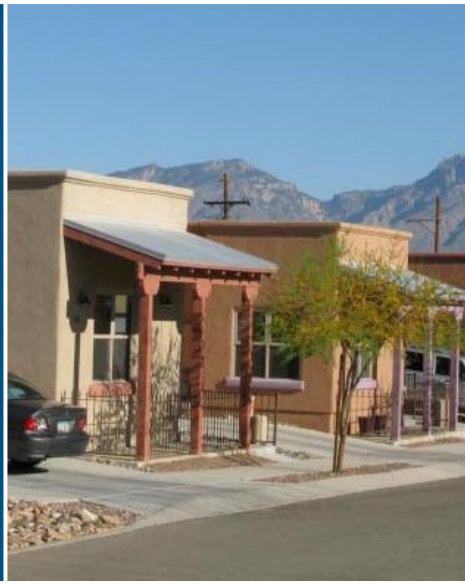
Building America
U.S. Department of Energy
Research Toward Zero Energy Homes

Builders Challenge Guide to Achieving 40% Whole-House Energy Savings in the Hot-Dry and Mixed-Dry Climates

Case Study:
CDC Realty Inc.

CENTENNIAL TERRACE | TUCSON, AZ



A Centennial Terrace home is an economical and energy-efficient choice for the first-homebuyer

Small Neighborhood, Big Savings

When Lee Rayburn decided to design and develop homes for a small subdivision called Centennial Terrace in Tucson, Arizona, he was determined to create an energy-efficient neighborhood, not just a row of houses. Rayburn had participated in the creation of Civano, a New Urbanist community located near Tucson that was pedestrian-friendly and featured energy-efficient homes. (Read more about Civano in the Building America Best Practices guide *Volume 6: Solar Technologies.*)

Impressed by the Building America systems approach he observed at Civano, Rayburn approached Building America partner Building Science Corporation (BSC) for guidance."I wanted to do the best I could as cost effectively as I could afford," said Rayburn. "This was not the bank's money—it was *my* money, so doing it right was very important to me."

Know the Market

Even before construction work began, Rayburn carefully targeted his market. While other builders in the Tucson area were focusing on large, sprawling houses, Rayburn's homes averaged a cozy 1,550 square feet and featured efficient storage—particularly appealing for young singles and empty-nesters. He also recognized that buyers were interested in healthier energy-efficient homes. Also, homebuyers loved the low energy bill guarantee that Rayburn offered through Tucson Electric Power.

Rayburn concentrated on the look and livability of the homes. "We focused on three main areas," he says, "First we wanted to keep the air circulation going with a whole-house fan and heat exchanger to ensure healthier indoor air quality. Second, we wanted to make use of as much natural light as possible. And third, we kept the ceilings as high as possible to keep the homes bright and airy—an important consideration in a smaller home." It would be up to Tom Doucette, the builder, to incorporate these design elements with energy-efficient systems. Doucette had also participated in the creation of Civano and was aware of the Building America systems approach to construction.

BUILDER PROFILE

Builder's Name:
CDC Realty Inc.

Where:
Tucson, AZ

Development:
Centennial Terrace

Size:
17-lot subdivision;
1,500 sq. ft. 1-story homes

Completed:
2006

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For more information
1-877-EERE-INF (1-877-337-3463)
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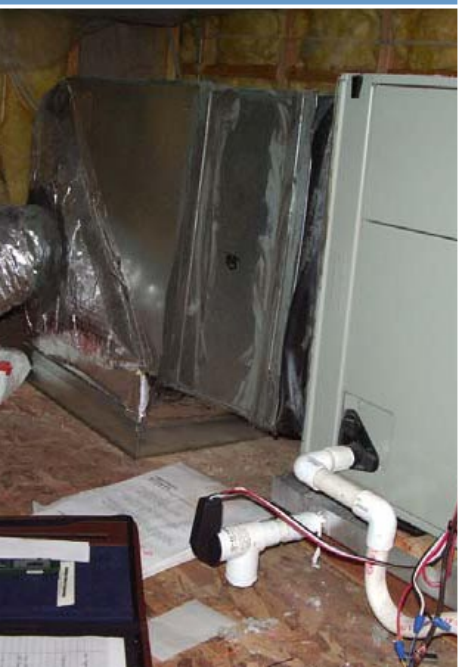
CDC Realty Inc.



The air handler is located inside the conditioned attic.

The 17 homes at Centennial Terrace feature R-38 blown-in cellulose along the underside of the roof decking providing conditioned space for the air handler and ducts.

KEY FEATURES

- Insulated attic with ducts and air handler in conditioned space
- Blown cellulose insulation, R-38 ceiling; R-19 walls plus R-5 rigid foam
- Double-pane, low-emissivity, spectrally selective windows;
- Overhangs to reduce solar gain
- 14 SEER A/C unit optional upgrade
- Programmable air exchange
- Tankless Water Heater, 82% Energy Efficient
- High ceilings throughout (minimum 9 feet, with 12 feet in the Great Room)
- ENERGY STAR appliances and lighting
- Solar features: Sun Earth Copperheart 40 combined collector/storage solar hot water panel, and Seisco instantaneous hot water system

Innovations

To achieve high levels of energy efficiency, a great deal of attention was paid to the building envelope. The standard unit is a simple slab-on-grade design with a flat roof, with nine-foot ceilings throughout the home and 12-foot ceilings in the great room and kitchen. A sloped section over the great room and kitchen provides the openness desired by Rayburn, while other ceiling sections hide the air handler and all of the duct work. R-38 blown-in cellulose was added to the underside of the roof deck providing a conditioned attic space for the HVAC equipment.

The space conditioning used an American Standard 12 SEER/7.5 HSPF air source heat pump (when SEER minimum was 10). Roof-top units are paired with an air handler located in the conditioned attic space above the laundry room, and insulated flex ducts supply and return air from every room. Ventilation is provided by a balanced system with both a dedicated air intake duct and a dedicated exhaust duct to bring in fresh air and exhaust stale air.

Homes Hit 40% Savings

The original home design for Centennial Terrace achieved a model energy consumption reduction of approximately 37% when compared to the Building America benchmark home (which is equivalent to a home built to the 1993 Model Energy Code). Before construction began in 2005, Rayburn contacted Building Science Corporation for design assistance to boost energy savings above 40%.

As a result of their work with Building Science Corporation, all the Centennial Terrace homes have ducts located in conditioned space between the insulated flat roof and a dropped ceiling. Blown cellulose to R-38 is applied along the attic roof line to make a conditioned space for the ducts and air handler. Walls are insulated to R-19 plus R-5 exterior rigid insulation. All of the homes are plumbed for solar thermal water heating and five of the homes include a Sun Earth Copperheart CP 40 integral collector storage solar hot water system which Rayburn offered to homebuyers at a reduced cost.

All of the homes have an instantaneous electric hot water system instead of a standard electric hot water tank. The HVAC was rated at 12 SEER/7.5 HSPF (compared to 10 SEER/6.8 HSPF which was code at the time).

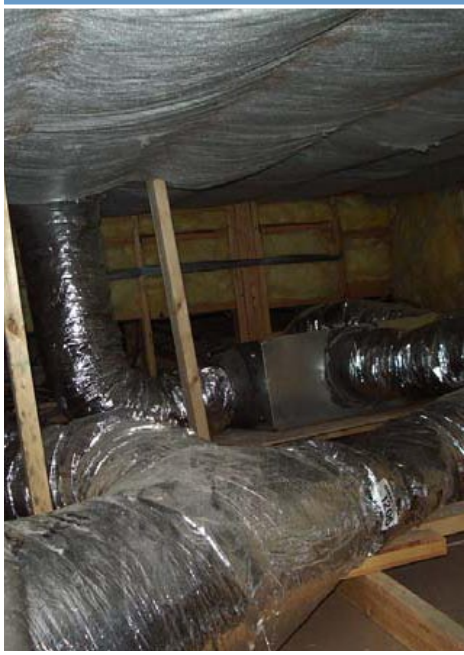
To further minimize energy losses, Building Science Corporation recommended reducing the window ratio from 18% to 12.2%. Overhangs shade the east, south, and west sides of the homes to help reduce solar heat gain through the windows. The windows are upgraded to the Milgard Classic Vinyl product with a U-value of 0.38 and an SHGC of 0.30.

Building Science Corporation modeled energy savings of 41% over the Building America benchmark. Building Science Corporation also analyzed utility bill savings in terms of costs. They found that when compared to the Building America benchmark home, the CDC Realty design achieves energy savings of 41%, costs $7,400 in upfront costs, and yields annual energy savings of $123 in space heating costs, $595 in space cooling costs, and $114 in domestic hot water costs per home. This adds up to utility bill savings of $833 per year.

The CDC Prototype Home:
Costs to Achieve 41% Savings over the Building America Benchmark

Feature	Cost of Change	Annual Energy Savings
Reduce windows 18% to 12.2%	*	$154
Overhangs	$200	$54
Upgraded vinyl, low-e windows, U=0.38, SHGC = 0.30	$1,000	$88
Attic insulation R-22 to R-38	$400	$139
Wall insulation R-12.7 to R-19 + R-5 rigid insulation	$700	$83
Air seal building envelope	$200	$41
Ducts inside conditioned space	$0	$106
Standard to instantaneous electric hot water heater	$200	$38
HVAC 10 SEER/6.8 HSPF to 12 SEER/7.5 HSPF	$700	$54
Add solar hot water	$4,000	$76
Total:	**$7,400**	**$833**

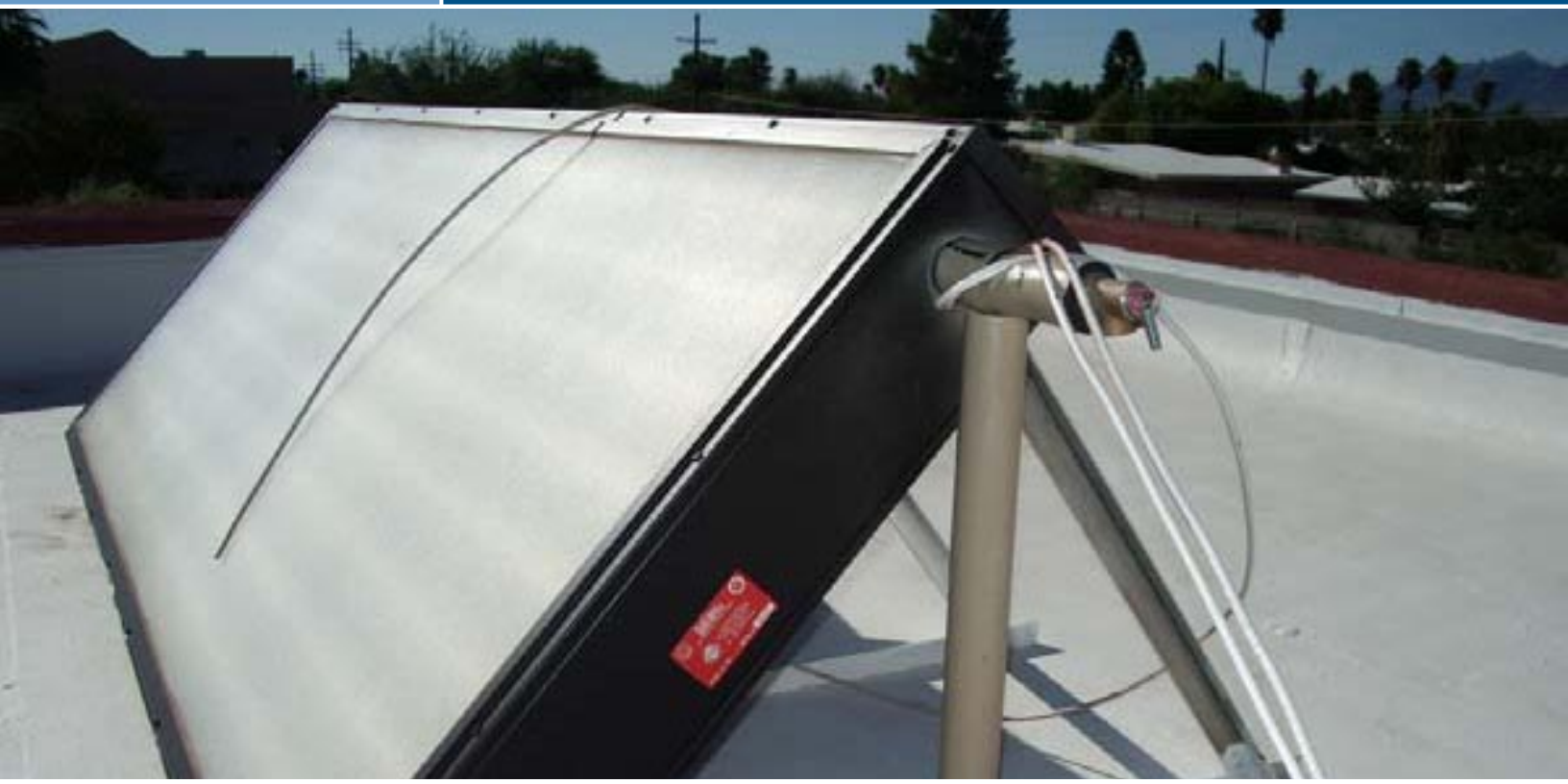
**Not quantified*



Ducts are located in conditioned space and mastic sealed to minimize heating and cooling losses.

"If you view the whole house as a system…it's not only easier, you end up with a better product."

Lee Rayburn, CDC Realty



A Sun Earth Copperheart CP 40 integral collector storage solar hot water system is mounted on the roof's flat surface.

Dollars and Sense

"Sales were quick," says Rayburn. "I think because they were well-designed and addressed the way homes are used. Now that people have been living in them, they really love the energy savings as well." Energy bills at Centennial Terrace run $60-70 per month in an area that typically sees monthly bills of $300-400.

The Bottom Line

As noted by Lee Rayburn, most builders view each aspect of the house—the electrical work, the plumbing, the framework—as separate jobs, but the Building America approach views each aspect as part of the whole. "Builders don't like to make changes—each subcontractor has their own system and they tend to stick with it," says Rayburn. "However, if you view the *whole house* as a system, so that any changes take place at the same time throughout the building, it's not only easier, you end up with a better product."