as a response to the economical situation and the need to save resources.

The second stimulus for the energy saving in construction is a CO_2 emission. "Building account today for about 40% of final energy consumption worldwide, and they are responsible for about one third of overall CO_2 emission (36% in Europe, 39% in the USA, about 20% in China)" (Eicker, 3).

Household is representing the same volume as industries or transport and it is a big part of energy consumption. If it is possible to reduce this part of consumption, it will be tremendous influence on CO_2 emission.

Since that time, the conception of household energy saving has gone through several stages. Today it can be divided into three type of household.



Transport: 31.5% = 41.0 x 10^{11} kWh per year
Household: 25.9% = 33.7 x 10^{11} kWh per year
Industries: 27.5% = 35.8 x 10^{11} kWh per year
Services: 11.4% = 14.8 x 10^{11} kWh per year
Agriculture: 3.7% = 4.8 x 10^{11} kWh per year

Distribution of end energy consumption within European Union with a total value of 1.3 x 10^{13} kWh/year (European Environment Agency, 2009)

Types of building

Passive House

First idea for energy saving was Passive house. The regulatory building codes and standards were created in the European countries by the mid-80s and at the same time, a German architect Wolfgang Feist developed the concept of the "Passive House". Today, the Passive House is an international building standard which results up to 90% reduction in building energy demand for heating and cooling. In the New York State region also exists a Building Passive House community.

Nearly Zero-Energy Building

Next step to reduce emissions is a Nearly Zero-Energy Building (nZEB). Overall nZEB concept has some similarities to the passive house standard, but nZEB pays more attention to using the alternative energy sources such as wind generators or solar panels.

Active House

Active House is a further development of the nZEB conception. The alternative energy sources of Active house generate so much energy, that the unused part of energy might be return into neighbors or electric grid.

According European classification the primary energy indicator (Ep_p) for:

Passive house:	$(EP_p) < 15\ kWh/m^2 = (4.8\ kBtu/ft^2/yr)$
nZEB:	$0 < (EP_p) < 5\ kWh/m^2 = (1.6\ kBtu/ft^2/yr)$
Active house:	$(EP_p) < 0$

(Kurnitski, 16)

Ways for Power and Energy saving

The engineering system for any of this conceptions may be different, but the main idea the same: building should has the minimum of energy consumption and less energy's loses.

Windows. The typical home loses more than 25 percent of its heat or cold through windows. Even modern windows insulate less than a wall. Therefore, an energy-efficient house should have few windows on its northern side.

Weather stripping and Caulking. Everywhere in a home should seal air leaks to reduce energy loss. Good air sealing alone may reduce utility costs by as much as 50 percent. It can accomplish most air sealing by using two materials: caulking and weather stripping.

Controlled Ventilation. Since an energy-efficient house is tightly sealed, it needs to be ventilated in a controlled manner. Controlled, mechanical ventilation prevents health risks from indoor air pollution, promotes a more comfortable atmosphere, and reduces air moisture infiltration.

Heat recovery ventilators (HRV) or energy recovery ventilators (ERV) are growing in use for controlled ventilation in airtight homes. These ventilators can salvage about 70 percent of the energy from the stale exhaust air and transfer that energy to the fresh air entering by way of a heat exchanger inside the device.

Ways for Power and Energy saving

Heating and Cooling Systems. Generally, energy-efficient homes require relatively small heating systems, typically less than 40,000 Btu/hour. Some require nothing more than sunshine as the primary source of heat along with auxiliary heat from radiant in-floor heating.

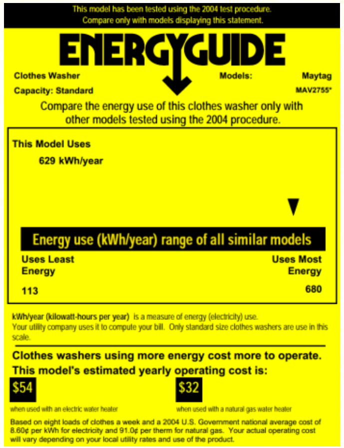
It's often require only a small air conditioner unit. Sometimes only a large fan and the cooler evening air are needed to make the house comfortable. The house is closed up in the morning and stays cool until the next evening.

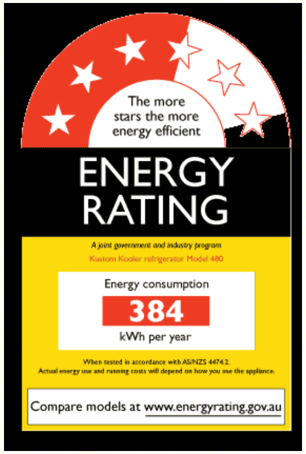
Smaller-capacity heating and cooling systems are usually less expensive to buy and operate. This helps recover the costs of purchasing more insulation, and other energy-efficient products, such as windows and appliances.

In climates where summer cooling requirements dominate, light-colored materials and coatings (paint) on the exterior siding and roof can help reduce cooling requirements by up to 15 percent. Carefully selected and placed vegetation also contributes to reduced cooling and heating loads.

Energy-Efficient Appliances. Home should be equipped in high-efficiency appliances – such as water heaters, clothes washers and dryers, dishwashers, and refrigerators.

ENERGY STAR





Sonoma house: First U.S. Passive House

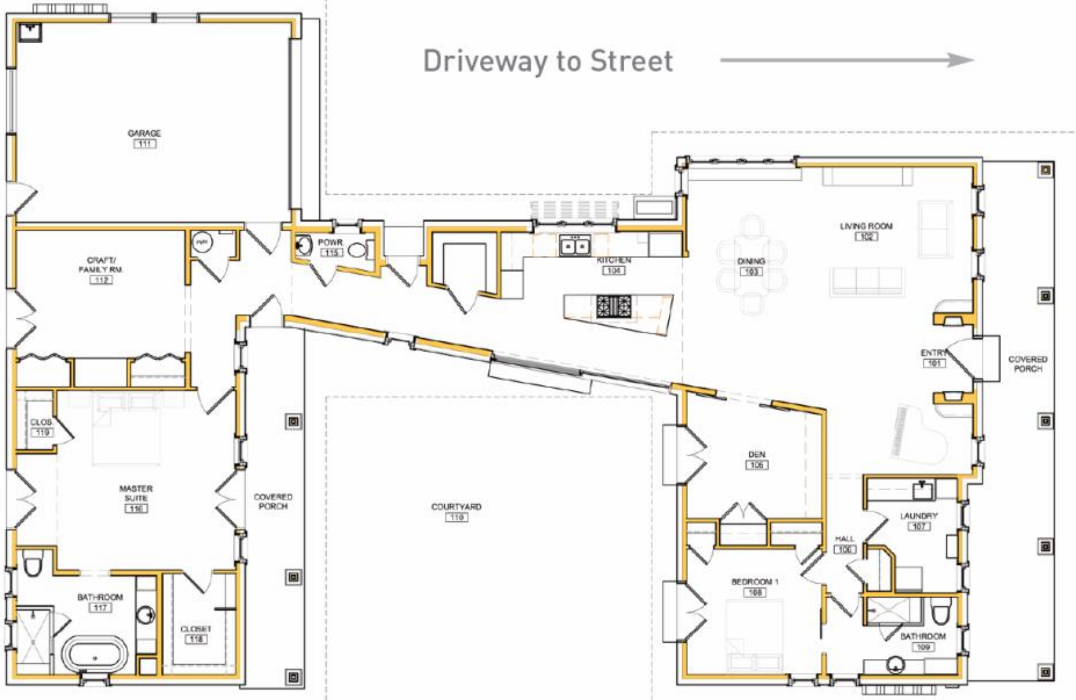
This is the first certified PH in California, and the first PH retrofit in the United States. Source energy savings are estimated at 56% compared to the pre-retrofit case.

The single story project in Sonoma, was completed at the end of October 2010.

The design was guided by Passive House (PH) principles, which promote the use of very high levels of wall, ceiling, and floor insulation to maintain a comfortable indoor environment with little or no need for conventional heating or cooling.

The 1,975 ft^2 home was originally built in the 1960s and consisted of two structures connected with an open breezeway.

The breezeway was re-designed and enclosed to unite the two structures into a two bedroom, two bath, 2,380 ft^2 residence.



Sonoma house: First U.S. Passive House

Measure	Pre-Retrofit	Post-Retrofit
Building Type / Stories	Single family, 1 story	Single family, 1 story
Conditioned Floor Area	180m^2 (1,937 ft^2)	221m^2 (2,380 ft^2)
Exterior Wall Construction	2 × 4 16 in. oc	New: 2 × 6 24 in. oc (~75% of existing walls remain)
Foundation Type & Insulation	Slab – Uninsulated	Slab – AeroGel
Roofing Material & Color	Asphalt shingles – dark	Metal roof/custom Bilt Zincalume
Ceiling Insulation	Vented, R-19	Unvented, none
Roof Deck Insulation	None	Minimum of R-42 blown in rafters
All Windows	Single metal pane	Optiwin triple pane
Heating & AC Type	Natural gas combined hydronic fan coil	Solar thermal w/ Mitsubishi Mr. Slim mini-split HP
Solar Water Heater	None	3 Heliodyne 4 × 6 collectors
PV Solar System Type	None	10 Sanyo 215N PV modules 2.15 kW

Sonoma house: First U.S. Passive House

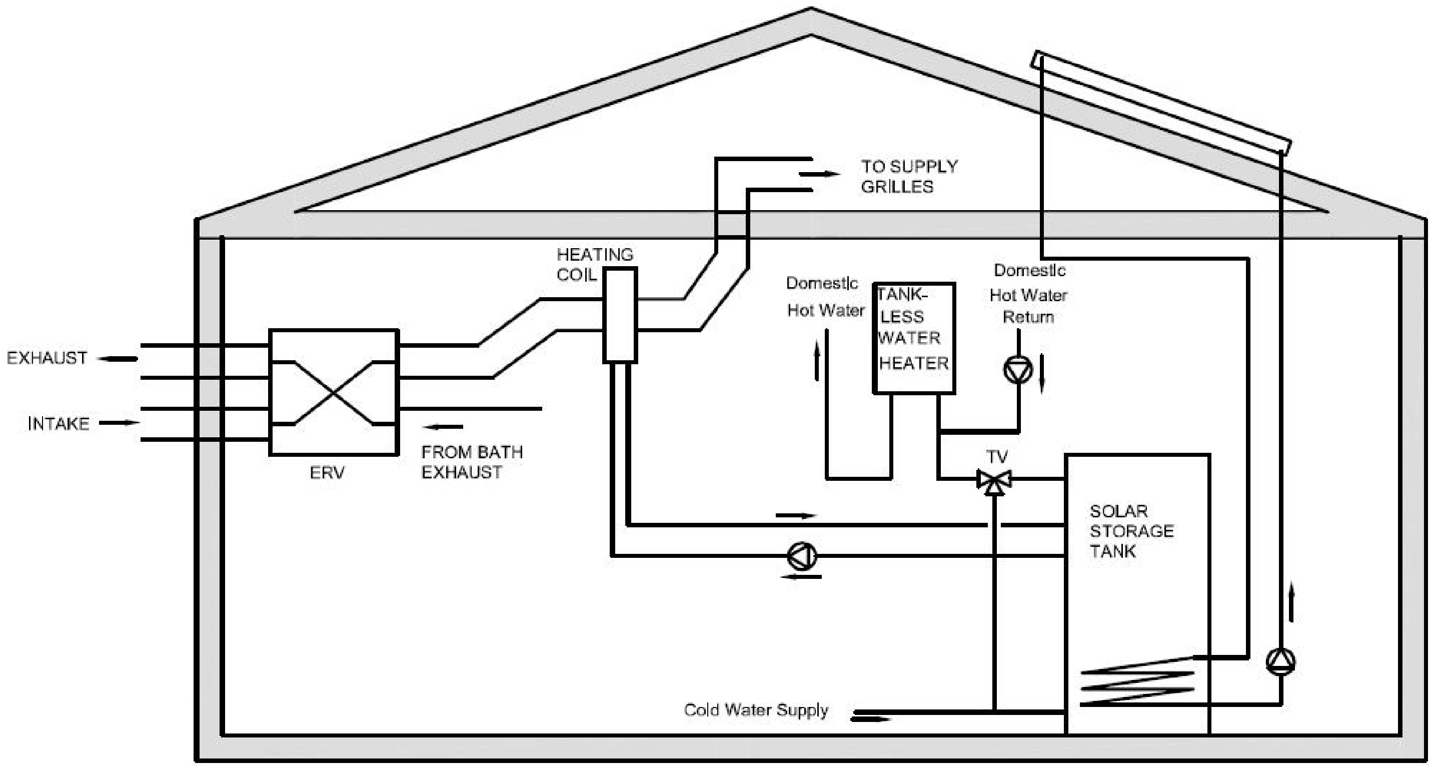
Mechanical and Electrical Systems

The primary energy source for water heating and space heating is solar thermal energy, with a tankless water heater serving as backup for water heating.

Photovoltaic System

A 2.15 kW rooftop PV system, consisting of ten PV modules provided onsite electricity and are mounted on the South-facing roof and controlled with an inverter.

The installed system was sized to provide about 2/3 of the total estimated house load.



Sonoma house: First U.S. Passive House

Description	Total Source Energy (kBtu/yr) / %	Heating Source Energy (kBtu/yr) / %	Cooling Source Energy (kBtu/yr) / %
Pre Retrofit Base Case (BC)	284 / —	166 / —	16.9 / —
BC + New Walls	262 / 8	147 / 11	14.3 / 15
BC + White Metal Roof (Cool Roof)	281 / 1	169 / -2	11.8 / 30
BC + Unvented Attic	223 / 21	113 / 32	9.3 / 45
BC + Slab insulation	255 / 10	134 / 19	19.8 / -17
BC + Triple Pane (Low-e windows)	208 / 27	99 / 40	8 / 52
BC + Reduced infiltration	256 / 10	139 / 16	16.5 / 2
BC + Mini-Split HP	202 / 29	91 / 45	10.2 / 40
BC + ERV	293 / -3	171 / -3	17.1 / -1
BC + Envelope Package	115 / 59	13 / 92	2.1 / 87

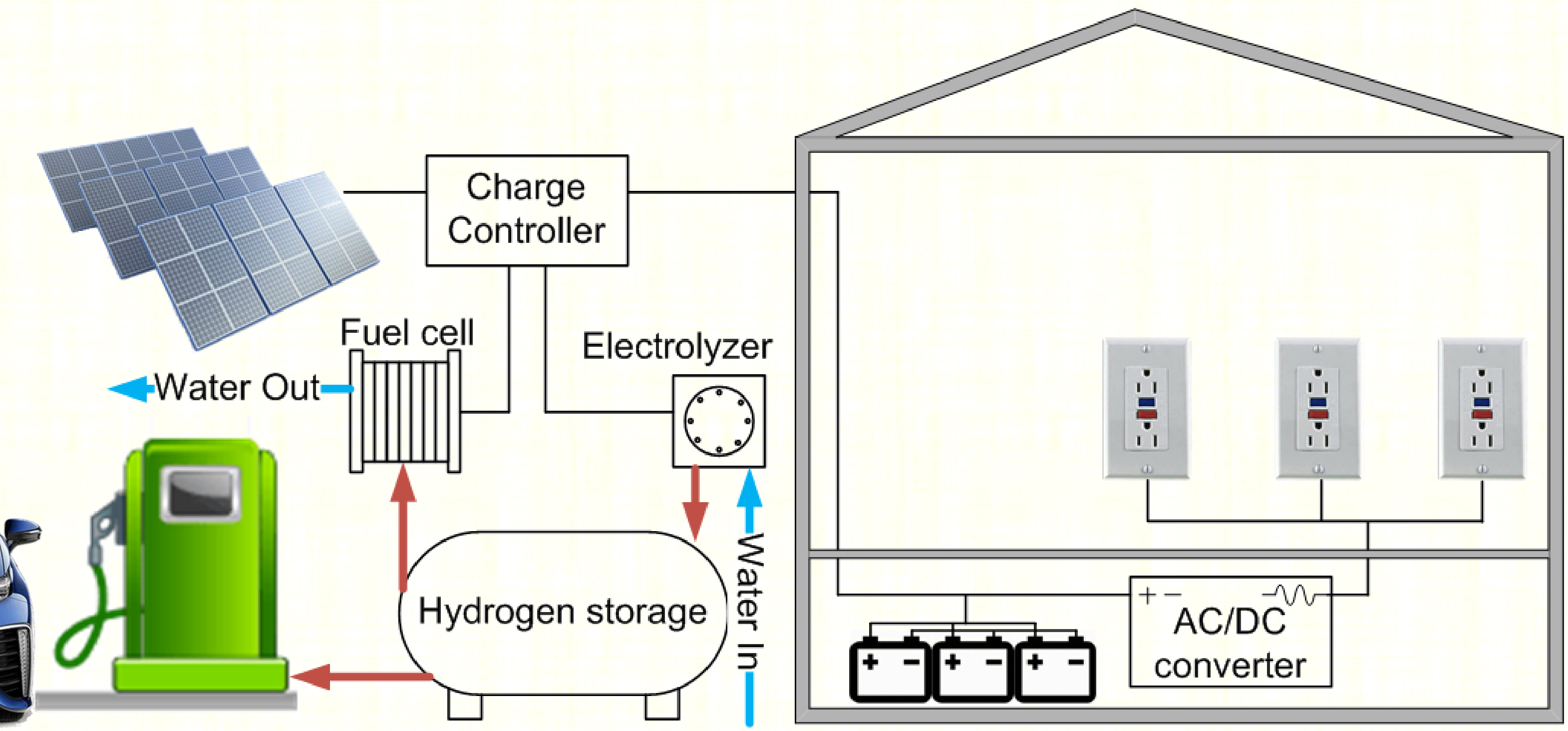
Annual energy use in Sonoma house is 3886kWh.
Primary energy indicator (EP_p) = 3886/221 = 17.5 kWh/m^2

Passive house: (EP_p) < 15 kWh/m^2
nZEB: 0 < (EP_p) < 5 kWh/m^2

The First Consumer Hydrogen House

This is the first commercially produced Active House project completed in Pennington, NJ in 2015.

Energy is generated by solar panels. After filling a bank of charge controlled lead/acid batteries, the continuing renewable electricity splits water into hydrogen and oxygen in an ‘Electrolyzer’. The hydrogen is pumped into standard propane tanks. When needed, a ‘Fuel Cell’ converts gas back to electricity. Within the cell, hydrogen recombines with oxygen to make water, essentially giving back the electricity used to split it. That power runs through the battery bank to maintain optimum power levels.



The First Consumer Hydrogen House

In 2015 Toyota presented a new hydrogen car Mirai. Range is around 300 miles, refueling will take about five minutes. It runs solely on hydrogen and its only emissions are water.

The Hydrogen home was designed to allow for expansion of a hydrogen and/or electric refueling station, which will be installed this year later.

Since that, this household can use only solar energy for all their needs and moreover, they can give an extra energy to their neighbors or electric grid.

Summary

Advantages. Those houses more comfortable because the additional insulation keeps the interior wall at a more comfortable and stable temperature. The indoor humidity and drafts are reduced. A tightly sealed air/vapor retarder reduces the likelihood of moisture through the walls. They are also very quiet because of extra insulation and tight construction. And finally, they save money. For example, hydrogen house does not need any outside power and more over it gives fuel to the cars.

Disadvantages. They cost more and take longer to build than a conventional home because it needs new construction techniques and products. The incremental cost for the Sonoma Deep Retrofit is about $96,000. The cost of equipment for Active House in NJ is about $135,000. Even though the house’s structure may differ only slightly from conventional homes, the builder and contractors may need more training if they have no experience with these systems.

But finally this choice is up to you, would you like to be a more independent and more friendly to the nature or keep feeding ConEd, BP, and others famous companies.

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Thank you

Any questions?