

Can Single Family and Multifamily Homes in the Zero Energy New Homes (ZENH) Program in California Reduce Peak Load and Reduce the Need for New Power Plants and Electrical Distribution?

Steve Vang and Rob Hammon, ConSol

Bill Kelly, PowerLight

Walker Wells and Ted Bardacke, Global Green USA

ABSTRACT

California, and the U.S. in general, has an increasing problem with the cost and growth of electric power during hot summer peak-demand periods. As population in California increases, and thousands of homes are being built each year, the California Energy Commission (CEC) has developed the Zero Energy New Home (ZENH) Program which offers an attractive solution to this problem. PowerLight, ConSol and Global Green are currently working with builders to bring the CEC's ZENH Program into the mainstream, while creating a long term sustainable market for single family and multifamily housing (in particular projects developed with federal Low Income Housing Tax Credits). The teams will identify areas where land entitlement incentives are established and areas where it might be possible to reduce time and cost for building ZENH communities. The teams will also identify barriers attempting to implement ZENHs and will propose strategies to address those barriers.

ZENH homes incorporate advanced energy efficient features with photovoltaic systems. Each home complies at least 25% above the 2005 Title 24 standards, has at least 70% annual electric bill reduction and draws no more than 1 kW during the system peak time. ZENH homes will be monitored by the utilities to see if they will shave the peak load and reduce underground branch circuits. Monitoring equipment will be installed in some of the ZENH homes or units.

Introduction

The California Energy Commission's PIER Program supports energy research, development and demonstration (RD&D) projects that will help improve the quality of life in California by bringing environmentally safe, affordable and reliable energy services and products to the marketplace. The program is currently funding three research projects designed to demonstrate and develop a sustainable market for homes that combine state-of-the-art energy efficiency with on-site generation from solar photovoltaics, called Zero Energy New Homes (ZENHs). Each of the four ZENH projects has a slightly different focus, but all were selected because of their emphasis on not just the technologies for ZENHs, but particularly the development of markets for ZENHs.

This paper focuses on the two projects/teams which includes 1) the *Commercializing ZENH Communities* project (single family homes), awarded to the PowerLight team which includes ConSol, RLW, Green Building Studio, Centex Homes and Premier Homes and 2) the *Affordable Multifamily Housing* project, awarded to the Global Green USA team which includes non-profit community development corporations such as *A Community of Friends* and *Community Housing Works*. Global Green USA is a national non-profit environmental

organization that has a long track record in promoting energy efficiency and the use of renewable energy technologies in the affordable housing sector.

Both teams' goal is to employ a turn-key systems approach to developing least-cost ZENH solutions using proven energy efficiency and building integrated PV systems combined with innovative sales, marketing financing packages that leads to the development of a robust ZENH industry in California.

This paper will also discuss expectations, findings, benefits and obstacles from other Zero Energy Homes (ZEH) and ZENH projects, and will propose strategies to overcome those obstacles.

Focus and Targets of ZENHs

A growing economy with dwindling non-renewable resources provides a strong basis for the California Energy Commission's ZENH program. California has been a leader in the development of new energy-efficiency standards and the development of markets for solar photovoltaic panels. Further, California has led the way in the development of homes that incorporate both energy efficiency and solar energy systems. By combining energy-efficient building construction and state-of-the-art appliances and lighting systems with photovoltaics, these homes can become "zero energy" homes because the electricity generated through the PV system offsets the total electricity consumed by the home. ZENHs offer a number of benefits:

- They offload congested utility transmission and generation resources by reducing peak loads and reducing the need to purchase peak electricity from the grid.
- They save energy and reduce pollution.
- They insulate their owners against future increases in energy prices.

Despite these benefits, there remain two principal barriers to widespread adoption of ZENH development strategies: cost premiums and lack of information. The overarching goal of the Energy Commission's ZENH program is to address these two barriers by demonstrating cost-effective ZENHs and developing new business models that help mainstream ZENHs in California new home construction. A major focus of the program is the creation of partnerships among the critical market players that can develop creative, cost-effective approaches to ZENH construction and financing, and in so doing, reduce the cost of ZENHs to homebuyers. Thus, the PIER ZENH program approach involves the following steps:

- Develop ZENH designs that optimize energy efficiency and on-site PV electricity generation;
- Develop innovative business models to reduce the incremental cost of a ZENH to the homebuyer;
- Demonstrate these designs and business models in at least one 75+ unit development;
- Monitor these homes to validate performance relative to the goals; and
- Initiate actions to ensure long-term sustainability of ZENH developments in California.

The specific performance targets for the ZENH projects are as follows:

- Energy Goal: Improve building energy efficiency performance by at least 25% over the Title 24, Part 6, 2006 Building Energy Efficiency Standards.
- Peak Demand Goal: Reduce summer peak demand to no more than one kilowatt per housing unit.
- Cost Goals: Reduce the homebuyer's incremental first cost for a ZENH to no more than \$5,000 and reduce annual electricity bills by 70%.

PowerLight's *Commercializing ZENH Communities* Project (Single Family Homes)

This project is focused on the development of turnkey PV systems for builders and enhanced building-integrated photovoltaics (BIPVs). The PowerLight team also includes ConSol, RLW and Green Building Studio and their contributions include energy analyses, evaluation, measurements and verification (EM&V) plan as well as a marketing/economic plan to commercialize ZENHs (for both a single-family and a multifamily development in PG&E Service Territory).

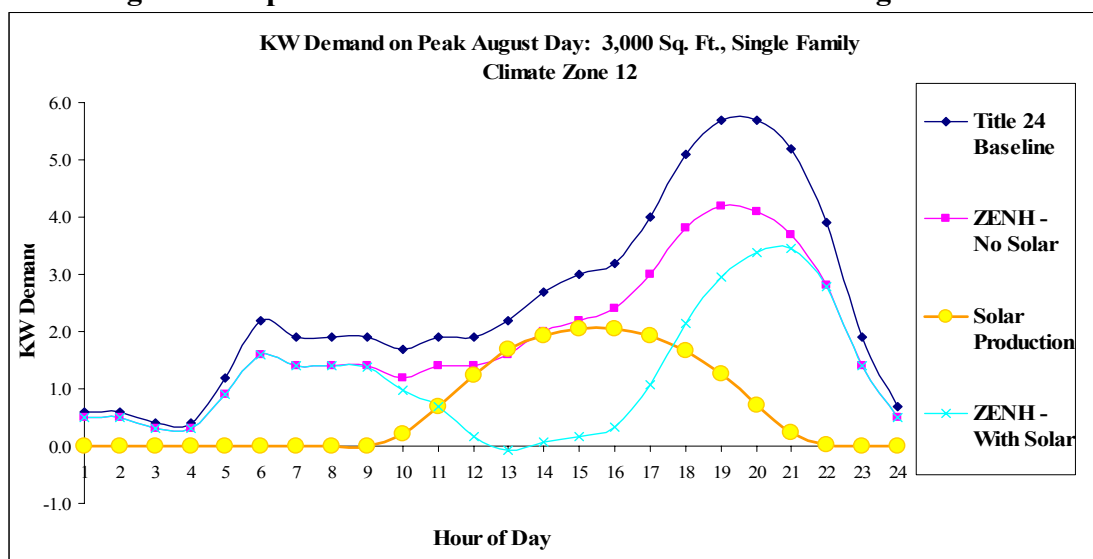
The 32 home project "Avignon" in Pleasanton, CA by Centex Homes is the first ZENH project, however it is not the demonstration project which requires at least 75 homes. The ZENH demonstration project is a 144 home community called "Lakeside" in Lincoln, California by Premier Homes. This project is in the planning stage and will start construction in late summer of 2006.

Monitoring Plan by PowerLight and Pacific Gas and Electric

PowerLight is installing a web-based monitoring system to track the PV performance (15 minute intervals). The monitoring system has the added value that it can also be viewed over the web in real-time by the homeowners allowing them to track how much energy they are producing as well as how much the home is using, thus ensuring them that the PV system is working properly and providing them with consumption information that might assist them in reducing consumption. PowerLight's turnkey solar electric systems are designed to be durable and simple to use. PowerLight has developed a comprehensive service program to ensure their systems perform without requiring any effort by the homeowners. PowerLight provides customers with a complete five-year system warranty. Included in this warranty are continuous remote monitoring of system performance and 72-hour on-site response to any system problem through a qualified local service technician. Customers also receive long-term solar system component warranties (e.g. 25 years on the PV modules) from the original equipment manufacturer (OEM). PowerLight will also provide lifetime telephone assistance with all aspects of the solar system, including interface with OEM suppliers. From year five through ten, they offer an annual service contract that includes routine maintenance and repairs.

PowerLight and ConSol also plan to obtain electric and gas bills from PG&E. Below is a graph showing the expected impact of a home designed with ZENH features during a "peak" day on the California electric grid.

Figure 1. Expected Performance of a ZENH House during Peak in CA



Source: PowerLight

Three Major Elements to Commercializing Single Family ZENHs and Make Them Sustainable in California

How to Best Package ZENH to the Builders so They are Acceptable

Lack of availability of turn-key systems for ZENH's is a key implementation barrier for residential builders. Turn-key systems integration will establish a single point of accountability for home builders and their respective customers, minimizing impact to the builder's construction schedule, minimizing builder risks/liabilities, and increasing end-customer satisfaction. Thus, a key element in this market transformation task will be to promulgate the turn-key solutions developed by the Contractor. Critical components of a successful turn-key system will need to include simplified bidding, contracting, permitting, installation, commissioning, maintenance, and utility connection and rebate processes. A simplified energy-efficiency element will also be important. Recent findings in previous ZEH projects suggest that builders have little time to deal with paper work such as permitting, interconnection agreement, rebate applications and the like. Builders having to execute these tasks on their own are reluctant to build ZENHs.

PowerLight is developing and starting to provide this turn-key system to their ZENH builders, with ConSol providing the specifications for energy efficiency measures, performing building commissioning, providing construction and marketing training and assistance. ConSol is also researching innovative market drivers for ZENH communities.

How to Sell ZENHs to Overcome Market Barriers

PowerLight and ConSol are working on a marketing message for the builder that will help convey the value of ZENHs to the homebuyers. As part of this effort, they are reviewing and critiquing grand openings and press events at Zero Energy Homes (ZEH) and ZENH projects to garner more information. Findings from recent ZEH projects suggest the following:

1. Anecdotal findings to-date are that ZEH builders have no more or less problems selling ZEH homes than they or their competitors do selling conventional homes. Market absorption data need to be collected to confirm or deny these findings.
2. ZEHs are less expensive to build when the ZEH features are standard and not offered as an option due to economies of scale and production scheduling. Actual cost data need to be compiled.
3. ZEHs will only sell well when the sales staff is knowledgeable and well trained. Initial in-depth sales training should be augmented with regular, perhaps monthly, mini-trainings to ensure the agents are comfortable and competent with the ZENH information. Also, a sales agent hotline would be good for agents who have buyers with immediate questions that they are unable to answer. These questions should be duly noted and included in future in-depth trainings.
4. More ZEHs options could be sold if sales staff received the commissions for selling the ZEH upgrade. Typically, the option commission goes to the design center sales staff. Currently, a community sales agent has no motivation to upsell the ZEH option.
5. The ZEH homeowner often becomes a ZEH zealot after receiving a number of VERY LOW energy bills. Enlisting the aide of current ZEH homeowners from other communities to speak at or just to be on hand at grand openings in the display area to talk to prospective homebuyers about the energy bills and comfort can fuel the fire better than any brochure. They could be offered a dinner coupon for their efforts.
6. A catchy tagline is needed, examples include:
 - “live in a home that pays you.” (Grupe ZEH project in Roseville)
 - ZENH – A home you can bank on!
 - ZENH – Making energy to save you money
 - ZENH – Powered by the sun, savings for the future
 - ZENH – Plugged into the sun, turned on to the environment
 - ZENH – A feel good home: feel good about your comfort, your utility bills, the environment

Land Entitlement Incentives for ZENH Homes

Reductions in time and/or costs for land entitlement and permitting could offset the additional costs for building ZENH communities. ConSol is researching whether there are jurisdictions in CA that provide such incentives for building ZENH. In addition, ConSol is currently working with the city planners in Cities of Santa Clarita and Rancho Cordova to see if they are willing to offer such incentives to builders building to ZENH standards. Entitlements are expected to be an important future driver for ZENHs. Research has found that San Diego and Oakland already have some permitting benefits for communities with solar. These programs are going to be fully explored and may serve as model programs. Roseville, through its electric muni has also recently opened an incentive program for energy-efficient communities with solar. Legislation has been introduced to allow entitlement benefits for green communities. These programs will all be evaluated from which a land-entitlement program will be developed. The ZENH demonstration project will be invaluable to this process, demonstrating to the local

jurisdiction that ZENH homes provide sufficient benefits to the community that their development should be encouraged, because they:

- are buildable and marketable;
- provide substantial energy-efficiency and peak reduction benefits;
- improve improved customer satisfaction; and they
- are a critical step toward sustainable communities.

Global Green USA's *Zero Energy Affordable Housing* Project: Benefits, Potentials and Obstacles

In the multifamily affordable housing sector, the benefits of Zero Energy Homes are augmented in ways that include:

- *Providing both consistent and lower utility expenses for persons of limited means.* Utility bills are the fourth largest monthly expense for low-income families, trailing rent, transportation and food, and larger than health care and education. (Bureau of Labor Statistics, 2005) The inability to pay utility bills is also the cause of up to 27% of low-income tenant evictions. (Energy Cents Coalition, 1997) By both lowering the overall utility bill burden and increasing predictability, Zero Energy developments substantially reduces their families high energy costs, freeing up resources to be used for other important family needs and create a more stable household financial environment.
- *Leveraging the inherent energy efficiency of the affordable multifamily building type.* According to the Department of Energy, multi-family housing has less than half of the energy use per household as compared to a single-family home because of smaller spaces, shared walls and the potential for central systems. (Department of Energy, 1990) In California, incentives in the tax credit allocation process typically result in efficiencies of 10-15 percent better than the Title 24 Energy Code. Adding photovoltaics to these already efficient buildings is a logical next step.
- *Increasing resources available for affordable housing development.* Most affordable housing in California is developed by non-profit developers who are required to own, operate and maintain the projects for at least 55 years. By reducing these owners/developers' operating expenses and protecting them from future increases in energy costs, Zero Energy developments provide the affordable housing development community with increased long-term financial stability, which can translate into an increased ability to build more affordable housing.

The Market Potential of Zero Energy Affordable Housing

The affordable housing developer community in California constructs approximately 5,000 units annually. These units are made available to people and families that meet income levels that are determined by the local or regional housing authority, based on standards issued by the Department of Housing and Urban Development (HUD).

**Table 1. Low-Income Housing Units Built in California
2005-2005**

YEAR	NUMBER OF UNITS BUILT	
	9% Tax Credits	Multi-Family Housing (MHP)*
2000	4868	n/a
2001	5167	n/a
2002	5744	n/a
2003	4573	2150
2004	4847	3631
2005	4938	2898
TOTAL	30,137	8,679

*Through fiscal year ending in June of that year

Source: California Tax Credit Allocation Committee and Global Green USA

Of the 5,000 units put into operation annually, Global Green estimates that a minimum of 20% or 1,000 units are suitable by a zero energy approach. Given the average project size of 55 units and a typical photovoltaic system size for such a building ranging from 85 kW – 125 kW, this would result in total potential of 1.5 MW – 2.2 MW of solar PV installed annually.

Adoption of the zero energy homes approach currently being refined by Global Green USA and implemented on two projects in Southern California has the potential to result in the installation of 10,000kW of photovoltaic systems in the state annually. With two successful demonstration projects and a proven business model, we estimate that 50% of the eligible projects (765 kW – 1.1 MW) could achieve the zero energy goal by 2008 and over 75% (1.1 MW – 1.7 MW) by 2013.

The affordable housing sector is particularly well suited to move toward the ambitious goals of zero energy projects. Currently, over 50% of multifamily affordable housing developments constructed annually incorporate energy efficiency measures that exceed California's 2005 Title 24 energy standards by at least 10%. This is the result of incentives in state's highly competitive process of allocating affordable housing tax credits. The affordable housing tax credit criteria also offer financial incentives for including on-site generation systems in affordable housing developments.

Global Green has developed an innovative financial model that combines the affordable housing tax credit incentives with:

- currently available rebates for energy efficiency and photovoltaic systems;
- the federal business investment tax credit established by the 2005 Energy policy Act;
- adjustments to the conventional utility cost deductions from operating income required by HUD; and
- the potential for third-party ownership/financing mechanisms.

Via the application of this business model, 75 – 100% of the cost of the zero energy features can be covered and the remaining gap can be filled through the additional borrowing

power generated by crediting expected utility cost savings toward increased operating revenue. The result is that the remaining investment, if needed, in the zero energy features is:

- relatively small in comparison to the overall cost of the project;
- provides a payback of less than seven years; and
- delivers an average return on investment of at least 5% (assuming that energy prices do not increase at a rate greater than the rate of inflation).

Zero Energy Affordable Housing – Two Catalyst Projects

In an attempt to refine and standardize a Zero Energy business model that will serve the entire affordable multifamily housing development community, Global Green USA is coordinating the development of two affordable housing projects with a combined unit total of 110 units. Both projects are located in Southern California.

The Solara

The Solara project is a seven-building 56-unit multifamily development in the City of Poway in the northern part of San Diego County. This project is in Climate Zone 10 and receives electricity service from San Diego Gas & Electric. The developer is *Community Housing Works*, a non-profit community development corporation and the largest developer of affordable housing in San Diego County. The project broke ground in the November of 2005 and is expected to be completed in February of 2007.

As currently designed, the Solara project is expected to perform between 9.3% and 12.8% better than 2005 California Title-24 Energy Standards. The average unit in the project is expected to consume approximately 3,600 kWh hours per year of electricity. With an average 2.2kW PV system per unit, it is expected that 87% of the annual unit kWh demand will be met by generation from the photovoltaic system. A 20kW system is also expected to meet 100% of the annual kWh usage of the common areas and 85% of the annual kW usage of the site lighting. Peak load from each unit will be less than 1kW.

Per SDG&E and CEC regulations, each unit will have an individual electricity meter operating on a net metering arrangement. Thus the total 141 kW PV system, located on the roof of each building and the carports, will actually be 65 separate systems with 65 separate inverters and meters.

Hartford Avenue Apartments

The Hartford Avenue Apartments project is a two-building 54-unit multifamily development in the Westlake/McArthur Park neighborhood just west of Downtown Los Angeles. This project is in Climate Zone 9 and receives electricity service from the Los Angeles Department of Water and Power. The developer is *A Community of Friends*, a non-profit community development corporation and one of the largest developers of affordable housing in Los Angeles County.

As currently designed, the Hartford Avenue Apartments project is between 10.6% and 14.2% better than 2005 California Title-24 Energy Standards.

The average unit in the project is expected to consume approximately 3,400 kWh hours per year of electricity. With an average 2kW PV system per unit, it is expected that 81% of the annual unit kWh demand will be met by generation from the photovoltaic system. Peak load from each unit will be less than 0.5kW.

The buildings will have two meters connected to the LADWP grid and operating on a net metering arrangement, while there will be submeters connected to each unit to monitor consumption. However, the developer/owner will not bill based on these meters; they will be responsible for all excess electricity charges. The total 107 kW PV system, will be located on the roof and façade of each building. In addition the canopy covering the entrance to the Boys and Girls Club will be constructed of PV panels.

Major Obstacles to Zero Energy Affordable Housing

In the course of implementing the two aforementioned Zero Energy affordable housing projects and in reviewing the possibility of implanting the model with other affordable housing developers, several obstacles in the areas of design, finance and regulation have been encountered. Those obstacles, and some possibilities for overcoming them, are described below.

Planning and Design

Space limitations. One major obstacle is the space limitations presented by the multifamily building type, particularly the ratio of roof area available for the placement of solar PV panels to the amount of occupied space in the building. In a typical multifamily housing project in Southern California, between 375 and 450 sq. ft. of roof area is needed to accommodate a solar PV system large enough to offset 100% of each unit's annual kWh consumption plus its portion of the common area load. In practice, this means that the available roof space is not sufficiently large to accommodate enough PV in projects with air conditioning and over 2 stories and in projects without air conditioning over 4 stories tall.

There are two basic ways to overcome this obstacle. The first is to increase energy efficiency to a point where the size of the necessary PV system shrinks. The second is to identify additional places in the project to locate PV panels, such as carports, façades, overhangs, and awnings. Both of these measures increase the design complexity – and potentially the design opportunities – of the project and can increase costs.

Financial

Tax credit benefits. The primary financial challenge with implementation of the zero energy affordable housing business model revolves around enabling affordable housing developers to take full advantage of the federal tax benefits. Known as the business investment tax credit, this mechanism currently allows owners of renewable energy systems to deduct 30% of the cost of the PV system after any rebates from any taxes owed in the first year the system is placed in service.

While the tax benefits of this provision are substantial in case of a zero energy affordable housing project (a 125 kW system would generate a first year tax deduction of approximately \$200,000), to date it has been difficult for affordable housing developers to realize the full value. The reason is that affordable housing developments are typically developed by non-profit

organizations that do not pay taxes. In order to monetize the affordable housing tax credits, the non-profit developer will partner with a tax-paying corporation and, in effect, trade the tax credits for equity. Individual developments are usually structured as a limited liability corporation with a general partner that owns 99.9% of the project (the corporation or tax credit investor) and /limited partner (the non-profit developer).

Because the market for affordable housing tax credits is well established and many developers have built a positive track record, investors are willing to pay close to full price (one dollar of equity for each dollar of tax credit value) for the affordable housing tax credits. But because the business investment tax credit is new and relatively untested, investors will either refuse to purchase the credits or offer to purchase them only at a greatly reduced rate.

The potential solutions to this challenge are to provide tax credit investors, and their attorneys with better and earlier information about the business investment tax credit and the likelihood that a specific project will offer these credits in addition to the affordable housing tax credits.

Regulatory

Inverter and metering arrangements. By reducing the need for extra inverters and simplifying PV array design, net metering of the entire project in just few locations is the most cost effective arrangement from a first cost perspective. Central net metering also pools energy usage of the units, thus offsetting tenants who consume more than expected with tenants who consume less. However, individual meters with separate bills to each tenant is an easy way to reduce overall consumption.

In California, Public Utility Commission regulations require individual metering and billing of each unit in a multifamily housing project. While this regulation is appropriate for projects without on-site generation, it adds costs, risks and design challenges to developers of Zero Energy affordable housing projects.

A regulatory arrangement that would overcome this obstacle would be to allow for net metering of the entire project on a common area basis with submeters to monitor individual apartment usage. Tenants would then get a monthly kWh quota of electricity for free and be charged by the owner for usage above that quota. This arrangement would require two changes to current PUC regulations – one that would allow for mastermetering with provisions submetering arrangement and another that would allow third parties to bill for electricity usage in a residential setting.

Utility allowances. Developers of affordable housing are bound by complicated criteria – called utility allowances – which determine much they can charge for rent, including utilities. Current utility allowances that incorporate self-generation are structured to create an “all or nothing” scenario whereby an affordable housing developer needs to install systems that that generate close to 100% of the annual kWh demand. This creates a gap between 20-70 kW common area systems and potentially larger systems that would serve at least a portion of the kWh demand from the residential units.

A flexible method for determining utility allowances – based on modeling of how large the reduction in actual energy bills will actually be by installing on-site generation – has been described as a “best practice by the Department of Housing and Urban Development and would go a long way towards overcoming this obstacle.

Conclusion

In the PowerLight single-family ZENH program, both projects (Avignon and Lakeside) are just starting and as of yet there are no monitoring data. However, according to simulation results ZENHs substantially reduce peak load and that their large-scale construction would reduce the need for new power plants. By summer of 2006, the team should have data and results from “Avignon” to demonstrate their impact on the electrical system peak.

Both PowerLight and ConSol are also working with other potential builders to try and enroll additional communities into the ZENH program by addressing three major elements that would help market ZENH and make ZENH a sustainable part of residential new constructions in California. These three elements include ways to 1) package a turn-key ZENH program, 2) to sell and market ZENHs to builders and buyers to overcome barriers and 3) to provide benefits through the land entitlement processes. More research and findings are needed to address and resolve ZENH barriers to make ZENH as part of new residential constructions in California. Research in these areas is just starting and we should have some results soon.

In the multifamily ZENH program, there are currently two affordable housing projects (The Solara and Hartford Avenue Apartments) under construction in Southern California. Global Green USA is attempting to refine and standardize a business model that will serve the entire affordable multifamily housing development community from these two projects. In doing so, Global Green USA will also address benefits, potential, and will propose strategies to overcome obstacles when attempting to implement the ZENH model in affordable communities.

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