AUTODESK UNIVERSITY

AR22002

Zero-Energy Homes with Revit and Insight 360: Make It, Market It, and Sell It

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Learning Objectives

- Learn research-proven methods to integrate solar panels into residential design as architecturally expressive elements
- Understand energy-analysis and solar-analysis capabilities in Revit and Insight 360
- Learn how to use Revit and Insight 360 to simulate, quantify, and visualize zero-energy metrics
- Learn how to market net-zero and positive energy homes to builders, realtors, architects, and prospective buyers

Description

There is a rapidly emerging market for net-zero and positive energy design and construction in the home building industry. Learn how to use Revit software and Insight 360 software along with external research sources to create trustworthy energy and solar simulations or net-zero design. Including real-world case studies and software demonstrations, this class will teach you how to utilize your simulation results in conjunction with cost-benefit analysis in determining the most economical path to zero energy, balancing energy-reduction measures with energy production. You will learn architectural methods of integrating photovoltaic (PV) panels into home design, as well as successful methods of marketing and financing net-zero and positive energy homes. You will see demonstrations and examples of Revit software techniques for design and visualization of integrated solar. This class will empower you with the knowledge and confidence to design, build, and sell net-zero and positive energy homes to an emerging market. This session features Revit, Collaboration for Revit, and Revit Architecture.

Your AU Expert

Jon A. Gardzelewski—AIA, LEED AP—is an associate lecturer in architectural engineering at the University of Wyoming (UW), and a licensed architect in the state of Wyoming. Gardzelewski has years of advanced industry experience focusing on computer modeling and energy efficiency. He is a passionate educator who incorporates the latest industry methods into both his teaching and research. He founded Freeform Energy, a building performance analysis consultancy, and recently helped found UW-BERG (Building Energy Research Group), where he focuses on zero and positive energy design. Gardzelewski is trained in both architecture and engineering with a Bachelor of Science degree in architectural engineering and a Master of Architecture degree. He is actively involved in several local and national professional organizations, including being on the board of directors for the United States Green Building Council, Wyoming Chapter.

Learn research-proven methods to integrate solar panels into residential design as architecturally expressive elements

Afterthought Solar

FIGURE 1. NO

FIGURE 2. NO NO NO!

Design Integrated Solar

FIGURE 3. YES! YALE KROON HALL BY HOPKINS ARCHITECTS

Students lead the way!

In 2002 the U.S. Department of Energy (DOE) hosted the first Solar Decathlon where students from Universities around the world build Net Zero Energy solar powered homes. These houses, designed and engineered by their University teams, would be fully functional for a week before judges rating the projects and gave out awards. After the first Decathlon in 2002, the judges increased an emphaisis on Aesthetics, but after the second decathlon in 2005 there was clearly no consensus for what the judges wanted in terms of aesthetic solutions (Denzer and Hedges 2007). The team at UW-BERG spent time understanding the various approaches of aesthetically incorporating solar panels that are believed to be successful. Aesthetics have been both objectively and subjectively evaluated, considering student designs from all years of the Decathlon (ten decathlons to date) as well as real world examples of homes that have either won major awards or received notable press. Aesthetic strategies for the treatment of PV have not been carefully described and categorized. From an evaluation of successful examples of aesthetic integration, we have developed a taxonomy using architectural terminology describing the design strategies:

Legibility—From High-tech Modernism, revealing and celebrating building systems. The downside of this strategy is that the house may look industrial rather than residential in terms of popular tastes and the norms of the real estate industry.

Material Planes—From early Modernism, composing in planes, often to emphasize or celebrate the "richness" of a material, and often achieving a lightweight or floating visual effect.

Form Follows—From the Modernist phrase "form follows function," the building form adapts to the need for a large area of PV panels facing south.

Shading—The PV panels also provide shading for the building or an outdoor space.

Disguise—The PV panels are hidden through either a compositional strategy or a technologogical innovation (PV embedded glass, etc). This includes a flat roof with a parapet to hide the panels.

Undesigned—The PV is applied after-the-fact to a predetermined form (Figures 1-2).

Examples from Solar Decathlon

FIGURE 4. ARIZONA STATE UNIVERSITY 2011 SOLAR DECATHLON HOUSE. AN EXAMPLE OF "LEGIBILTY" AND "SHADING."

FIGURE 5. UNIVERSITY OF ILLINOIS AT URBANA CHAMPAIGN 2009 SOLAR DECATHLON HOUSE. AN EXAMPLE OF "MATERIAL PLANES."

Figure 6. University of Calgary 2011 Solar Decathlon house. An example of "Material Planes," "Form Follows," Legibilty," and "Shading."

Figure 7. Georgie Tech University 2007 Solar Decathlon house. An example of "Legibilty."

Figure 8. Universitá Degli Studi di Roma, Winner of Solar Decathlon Europe 2014. An example of "Material Planes."

Figure 9. University of Minnesota 2009 Solar Decathlon house. An example of "Form Follows," and "Disquise."

FIGURE 10. MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT), INSTITUTE FOR ADVANCED ARCHITECTURE OF CATALONIA (IAAC) AND GLOBAL FAB LAB NETWORK, 2010 SOLAR DECATHLON EUROPE HOUSE. AN ECCENTRIC EXAMPLE OF "FORM FOLLOWS"

FIGURES 11-12. UNIVERSITY OF MASSACHUSETTS 2011 SOLAR DECATHLON HOUSE. AN EXAMPLE OF "LEGIBILTY" AND "SHADING."

Looking at all of the Decathlon contestants over the years, most fit reasonably well into one or more of these categories. Even notable avant-garde outliers such as the Fab Lab house (Figure 10) from the first European Solar Decathlon, claim the "Form Follows" influence. While such a response is probably too unusual for the conservative homebuilding industry, where houses are seen as investments, it is worth learning from them—particularly considering that this house won the people's choice award for that year.

Fundamental to making any of these strategies work is a careful consideration of the modular repetition and dimensional coordination of the panels and how they fit into a larger PV array. In some cases the form of the building (including the dimension) is carefully aligned with the size of the array (Figure 5). In other cases the array has its own modular & structural logic which is somewhat free from the dimensional logic of the building (Figure 4). The former has more compositional integrity in a high-modernist sense. The latter is more pragmatic, especially if you assume that the building will outlast the equipment. Some additive structures may be complementary to the architectural form (Figures 11-12), while others may be independent or even discordant.

Your Turn

FIGURE 13

FIGURE 14

FIGURE 15

Understand energy-analysis and solar-analysis capabilities in Revit and Insight 360

Demo

Learn how to use Revit and Insight 360 to simulate, quantify, and visualize zero-energy metrics

Demo

Learn how to market net-zero and positive energy homes to builders, realtors, architects, and prospective buyers

New Home Financing Examples

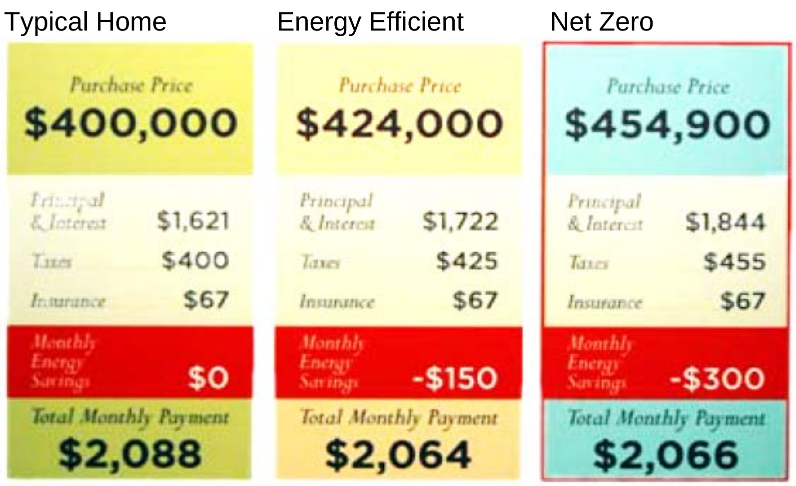

FIGURE 16. TYPICAL COLORADO NET ZERO MARKETING BASED ON MONTHLY MORTGAGE PAYMENT

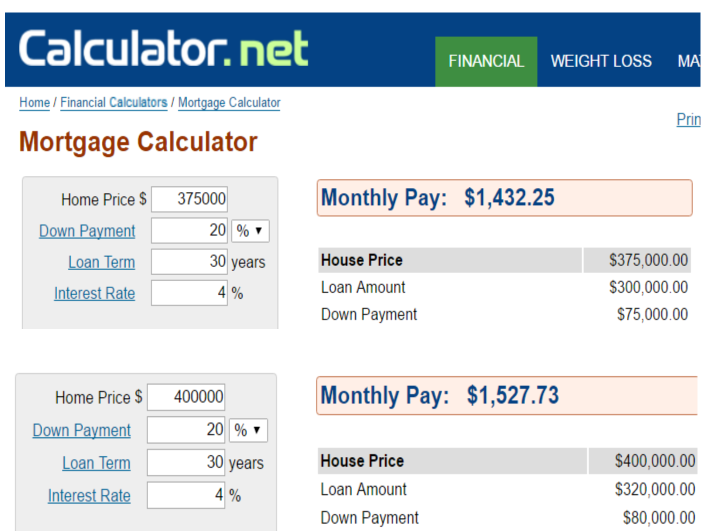

FIGURE 17. UW-BERG MORTGAGE MATH

Multiple Definitions, Multiple Pathways to Zero

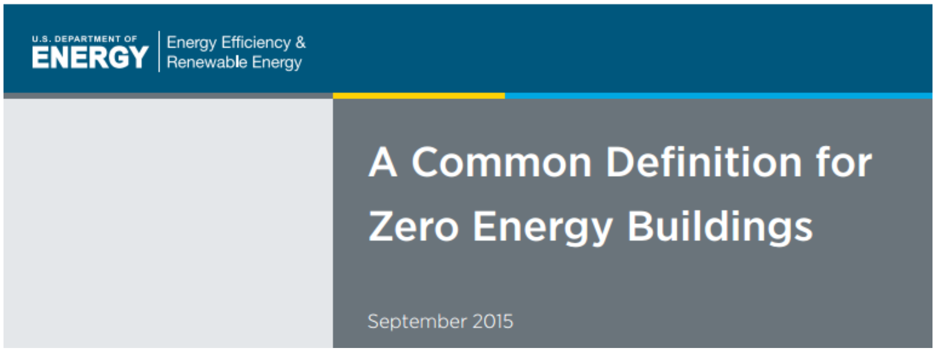

FIGURE 18. NEW DEFINITION OF ZERO ENERGY FROM DOE

Building Energy: Energy consumed at the building site as measured at the site boundary. At minimum, this includes heating, cooling, ventilation, domestic hot water, indoor and outdoor lighting, plug loads, process energy, elevators and conveying systems, and intra-building transportation systems

On-site Renewable Energy: Includes any renewable energy collected and generated within the site boundary that is used for building energy and the excess renewable energy could be exported outside the site boundary. The renewable energy certificates (RECs) associated with the renewable energy must be retained or retired by the building owner/lessee to be claimed as renewable energy.

Source Energy: Site energy plus the energy consumed in the extraction, processing and transport of primary fuels such as coal, oil and natural gas; energy losses in thermal combustion in power generation plants; and energy losses in transmission and distribution to the building site.

Energy Form	Source Energy Conversion Factor (r)
Imported Electricity	3.15
Exported Renewable Electricity	3.15
Natural Gas	1.09
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19
Propane & Liquid Propane	1.15
Steam	1.45
Hot Water	1.35
Chilled Water	1.04
Coal or Other	1.05

FIGURE 19. NATIONAL AVERAGE SOURCE ENERGY CONVERSION FACTORS