Building America's Borrego Springs Project

Rob Hammon, Ph.D.

synopsis

- ***California's finite and expensive sources of electricity provided the impetus for this project, since summer cooling is the biggest load factor on the state's utilities.***
- ***Analysis of the demonstration homes to date presents an overall energy savings of approximately 65 percent, including heating, cooling, lighting, and other uses.***
- ***The use of sustainable, renewable resources in residential new home construction, such as the photovoltaic solar system that generates electricity from sunlight, available in abundant quantity in Borrego Springs, is the way of the future.***

Introduction

There are three certainties in life: death, taxes, and the fact that Borrego Springs, California will be very hot in the summer months. That's why Palo Alto, California-based Clarum Homes, working in partnership with the U.S. Department of Energy's Building America program, ConSol™, and the Davis Energy Group recently constructed four zero-energy test homes in this desert area.

How The Project Came To Be

California's finite and expensive sources of electricity provided the impetus for this project, since summer cooling is the biggest load factor on the state's utilities. Clarum Homes' president John Suppes, an outspoken proponent of energy-efficient building practices, continually searches for new methods he can incorporate into his company's production home communities, and Borrego Springs was the perfect setting for this experimental project. Located 85 miles northeast of San Diego in the Sonoran Desert, Borrego Springs is a hot, dry desert area with average summer temperatures ranging from 100 to 107 degrees. The resort town of 3,000 is surrounded by a 600,000-acre state park and is often listed as the hottest place in the U.S. on certain summer days. The severe climate of Borrego Springs made it an ideal place to study the reduction of cooling loads in residential new homes. Four prototype/demonstration

homes were built, using four different sets of energy features. The project includes the use of three different types of wall systems on one home design.

The Project Goals

The project goals were specific and measurable. The first goal was to find new ways to build highly energy-efficient, sustainable production housing for the entry-level buyer or move-up market, by California standards. A second goal was to achieve up to a 90 percent

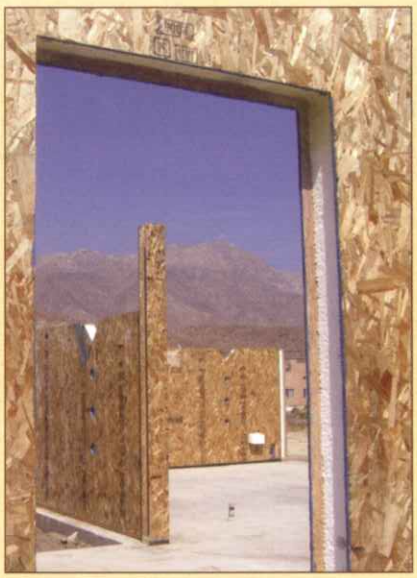
"Energy-efficient green building methods are gaining currency in the West, and this project will provide much data and information for builders who want to build smart for many years to come."

reduction in cooling costs than would be observed in a contemporaneous home built without the special energy-efficiency features of the Borrego Springs project. Third, Clarum Homes and its partners wanted to build energy-efficient homes with highly sustainable characteristics, while meeting California Zone 4 structural requirements. A fourth goal was to collect data on costs, construction schedules, production feasibility, energy efficiency, product lifecycles, and energy savings to determine cost effectiveness of sustainable technology applications in relation to affordable and entry-level new residential construction. Clarum's overarching goal was to generate data that could assist residential builders of production homes, not just custom builders with unlimited budgets, to provide attractive, appealing homes that are also highly energy efficient and comfortable to live in.

The Project Particulars

The following graph depicts the four demonstration homes, and which specific energy-efficient features were used in each. All four homes used:

- 3.2-kW photovoltaic solar electricity generating systems
- tankless water heaters
- re-circulating hot water systems
- tightly sealed ducts



- radiant roof barriers
- low-E windows
- five-foot shade overhangs at perimeter
- shade screens on all windows and doors
- ENERGY STAR® appliances
- fluorescent lighting
- colored concrete floors
- natural stone countertops
- water-conserving fixtures
- drought-resistant landscaping
- energy-efficiency monitoring equipment

Energy Savings

Preliminary data shows that the Borrego Springs project is well on its way to meeting the goals set forth (see above). Analysis of the demonstration homes to date presents an overall energy savings of approximately 65 percent, including heating, cooling, lighting, and other uses. A number of inspection tests have already been completed on the duct system, windows, and insulation, with more comprehensive building envelope air-leakage tests expected in the next few weeks. The benchmark home data is provided by Building America, and comparisons are done using the same floor plan, the same square footage, and the same climate zone.

Through the use of the 3.2-kW rooftop photovoltaic electricity generators, each home will, on an annual basis, produce almost all of the electricity required for normal home operation. Electricity meters at each home are hooked up to the local utility grid and can actually send electricity back to the grid during the day whenever the photovoltaics are producing more than the home needs. The home then draws the electricity it needs after sundown from the grid. The Borrego Springs homes will be nearly self-sufficient.

Wall System Comparisons

In Demonstration Homes 1 and 2, thermal mass wall systems with standard interior framed walls were used. The project manager noted a longer plan review time from the local jurisdiction for this feature, which can add cost. Other issues with this wall system included difficulty in providing adequate flashing at windows and doors, and the cost and time to ship, handle, and erect the systems. In Demonstration Home 3, the Structural Insulated Panels (SIPs) presented difficulty in installation with seismic requirements for hold-downs and inadequate provisions for electrical wiring and plumbing. It is anticipated that with subsequent use and practice, these concerns will be minimized. In Demonstration Home 4, no issues were noted with the high-efficiency framed walls and engineered lumber.

Building For The Future

Every partner working on the Borrego Springs project is committed to higher energy-efficiency standards in building and undertook this assignment to further that cause. "More builders should be building responsibly," says Clarum Homes' Suppes. "We embarked on this project to generate data that will give production builders the methods to build the entry-level and move-up homes California needs, while not overburdening the state's already taxed energy infrastructure," he added.

The use of sustainable, renewable resources in residential new home construction, such as the photovoltaic solar system that generates electricity from sunlight, available in abundant quantity in Borrego Springs, is the way of the future. Increasingly, architects and home designers are learning the techniques of climate-responsive and climate-specific architecture, on display at the Borrego Springs project.

Borrego Springs Project Partners

The Building America project combines the knowledge and resources of industry leaders with the U.S. Department of Energy's technical capabilities. Building America is a private/public partnership that develops energy solutions for new and existing homes. Together, they act as a catalyst for change in the home-building industry. The partnership

works on a cost-shared basis with more than 470 industry partners, which include leading national and regional builders who produce about 50 percent of all new housing, local home building associations, and individual builders. The primary goal is to enable the industry to adopt Systems Engineering approaches to the design and construction of a large portion of all new housing. By 2020, the Building America program is aiming for a 70 percent reduction in energy use through energy efficiency with the remaining 30 percent provided by on-site generation, such as photovoltaics. New Building America research homes already use from 30 to 40 percent less total energy than comparable traditional homes, and in the case of these Clarum test homes, 60 to 70 percent less total energy.

The Building Industry Research Alliance (BIRA) team, a diverse coalition of thirty-one industry partners, is a group within the Building America program dedicated to furthering the cause of the Zero-Energy Homes (ZEH) program. The team uses a Systems Engineering approach to produce homes on a community scale that use 40 to 70 percent less energy, reduce construction time and waste, improve productivity, provide new product opportunities, and implement energy and material-saving technologies.

ConSol, BIRA team lead, and Borrego Springs team lead have been working for builders since 1981 providing a full range of services to improve quality control of energy-related features in new homes and are recognized as the builder's energy advocate for the building industry at local, state, and national levels, and is committed to assisting the builder to improve profits, cost-effectively achieve the highest level of quality, and avoid costly litigation. ConSol provides energy code compliance,

mechanical engineering, ComfortWise, and many consulting opportunities to the residential builder.

The Davis Energy Group (DEG) has been a leading innovator in cooling and heating technology for residential, commercial, and institutional applications since 1981. Their work encompasses efficient cooling, heating, and building systems, including system analysis, design, controls, simulations, product development, and technology transfer. The NightBreeze ventilation cooling and OASys advanced evaporative cooling systems used at the Borrego Springs homes were developed by DEG.

Conclusion

The Borrego Springs project has already demonstrated that cooling loads and electricity costs can be sharply reduced with the addition of energy-efficient building methods and features, even in a climate area that registers routine temperatures of 100-degrees Fahrenheit or more. Energy-efficient, green building methods are gaining

Energy-saving feature	Demonstration Home #1	Demonstration Home #2	Demonstration Home #3	Demonstration Home #4
Thermal mass wall	X	X		
Structural Insulated Panel System (SIPS)			X	
2 X 6 framing				X
Engineered lumber				X
Polystyrene insulation (walls & foundation)	X	X	X	X
Freus cooling system	X			
NightBreeze cooling system	X			
OASys cooling system		X	X	
Lennox cooling system				X
Icynene insulation				X
Foam-wrapped building envelope				X
Radiant cooling	X	X	X	
Radiant heating		X	X	
High-efficiency gas furnace	X			X

currency in the West, and this project will provide much data and information for builders who want to build smart for many years to come. UHD

Glossary Of Terms

Thermal mass walls: Thermal mass is the ability of a material to absorb heat energy. A lot of heat energy is required to change the temperature of high-density materials like concrete, bricks, and tiles. They are, therefore, said to have high-thermal mass. Lightweight materials, such as timber, have low-thermal mass.

Polystyrene insulation: Polystyrene—a colorless, transparent thermoplastic—is commonly used to make concrete block insulation and a type of loose-fill insulation, which consists of small beads of polystyrene.

Freus cooling system: Freus is an efficient split system condenser, which utilizes a cooled condensing coil, achieving a high-cooling efficiency.

NightBreeze cooling system: NightBreeze is an integrated heating, ventilation cooling, air-conditioning, and fresh air ventilation system that saves energy, improves indoor air quality, and enhances comfort.

OASys cooling system: An evaporative system, where outside air is pulled in by a blower, which is first indirectly cooled, then directly cooled before entering the conditioned space, using about 75 percent of the outside air. The remaining air is humidified and exhausted.

Tankless water heating: A water heater that has no holding tank, but heats water instantaneously as it's needed in a fin-tube heat exchanger. Since storage is unnecessary, there is no standby energy loss associated with the storage of hot water.

Re-circulating hot water: When the hot water faucet is turned on, all the water sitting in the supply line has to move through the pipes before the hot water from the tank reaches the faucet. By adding a return line from the most distant faucet and installing a re-circulating pump, hot water is constantly circulated in the supply line, resulting in appreciable water savings.

Tightly sealed (air) ducts: According to protocols, the use of materials such as galvanized metal and flexible duct, as well as mastic sealants and mesh in the seams between the ducts, conditioned air loss is greatly minimized by tightening the ducts, resulting in huge energy savings.

Low-E windows: Low-emissivity interior and exterior coatings block and reflect much solar heat gain while transmitting most visible light in both the winter and summer, increasing comfort in the home.

Radiant barriers: A radiant barrier is an aluminum foil tent installed in an attic space to deflect radiated heat from the roof. This reflective surface blocks the heat waves from radiating to the ceiling below, so less unwanted heat reaches the living spaces.

Shade screens: A high-quality, optical grade of shading mesh, designed to block up to 90 percent of the sun's heat without blocking the view.

Fluorescent lighting: The light produced by a fluorescent tube is caused by an electric current conducted through mercury and inert gases. Used mainly indoors, it is three to four times as efficient as regular lighting and can save much energy.

Structural Insulated Panel System (SIPS): Panels are made of super-insulating expanded polystyrene (EPS) glued to an inner and outer skin. The result is a single stressed-skin panel with strength, durability, and thermal efficiency. The panels join together to build walls, floors, and roofs that are lightweight yet can withstand high wind loads and the twisting and flexing that slowly deteriorate conventional buildings.

Lennox: Manufacturer producing high-end heating and cooling systems that save energy and money.

Icynene: Manufacturers of the Insulation System, an environmentally friendly, dual-performing insulation and air barrier.

Engineered lumber: High-grade wood fiber, environmentally safe adhesives, and heat and pressure create virtually defect-free engineered lumber capable of supporting heavy loads over long spans. Engineered lumber uses less timber and can be made from young, rapid growth trees.

The Author

Rob Hammon, Ph.D., is the Principal at Stockton, California-based ConSol. Hammon's consulting team was able to play a key role in the Borrego Springs project. His work as co-chair of the California Energy Commission's (CEC) New Solar Homes Partnership Advisory Committee, whose mandate is to advise the CEC how to create the most effective program to encourage solar technology in new home construction, is closely aligned with the Borrego Springs project. Hammon's overall goal is to couple energy-efficiency with solar, and the data gained from the Borrego Springs project will substantially help in furthering that objective.