

The First Optimum Performance Home™



energy generation
part XII

Gary Reber

Architectural Illustration By Ronald Devesa

synopsis

A key component of the next era in new home design should be that every home needs to be self-sufficient, to the greatest extent possible, and thus should embrace clean, renewable and sustainable energy generation on-site in the form of electricity production through solar photovoltaic (solar cell) technology and wind power (where feasible).

The Optimum Performance Home will be equipped with a Day4 Energy® solar PV system, dual-stack PacWind® vertical-axis wind turbines, and GridPoint® Connect™—capable of generating enough electricity that the end result is a Zero Energy Home (ZEH) cost operation, with backup power for critical circuits in the event of a power grid failure.

Three other essential elements will be integrated into the mechanical infrastructure for the Optimum Performance Home for heating water for potable household use and radiant floor energy—TrendSetter® solar hot water system, Seisco® on-demand electric tankless water heater, and WaterFurnace® geothermal system.

Introduction

This is the twelfth article in the series documenting the design and construction of the first Optimum Performance Home™. The project has been selected by the U.S. Green Building Council (USGBC) for inclusion in the national Leadership In Energy & Environmental Design (LEED®) for Homes pilot program, their new green build certification initiative, and the goal is Platinum certification.

The home will be built at The Sea Ranch, located in Sonoma County, along the Northern California coastline of the Pacific Ocean, approximately 110 miles north of San Francisco.

The showcase project is exemplary of the “Ultimate Home Design®” concept, which integrates age-friendly universal design with the best sustainable building practices, while exerting minimal impact on the natural environment. Universal design is the inclusive, non-discriminatory design of products, buildings, environments, and urban infrastructure; as well as information technologies that are accessible to and useable by (almost) all. With respect to home design, the idea is to design and build homes that have no physical barriers, thus sustaining people of all ages and all capabilities in a functional, comfortable, and aesthetic lifestyle.

A building-science systems approach to home building is the cornerstone of the project, with emphasis on the relationship between the home’s components and the envelope they create. Also paramount is good stewardship—proper regard and respect for the rights of neighboring homeowners and the

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The Sea Ranch, Sonoma County, California
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surrounding natural setting, and resource efficiency. The goal is to optimize occupant health, comfort, and safety; maximize energy efficiency and structural durability; and minimize environmental impact. In addition, the aim is toward providing a nurturing home environment to support independent living and sustainable lifestyles.

Part I of this case study series appeared in Issue 1, January/February 2006. The introductory article covered the project scope. Thereafter, each issue has contained a part of the continuing series by working through site planning and preparation; Low-Impact Development (LID); further refinements to the site plan and drainage design; The Sea Ranch Design Committee-approved architectural/structural and grading/drainage submittals with conditions that translated to clarifications on certain building components and material finishes; particular aspects of the home's mechanical plan; structural aspects of foundations, structural walls incorporating Insulating Concrete Forms (ICFs) and Structural Insulated Panels (SIPs), as well as roofing; the acoustical design of the dedicated Optimum Performance Home Theatre™ and rear-projection room; interior design approaches and materials; kitchen, bath, and home fixtures; universal design architecture; and fire risk mitigation.

A Final Approval letter for The Sea Ranch Association Construction Performance Permit was issued on October 11, 2006, which is required by Sonoma County prior to obtaining a county building permit.

The necessary work to secure the building permit has been completed. Final construction plans have been approved by the Sonoma County Building Department. Six permits have been issued: site plan, landscape plan, septic system, geothermal boreholes, grading, and building. Commencement of construction with initial site grading, foundation, and mechanical

infrastructure is now scheduled for early November 2007, pending no major rainstorms.

"Mortgage Meltdown" Impact

Our initial approved construction loan was lost in early August just before issuance due to the "mortgage meltdown" and a harrowing global credit crunch, which has severely impacted new construction financing. The loan company who approved the loan closed its new construction division and terminated all approved loan transactions where monies had not yet been released. With the continuing downward spiral in housing and the value of the dollar, the credit crunch for new construction, in particular, has escalated.

"Mortgage meltdown" worries surfaced in November 2006 when Investment Bank UBS reported that borrowers with sub-prime loans—the kind made to people with weak credit—were falling behind on their payments at a record pace. In the months ahead, several wholesale lenders shut down because Wall Street had cut off funding for their sub-prime loans, throwing thousands out of work. Major loan companies such as Countrywide, the nation's largest, reported in January 2007 that foreclosures the previous month had soared dramatically over the year-earlier period.

By the end of September 2007, single-family housing starts were down nearly 27 percent for the year. The September 2007 seasonally adjusted annualized pace of U.S. housing starts plunged to its lowest absolute level in over ten years, and now stands at nearly 40 percent below its peak, recorded in January of 2006.

The National Association of Realtors, a trade group that has tried to couch the slumping housing market in the best possible terms, cites the recent turbulence in the mortgage market as the reason for the dramatic downturn in home sales. Such mortgage disruptions and uncertainties, and the subsequent tightening of lending standards with tighter restrictions, are deepening the slump and now make it

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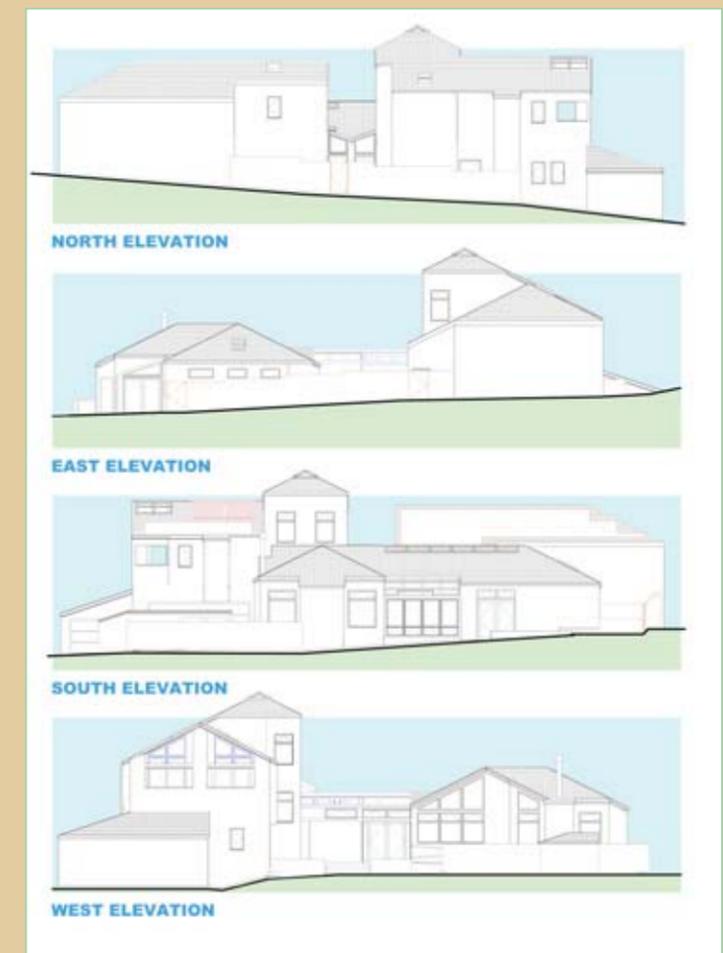
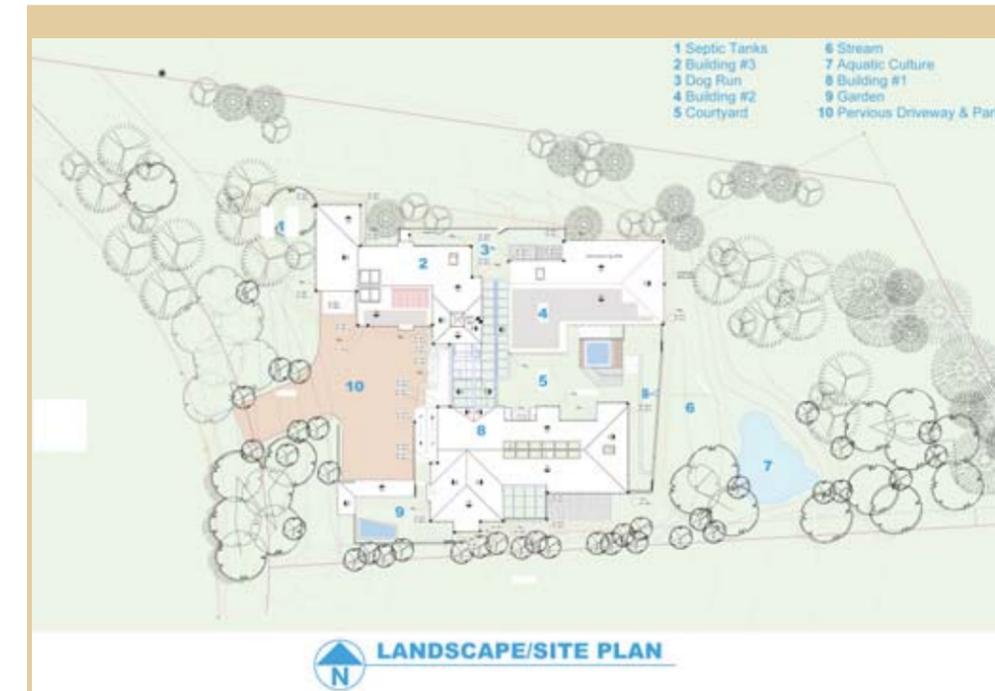
extremely difficult to secure a new construction loan. With the financial tumult, cash has been drained from the mortgage industry, and more than 50 lenders have gone bankrupt and a number of investment funds have collapsed. The tougher standards are affecting not only borrowers with shaky credit but also more creditworthy consumers and projects purported to be of the highest quality. Complicating matters, spooked lenders have started to shun larger deals, no matter their worthiness. Loan programs now require larger down payments, higher credit scores, and more thorough income and asset documentation. In addition, lenders are requiring more precise appraisals of properties before they approve a loan. Thus, appraisals have become extremely conservative.

This less borrower-friendly environment has made the re-funding for constructing the first Optimum Performance Home a challenge, to say the least, even though the project meets the tougher standards and is a national showcase for "green building" and "universal design" architecture. Nevertheless, the project is moving forward with a new construction loan in place through New Resource Bank.

New Resource Bank

New Resource Bank is the nation's first "green" commercial bank. The bank, located in San Francisco, opened its doors in November 2006 after receiving final approval from the California Department of Financial Institutions and the Federal Deposit Insurance Corporation (FDIC).

As a bank that is founded by world-class entrepreneurs and green business experts, New Resource Bank is developing its green building program by drawing on leading experts within the "New Resource Community." The bank is chartered to serve the San Francisco Bay Area community. Its



The elevations of the Optimum Performance Home at The Sea Ranch



chosen focus is to serve entrepreneurial community businesses and to help finance sustainable resources by funding "green" businesses and projects. The bank has specialized knowledge and networks to provide differentiated solutions to "green" and sustainable businesses and to help community businesses access options to improve their resource efficiency and sustainability. Its clients include businesses developing clean technologies, entrepreneurs specializing in ecologically friendly industries, and consumers concerned about the environment. Its staff understands the costs of doing "green" business and, therefore, can better meet their needs. As such, the bank appreciates the "ultimate home design" concepts integrated into the first Optimum Performance Home.

New Resource Bank offers financial incentives for green building projects by providing more money at a lower cost, with incentives that include lower interest rates and higher loan-to-value for projects that are designed and built to green leadership standards. The higher loan-to-value can help offset any higher initial costs to building green, however, the bank still bases its credit decision on the fundamentals of real estate lending, such as market, location, appraisal, developer/builder quality, etc.

To determine green leadership, the bank will initially rely on criteria established by the U.S. Green Building Council and its LEED

certification programs but remains open to alternative approaches to demonstrate green design excellence. The bank's office on Howard Street is certified LEED Gold CI. The office incorporates extensive recycled and rapidly renewable materials, low-energy consumption lighting and HVAC, and paints and adhesives that have low VOCs (Volatile Organic Compounds) and no toxins.

As an example of its special loan offers, New Resource Bank has partnered with SunPower Corporation, a Silicon Valley-based leading manufacturer and seller of high-efficiency solar cells and panels. The bank offers financing to residential customers buying solar panels for their homes. The bank will try to match monthly loan payments to customers' electricity bill savings and spread payments over periods of up to 25 years to make the \$20,000 to \$40,000 installations more affordable. Customers finance their solar installation through an easy, one-step application process, and then can make monthly payments while generating their own electricity. When coupled with existing rebate programs and tax credits, the bank's attractive financing terms can bring solar energy to many more homeowners, easily and more cost effective.

This Issue

In this issue, the focus will be on the energy-generation systems for the home in terms of premium solar photovoltaic (PV) modules and vertical-axis wind power turbines and their energy management, as well as solar hot water collectors, on-demand hot water, and geothermal water heating.

Design Concept

As previously noted in this series, the home design integrates all of the concepts advocated in *Ultimate Home Design*. The goal is to demonstrate how modern building products and methods can make life safer, more comfortable, and more enjoyable. The science of optimum performance homes concerns itself with building structures that use less energy, are quieter and more comfortable, have fewer problems with material degradation, provide clean air and water, and do less damage to the environment. As an integrated and holistic design, the house will serve as a permanent residence that allows its occupants to age in place.

The high-performance building systems to be employed are designed to exceed building code requirements and resist natural disasters more effectively than a code-minimum house. Built with stronger building materials and superior techniques, the home will be safer, allowing homeowners greater peace of mind. The Optimum Performance Home qualifies for the Fortified...For Safer Living® program of the Institute for Business & Home Safety (www.ibhs.org/business_protection). This program specifies construction, design, and landscaping guidelines to increase a new home's resistance to natural disaster.

In addition, the home will meet the guidelines and qualifications for the U.S. Department of Environmental Protection's ENERGY STAR®, the EPA's (Environmental Protection Agency) WaterSense™, and the American Lung Association® Health House® programs. It also will meet the requirements of the National Association of Home Builders' (NAHB) Model Green Home Building Guidelines, the Sustainable Buildings Industry Council (SBIC) Green Building Guidelines, and the "Green Points" program. Sonoma County and The Sea Ranch Association are now considering this program for adoption.

Furthermore, the home's design will be the subject of a case study analysis presentation before the Custom Residential Architects Network (CRAN), Full Spectrum Practice Convention of the American Institute of Architects on October 20, 2007 in Chicago, Illinois.

The home is also a case study of the California Energy Commission in terms of energy-efficiency applications and an advanced water-saving plumbing plan.

Finally, the home is a national showcase for CEDIA (Custom Electronic Design and Installation Association), and is the subject of a series of articles on the design and installation of the electronic lifestyle components in the home.

The Setting

The Sea Ranch is an internationally renowned 5,000-acre environmentally protective residential development situated within a pastoral and forested coastal enclave and nature preserve approximately 110 miles north of San Francisco, California. This stunning development,

now celebrating its 42nd anniversary, straddles a ten-mile stretch of Highway 1 along a stretch of uniquely beautiful rugged coastline, ending at the northern tip of Sonoma County and the south bank of the Gualala River.

The Sea Ranch is widely regarded as a unique and remarkable residential development. During the 1960s and 1970s, The Sea Ranch was at the forefront of environmentally responsible development. It was conceived and designed by architects and landscape architects who wanted to provide a harmonious mixture of custom homes and pristine natural Northern California landscape in oceanfront, meadow, and forest environments. In fact, The Sea Ranch concept and its architecture are recognized in schools of architecture around the world, and it is frequently used for case studies in environmental and architectural design. The first condominium complex to be built on the southern coastal bluffs of The Sea Ranch is now a registered national architectural site.

Single-family development occupies approximately 2,500 acres without borderline fences or other visible delineation of property lines. The remaining acres are permanent green-scape commons with 45 miles of nature trails for walkers, bicyclists, and equestrians. Each home is custom designed by an architect/architectural designer following site-specific design guidelines and is situated off a private road network without curbs, sidewalks, or streetlights. The Sea Ranch is a very unique residential development woven into a tapestry of buildings and nature and committed to environmental preservation. The development includes 2,288 lots for single-family custom homes, with 541 remaining to be developed (1,747 already developed and 29 under construction).

The Sea Ranch is managed by The Sea Ranch Association, a Common Interest Development (CID) with an elected volunteer Board of Directors, and supported by numerous volunteer committees. All development on The Sea Ranch is subject to design review and the approval of a Board-appointed autonomous Design Committee. The Design Committee is presently comprised of architects and landscape architects, though it does not include anyone with experience in vegetation management. A legal set of Covenants, Conditions, and Restrictions (CC&Rs) govern the development and are designed to protect The Sea Ranch concept.

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The Home

The Sea Ranch Design Committee imposes upon designers architectural building blocks derived from the original rural structures found on the northern California coast. Designers are expected to apply their creativity to render various arrangements and deviations to arrive at a custom solution that specifically responds to the site. Successful proposals submitted to the Design Committee address the issues of passive solar positioning, wind, glazing (window) layout, privacy between neighbors, vegetation protection, view preservation, topography and grade changes, roof slopes, appropriate exterior materials and finishes, and other exterior design considerations—all within the building and site design.

A focus of the Optimum Performance Home's design is to stand as a showcase for the "green" movement and demonstrate means of reducing a home's impact on the planet through the use of Low-Impact Development (LID) and environmentally responsible building materials. It is hoped that the home will become a case study for a "Green Points Program" suited to the scale of The Sea Ranch.

The home's 3,272-square-foot living space (4,441-square-foot total building "footprint," including garages, covered walkways, courtyard, and decks) will be arranged in a three-building compound using a well-sealed, well-insulated, super-tight building envelope that reduces temperature fluctuations and enhances overall energy efficiency. This arrangement provides for an alcove courtyard protected from the prevailing wind from the northwest. The home is designed with differing spatial experiences throughout to encourage exploration. The home will display innovative interior design and be furnished in a contemporary Frank Lloyd Wright style appropriate to its dimensions. The home design connects the indoors and the outdoors with covered walkways, a courtyard, decks, and a garden to expand livable space, without requiring heating or air conditioning. The home is designed in accordance with biophilic-design principles with abundant and excellent use of natural light and natural indigenous landscaping planned. (For an in-depth analysis of the biophilic attributes of the home, please read "Biophilic Design," "Biophilic Design Attributes," and "The Interior Design Process, Part I: Synthesizing Sustainability, Universal Design, And Technology" authored by Julie Stewart-Pollack in Issue 3 (May/June 2006), Issue 4 (July/August 2006), and Issue 10 (July/August 2007), respectively.

The main-floor living area is designed to accommodate the capabilities of all occupants without any challenging physical barriers, even for the elderly and disabled. The home design features a ground-level open plan for the living room, dining room, master bedroom suite, and spacious kitchen with solarium, exhibition cooktops, and home management system.

The second building in the compound is designed to accommodate a large state-of-the-art Optimum Performance Home Theatre™ with integrated rear-screen projection room and a home office.

The third building will include a two-car and boat garage, workshop, main-level guest bathroom, and laundry room. The second level

of this building will have two guest bedrooms, a bathroom, and a dedicated library/home theatre/surround music room distinguished by a high-tower feature. To insure universal access to this floor, the design provides for an Otis® Gen2 residential elevator.

The entrance and walkways that connect the three buildings and the solarium will be enclosed with insulated- and solar gain-reduced-tempered glass. There will be a seating area at the vestibule entrance to the home. The main entrance vestibule will serve as an oversized mudroom. The driveway, area around the garage, guest parking, and entrance to the home—as well as all paths—are designed in accordance with The Sea Ranch guidelines governing exterior hard-surfaced paths. All such surfaces are pervious to virtually eliminate water runoff. The surface will be packed with decorative gravel to enhance the natural appearance of the home's setting. There also will be a dedicated equipment room off the courtyard, which accommodates the Uponor® and WaterFurnace® radiant-heating apparatus, TrendSetter® solar hot water storage tanks, Microtherm's Seisco® on-demand electric tankless water heater, and other equipment. The backup Kohler® generator is housed within a separate weather-resistant tower located off the north wall of the two-car garage and guest bedroom, within the fenced dog run. This tower is designed to optimize the northwest wind performance of the PacWind® Seahawk® vertical-axis Savarrius™ wind turbine disguised within.

The home site is nestled on an almost-acre parcel at the edge of a forested area of the southern section overlooking the Pacific Ocean, offering distant water views. Some of the home's features will include a Benissimo® slate-floor outdoor courtyard, two hardwood Ipé deck areas, in-ground Dimension One Spa® hot tub, Finnello® Finnish sauna, and underground wine cellar. The orientation of the home on the site is designed to take advantage of natural lighting and passive solar heating and cooling. Good site and land planning will result in minimal land disturbance and preservation of natural features and environments.

Landscaping will consist of The Sea Ranch-approved indigenous vegetation with low-water requirements and unique water conservation features, including two ponds and a stream supported by rainwater catchment and captured runoff. Site grading has been specifically planned to

enhance the project's placement in the watershed, and the design incorporates the principles of Low Impact Development to minimize runoff from impervious surfaces and mimic the natural hydrology in overall effect. The resultant water harvesting will then minimize the use of irrigation, and the increased infiltration and retention will passively support the native landscape. Additionally, a gray water system will be used for undersurface plant irrigation.

An "Energy Factory"

While the foundation for the extraordinary quality of life enjoyed by Americans has been our ability to generate and control large quantities of energy inexpensively, a major change looms in the future. This will be the century that America will undergo significant and fundamental changes in the way we generate and use the energy upon which our modern quality of life depends. Renewable energy sources, particularly solar energy, will play an increasingly important role in that transformation as the next decades unfold. Using solar-cell technology is the most direct method of producing useable energy from sunlight.

A key component of the next era in new home design should be that every home needs to be self-sufficient, to the greatest extent possible, and thus should embrace clean, renewable, and sustainable energy generation on-site in the form of producing its own electricity through solar photovoltaic (solar cell) technology and wind power (where feasible). To this extent, homes need to be equipped with a solar PV system capable of generating enough electricity that the end result is a Zero Energy Home (ZEH) cost operation, with backup power for critical circuits in the event of a power grid failure. The first Optimum Performance Home is designed to perform in full compliance with this requirement through the application of a Day4™ Energy high-performance premium solar PV system and a PacWind Seahawk vertical axis wind turbine system, intelligently managed by two series-connected GridPoint® Connect™ energy-management appliances.

There is no better time, at least in California, to implement an on-site energy-generation system. On January 12, 2007, the California Public Utilities Commission approved a \$3.2 billion solar initiative, the largest solar program ever established in the

United States. The plan is to channel 3,000 megawatts of solar power—enough to power over one million homes—into homes, businesses, schools, and public buildings. The initiative's incentives, which will apply over an 11-year period, contribute to the capital cost of solar systems that range from one kilowatt to one megawatt.

Day4 Energy Solar Photovoltaic Module System

The Optimum Performance Home will use a large high-performance premium photovoltaic module system (also called panels or receivers) developed by Day4 Energy. There are two reasons that Day4 Energy was selected:

- Patented Day4 Electrode™ technology is a radical departure from conventional PV design and manufacturing processes, offering a new and improved method of connecting to and interconnecting with crystalline silicon photovoltaic material, resulting in high electrical conductivity, exceptional power density performance, increased electrical contact redundancy, long-life durability, and cost efficiency—resulting in a significantly reduced PV cost to the end user.

- Aesthetically, the 48MC all-black-on-black 190-watt mono-crystalline silicon module is refined in appearance and stunningly attractive. The aesthetics will complement the Evergreen Welsh Black solid stone slate roof. Their appearance is a no-compromise solution, providing clean, quiet distributed solar power generation while complementing the aesthetic appearance of the Optimum Performance Home and its surroundings. Forty-six modules will be integrated into the two 27-degree slopped south-facing roofs. The uniform black-on-black appearance of the Day4 48MC modules will blend with and enhance the roof design. Solar Works, based in Sebastopol, California, will provide the installation.

Day4's proprietary technology is designed to leverage the stability as well as manufacturing infrastructure associated with the conventional PV cell production process, while addressing the inherent weaknesses of this well-established approach. Day4's proprietary Electrode technology addresses the perennial problem of connecting to photovoltaic cells, efficiently harvesting electrical current from them and interconnecting them. As a result, the resistance to the flow of electrical current from the cell is decreased by a factor greater than 10, when compared to the industry standard method, and a simpler interconnection method leads to lower manufacturing costs. The fundamental idea behind Day4's technology is to replace the widely accepted screen-printing process of the PV cell's front contact metalization with technology capable of significantly reducing the total series resistance of the PV cell.

Day4's proprietary Electrode technology, when incorporated into PV cells, can be tailored to meet the requirements of a specific power-generation application. In residential applications, Day4 PV cells have higher power output than conventionally produced alternatives. This means fewer panels are needed, meaning lower installation costs.

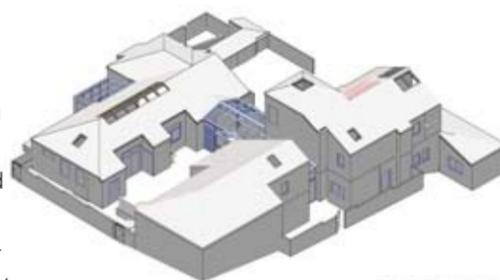
Day4's One-Sun Receiver Solar Panels can be used in a variety of both grid-connected and off-grid applications. The advanced cell interconnection means more power from less area. Because the technology

does not use ribbon bonding on the front of the panel, no energy is lost in this transfer.

Panel construction is robust and incorporates no solder-ribbon bonding on the front of the panel. The frame is made of exceptionally sturdy anodized aluminum, with extra grounding and water-draining holes for easier installation and better protection and reliability against the elements.

Day4 Energy is headquartered in the Vancouver, British Columbia area (Burnaby) of western Canada. Former Moscow State University Biophysics Professor Leonid Rubin, who is the Chief Technology Officer of the company, initially pioneered the Electrode for concentration photovoltaics in the 1990s. Day4 Energy was formed in 2001 with the mission to create solar products that will lead to price-parity with today's electrical generation technologies, without the need for subsidy programs. John MacDonald, the former aerospace pioneer and Massachusetts Institute of Technology (MIT) and University of British Columbia (UBC) professor, is the Chairman and CEO of Day4 Energy. The company has been producing the 48MC panel for the past year and introduced the black-on-black version at the Solar Power 2007 Expo in Long Beach, California, held in late September.

As an advocate for the idea of a "feed-in tariff," giving anyone who generates power from solar, wind, or hydro a guaranteed payment from the local power company, the 8.7-kW Day4 system will not only assure a net-zero cost operation with a zero power bill, but in the near future Pacific Gas & Electric (PG&E) may be required to purchase electricity produced at the home for 5.5 to 6.5 (or more) cents-per-kilowatt hour, the wholesale price of conventional power in California today. The installed system will produce an estimated 9,600 kWh annually. This is after losses from the panels, inverter, wiring, and



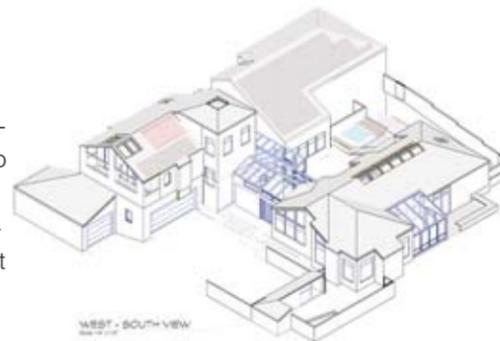
EAST-NORTH VIEW
SCALE 1/8" = 1'-0"



SOUTH-EAST VIEW
SCALE 1/8" = 1'-0"



NORTH-WEST VIEW
SCALE 1/8" = 1'-0"



WEST-SOUTH VIEW
SCALE 1/8" = 1'-0"

Four perspective views of the Optimum Performance Home at The Sea Ranch

losses due to the semi-cloudy weather in The Sea Ranch.

PacWind Seahawk Wind Turbine System

The second on-site energy source of usable power is a twin-vertical-axis wind-turbine system based on new technologies created by PacWind, Inc. located in Torrance, California. PacWind's mission is to make the use of wind energy a feasible energy component of both rural and populated areas.

The Seahawk system is a proprietary turbine design that incorporates the characteristics of the Savonius design of the past, invented by S.J. Savonius in 1922. His designs are referred to as drag designs that were pushed by the force of the wind. They typically work well in lower wind conditions but have generally been lacking in energy output and never exceed a one-to-one tip-speed ratio (blade speed versus wind speed). This is due to the fact that while the wind is propelling the blades on one side of the turbine, the oncoming blades are creating resistance back into the wind. Because of this, the Savonius' decade-old designs have never been able to pack much of a punch when it comes to energy output, thus making them economically unviable in most situations.

Phil Watkins, founder and CEO of PacWind, armed with decades of experience in the wind industry, has created revolutionary turbine designs that perform admirably in the full range of wind speeds and surpass a one-to-one tip-speed ratio, without the need for either starting or braking mechanisms. His creation is a proprietary vertical-axis wind turbine (VAWT). The design incorporates characteristics of not only the Savonius' designs of the past but also the Darrieus' designs.

The Darrieus is a lift-producing version of the VAWT that captures the

power of the wind in a much different manner than Savonius' designs. These designs have no problem surpassing a one-to-one tip-speed ratio in moderate to high wind speeds, as long as they incorporated separate starting and braking mechanisms. While they are great in the fact that they can harness a great deal of the wind's energy, they are severely handicapped, in a similar fashion as horizontal axis, or propeller-based, wind turbines (HAWTs), in that they need fairly high winds to start rotating and also cannot self-regulate themselves to prevent mechanical failure from over-spinning.

The innovative PacWind Savaarrius turbine designs are a breakthrough in that they do not require starting and braking mechanisms as previous HAWT and Darrieus VAWT designs typically do.

The Seahawk model is designed to blend into nearly any environment. This was a critical requirement of the Design Committee at The Sea Ranch, who is particularly guarded about the aesthetics of a wind apparatus.

The Seahawk design does not require monstrous towers, as conventional HAWTs do. The reason that HAWTs must be mounted on 60- to 150-foot towers is that they require clean, or non-turbulent, air to operate effectively. If an HAWT were to be installed in a location with turbulent air, it would simply try to locate where the wind was coming from by pivoting back and forth without creating any energy, which would cause immense wear and tear on the turbine.

The Seahawk has no trouble with turbulence whatsoever, which is important for the application in the Optimum Performance Home, due to the turbulent directional airflows that occur along the Pacific Ocean coast where The Sea Ranch is located. Wind gusts of 35-miles-an-hour and greater are not uncommon at The Sea Ranch. The Seahawk doesn't care what direction the wind is coming from. Should the wind shift direction suddenly, which it generally does, the Seahawk will maintain a constant power output. There is also no wear and tear on the unit in turbulent or high winds, since it is so stable and doesn't need to pivot to find the wind direction. The unit is designed to be maintenance-free and durable, and should perform optimally over many decades.

The Seahawk can be used aesthetically nearly anywhere on a property—even attached to a home or incorporated into one, as is the case with the

Day4 Energy Solar PV System

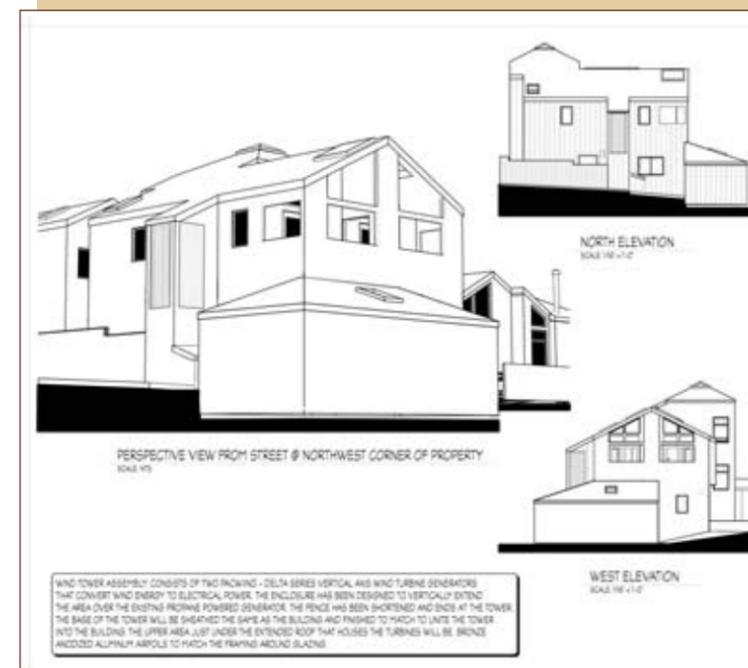


- Day4 Energy's 48MC all-black-on-black 190-watt mono crystalline silicon module is both aesthetically attractive and delivers high electrical conductivity, exceptional power density performance, increased electrical contact redundancy, long durability, and cost efficiency.

PacWind® Seahawk Vertical Axis Wind Turbine



- Two vertical-axis PacWind® Seahawk wind turbines will be integrated into the home's architecture and are each power-rated at 500 watts in a 28-miles-per-hour (mph) wind, with a maximum output of approximately 1 kilowatt (kW).



Optimum Performance Home. The Seahawk is compact (48 inches high x 30 inches deep) and lightweight (140 pounds), and is power-rated at 500 watts in a 28-mile-per-hour (mph) wind, with a maximum output of approximately 1 kilowatt. Two vertically stacked Seahawk turbines will be integrated into a disguised tower configuration on the north-facing side of the home's two-garage and guest bedroom structure (see architectural illustration).

For more reading see Ken Johnson's article, "PacWind: Shaping The Use Of Wind Power In Residential Architecture And Green Building," in *Ultimate Home Design* Issue 11, September/October 2007.

GridPoint® Connect™ Series Energy Management

- GridPoint® Connect™ is the first “plug-and-play” intelligent energy-management appliance to easily integrate renewable energy sources with remote-monitoring capabilities while providing clean, instant, and reliable battery backup power.



GridPoint Connect Intelligent Energy-Management System

GridPoint provides an intelligent energy-management solution that aligns the interests of consumers, electric utilities, and the environment to enable the Smart Grid.

The GridPoint Connect appliance will enhance the Day4 Energy solar PV and PacWind Seahawk Savaarrius wind turbine renewable-energy systems by adding battery backup power, real-time monitoring, and online energy-management capabilities.

GridPoint Connect is the first “plug-and-play” intelligent energy-management appliance to easily integrate renewable energy sources with remote-monitoring capabilities while providing clean, instant, and reliable battery backup power. GridPoint Connect qualifies for federal tax credits, allowing homeowners to claim up to 30 percent of the cost of the solar system, in addition to state and local incentives.

GridPoint Connect's standard solar/wind input capacity is 4.2 kW, but two or more Connects can add capacity for homeowners with larger energy-generation systems. In the case of the Optimum Performance Home, two GridPoint Connects will act as an intelligent hub connecting the home to its renewable energy sources, backup power, and the Pacific Gas & Electric power grid, while providing online energy-management tools to optimize electricity demands in the home.

GridPoint Connect's battery backup feature will keep the power on when it is needed most. With 10-kilowatt hours of battery backup power and a 30-amp capacity in backup mode (double for two), GridPoint Connect will alleviate the frustrations of a power outage and power sags for critical loads. The appliance harvests energy from both residential solar arrays and wind turbines, even if the electric grid fails. Thus, homeowners can reap the benefits of increased battery longevity supplemented by the sun and wind, and enjoy hours—or even days—of clean, instant backup power.

Critical circuits in the Optimum Performance Home will be assigned to a secondary load panel—the secure load panel—to draw power from the batteries in the event of a power outage. Among the circuits to be assigned will be lights, refrigeration, kitchen appliances, heat pumps for radiant heating and hot water, home office computers, and communication systems, as well as a few easily accessible electrical outlets to power portable equipment. The duration of the actual protection is directly impacted by the homeowners' energy consumption during an outage. Even though the backup batteries draw power only as it

is needed, limiting the number of loads and using highly efficient ENERGY STAR-qualified appliances will greatly increase the duration of backup power. Through GridPoint's online energy-management portal, GridPoint Central™ homeowners can adjust energy usage during the power outage.

GridPoint Connect has a 60-amp pass-through capacity and a 30-amp capacity in “backup mode.” Therefore, in the event of a power outage, the appliance will provide up to 30 amps of backup power to the secure load sub-panel with a surge capacity of 70 amps. The maximum continuous operating power is 3.6 kVA, and the appliance has 10 kWh of battery storage—meaning it will support a 1-kW load for around ten hours (or 20 hours using two GridPoint Connects).

The system will integrate the renewable energy sources to increase battery longevity during a sustained grid failure. During a power grid outage, the Day4 Energy and PacWind renewable-energy systems connected to the GridPoint Connects will continue to provide electricity and recharge the batteries. So, in addition to the 10 kWh of stored energy in the batteries, homeowners will continue to have a steady lifeline of power equal to the amount of energy received from the renewable energy source. In the event there is no solar- or wind-power production available, the appliance will charge the batteries when grid power resumes.

The GridPoint Connect appliance, unlike fuel-based outdoor generator installations, is a clean technology designed for safe, indoor installation—combining power electronics, high-capacity battery storage, and an advanced computer system. The appliance actively communicates with the GridPoint Operations Center to ensure optimal performance, and is programmed to perform a secure data transfer to the online energy-management center and report any maintenance need to GridPoint's customer service department. The portal is as easy to use as online banking. With a few clicks, homeowners can create a personal energy profile to automatically optimize energy usage based on consumption patterns and utility rate schedules. User-friendly, graphical interfaces empower homeowners to easily monitor energy usage (i.e., energy-usage patterns, renewable energy production, and the available energy stored in the batteries).

Through circuit-level management homeowners can learn how much energy each appliance consumes and, thus, turn loads off based on usage or

on economics, and conserve energy during peak periods when electricity rates are high.

Homeowners can access easy-to-understand environmental data based on their renewable energy production efforts (e.g., your avoided carbon dioxide emissions is equivalent to removing 100 cars from the road for a day). Homeowners can also view cost-savings information related to their participation in utility-sponsored demand response programs, enabling utilities to turn off non-essential loads to efficiently manage peak demand periods.

Homeowners can subscribe to e-mail or text-message alerts (e.g., an outage has occurred, you have ten hours of backup power available) and receive comprehensive energy reports on consumption, production, and system performance.

For more in-depth reading see Betsy Cragon's article, “Residential Energy Management: Aligning Consumers, Utilities, And The Environment To Enable The Smart Grid,” in *Ultimate Home Design* Issue 11, September/October 2007.

Energy Systems To Generate Hot Water

There are three other essential elements to the mechanical infrastructure for the Optimum Performance Home. These elements pertain to heating water for potable household use and radiant floor energy.

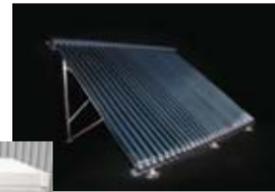
TrendSetter® Solar Hot Water System

The main energy source for heating water for potable household use will be provided by TrendSetter® Industries, Inc., using two proprietary solar collectors on the southern roof above the guest bedroom. Each of the black solar collector arrays is made of 30 non-combustible borosilicate impact-resistant evacuated glass tubes with a copper super-heat pipe and aluminum heat fin within each tube. The evacuated tubes are tied together with a single 30-tube header. The header consists of a fiberglass-insulated copper manifold contained within a black powder-coated aluminum casing, which is mounted to the roof as a complete evacuated tube array with a stainless-steel frame.

A 200-gallon TS-200 TrendSetter Solar Thermal Storage Tank will supply preheated water. The weather-resilient tank will be located in the courtyard equipment room. All TrendSetter solar tanks

TrendSetter® Industries' Evacuated Solar Tube Collectors

- TrendSetter® solar-tube systems reduce the water-heating portion of a utility bill by as much as 90 percent. Each of the solar collector arrays are made of 30 non-combustible borosilicate impact-resistant evacuated glass tubes with a copper super-heat pipe and aluminum heat fin within each tube.



Seisco® RA-28 On-Demand Electric Tankless Water Heater

- The Seisco® RA-28 is designed for whole-house replacement of storage tank water heaters or backup applications using solar and geothermal passive heat-recovery systems where the inlet water temperatures are above 65 degrees Fahrenheit.



feature a drain-back design, with internal copper heat exchangers installed. They are extremely robust and dependable, and will remain maintenance free for decades.

The concept of solar water heating is to heat the water before it enters the gas-fired water heater, whether it is a tank or tankless water heater. Most water heaters use either natural gas or liquid propane as the source heat. It costs three times less to solar preheat electric water heaters than it would using natural gas or propane. There is a \$2,000 Federal Government tax credit for the purchaser of a new solar system approved by the Solar Rating Certification Corporation.

For more reading, see Norm Ehrlich's article, “Solar Water Heating...A Sure Bet,” in *Ultimate Home Design* Issue 5, September/October 2006 and “Pushing The Envelope With The TrendSetter PiggyBack™ Solar Water Heating System,” in Issue 11, September/October 2007.

Seisco® On-Demand Electric Tankless Water Heater

A Microtherm Seisco® on-demand electric tankless water heater will serve as the perfect backup to the TrendSetter solar water heating system, should that system not achieve the desired hot water temperature at any given moment. The Seisco was introduced to the market after 14 years of research and testing. The technology has earned its developer, David Seitz, five separate U.S. and many additional foreign patents, and is recognized as a STANDARD for all tankless water

WaterFurnace® Geothermal System



- The efficiency ratings of a geothermal system are up to five times higher than conventional heating and cooling systems. WaterFurnace® leads the industry with its ENERGY STAR®-qualified Envision Series, the first to achieve 500 percent efficiency in heating.

heaters by providing the highest level of temperature-control performance, reliability, and safety in its operation over any tankless water heater anywhere in the world today.

The Seisco was chosen for HUD's (the U.S. Department of Housing and Urban Development) first ever "PATH Concept Home." Standard off-the-shelf heating elements and no moving parts or flow-restricting devices are used in Seisco heaters. Seisco uses a unique flow/no-flow detection system utilizing its temperature sensors for flow detection. In standby, the heater maintains a very subtle temperature gradient, and flow is detected when there is a change in the gradient. The advanced microprocessor control turns the power on through a set of relays and turns the power off when flow stops. An important feature is the patented "Power Sharing" technology, which provides for evenly distributed power to the heating elements. This, in turn, helps eliminate scalding potential, scaling, and sediment buildup. Also, the control logic allows the power level to vary, which is beneficial in minimizing the use of power for periods of less demanding usage.

The Seisco RA-28 is designed for whole-house replacement of storage tank water heaters or backup applications, using solar and geothermal passive heat-recovery systems, where the inlet water temperatures are above 65 degrees Fahrenheit. The RA-28 will provide endless hot water in combination with the TrendSetter solar collectors and Solar Thermal Storage Tank and WaterFurnace® geothermal system. The Seisco will only be activated after the water temperature drops below a predetermined set point, say 115-degrees Fahrenheit, then heating ONLY the water actually used, and only for the temperature difference required. The Seisco will not only improve the overall efficiency and cost effectiveness of the passive systems, it will insure an endless and continuous supply of hot water, whether the passive systems are providing heat or not. The four-chamber model contains four electric heating elements whose combined wattage is the total power rating of the heater. The RA-28 model is equipped with four 7,000-watt elements, for a total of 28,000 watts, or 28 kilowatts (kW) of power.

WaterFurnace® Geothermal Energy System

A geothermal system utilizes the Earth as a free heat source. While outdoor air temperatures fluctuate from season to season, ground temperatures stay consistent all year long. The ground is able to maintain a higher rate of temperature consistency because it absorbs 47 percent of the sun's energy that reaches the Earth's surface. During the

heating cycle, a geothermal system regularly circulates water through its ground loop to extract heat. The unit then transfers this heat from the loop to the home in the form of forced air distributed through a conventional duct system (heating or air conditioning), hot water for radiant floors, and domestic hot water heating.

For the Optimum Performance Home, a geoexchange system manufactured by WaterFurnace International, Inc. has been chosen as the means for heating and air conditioning. The system (also commonly referred to as a ground-source heat-pump system or geothermal heat-pump system) consists of three main components—the heat pump, which is the foundation of the system (manufactured by WaterFurnace); a closed-loop vertical "well" system, which is drilled into the constant temperature Earth on site; and water, which is circulated between the ground loop and the heat pump in high-density polyethylene pipe. The ground-loop portion of the geoexchange system uses the constant temperature of the Earth as a heat source instead of natural gas or propane for increasing the efficiency of an electric ground-coupled heat pump. A heat pump can provide both heating and cooling, and it operates on the same type of refrigeration cycles as conventional HVAC equipment. The difference is that the ground-coupled heat pump can take 1 kW of electricity and turn it into 3 or 4 kW of heating energy for the home.

On the Optimum Performance Home project, the water-to-water ground-coupled heat pump will be making hot water to be distributed through the home in a radiant floor distribution system manufactured by Uponor®. All of the rooms in the home will have radiant floor heating. In addition, the Optimum Performance Home Theatre™ and rear-projection room will be cooled with a two-zone water-to-air ground-coupled heat pump. This type of system was selected for the home theatre and projection room because it is expected that more continuous cooling will be required to offset the heat created by the projection and audio equipment. These heat pumps will be connected to a single ground-loop system that will allow the heat pumps to operate in heating and cooling modes simultaneously.

The system will consist of five vertical boreholes drilled 310 feet down into the Earth by Weeks Drilling & Pump Company, based in Sebastopol, California. The boreholes will be located under the

guest parking area at the front of the home. WaterFurnace Envision heat pumps are specified. The units utilize ozone-safe R-410A refrigerant to meet the most stringent Environmental Protection Agency (EPA) requirements.

The efficiency ratings of a geothermal system are up to five times higher than conventional heating and cooling systems. WaterFurnace leads the industry with its ENERGY STAR-qualified Envision Series, the first to achieve 500 percent efficiency in heating and an impressive 30 EER (Energy Efficiency Rating) in cooling as rated by the Air Conditioning and Refrigeration Institute in category 13256-1 (GLHP).

WaterFurnace systems utilize ultra-quiet Copeland Scroll™ UltraTech™ compressors, extra insulation buffers, and acoustic metals to provide the quietest heating and cooling system on the planet.

Geothermal systems are great for the environment because they burn no fossil fuels while operating. The EPA (Environmental Protection Agency) stated that installing a geothermal system in a typical home is equal to planting an acre of trees or taking two cars off the road in greenhouse gas reduction. The average geothermal system reduces carbon emissions by over 50 tons during its operational life span. In addition, current geothermal installations save more than 14 million barrels of crude oil per year. If one in 12 California homes installed a geothermal system, the energy saved would equal the output of nine new power plants.

Federal tax credits are available for geothermal systems. These can be viewed on the ENERGY STAR Web site at www.energystar.gov/index.cfm?c=products.pr_tax_credits.

For more reading, see Lisa Meline's article, "The Mechanical Engineer's Role," in *Ultimate Home Design* Issue 5, September/October 2006 and Ryan Stauffer's article, "Geothermal Systems Save Homeowners Money And Protect The Environment" in Issue 11, September/October 2007.

Next

Now that all of the necessary Sonoma County Building Department permits have been issued and our new construction loan is secured, this continuing series of articles will focus on the design elements as

For more information on this advertiser, circle 11

they pertain to each stage of construction, and will include coverage of the technologies and building systems and the materials used and applied to construct the first Optimum Performance Home. **UHD**

The Author

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- GridPoint, 2020 K Street, NW, Suite 550, Washington DC, 20006, 888 998 GRID (4743), www.gridpoint.com
- Microtherm Inc., 223 Airtex, Houston, Texas, 888 296 9293, www.seisco.com
- New Resource Bank, 405 Howard Street, Suite 110, San Francisco, California 94105, 415 994 8100, www.newresourcebank.com
- PacWind, Inc., 23930 Madison Street, Torrance, California 90505, 310 375 9952, www.pacwind.net
- SolarWorks, 4925 Gravenstein Highway North, Sebastopol, California 95472, 707 829 2518, www.solarworksca.com
- TrendSetter Industries, Inc., 818 Broadway, Eureka, California 95501, 800 492 9276, www.trendsetterindustries.com
- Uponor North America, 5925 148th Street West, Apple Valley, Minnesota 55124, 952 997 5329, www.uponor-usa.com
- WaterFurnace International, Inc., 9000 Conservation Way, Fort Wayne, Indiana 46809, 800 222 5667, www.waterfurnace.com
- Weeks Drilling & Pump Company, 6100 Highway 12, Sebastopol, California 95472, 707 823 3184, www.weeksdrilling.com