

# Beyond Zero Energy

A new zero impact home in Boulder addresses not just energy use, but the entire ecological footprint of the building. **BY BRIAN ANDREW FUENTES, AIA**

Clad in shimmering natural lime plaster and dark reclaimed redwood siding, Stephanie and David Adamson's brand new two-story straw bale home at 815 North Street in Boulder almost looks old. In fact, a single story house stood on the property until a year ago, dated by the 1935 Denver Post newspaper "building paper" found beneath the floorboards during deconstruction.

The home combines old world artistry in natural materials and the latest in high performance energy design. From locally sourced, hand applied, plastered straw bale walls to the 8.4 kilowatt (kW) photovoltaic (PV) solar electric system on the roof, low tech and high tech come together to make this project "green" in both a local and global context.

While humble in appearance, this project's lofty goals were not only to provide a healthy, affordable, and comfortable space for a growing family, but also to help define green building in a construction industry suddenly awash with the color.

## BRIGHTER SHADE OF GREEN

Standing on a terrace paved with born-again concrete Immix tiles, recycled from a Stapleton Airport runway, David Adamson explains the difference between a net zero energy building and what he calls a net zero impact building.

"Although a successful net zero *energy* building will have no utility bills on an annual basis, a net zero *impact* building's goal is to eliminate its unseen ecological bills as well," says Adamson.

Today, buildings are responsible for nearly half of all climate-changing carbon dioxide emissions. According to Adamson, there are two parts to the energy pie of a building project. First, there is the energy appetite of a building over time—the energy consumed for heating, cooling, lighting, refrigeration, as well as running computers, televisions, and other plug loads.

Second is the energy embodied in the materials. This includes the energy required for extraction, manufacture,



*The open plan and barrel vault ceiling on the top floor of the Adamson home create an inviting living area with a spacious feel.*

assembly, and delivery. All these processes also create other ecological burdens such as pollution and habitat loss.

"In the future, as more and more buildings approach the net zero energy target, embodied energy will be a larger share of the overall ecological footprint of a building," explains Adamson.

Materials with high embodied energy include aluminum, concrete, plastics, and nylon carpeting. Reclaimed wood, earthen products, and straw bales have very low embodied energy if they are sourced locally.

## THINKING IT THROUGH

Net zero impact building involves three steps. Just as common practice calls for reducing loads before considering renewables to achieve net zero energy, net zero impact first reduces the impact of the building, then measures what's left, and finally offsets the remainder of its ecological footprint offsite.

With the help of the Rocky Mountain Institute's architect Victor Olgyay and staff, who contributed significantly to the design, Adamson has been measuring the embodied energy (and thus the carbon released into the atmosphere) from the manufacture of every nail, appliance, light fixture, and solar electric panel. This level of detail is critical as we develop strategies to truly reduce the climate change impacts of build-

ings. If zero energy buildings require massive amounts of energy to construct, replacing our entire building stock with them makes little sense. We need to assess the total impacts of the building industry, because that information will allow owners, architects, and builders to make better choices about where, what, and how they build.

After calculating the home's total carbon footprint, the Adamsons plan to offset these emissions by supporting local land restoration through the Colorado Chapter of The Nature Conservancy. Restoration is more expensive than buying off-site green power or financing energy efficiency projects (\$10 to \$15 per ton versus \$2 to \$3 per ton), but more completely captures the environmental degradation caused by building material manufacture and transportation.

"Every building built should improve the ecological health of a building site and help create a nature preserve or restore degraded habitat elsewhere," says Adamson. "This 3-step approach to true building sustainability can be used for all projects, whether new construction, remodels, or existing buildings."

## GREEN FROM THE START

This kind of global thinking led to local action at the Adamson home. Less is more when it comes to reducing impact, and it is most cost-effective to make green choices from the very beginning of the design process.

For example, modest, cozy bedrooms on the lower levels of the Adamson house made resources available to fund outdoor terraces on the roof. These outdoor spaces make the house feel larger without increasing the amount of conditioned space. They also accommodate year round outdoor living by orienting both to the north for summer comfort and the south for cooler times of the year. On the top level, the kitchen, living, and dining area float under a barrel vaulted ceiling, opening up into the trees and onto the terraces for foothills views.

True sustainability also means growing community and saving money. David and Stephanie recruited and fed more than 100 friends, family members, and volunteers over 20 workdays to fill the post and beam wood frame full of dry straw bales and slather it with straw clay plaster inside and out. This straw covered "barn" was then transformed into a glowing cathedral of finished plaster under the watchful eye of local natural materials guru Ryan Chivers of Artesano and his crew.

The local clay, gypsum, and lime plaster applied over the straw bales also adds 400 pounds of sun-absorbing thermal mass per linear foot of wall to the home's superinsulated envelope. This enables the house to maintain a more even temperature than other comparatively high R-value but low mass wall materials.



Tim D'Antonio, www.dantoniophotography.com

*The Adamson's net zero impact home in Boulder, Colorado, features straw bale walls finished in natural lime stucco and reclaimed redwood siding, outdoor terraces, and a large (8.4 kW) photovoltaic system.*

Modeled on the classic passive solar example of Mesa Verde, the Adamson residence uses properly sized overhangs to block sun in the summer, while allowing it to pour in during the winter. The south glass features a high solar heat gain coefficient to maximize winter solar heat gain.

## BUILDING IT RIGHT

Project manager Jon Kinstad and general contractor Doug Parker of Big Horn Builders oversaw the construction process. Parker has 30 years of experience building energy-efficient solar homes, and he and HVAC (heating, ventilating, and air conditioning) designer Mark Shadowen of Advanced Air encouraged a simple heating system of electric baseboard heaters. Because of the extremely low heat loads predicted by our energy models, these inexpensive backup heaters will rarely be necessary, but will be available to augment the passive solar heat gain during long cloudy cold periods. The photovoltaic system provides the electricity to operate these heaters.

Parker's attention to detail in sealing and caulking of all framing joints kept the natural air change rate near what we used in our initial energy model (.15 air changes per hour or ACH). This tightly sealed straw bale home required mechanical ventilation, so Doug and Mark also helped fine tune the heat recovery ventilation (HRV) system, pairing Panasonic bath fans with a Broan HRV unit that supplies pre-conditioned fresh air to the bedrooms and living space while exhausting air from the bathrooms and kitchen.

**LESSONS LEARNED**

Adamson admits that the process was overwhelming at times. He helped with the general contracting of the home and tried to run his business, EcoBuild, while his wife, Stephanie, was pregnant with their second child, and both of them were still making decisions about the home as it was being built.

Although Stephanie was less involved as an owner than David, she has some solid advice for future custom green home clients and especially those planning to be involved with the contracting. According to Stephanie, green building requires another layer of product scrutiny. She suggests that owners carefully review and select each product, and ask questions about maintenance, warranty, and installation timelines.

“It is the same as building a conventional home, but there are additional things you have to focus on,” she explains. “Do your research, and find people to work with who have done it before.”

David agrees.

“Be clear on your goals and share them with every participant in the building process,” he says. “Find experienced professional partners who are enthusiastic about your project and willing to communicate with each other starting with the initial design charrette and continuing throughout the project.”

In addition, the Adamsons encourage prospective green homeowners to assess and visualize all aspects of the design before construction begins.

“Mock up the floor plan on the ground,” says David. “Use 3-D modeling of the design.”

And finally, counsels David, “Expect just being a client to be a part-time job.”

Many decisions were difficult, but Stephanie is glad they decided on cool and cozy smaller bedrooms on the lower levels. The upper common areas are filled with light, and she and her family live every day among trees and views of the foothills.

Had the budget allowed, she would have liked more fun places for the kids in the house, and would not choose steel top railings again because they get too hot in the sun for her children. Overall, however, Stephanie sounds quite content now that all the dust has settled.

“Straw bale homes feel different than other houses,” she says. “When I was here having my baby, it felt really good—earthy and connected.”

**A COLLABORATIVE EFFORT**

Building a home is always a team process, but teamwork is especially important when the project requires integrating time-tested passive solar and high performance design tech-

**PROJECT DETAILS**

**Project Description:** Straw bale single family home

**Location:** 815 North Street, Boulder, Colorado

**Owners:** David & Stephanie Adamson

**Designers/Architects:** RMI/ENSAR & Fuentes Design

**Materials Consultant:** EcoBuild Inc.

**Inspiration:** Julee Herdt/The Farmhouse & her CU architecture students

**Builder/General Contractor:** Big Horn Builders

**Size:** 3000 (net) 3600 (gross). Includes 300 ft<sup>2</sup> EcoBuild office, 1000 sf grandparent suite

**Construction cost:** \$193/gross ft<sup>2</sup> (includes landscaping + 1,000 ft<sup>2</sup> of decks)

**Date completed:** September 2007

**RENEWABLE/ENERGY-EFFICIENT FEATURES**

- R-30 garden level walls with expanded polystyrene rigid exterior and blown 30% soy polyurethane
- Blown polyurethane and cellulose insulation (R-45 to R-50 roof)
- Furnace-free passive solar design with a high mass concrete floor and earthen plaster
- Heat recovery ventilator
- Electric hot water pre-plumbed for solar
- 8.4 kW PV system
- Low-e triple-paned windows
- Maximum daylighting

**GREEN FEATURES**

- High fly ash concrete walls and slab
- FSC/engineered/reclaimed wooden structure with straw bale infill
- Reclaimed redwood siding
- Exterior earthen stucco and St. Astier Natural Hydraulic Lime waterproofing
- Interior earthen plasters (gypsum and clay), St. Astier Natural Lime paint
- Nature’s Carpet natural latex carpets
- Natural Cork cork flooring
- Immix pavers made from 80% recycled Stapleton runway
- Wheat straw particleboard
- Colorado Aspen and reclaimed glulam millwork
- Water directed from roof into planters and garden
- All paths and landscaped surfaces use permeable materials
- Permaculture and restoration of native vegetation (shortgrass prairie and transition zone)
- Exterior planters and “green walls” to provide shade and to soften structure
- Trex decking

niques with innovative green building products and systems. Our task was not only to build a beautiful home, but also to develop relationships and refine our ability to successfully innovate together on future projects.

Every project we undertake as architects, builders, and suppliers, no matter how small, reflects our values and embodies our intentions. Whether we think about them or not, design and materials choices have global impacts. By choosing local materials, people, and services, we make it easier to understand these impacts. Just as many people now understand the impor-

Natural materials and a heat recovery ventilator ensure good indoor air quality in this very tight home, which is particularly important when there are small children living in the house. Note the vibrant colors of the natural interior plaster.



Tim D'Antonio, www.dantoniophotography.com

tance of local food production, I hope more will come to value supporting local sources of natural materials and craftspeople for their homes.

I believe the development of a local, authentic, regional architecture driven by climate and culture can achieve not only zero fossil fuel use in operation, but eventually give the world something back rather than only taking from it during its creation.

Such a positive transformation of the entire building industry will require a daunting amount of time and work. But projects like the Adamson home convince me that the obstacles are not primarily technical or financial. The only limitation is our willingness to try.

*Brian Andrew Fuentes, AIA, (brian@fuentesdesign.com) is principal of fuentesdesign LLC.*

**RESOURCES**

**Architecture/Design**

Local contacts: Victor Olgay, Vikram Sami, and Ashley Muse  
RMI/Ensar  
www.rmi.org

Local contact: Brian Fuentes  
Fuentes Design  
www.fuentesdesign.com

**Cabinets**

Local contact: David Larsen  
Castlewood Studios  
720.733.9067  
www.castlewoodstudios.com

**Countertops**

Local contact: Ryan Waxman  
970.385.4044  
www.stonevesselsink.com

**Energy-Efficient, Passive Solar Building**

Local contact: Doug Parker  
Big Horn Builders  
303.444.8811  
www.bighornbuildersinc.com

**Demolition/Deconstruction/ Recycling**

Local contact: Russell Callas  
Haul Away Recycling  
303.931.7398

**Feng Shui**

Carole St. Germaine  
303.818.2276

**Flooring**

*Cork*  
Local contact: EcoBuild, Inc.  
(www.eco-build.com)  
Natural Cork  
www.naturalcork.com

*Natural Latex Carpets*

Local contact: EcoBuild, Inc.  
(www.eco-build.com)  
Nature's Carpet  
www.naturescarpet.com

**Green Building Materials**

Local contact: David Adamson  
EcoBuild Inc.  
www.eco-build.com

**HVAC**

Local contact: Mark Shadowen  
Advanced Air  
970.207.0057

**Insulation**

Local contact: Roger Sims  
Bio-Based Foam  
303.818.1953

**Landscaping**

Local contact: Bill Melvin  
Ecoscape  
www.ecoscapedesign.com

**Lighting**

Local contact: Cheryl Gaiser  
Inlighten Studios  
303.499.9899

**Natural Stucco/Plaster**

Local contact: Ryan Chivers  
Artesano  
www.artesano-home.com

**Solar Electric (PV)**

Local contact: David Adamson  
EcoBuild, Inc.  
www.eco-build.com

**Solar Thermal**

Local contact: Eric Anderson  
Low Energy  
303.781.9437, ext. 108

**Straw Bales**

Local contact: Albert Francis  
Alamosa, Colorado  
719.580.9075

**Structural Engineering**

Local contacts: Jeff Ruppert & Ian Smith  
Odisea Design  
303.443.4335

**Windows**

Local contact: Mike Douglas  
Mountain States/Loewen  
303.377.8566  
www.loewen.com