

# The New American Foursquare



**Overview:** The house sits in a transitional suburban DC neighborhood, where many older cottages are being replaced by large McMansions. It was built as a spec house in the worst real estate market in memory, completed in June of 2011 and sold in September. The project is a joint venture partnership between the builder and the architects, the first Passive House project for each, and the first Passive House in the DC region.

**Design Challenges:** The team's goals for the project created very

specific design challenges. Those goals were:

- To prove that a spec-built Passive House can compete successfully in the market side by side with houses of standard construction;
- To demonstrate that a Passive House can look and feel like a traditional American house;
- To prove that a Passive House can be built successfully by normal tradesmen and subcontractors with familiar, readily available products.

As an additional challenge, the small narrow site was not chosen

<b>Location:</b>	Bethesda, MD
<b>Climate Zone:</b>	Four; Mixed Humid
<b>Size:</b>	4,120 sq. ft.
<b>Levels</b>	B, 1, 2, Attic
<b>Construction:</b>	Residential
Walls:	R-36: 8" SIPS w/1.5" EPS over ext. Tyveck, 1x furring & fiber-cement siding.
Roof:	R-45: 12" thick SIPS Panels
Floors	R-20: 4" concrete slab over 15mil VB over 4" EPS insulation board.
<b>Mechanicals:</b>	PEX pre-tempering subsoil system. Ducted Zehnder ComfoAir 350's rated 86% efficient. Variable Mitsubishi heat pump. 2 ducted mini-splits ducted into ERV's.
<b>Windows:</b>	Thermotech triple glazed w/insulated frames and sashes. N&S U=.23btu/hr./ft/F SHGC=.59 E&W U=.21btu/hr./ft/F SHGC = .28
<b>Total Cost:</b>	\$220/Sq. Ft.
<b>PH Upgrades:</b>	7% upgrade over conventional construction
<b>Savings/Yr.:</b>	\$5,800/Year
<b>LifeCycle:</b>	11 Year ReCoup, without accounting for increases in fuel costs over next 11 years

with Passive House design principles in mind, and had a number of limitations, most notably a long axis running north-south.

### Design Solutions: Site

Beyond its poor solar orientation, the larger challenge posed by the site was its \$600,000 cost, based on its close proximity to shops in Bethesda and metro access. To make the venture succeed financially, a large house was required to meet the real estate market demand of the neighborhood. To fit such a house to the site, the designers took advantage of the slope to the rear, which allowed a full walk-out finished basement, effectively making the house 25% larger than it appears from the street. All rainwater striking impermeable surfaces is channeled to an onsite underground rainwater collection and dispersion system, eliminating any runoff from the site.

### Design Solutions – Envelope

The choice of the American foursquare style solved a number of design challenges:

- The nearly cubical form is ideal for a Passive House from the standpoint of surface/volume ratio.
- Traditional American foursquares tend to be rather large, so it was a logical fit, allowing the designers to fit the amount of program required, without making the common mistake made in most latter day traditional homes of supersizing the original model.
- The large overhangs which are one of the hallmarks of the style work handily to deal with summer solar overheating.



- No style could more powerfully prove the point that a Passive House can look traditionally American.

In the mid-Atlantic climate, summer over-heating is as large a challenge as winter solar gain.

Solar issues were handled in this case by:

- Deep roof overhangs protecting second floor windows, mentioned above;



*"After visiting a Passive House in Midwest blizzard conditions, I was struck by its performance capabilities. So much so, that I was committed to building one. Having now done so, I look back at the completed project occupied by a happy owner with a great deal of satisfaction."*

Brendan O'neill  
Developer/Builder

- A shallow porch on the south façade;
- Motorized canvas awnings at all main west windows, capable of 100% shading when required;
- High solar gain glass at north and south facing windows; low solar gain glass at east and west facing windows.

Due to its innate air-tightness and low thermal bridging characteristics, SIP wall and roof construction was the logical choice to meet the challenge of using familiar, readily available products. An add layer of EPS was placed on the exterior of walls to completely eliminate all thermal bridges.

**MEP Systems:**

The mid-Atlantic climate has temperature extremes equal to those of the Deep South and northern New England. In designing for an unknown client, the team had to design for the

most demanding user and create a system that could handle both extremes. As a result, this is the first Passive House project to incorporate an integrated ducted cooling/dehumidification system and ERV system, all controlled by a single programmable thermostat.

Fresh air is tempered by means of a loop of PEX tubing set 5' below grade in the backfill of the footings. Water from this loop continually circulates through a heat exchanger upstream of the ERV.

For winter heating, water from the hot water boiler runs through another heat exchange coil in the ductwork downstream of the ERV. This can be modulated to the exact demand required.

A fully modulated Mitsubishi City-Multi mini-split heat pump ducted together with the ERV ducting provides summer cooling and dehumidification. It also provides back-up heating in winter if required.



# Lessons Learned:

*“The greatest insights are gained through experience.” The architect shares what knowledge was gained through the design & construction process.*

The project’s greatest lesson was the value of integrated design. From the very beginning of construction documents, the entire project team was involved in the process. Concrete and insulation subcontractors helped develop practical details for sub-grade thermal bridge-free construction. The SIP installer and window manufacturer helped develop the details for thermal bridge-free window installation. The job superintendent consulted throughout. The result: long before the pre-construction conference each player had a good sense of his role and how it related to those of others. The byproduct was total buy-in and a sense of ownership on the part of all involved. With that preparatory careful development work in place, the project proceeded as smoothly and as quickly as any other construction project.

The project was built as a prototype, and the team plans to develop several smaller models in addition to this model. A monitoring system collects information about interior air quality, temperature and humidity, and document energy used by each individual piece of equipment. Of particular interest is the performance of the pre-tempering ground loop and the mini-split heat pump system. In the case of the former, the goal is to expand upon this low cost system if the energy returns are good. In the case of the latter, the goal is to downsize from the expensive CityMulti heat pump to a Mitsubishi Mr. Slim type system if the larger system proves to have been overly conservative.

### Cost benefit analysis

Construction costs for the house were 7% higher than had the house been built to the Energy Star standard. The partnership anticipates that this figure will be reduced in subsequent projects as familiarity grows with Passive House techniques. The marginally higher monthly mortgage payment is offset by the monthly savings in

energy costs predicted by PHPP modeling. While the savings are negligible today, as energy costs rise, the savings become dramatic. At a 5% annual hike in energy costs, those monthly savings will be over \$1,000 at the end of the mortgage period. Passive Houses, in addition to their benefits to health and comfort, offer sound insurance against rising energy costs.



## THE TEAM



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