Zero Energy Communities: UC Davis' West Village Community

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ABSTRACT

West Village, a new multi-use project underway at the University of California Davis, represents a ground-breaking sustainable community incorporating aggressive energy efficiency measures and on-site renewable generation to meet the total annual energy needs while minimizing summer peak energy demand from non-renewable sources. The planners for West Village (Chevron Energy Solutions, the developer West Village Community Partners, and UC Davis), have completed analysis on how to combine energy-saving measures with a sophisticated "smart grid" network for generating, storing and distributing energy. As the energy consultant for the project, Chevron worked with UC Davis and West Village Community Partners on achieving the ambitious goal of zero net energy on an annual "site" basis. Project generation will be provided by approximately 5.4 MW of centralized photovoltaics and a 300 kW biogas fuel cell plant utilizing campus agricultural waste. A key component of the "zero net energy" goal relies on aggressive energy efficiency efforts to reduce the project's overall energy demand.

This paper describes the strategies used for to develop cost effective packages of energy efficiency measures used to achieve the community zero energy goals, and additional educational and feedback strategies to encourage behavior modifications that will contribute to promoting energy use reductions and help promote a sustainable community. Results from this study show 57% savings due to the selected energy efficiency measures, with renewable generation providing the remaining portion of the electrical energy use.

Introduction

The state of California and the California Public Utilities Commission (CPUC) has adopted a roadmap that includes the goal for all residential construction in California to be zero net energy by 2020 and all commercial construction be zero net energy by 2030. To move towards that goal, UC Davis developed the West Village project with the goal of being environmentally responsive and reducing energy consumption and emissions, which is reflected in every aspect of the planning and design process. West Village is a unique community with aggressive energy efficiency measures and on-site renewable resources designed to meet the community's entire annual energy demand.

The West Village development project is based on three core principles:

- **Housing affordability** - provide new housing for faculty and staff offered at below market prices, and expand the choices for student rental apartments
- **Environmental responsiveness** - integrate sustainable design into the site plan and building designs to enable those living in West Village to reduce their reliance on the automobile, limit energy consumption, and enjoy the benefits of the local climate in a healthy environment

- **Quality of place** - create a network of open spaces, parks, gardens, pathways and courtyards that promote the attributes and character of traditional Davis neighborhoods

The developer broke ground on the first 130-acre phase in late 2009 and plans to start building the town center and student apartments for 600 students for fall 2011 occupancy in spring 2010.

The development of this project and the efforts to meet the community goals have been a joint effort between UC Davis, West Village Community Partners (WVCP), Chevron Energy Solutions (CES), and Pacific Gas and Electric (PG&E). The complexity of this project stems from many factors including the University's requirement for price controls on single family housing, structuring the ownership and control of on-site generation the relationship between the renewable energy provider and PG&E (the local utility), the impact of this outcome on WVCP's investment in energy efficiency, and the rapidly changing environment in rebates /tax credits for energy efficiency and renewables. These issues and background on the evolution of this community are covered in another 2010 ACEEE Summer Study paper[1].

In late 2008, Davis Energy Group (DEG) was retained by CES to design, evaluate, and quantify the cost-effectiveness of energy efficiency packages as well as providing detailed hourly energy usage profiles for each of the key building construction types in the project. Development of the hourly profiles was critical for CES in quantifying the complicated energy transfers that must occur with PG&E to balance generation and consumption over the course of a year. The scope of work included both single and multifamily buildings, commercial spaces, common area lighting, and community-wide energy consumption. A majority of the single family evaluations were completed with support from DOE's Building America program.

Table 1: West Village Project Building Types

Building Type	Floor Area (ft2)	% of Total	# of Units
Student Apartments	673,500	42%	528
Student Townhomes	33,400	2%	20
Single Family (60% with granny flats)	637,600	41%	343
Mixed Use Commercial	42,300	3%	TBD
Mixed Use Residential	116,700	7%	120
Leasing Building	13,300	1%	
Community College	56,000	4%	3 buildings

West Village Project Characterization

The 200+ acre project located adjacent to the main UC Davis campus will provide housing for an estimated 4,350 people: 343 new homes for faculty and staff, and housing for 3,000 students. In addition, the development will have a Town Center with 45,000 square feet of commercial space, a leasing/recreation center, and generous green space with bicycle and pedestrian paths connecting to the main campus nearby. Additional features will include a site for the Los Rios College, and sites for the local Davis School District and a small day care facility. Table 1 presents the breakdown of each of these building types to demonstrate the

[1] Achieving Zero-Net Energy and Zero Net-Peak Buildings at the Community Scale; Ben Finkelor, et.al.; ACEEE Summer Study 2010.

relative contribution to the overall project energy budget. Combined, the student housing and single family homes represent 87% of the entire project conditioned floor area.

Zero Net Energy Strategy

The identified goal for the West Village development is to have it generate all its energy needs, on an annual basis, from on-site clean and renewable resources. In order to meet all the energy needs of the development from clean and renewable local resources, a decision to design an all-electric development was made. This decision was driven by the multiple technical, financial and environmental aspects of the project. While this approach successfully demonstrated viability and proven feasibility, it is important to keep in mind that on-site resources availability differs from one place to another and all clean energy technologies should be investigated and explored including energy conservation. The West Village project team explored several energy resources and technologies, including solar thermal, waste to energy, and solar photovoltaics.

Another project goal was for the community to be net zero peak, where excess on-site generation is produced when it is needed the most, offsetting the demand for energy from power plants used during peak utility periods that are less efficient, more expensive to run and have the biggest CO_2 impact. The development on the other hand will need to import energy from the grid during the early morning and evenings, which are mostly cleaner and more efficient generation sources. The addition of the advanced energy storage will ensure reliability of the renewable energy production and should eliminate the need for energy during peak hours.

When the development generates all of its electricity usage, excess power flow to the grid will serve the distribution portion of the utility grid and neighboring users more efficiently as it reduces the transmission losses in the utility grid.

The West Village project team paid tremendous attention to the regulatory and economical viability of the project. On-site generation from solar photovoltaics was chosen as the primary generation source, because the current market mechanisms needed to develop on-site electric generation resources favor this strategy. This reduced the financial and regulatory risk of the project and was critical when studying the feasibility of a zero net energy community development.

Through careful evaluation of the available area on site for solar generation, and the hourly production profiles based on local solar data and efficiency of current PV generation technology, 5.4 MW of centralized photovoltaics will be installed providing approximately 9.2 million kWh per year.

A 300 kW on-site biogas fuel cell generator using agricultural and dining hall food waste will be used for combined heat and power to provide additional power during peak periods and offset any natural gas use. The available on-site biogas potential was not enough to provide the entire thermal demand for the project. Solar thermal was introduced to help meet some of the load but was still not sufficient to meet all of the loads if space and water heating are from gas-fired equipment. This favored electrical sources for space and water heating equipment in order to minimize natural gas use on site and maximize the contribution of on-site generation to on-site energy loads.

Evaluation Methodology

The primary goal of this study was to develop cost-effective packages of energy efficiency measures (EEMs) that provide favorable life cycle economics and insure that the required level of energy efficiency is integrated to meet the community zero net energy goals. This meant keeping annual community energy consumption to 9.2 million kWh/year. The following tasks were completed to estimate the community's energy consumption and compare it to estimated production profiles.

1. Evaluate project-wide full year hourly energy use profiles, by developing hourly electrical and natural gas demand projections for each product type. These hourly profiles were then used in conjunction with hourly production profiles to ensure net zero peak conditions could be met.
2. Estimate expected energy bill savings for the different product types using standard local utility tiered electric and gas rates.
3. Develop simple payback and life cycle cost economic evaluations to document package performance.
4. Supporting WVCP and their design team in finalizing the package of energy efficiency measures.

Overview of Analysis Methodology

The basic analysis approach used in this study was to assemble packages of energy efficiency measures that demonstrate cost-effectiveness while achieving the desired project-wide energy usage goals of zero net energy. The package design approach was based on the concept of "sequential analysis" which involves the detailed assessment of individual measure cost effectiveness relative to other competing measures. As the most cost effective measure is added into the package, the remaining measures are then reevaluated relative to the new higher efficiency baseline. This iterative approach insures that the most cost effective measures are installed first, and that subsequent measures demonstrate cost effectiveness relative to an increasingly stringent base case. The packaging process also involved discussions with the project team in adjusting the selected measures based on their comfort level with the technology, expected lifetime and maintenance requirements, marketing issues, and product reliability.

Modeling Assumptions

Given all the building types and single family plan options, package development and evaluation process was streamlined by focusing on modeling one mid-sized single family plan, one student apartment type (Ramble A), and one mixed-use building type. Once the energy efficiency packages were developed for the single and multifamily cases, they were applied to all other single and multifamily plans.

In modeling energy usage for each of the building types, a series of assumptions were made in terms of occupancy, thermostat schedules, hot water usage, and miscellaneous electrical load assumptions. For simplicity, all buildings were assumed to be 100% occupied, i.e. no vacant units. Fixed thermostat set points of 71°F heating and 76°F cooling were assumed (consistent with Building America Benchmark assumptions). Hot water loads and miscellaneous electrical loads were based on Building America Benchmark assumptions developed by the National Renewable Energy Laboratory (NREL). The Benchmark was developed for Building America analysts to have access to a standardized miscellaneous energy use compilation for single family homes[2].

Multifamily apartments have slightly different patterns of energy consumption than single family homes. Based on relative energy use data presented in the California Residential Appliance Saturation Survey (RASS)[3], the single family Benchmark miscellaneous usage was reduced by 25% to demonstrate better alignment with RASS. Since student housing is subjected to “off season” changes in usage patterns, adjustments in occupancy and usage were implemented for all student apartments to reflect school year “breaks”, and lower average occupancy in the summer months.

Current residential gas and electric rates from the local utility (PG&E) were used for this study. Utility costs accounted for tiered rates on usage over baseline. Available federal and state credits, as well as utility rebates were factored into the net incremental costs.

Incremental Costs and Economic Evaluation Methodology

Detailed costing and economic evaluations were completed for different building types. An initial list of potential EEMs for each building type was vetted through a process that included achieving the community energy goals and the addressing the development team’s concerns on constructability and incremental costs associated with the EEMs. Costs for the selected measures were used to develop the EEM packages and the economic evaluations.

Two approaches were taken to represent cost effectiveness of the identified energy efficiency measures: simple payback and life cycle internal rate of return (IRR) [4.] Simple payback in years, was calculated by dividing the package initial incremental cost by annual first year energy cost savings. The IRR was calculated based on the twenty year discounted revenue stream of energy savings divided by the discounted incremental cost for the energy efficiency measures, including first cost, O&M cost, and replacement incremental costs. A 3% discount rate and 4% fuel escalation rates were assumed.

Development of a Base Case Construction Scenario

A builder standard case was developed for the purposes of evaluating the economics of the EEMs. California’s 20008 Title 24 Energy Standards were used as the builder standard for both performance and cost effectiveness evaluation purposes. Table 2 summarizes the features included in the base case. The features are based upon the prescriptive 2008 Title 24 standards for the appropriate climate zone. Base case window properties are better than the prescriptive values to compensate for the larger typical window areas included in the designs.

[2] http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/44816.pdf
[3] http://www.energy.ca.gov/appliances/rass/
[4] The LCC tool used was the Building Life-Cycle Cost Analysis (BLCC) program.

EEM Package Selection

The selection of efficiency measures looked at both performance and cost-effectiveness of the measures. The measures included window and building envelope measures, high efficiency mechanical equipment, lighting, and appliances, and solar water heating, as well as lighting and miscellaneous energy use controls. Third party construction quality inspections and systems testing were also included to ensure that the performance of the building and installed features perform as designed. Based on the decision to minimize natural gas use, several electric space and water heating technologies were evaluated. High efficiency air-source heat pumps were proposed for both space conditioning and water heating. Efficient building envelope measures reduced space heating and cooling loads to where it did not justify more expensive system options.

Table 2: Base Case Assumptions (2008 Title 24)

	Single Family
BUILDING ENVELOPE:	
Walls (Exterior)	2x6 16" o.c. R-19 batt.
Roof (Attic)	R-38 blown insulation; Radiant barrier roof sheathing
Roofing Products (roof slope > 2:12)	Aged solar reflectance ≥ 0.2; thermal emittance ≥ 0.75 (Cool Roofing products)
Glazing U-Factor/ SHGC	Average U ≤ 0.35 / SHGC ≤ 0.35
HVAC:	
Cooling	13 SEER / 10.5 EER AC split system
Heating	80% AFUE Gas Furnace
Ducts	R-6.0 ducts in attic
Mechanical Ventilation	Per ASHRAE 62.2, mandatory Jan. 2010
WATER HEATING:	
Type	Individual 50 gal. gas storage water heaters; 0.62 Energy Factor
3RD PARTY TESTING / VERIFICATION:	
Duct Tightness / Duct Location	Tight Attic Ducts; Tested at < 6% Leakage
LIGHTING / APPLIANCES:	
High Efficacy Lighting	Kitchens: 1/2 of installed Wattage must be fluorescent. Other Rooms/ Outdoors: High efficacy or motion sensor/dimmer
Energy Star Appliances	Dishwasher only

Selected Measures

Table 3 summarizes the proposed EEM measures for the student apartments and single family homes. The results in this section focus on the detailed economic evaluations for a 3-story student apartment building which includes six three bedroom and six four bedroom units, and the 1,867 ft2 Type 2, Plan 2 single family home design which has five bedrooms. Measures that are italicized in Table 2 indicate no change from the base case specification (2008 Title 24).

Space heating heat pumps, although not very common in Northern California, have demonstrated long term reliability and pose no significant implementation issues. Heat pump water heaters (HPWH) are much less common than space conditioning heat pumps. There are several manufacturers making units suitable for central water heating applications and beginning in 2009, several major manufacturers have begun offering residential scale heat pump water heaters.

Table 3: Multifamily Building Description - Summary of Final Package

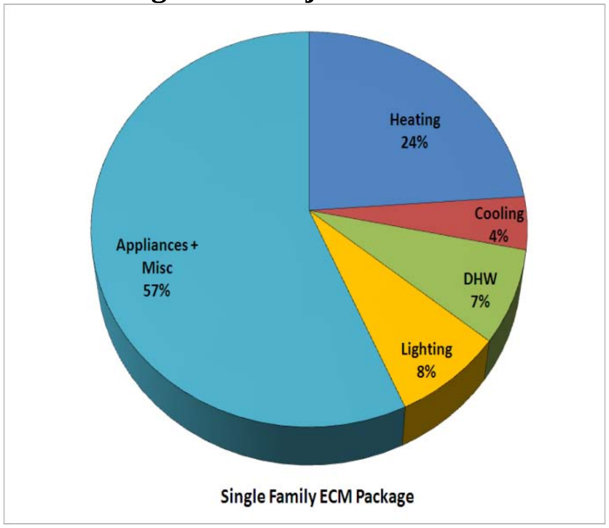
	Single Family	**Multi-Family**
BUILDING ENVELOPE:		
Walls (Exterior)	2x6 16” o.c. R-21 batt w/ 1” exterior foam. Quality Insulation Inspection.	2x6 16” o.c. R-21 batt w/ ½” exterior foam. Quality Insulation Inspection.
Roof (Attic)	R-49 blown insulation; Radiant barrier roof sheathing	R-49 blown insulation; Radiant barrier roof sheathing
Roofing Products (roof slope > 2:12)	Aged solar reflectance ≥ 0.2; thermal emittance ≥ 0.75 (Cool Roofing products)	Aged solar reflectance ≥ 0.2; thermal emittance ≥ 0.75 (Cool Roofing products)
Glazing U-Factor/ SHGC	Average U ≤ 0.33 / SHGC ≤ 0.21	Average U ≤ 0.33 / SHGC ≤ 0.21
Distributed Thermal Mass	5/8” drywall throughout	Addit. 1/2" gypcrete on Floors 2 and 3
HVAC:		
Cooling	15 SEER / 12.5 EER Heat Pump	15 SEER / 12.5 EER Heat Pump
Heating	8.5 HSPF Heat Pump	8.5 HSPF Heat Pump
Ducts	R-6.0 ducts in conditioned space	R-6.0 ducts in conditioned space
Fresh Air Mechanical Ventilation	NightBreeze for summer night ventilation cooling & fresh air mechanical ventilation	Per ASHRAE 62.2, mandatory Jan. 2010
Ceiling Fans	In bedrooms	
WATER HEATING:		
Type	Heat Pump Water Heater in garage or exterior closet.	Central HPWH in each bldg
Mfg / Efficiency	Energy Factor ≥ 2.0	ETech / 3.3 COP
Solar Water Heating	Active solar water heating system. 1- 4x8 collector per home.	Active solar water heating option
3RD PARTY TESTING / VERIFICATION:		
Duct Tightness / Duct Location	Ducts Conditioned Space; Tested < 6% Leakage	Ducts Conditioned Space; Tested < 6% Leakage
Envelope Integrity / Tightness	Blower Door Testing @ CFM50: ≤ 1.5 SLA; 3rd Party Quality Insulation Inspection	Blower Door Testing @ CFM50: ≤ 3.0 SLA; 3rd Party Quality Insulation Inspection
Cooling System	ACCA Manual J & D; Fan Power and EER Verification; Cooling Coil Air Flow	ACCA Manual J & D; Fan Power and EER Verification; Cooling Coil Air Flow
LIGHTING / APPLIANCES:		
High Efficacy Lighting	All hard-wired lighting fluorescent or LED. Assume 80% hardwired lighting. Lighting controls / Vacancy sensors.	All hard-wired lighting fluorescent or LED. Assume 80% hardwired lighting. Lighting controls / Vacancy sensors.
Energy Star Appliances	Dishwasher; Homeowner incentives to encourage purchase of other EStar apps	Dishwasher, Refrigerator, Washer
Miscellaneous Load Control	One switch wiring, energy usage displays	One switch wiring, energy usage displays

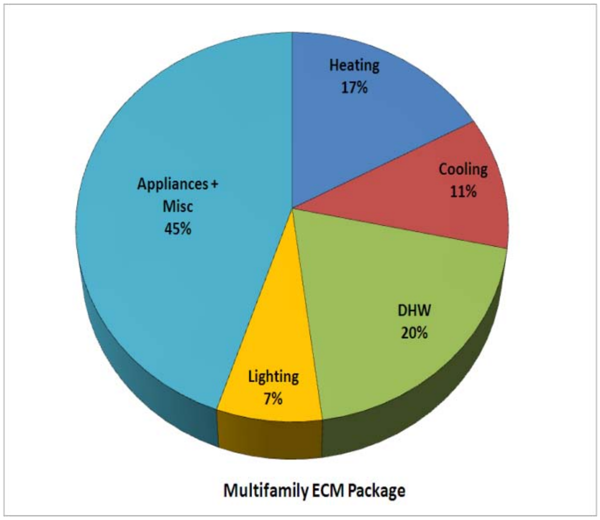
Energy consumption displays and switched plugs are also included to promote the awareness and reduction of miscellaneous energy uses (MELs).

Projected Annual Energy Usage and Utility Cost Savings

Figure 1 presents the end use energy in terms of site energy for the proposed EEM packages of both single and multifamily building types. Of particular note in the final package summary, is the high percentage of usage attributed to appliances and miscellaneous electrical loads (45% for multifamily and over 50% for single family). Addressing this end use primarily involves providing energy consumption displays for occupants, switched controls of plug outlets, and educational efforts for achieving behavioral changes that would lead to a reduction in energy usage. Space cooling budget is lower in single family than multifamily due to night ventilation cooling. This strategy was evaluated for the student housing buildings but was too challenging to incorporate into the design. Water heating end use is also larger for multifamily due to higher occupant densities and lower efficiencies on the central heat pump water heaters.

Figure 1: Projected Annual Site Energy by End Use (Final EEM Package)





Estimated annual energy and costs savings are summarized in Table 4 below. Negative electric savings in both single and multifamily buildings are the result of fuel switching from gas to electric space and water heating. Single family electric energy savings are more negative due to the implications of going from gas dryer and cooking in the base case to electric in the proposed case, without any improvement in efficiency. Because electricity is more expensive relative to natural gas, utility cost savings are diminished slightly due to the fuel switching of these appliances.

Life Cycle Economics Evaluation

Table 5 summarizes the economic results with the proposed package of efficiency measures. Key inputs include incremental first costs, annual operating costs (under PG&E tiered rates), gas and electric rate escalations, and projected maintenance and replacement costs. The decision to incorporate solar water heating is still under consideration for multifamily. Due to federal and state incentives for solar hot water systems, the cost effectiveness of single family solar water heating was favorable enough to be retained as part of the overall package.

Table 4: Projected Energy and Utility Cost Savings

	Savings		
	Single Family w/ Solar Water Heat	**Multifamily Building**	**Multifamily Building w/ Solar Water Heat**
Electricity (kWh/yr)	-3,125	-2,197	7,477
Gas (Therms/yr)	641	4,449	4,449
Source Energy (MBtu/yr)[1]	34	461	572
Site Energy (MBtu /yr)	53	437	470
Utility Cost ($/yr)	$505	$6,546	$7,661
% Utility Cost Savings	32.3%	38.9%	45.5%

1. Source energy use is based on site to source energy use multipliers of 3.365 and 1.092 for electricity and natural gas, respectively.

Table 5: Summary of Ramble A Building Economics vs. Base Case

		Single Family[1]	**Multifamily Building No Solar WH**	**Multifamily Building w/ Solar WH**
Incremental first cost for EEM's (w/o incentives)		$12,269	$61,992	$94,558
Projected incentives:	PG&E Utility Incentives	$1,900	$6,300	$6,300
	Solar Thermal Incentives	$2,130		$15,930
	Fed Tax Efficiency Tax	$2,000		
Net cost after incentives		$6,239	$55,692	$72,328
Annual operating cost savings (PG&E rates)		$505	$6,546	$7,661
Simple payback (with incentives)		12.4 years	8.5 years	9.4 years
Adjusted Internal Rate of Return (with incentives)		6.6%	8.2%	7.6%

1. Single family evaluation includes solar water heating

Performance Relative to Code and Benchmark

The proposed single family designs were evaluated relative to both the Building America Benchmark and California's Title 24. Benchmark and Title 24 analysis of the prototype yielded source energy savings in excess of 50% and 30%, respectively[5]. The multifamily buildings were evaluated relative to Title 24 only, since at the time of the study, Building America did not have a methodology for evaluating multifamily buildings. Performance of the multifamily buildings relative to 2008 Title 24 is approximately 45% without solar water heating and over 50% with solar water heating.

[5] Source energy use is based on site to source energy use multipliers of 3.365 and 1.092 for electricity and natural gas, respectively, based on Building America Benchmark (NREL, 2008).

Common Area Lighting Design and Electrical Loads

One of the smaller project end use components is the public lighting required for streets, parking areas, alleys, and walkways. Initial community-wide lighting demand estimates were 63.9 kW for all nighttime hours. This amounts to nearly 300,000 kWh per year in community lighting, or 3% of the total community energy use. Achieving significant reductions in community lighting energy use is critical in meeting the community zero energy targets. The original project assumption, prior to any lighting design efforts, was that the base case energy could be reduced by 50% through specification of higher efficiency alternatives such as LED lighting and bi-level controls. Currently, the lighting design and selection has been completed for street lighting, pedestrian walkways, and parking lots. Finalized fixture selection and counts are still needed for the PV canopy, parks and architectural lighting. Based on the lighting areas that have been specified, it appears that the 50% savings goal can be achieved.

Community-Wide Results

Table 6 summarizes the annual community-wide energy consumption estimates when the project is fully built out. These values include multi and single family products, as well as the mixed use, commercial, and community college buildings. Since community energy use is comprised of both electricity and gas consumption, the zero net energy calculation requires a conversion of the energy use to a common set of units. This conversion can either be made at a power plant "source" efficiency (9.5 kWh/therm at assumed 30% plant efficiency), or "site" efficiency level (29.3 kWh/therm, which actually means 1kWh/kWh). For this study, because the project goals are to produce all electricity on-site, the "site" efficiency assumption of 29.3 kWh/therm was assumed. This was used to ensure the net zero energy and carbon neutral requirements and goals of the project are met. The site and the grid are interconnected, with permanent exchanges between them. Injections or takings of electricity to or from the grid occur on a regular basis.

The consumption estimates are based upon the final package assumptions listed above. Solar thermal contributions are not included in the community-wide multifamily package because a final decision to include solar thermal has not been made. Efforts to include solar thermal are being pursued in order to lower the overall community energy consumption budget. The original 50% projected savings are shown for the common area lighting based on the use of high efficiency fixtures and bi-level lighting controls.

The results show that the community energy use is approximately 9.8 million kWh, which is a 57% reduction from the baseline, but slightly above the community net zero energy target of 9.2 million kWh. Based on the hourly energy use profiles of the development the West Village community was found to operate at what can be called a "negative" peak. During the day, the site will produce excess clean renewable energy when it is needed the most, offsetting the lower efficiency, "dirtier' peaker power plants thus benefiting the regions CO_2 impact during peak periods. It will, in turn import energy from the grid during the early morning and evenings, when utility generation sources are mostly cleaner and more efficient. The addition of the advanced energy storage will ensure reliability of the renewable energy production and should eliminate the need for energy during peak hours.

Table 6: Community-Wide Consumption Estimates

	Total Site Energy (kWh/yr equiv)[6]			
Building Type	**Base Case 2008 T24**	**Proposed EEM Package**	**% of Total Energy Budget**	**% Savings Reduction**
Single Family	9,863,100	3,484,500	36%	65%
Multifamily (Ramble/Townhouse)	9,781,500	4,067,900	41%	58%
Commercial / Mixed Use	1,967,100	1,090,500	11%	45%
Leasing / Rec Building	347,000	225,500	2%	35%
Community College	1,036,400	785,400	8%	24%
Common Area Lighting	299,500	149,800	2%	50%
Totals	23,294,600	9,803,600	100%	58%

Discussion

First phase construction, including student housing, and the mixed use buildings, is scheduled to begin in the first half of 2010. Construction of the single family homes will likely not begin until 2011, but because the community zero energy goals need to be evaluated and estimated now to demonstrate project feasibility, it was necessary to develop estimates for all community energy use sectors. Additional effort is needed to bring the current estimated site energy use in line with the site generation target. The project team is continuing to work with the developers and designers on design optimization. Further development of community energy reductions are under consideration to bring the estimated project-wide consumption values closer to the targeted annual production values. These include but are not limited to:

1. Adding solar water heating in multifamily and mixed use buildings. While the developer is still reluctant to incorporate this, inclusion of solar thermal would result in a 450 MWh/yr reduction community wide, and provide nearly all of the difference between current consumption estimates and the community zero net energy goals. The reluctance is driven by several factors including higher than anticipated bids and the developer's concerns over the long term reliability of solar water heating systems.
2. Glazing reductions in single family designs. Currently the average glazing area averages 25% of floor area, significantly higher than the average of 14% of floor area for homes built in the inland California climates[7]. Reducing the amount of glass in the homes will reduce overall energy use and reduce construction cost. Since the single family homes constitute 36% of community site energy use, reducing glass area can have a beneficial effect.
3. Reducing occupant-owned miscellaneous electrical loads through load control devices and occupant education programs. Clearly one of the biggest variables is occupant use patterns and occupant-supplied loads. In-home energy use displays and equipment to reduce stand-by energy use from non-critical appliances and electronic devices, informational seminars, and flyers on comparative energy performance of appliances are

[6] Site conversion of natural gas energy use of 29.3 kWh/therm used

[7] "Residential New Construction (Single Family Home) Market Effects Study – Phase I Report", KEMA Report for the California Public Utilities Commission Energy Division, May 21, 2009, Table 3.1-6.

all potential strategies in modifying energy usage in a positive direction. UC Davis was recently awarded a $2M RESCO grant from the California Energy Commission with some of the funding directed towards evaluating control strategies to reduce miscellaneous plug load use.

4. Evaluation of improved building system or renewable generation technologies. Future improvements in solar thermal or electric system performance may be implemented into the community to help bridge the current gap. Construction phasing and the delay in construction of the single family homes will allow additional time for new and emerging technologies to enter the market. Those that demonstrate viability could be incorporated into the later phases, benefiting the community energy totals.

Conclusions

The West Village project represents a cutting edge zero energy sustainable development. Aggressive energy efficiency efforts, coupled with renewable generation, and community-wide consumer energy educational efforts will all play key roles in delivering a successful project in the coming years. The analysis presented in this study indicates that the current proposed design strategies are projected to result in a project that is approximately 6% above the community-wide energy target of 9.2 million kWh per year. Clearly there are many assumptions embedded in this evaluation, making the exercise a balance of art and science. Three key issues will need to be resolved:

1. Use of solar thermal water heating on the multi-family and mixed use products. If solar thermal is installed on both, projections indicate the 9.2 million kWh target will be met.
2. Single family glazing area. If glazing area reductions can be implemented to bring the designs in-line with standard practice, both construction cost and energy use will be reduced.
3. Behavioral impacts. We have relied on “typical” miscellaneous electrical loads and thermostat assumptions. Our sense is that the assumptions may be overly conservative for a project that is strongly defined by energy efficiency and sustainability.

Other significant project conclusions include:

1. The energy efficiency piece of this project is projected to generate over 57% of the savings relative to a standard “business as usual” case. Renewable energy generation will provide the remaining portion. Energy efficiency represents the natural first step in designing an advanced project such as West Village since it is much more cost-effective that renewable generation technologies.
2. The proposed energy efficiency components are estimated to have a simple payback of less than 13 years for Single Family and less than 10 years for Multifamily buildings.
3. Third party construction quality inspections and commissioning of advanced systems will be a critical component in realizing the projected savings. Specification and installation of energy efficiency measures does not insure savings. Thorough and consistent field verification is absolutely critical.

References

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