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**PROUD ARCHITECTS AND BUILDERS OF THE FIRST
USGBC LEED PLATINUM CERTIFIED HOME IN ARIZONA**

**LOOK INSIDE FOR A COMPLETE
ACCOUNT OF THIS EXCITING
AND HISTORIC PROJECT!**

Mining Platinum in Arizona

Platinum certification is the highest green-rating achievable in the LEED for Homes program. This means a net zero energy, net zero carbon and net zero water home that is comfortable, healthy, beautiful, and sustainable.

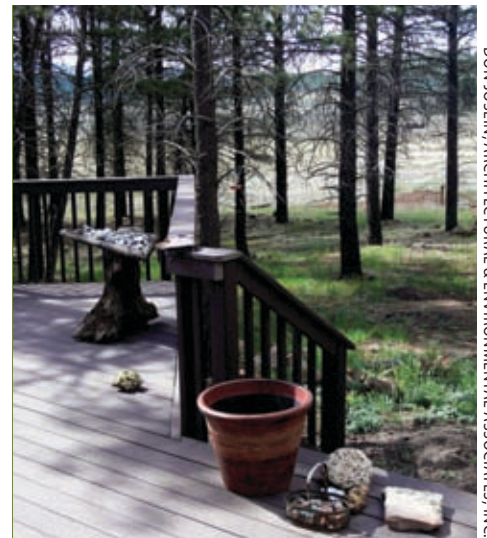
by Don Joslin

In 1939, when Flora and Willy Dwiggin established their original homestead on a beautiful and farmable property in north central Arizona, the world was a very different place. Germany was invading Poland, marking the beginning of World War II, and even though the largest oil field on Earth would not be discovered for another nine years, America was beginning a journey toward oil addiction, environmental degradation, and climate change. Nearly 70 years later, the Dwiggin's Arizona homestead would become the site of a remarkable home.

Conceived under the U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) for Homes pilot program, the Bellemont home was built and is owned by Carl Ramsey, a registered architect and contractor in Flagstaff. Ramsey is the owner and principal at Architectural & Environmental Associates, a firm with green building as its focus. The Ramsey

home was recently awarded a Platinum certification, the highest rating achievable from USGBC, and is one of only 23 residences worldwide to achieve this honor (see "USGBC LEED for Homes Rating System").

The home blends time-tested design strategies, such as passive-solar techniques and rainwater harvesting, with modern, high-tech systems. Electricity for the home is supplied by a grid-tied PV system and a grid-tied wind turbine. Solar-thermal hydronic systems supply domestic hot water and heat for the radiant floor system. Additional biological and environmental technologies are applied in the UV light water purification systems, the graywater system, and the indoor air quality (IAQ) systems. A custom-designed, software-based control system monitors and automates these other systems. The end result is a net zero energy, net zero carbon, and net zero water house that is comfortable, healthy, beautiful, and sustainable.



Extensive decking augments the living space and is made entirely of recycled materials.

Building Design and Efficiency

Ramsey knew that he had a locally unprecedented opportunity to provide a real-world example of household sustainability. His goal was to design and build a home that would provide its own potable and irrigation water and would produce its energy on-site, all with minimal impact on the environment. To earn a Platinum certification, the materials and methods of construction also had to minimize impact on the environment and meet set energy performance levels as well (see "A Model Home").

PASSIVE COOLING. The home's innovative design includes a tower structure that cools the house naturally during Flagstaff's summer evenings. The home has no other air conditioning. Cooling is important during the hot Arizona summers, even at 7,000 feet

USGBC LEED FOR HOMES RATING SYSTEM

The LEED standard was created by USGBC as a national standard for the design, construction, and operation of high-performance green buildings. The standard began as a pilot program approximately two years ago and was released from pilot status in early 2008. USGBC has created standards for several types of construction, including commercial, schools, homes, core and shell, interior design, and existing

buildings. The Ramsey home was rated under the LEED for Homes pilot program, version 1.11.

The LEED for Homes pilot version 1.11 rating categories, and how the Ramsey home scored in each category, are as follows:

■ **Innovation and Design Process:** Addresses special design practices, regional variations, exemplary performance, and areas not

currently addressed in the rating system. 9 points available. Ramsey home scored 7.5.

■ **Location and Linkages:** Addresses the home's location with respect to the larger community. 10 points available. Since the Ramsey home is located in a remote area, 13 miles from Flagstaff, it only scored 4 points in this category.

■ **Sustainable Sites:** Addresses the impact of construction on the site. 21 points available, minimum of 5 points required. Ramsey home scored 16 points.

■ **Water Efficiency:** Addresses water conservation measures. 15 points available, minimum of 3 points required. The Ramsey home maxed out in this category, scoring all 15 points available.



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The home features a passive cooling tower (center of structure) and clearstory glass for passive thermal gain. The solar thermal system can also be seen on the roof to the right.

above sea level. Ventilation through windows in the tower and clerestory is automated by the control system. The windows open and close automatically to provide both ventilation and additional daylighting. Warm air is exhausted at the apex of the tower through the process of stratification, creating a natural convection path that draws cooler air inside the home from the lower levels of the tower.

EXPANSIVE LIVING SPACE. Extensive exterior decking, built with recycled materials, and large patio areas paved with recycled glass and concrete pavers, provide an additional 1,600 square feet of living area to the 2,700 ft² house, without the additional expense of building infrastructure. A detached garage is connected to the home by an open breezeway and prevents airborne automobile combustion contaminants

from entering the home. Exterior walls are constructed using structural insulated panels (SIPS), and sprayed-foam insulation is used in the attic and crawlspace. Windows in the home are all low-e spectrally selective windows except windows on the south side, which are standard single-pane windows.

This Platinum home is so energy efficient that it easily earned the Energy Star Homes rating with a HERS Index of 24 (to achieve Energy Star certification, a home must score a HERS Index of 85). The design for the home also incorporates advanced framing technologies that reduce the materials and labor required to frame a typical home by approximately 15%. The home includes space for a home office.

INDOOR AIR QUALITY. As a part of the comprehensive green design, special attention was paid to ensuring a healthy

indoor living environment. Interior finishes are all low- or no-VOC materials. The detached garage is connected to the home by an open breezeway, which prevents IAQ degradation by ensuring that automobile combustion contaminants cannot enter the home. There is also a central vacuum system that exhausts pollutant particulates (dust, pollen, microscopic pollutants) to the outdoors. These particulates would be circulated throughout a home by traditional housekeeping appliances and practices. All of the interior flooring materials are hard, nonporous surfaces. There are no carpeted surfaces in the home. Traditional carpets off-gas chemical contaminants and harbor dust mites, cockroaches, bacteria, mold, and dirt. To provide clean, fresh air within a very well-sealed building envelope, a Honeywell automated heat recovery ventilation (HRV) unit was installed with a Broan-Nutone Guardian Plus high-efficiency particulate air (HEPA) filtration system. To reduce energy losses, an exchange manifold is used to capture warmth from indoor air in the winter and leave cool indoor air in the summer before exhausting the stale air from the house. The HEPA filtration system traps dust and pollen and prevents them from entering the home with the fresh-air supply.

Interior humidity levels are maintained by a Generalaire Elite steam electrode humidifier. The system maintains the humidity level at 40%—the optimum level for a human habitat. The home’s automated management system adjusts the humidity, temperature,

- **Energy and Atmosphere:** Addresses energy efficiency, especially relating to the home’s thermal envelope and heating and cooling loads. 38 points available. The Ramsey home scored 34 points.
- **Materials and Resources:** Addresses waste reduction, efficient use of materials, and selection of materials that limit the impact on the environment. 14 points available,

- minimum of 2 points required. The Ramsey home scored 12.
- **Indoor Environmental Quality:** Addresses IAQ problems through reduced exposure to, and creation of, pollutants. 20 points available, minimum of 6 points required. The Ramsey home scored 16.
- **Awareness and Education:** Aims to educate the homeowner, tenant, and/or building manager about the

features and benefits of a green home; teaches them how to operate and maintain the home properly. The Ramsey home scored 2 of 3 points available. The Ramsey home scored 106.5 points out of a possible 130. The total points available in the current LEED for Homes rating system is 136. The current certification levels for LEED for Homes are as follows:

- Certified 45–59 points
- Silver certification 60–74 points
- Gold certification 75–89 points
- Platinum certification 90–136 points

—Chris Watson

Chris Watson is a LEED Accredited Professional at Architectural & Environmental Associates, Incorporated.

A MODEL HOME

In energy modeling, a computer is used to simulate, or predict, the energy performance of a building. This is done very early in the design process. Modeling is a way to test materials or design options before committing to a direction or a methodology, and to quickly identify the most cost-effective, energy-saving measures. It is crucial to effective energy design and management.

Energy modeling for the Ramsey home was performed using the Energy-10 software package developed by the National Renewable Energy Laboratory (NREL) Center for Building and Thermal Systems. Although the LEED standards require that Energy Star-rated low-e windows be used throughout a structure, the models generated with Energy-10 were used to demonstrate to USGBC that to maximize passive-solar heat gain, traditional clear glazing on the south side of the home was preferable to low-e coated glass. Modeling is also used for analysis to assign residential Energy Star ratings. This specialized modeling was performed using REM:Rate, a highly sophisticated residential energy analysis, code compliance, and rating software developed specifically to meet the needs of HERS providers (see "REM:Rate 12.5—A Versatile Energy Application," p.10). The software calculates heating, cooling, hot water, lighting, and appliance energy loads, and consumption and costs for new and existing single and multifamily homes, using climate data available for cities and towns throughout North America. As a home energy rating tool, REM:Rate calculates energy loads, consumption, and costs. It also sizes mechanical equipment and performs automatic Council of American Building Officials (CABO) Model Energy Code, ASHRAE 90.2, and International Energy Conservation Code compliance analysis. The software features a utility that performs EPA Energy Star home analysis. The REM:Rate analysis indicated that the Ramsey home exceeded the applicable Energy Star requirements by approximately 70%.

and air flow to keep the interior of the home comfortable and healthy. An evaporative cooler was not considered for cooling, as it would increase the humidity to an unhealthy level inside the home.

INTELLIGENT LIGHTING SYSTEM. At night, the home uses Energy Star-rated lighting fixtures exclusively. The exterior lighting fixtures are also Energy Star rated. The exterior fixtures have a Dark-Sky rating as well. This rating means that the fixture must shine toward the ground and cannot contribute to light pollution in the night sky. Flagstaff is home to the world-renowned Lowell Observatory (where Pluto was discovered), and these Dark-Sky fixtures are a local building code requirement designed to make possible celestial viewing.

ENVIRONMENTALLY FRIENDLY MATERIALS. Sustainable interior finishes include earthen plaster wall finishes, renewable cork floors, clay-painted ceilings, and concrete countertops infused with recycled glass

aggregate and fly ash (waste from coal-fired power plants). To complement the home's natural surroundings, locally harvested and milled beetle-kill ponderosa pine was used for wood cabinetry, as well as base, window, and door trim.

REDUCED CONSTRUCTION WASTE. Leftover materials generated during construction were ground on site to create gravel for the driveway and mulch for the native landscaping. These practices reduced the waste from construction from a national average of approximately 5 lb per square foot of home, to under 0.5 lb per square foot. A large portion of construction waste would typically end up in a landfill.

Renewable Energy Systems

The renewable electricity systems were sited away from the house. This made it possible to position the house to take advantage of passive-solar orientation, shade resources, and a natural windbreak to the north, without



Two grid-tied SMA Sunny Boy inverters are powered by the PV system and supply electricity for the home.

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compromising the performance of the renewable energy systems.

A 7.2 kW grid-tied PV system is the primary source of electricity. The PV system also serves as the carport roof. Integrating the renewable electricity system into a stand-alone structure earned the Ramsey home additional LEED points. The PV system consists of 40 Sharp 180W modules feeding two inverters: an SMA America Sunny Boy SB3000U in parallel with a Sunny Boy SB4000U. The smaller inverter is served by a 2,880W subarray. The second inverter is supplied by a 4,320W subarray. The total array was sized to provide more than 11,000 kWh of AC production annually. Environmental models indicate that over a 25-year life cycle (which coincides with the warranty period for the modules), the PV system will prevent 2.8 tons of sulfur dioxide (a greenhouse gas that contributes to acid rain), just over 1.2 tons of nitrogen oxides, and nearly 300 tons of climate-altering CO₂ from entering the atmosphere.

To balance out renewable energy production during Flagstaff's rainy season, which runs from August through early October, a small wind turbine was installed. Early-afternoon thundershowers roll in almost daily, appreciably reducing good solar-



The PV system also serves as the roof for the carport. This idea was awarded LEED points for using the PV to shade a man-made hard surface. A grape arbor connects the carport to the entrance of the home.



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Rainwater catchment harvests all water, potable and irrigation, used by the home.

production hours but bringing a fairly reliable wind resource when clouds compromise the solar resource. The utility-interactive wind turbine, built locally by Flagstaff-based Southwest Windpower, Incorporated, is a Skystream 3.7 rated at 1.8 kW (2.4 kW peak, at a rated wind speed of 20 mph) and supplies 240 VAC at 50–60 hertz. It features three fiberglass-reinforced composite blades that sweep an area of 115.7 square feet (approximately 12 feet in diameter). The turbine cut-in wind speed is rated at only 8 mph. The auxiliary wind turbine is located in an open field approximately 100 yards from the home. This location reduces noise at the home and provides an unobstructed wind resource when wind energy is available to harvest. Based on a local annual average wind speed of 6.4 mph, the Skystream 3.7 has the potential to produce approximately 1,200 kWh per year.

Water Systems and Waste Management

With no well and no connection to the municipal water supply, the home is completely water independent. All water needs are met on-site by a rainwater catchment system, which functions through a series of gutters and storage

tanks that utilize every available roof on the property, including the outbuildings, for collection. The system can store approximately 37,000 gallons of water and can harvest more than 120,000 gallons in an average year, based on local average annual rainfall of 21.35 inches. Of the 37,000 gallons stored, 11,000 gallons are allocated for potable water and 26,000 gallons are allocated for irrigation water.

The land around the home is xeriscaped to minimize water used for irrigation. An arbor will soon be covered in grape vines and the grapes will be used to make wine (see photo above).

To achieve the Platinum certification, the environmental impact of human waste had to be minimized. The septic system that serves the home is a Norweco Singulair Bio-Kenetic Alternative system, which provides flow equalization, pretreatment, aeration, clarification, tertiary filtration, and optional chemical addition in a single precast concrete tank. The only mechanical component is the fractional horsepower aerator, which runs at 1,725 rpm and is certified with a run time of 30 minutes per hour. The system also uses UV light to disinfect the effluent. This step reduces the size of the septic leach field required, and it allows recycling of wastewater that

would otherwise pollute aquifers, as well as surface water reservoirs. The system relies on an extended aeration process, similar to that used in municipal wastewater treatment facilities, which breaks down the organic matter by natural, biological means. The septic system provides pretreatment, secondary treatment, tertiary treatment, and disinfection, reducing harmful pathogenic bacteria to levels below the bathwater standard. The septic system is equipped with a Geoflow Wasteflow subsurface drip irrigation system for wastewater dispersal. Dispersal occurs underground, where wastewater is absorbed in the biologically active layer of soil. There is no surface contamination, no ponding, no runoff, and no unpleasant odor.

Water-saving plumbing fixtures used in showers, faucets, and toilets reduce water consumption in the home to 70% below the national average without compromising comfort or convenience. The water-conserving design is augmented with a graywater collection system that harvests wastewater from bathroom lavatories, the bathtub, shower, and clothes washer to provide additional recycled water for irrigation on the site. On the LEED assessment for Platinum certification, the



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home achieved a perfect score (15 LEED points) for Water Efficiency.

Performance

Home Energy's readers are looking for information about homes that perform well, not just homes that look good, are designed well, or use all the latest technology. In the first month of occupancy (May 16–June 20, 2008), the Ramsey household consumed 806 kWh (24 kWh per day average) of electricity, while producing 987 kWh (29 kWh per day average) from the home's renewable energy systems, for a net energy production of 181 kWh. The energy modeling predicted that the renewable energy systems would meet 119% of the electric load for the house for this time period. The renewable systems actually produced 122% of the electric load.

The single resident of the house is comfortable and is happy with all the water and energy saving low-flow fixtures in the house. Two types of low-flush toilets were installed, one by Coroma and one by Kohler; although they both work, the Coroma has worked better than the Kohler. The rainwater catchment was designed to support a



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The renewable systems actually exceed the expected 119% and produced 122% of the electric load for the house.

home of 4, but with only one person currently living in the home, even with the dry weather water is no problem.

There was a small problem with the humidifier, which was not designed to use rainwater. The device is designed to use city water with some chlorine in

it, which allows a current flow in the water pan to indicate the presence of water. Since the recycled water is free of chlorine, the humidifier system had to be adjusted to work with purer water.

Time will tell us more, but so far the Ramsey home has met expectations for energy and water efficiency, health, and comfort. Looks like it earned its platinum designation.

Don Joslin graduated at the top of his class from the Renewable Energy Program at San Juan College, with an emphasis on PV technologies. He is currently serving as a renewable energy systems project manager at Architectural Energy Associates in Flagstaff, Arizona.

This article would not have been possible without the individual knowledge, support, and assistance of Carl Ramsey, Jason Campbell, Chris Watson, Katy Johnson, and Nathan Hodgson.

For more information:

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