# West Village Case Study: Designers and Occupants

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**ABSTRACT**

West Village is one of the largest zero net energy (ZNE) developments in the US. This paper is about the performance of West Village, in particular the role of resident behavior. It explores the assumptions designers and the energy modeler made during design about resident behavior. Comparisons of the energy modeler's assumptions (e.g. default settings) to actual performance by end use reveal a slight mismatch, mostly regarding HVAC. While West Village is close to achieving ZNE, it is not quite there as revealed from the energy modeler assumptions. As a result, an engagement program is necessary to achieve and maintain ZNE at West Village. Various resident engagement strategies have been designed and implemented at West Village. Preliminary results reveal thermostat reprogramming is generating a 16% reduction, a plug load pledge is generating a 7% reduction, and letters to excessive users are also working. The results also suggest interventions are persisting. The wide angle view of this paper, that is design, operations, and resident behavior, provides feedback to the design and ZNE communities on the role of behavior, in particular HVAC behavior, on achieving the state's zero net energy goals for multi-family low-rise developments.

## Background

In the 2008 California Long Term Energy Efficiency Strategic Plan, the California Public Utilities Commission (CPUC) put forward four "Big Bold" goals to define California's energy future. Two of these goals focus on zero net energy construction: that all new residential construction is ZNE by 2020 and that all new commercial construction is ZNE by 2030. Having the ZNE goal has been a catalyst among certain building designers, building owners, and policy-makers. There has been significant progress in moving California building energy codes towards ZNE by requiring designers to demonstrate that the building is capable of ZNE performance according to certain standards, under certain assumptions, and modeled with specific software tools. However, built into the concept of ZNE is that it is inherently a measure of net energy used over the course of a year, with specific definitions differing on the energy unit measured and whether the calculation is done at the site or the source. Achieving building performance at the ZNE level over the long term involves a number of practical challenges.

A study "The Technical Feasibility of Zero Net Energy Buildings in California", determined that a "wide portion of California's new construction can move to Zero Net Energy by 2020 for homes" using technology that's generally available and in buildings now (Arup 2012). The study is careful to note that it assessed the "potential performance of best-in-class building designs," though, and cites the importance of careful building operations to achieve long term ZNE performance. Fundamentally, the study has found that it is generally feasible to design buildings that are capable of ZNE performance, assuming that the technologies and systems function as designed, building operators and owners are careful and diligent, and occupant behavior and schedules are consistent with the design team's assumptions.

## Project Summary

West Village in Davis, California is one of the largest planned zero net energy (ZNE) multi-family housing developments in the United States and one of Pacific Gas and Electric Company's (PG&E) zero net energy pilot projects. [1] It is a 130-acre master-planned community consisting of  several sets of buildings:384 student apartments (Ramble), 156 student apartments (Solstice), 123 staff apartment units (Viridian), a 15,000 sq. ft. recreation center (which includes a leasing space, fitness center, gym, and game room), and 60,928 sq. ft. in retail space across 6 main tenant spaces. The University of California-Davis selected the developer Carmel Partners and its design team in 2006. Students began occupying the first phase of the Ramble in 2011. Residents do not receive a utility bill. There are some energy related requirements in the lease, some are enforceable, and others at this time are not.

PG&E retained Architectural Energy Corporation (AEC) to submeter and monitor the performance of West Village and Sustainable Design + Behavior (SD+B) to design and implement engagement worked related to resident behavior; SD+B also performed an evaluation of the design process. The primary goal of AEC's monitoring work is to assess whether West Village was achieving its ZNE performance goal, and to compare predicted energy use from modeling during the design phase to actual energy use during occupancy. In 2011, AEC launched a *Verification & Assessment Study* of the Ramble apartments to assess the ZNE performance of 24 apartment units and gather energy end-use data in the categories of HVAC, plug loads and lights, and appliances. In 2012, the number of monitored units was expanded to a total of 132 units. Flow meters and loggers were installed in December 2013 to measure domestic hot water production and consumption at a building level for 14 water heating plants which serve all the units in a building.

Based on the energy performance of a large sample of the residential units monitored by AEC, West Village is not yet performing at zero net energy, but close.[2] In general, energy consumption of the monitored residential units is about 15% higher than the predicted model consumption from April to December 2013. HVAC energy use is 18% higher than the modeled prediction, plug loads and lighting energy use is 33% higher, and appliance energy use is 50% lower than the modeled prediction (AEC 2013). A longer period of time is necessary to understand domestic hot water; for now it is assumed to be equal to the modeled prediction. These results are generally consistent with similar work performed by Davis Energy Group on all apartment units (UC Davis 2013) as shown in Table 1.

Table 1.

1 For more information visit http://www.pge.com/mybusiness/energysavingsrebates/rebatesincentives/znepilotprogram/

2 For the purpose of the West Village project, Carmel and their design team defined the ZNE goal as "zero net electricity from the grid measured on an annual basis" (UC Davis, 2013).

**ENERGY PRODUCTION AND CONSUMPTION - MARCH 2012 THROUGH FEBRUARY 2013**[1]

Source: Evaluation of UC Davis West Village Phase I Energy Use and PV Production. Davis Energy Group, Inc. September 19, 2013

| Facility | Production (MWh) | | | Consumption (MWh) | | | Percent (AP/AC) |
|---|---|---|---|---|---|---|---|
| | Modeled (MP) | Actual (AP) | Percent (AP/MP) | Modeled (MC) | Actual (AC) | Percent (AC/MC) | |
| **RAMBLE APARTMENTS PHASE 1** | | | | | | | |
| Apartments | 1,024 | 1,110 | 108% | 1,127 | 1,377 | 122% | 81% |
| Common Areas[2] | 471 | 451 | 96% | 390 | 602 | 155% | 75% |
| TOTAL | 1,495 | 1,561 | 104% | 1,516 | 1,979 | 131% | 79% |
| **VIRIDIAN APARTMENTS** | | | | | | | |
| Apartments | 519 | 530 | 102% | 530 | 515 | 97% | 103% |
| Common Areas | 321 | 314 | 98% | 141 | 432 | 306% | 73% |
| TOTAL | 839 | 844 | 101% | 672 | 947 | 141% | 89% |
| **VIRIDIAN COMMERCIAL AREAS** | | | | | | | |
| TOTAL | 415 | 358 | 86% | 377 | 84 | 22% | 424% |
| **LEASING AND RECREATION CENTER** | | | | | | | |
| Building | 225 | 218 | 97% | 225 | 292 | 130% | 75% |
| Pool / Outdoor | 0 | 0 | n/a | 0[3] | 109 | n/a | 0% |
| TOTAL | 225 | 218 | 97% | 225 | 402 | 178% | 54% |
| **TOTAL** | **2,974** | **2,981** | **100%** | **2,790** | **3,412** | **122%** | **87%** |

This paper is a story about the performance of West Village, in particular the role of resident behavior in the life of a building. The story begins during design with the decisions and assumptions designer's made and continues into operations as the designers' decisions and assumptions play out. To tell the story about the design process, we use a qualitative evaluation of the design process that reveals the designer's decisions and assumptions about how residents (who don't necessarily behave as a cohesive family unit) would use their spaces. To tell the story about operations, we use rich, end-use data. As for most buildings, the story will continue into the future, but for now the performance of West Village depends upon engaging residents to change their behavior to achieve and maintain zero net energy.

## Research Questions

The energy performance of West Village to date prompts numerous research questions. For the design community, some of the research questions are *What conscious or unconscious assumptions do designers make about resident behavior*? *What assumptions did the energy modeler make about resident behavior*? *Is the performance of West Village the result of designers' accurate or inaccurate assumptions about resident behavior*? *What role do designers play (if any) to address the growing energy issue of plug loads? What can designers and modeling community learn from West Village about behavior?*

For the behavior community, some of the research questions are *What are the savings from various interventions? Are interventions persisting?*

For the larger ZNE community (e.g. California Energy Commission, CPUC, investor owned utilities, etc.) some of the research questions are: *What role does resident behavior play in achieving the state's goal that all new residential construction is zero net energy by 2020?*

## Review of Literature

There are now a sufficient number of occupied buildings that were designed to be ZNE and have been monitored to get a sense of whether they are consistently achieving ZNE performance targets; specifically there are 160 ZNE verified and ZNE emerging projects in the US (NBI 2014). In most of these buildings, the occupants are engaged, plug load strategies were incorporated, and in commercial buildings, operators are continually maintaining and modifying systems to ensure optimum performance (NBI 2014).

Research on the performance of low-energy consuming homes confirms the role of behavior. In a study comparing a treatment group of homes to a control group at two Habitat for Humanity developments in Florida, energy use varied by a factor of 3 depending on occupant behavior (Parker 1996). Cooling energy use varied by a factor of 5 (Parker 1996). Research, in general, suggests the behaviors contributing to variations in cooling energy use are "cooling system control based upon 'on-off' scheduling, interior temperature settings, ventilation and window behavior, use of drapes and blinds, and zone of supply registers" (Parker 1996).

Design team selection of thermostats and how they are programmed can be important factors. While programmable thermostats can reduce energy consumption, they are often not used properly. The user interfaces of many thermostats appear to be a major cause of confusion and errors leading to incorrect settings, failure to override programs, and failure to return to regular schedules after exceptions (Daniel 2011).

## Methodology

SD+B conducted a qualitative evaluation of the West Village design process in 2012 by interviewing key West Village design team members. By documenting what worked and what didn't work during the West Village design process, the evaluation provides useful support to other designers and owners to create ZNE projects. Phone interviews were conducted with the project's electrical engineer, architect, and landscape architect, as well the University of California-Davis, the West Village developer, Carmel Partners, and SunPower, the photovoltaic provider. A few quotes from the interviews have been provided.

The methodology for the resident engagement work included a pilot energy conservation competition, designing behavior change strategies based on a specific end-use, and a control group consisting of 20 units. See Experimental Design on page 10 for a discussion about the control group.

To measure the effectiveness of an intervention we are comparing the treatment group to "all monitored" units as well as to the control group.

## Discussion

The energy performance of West Village begins at design, as most performance stories do. SD+B's evaluation of the design process revealed numerous findings on the West Village design process' strengths and weaknesses to achieve zero net energy (Hammer 2013). The following table summarizes all the findings, however, the focus of this paper is the findings specific to occupant and building operator behavior during design and operations

Table 2. Summary of findings from design process evaluation

| Design Process Strengths | Design Process Weaknesses |
|---|---|
| Strong Client Leadership | Optimistic Assumptions About Resident Behavior |
| Experienced Teams | Reluctance to Employ Innovative Construction Techniques |
| Early Goal-Setting | Inadequate Energy Modeling Tools |
| Integrated Design Process | Renewable Incentives and Rebates Oriented to Single Family |
| Simple, Cost Effective Solutions | Unclear Regulatory Environment |
| Bridged Design and Operations | |

## Designer and Modeler Assumptions About Resident Behavior

Designers make assumptions, consciously or unconsciously, about user behavior and energy modelers select default settings about user behavior. One of the weaknesses of the design process may have been designers' assumptions about resident behavior. Table 3 compares Davis Energy Group's modeled values to AEC's measured performance values by end-use from April to December 2013. It illustrates the differences between the designer and modeler's assumptions and the West Village measured performance (AEC 2013).

Table 3. Modeled energy consumption by end use vs. measured average energy consumption by end-use (April-December 2013) (kWh/sqft/month)

| | HVAC | Plugs & Lights | Appliances | Domestic Hot Water | Total | PV Production | Net |
|---|---|---|---|---|---|---|---|
| Modeled | 0.11 | 0.12 | 0.18 | 0.05 | 0.46 | 0.46 | 0.0 |
| Measured | 0.23 | 0.16 | 0.09 | 0.05 | 0.53 | 0.46 | 0.07[3] |

Some of the reasons for the difference may be:

- The contrast between designer's assumptions about resident behavior and how they actually use energy,
- the evolving role of designers on addressing plug loads,
- the pivotal role of thermostat programming,

[3] This value is based on 69 of the monitored units with high quality data for all nine months from April 2013 through December 2013.

- industry's lack of rich, end-use data on *typical* behavior,
- performance issues associated with heat pump water system,
- inadequate modeling tools.

The energy modeler offered this assessment:

*There are general challenges in modeling ZNE buildings. The big unknown is the assumptions for plug loads and occupant behavior. The assumptions used by BEopt and the Building America simulation protocols are probably the best resources out there, but I don't know if we really know how accurate they are. The equations used are based upon past research but assumes certain thermostat set points, as well as other assumptions for occupant such as gallons per day of hot water use and other occupant behavior assumptions. Occupant behavior and use can vary significantly in reality so all it really can do is predict "typical" or "average" use, not "actual".*

As table 3 illustrates, HVAC is a significant load and the end-use with the greatest difference between actual and modeled. While the designer may have assumed residents would typically cool passively (e.g. ceiling fans, Delta breezes[4] through operable windows, and closing blinds during the day) they may be cooling mechanically instead. Likewise, the energy modeler assumed thermostats would be installed with default settings or residents would set them at auto "off" instead of auto "on". The latter is inefficient, causing a fan to run continuously instead of as needed to meet temperature.

Let's look at how the residents are actually behaving. The following Table 4 compares HVAC, plug loads and lights, and appliances for low-use residents and high-use residents (AEC 2013). For HVAC, high-use residents consume disproportionately more energy than low-use resident. While low users appear to be energy efficient in all three end-uses, high-use residents consume much more energy in HVAC [5]. Cooling is a significant load in Davis. This data provides insights to the CPUC, California's IOUs, and the ZNE community in general, about resident HVAC behavior and the role it plays in meeting state goals.

Table 4. End use breakdown for lowest and highest units (September-December 2013)

| End-use Category | Lowest 10 Units (Average) | Average Unit | Highest 10 Units (Average) |
|---|---|---|---|
| HVAC (kWh/sqft/month) | 0.09 | 0.24 | 0.51 |
| HVAC (% of total) | 35% | 50% | 60% |
| Plugloads & Lights (kWh/sqft/month) | 0.10 | 0.16 | 0.23 |
| Plugloads & Lights (% of total) | 36% | 32% | 28% |
| Appliances (kWh/sqft/month) | 0.08 | 0.09 | 0.11 |
| Appliances (% of total) | 29% | 18% | 12% |
| TOTAL (kWh/sqft/month) | 0.26 | 0.49 | 0.85 |

[4] Delta breezes is wind from The Delta of the Sacramento River and San Joaquin River. This wind carries with it cooler air from the Pacific Ocean.

[5] The lowest and highest users are out of 107 units with high quality data during the period September 2013 through December 2013. We examined this period because there is a change in occupants at the beginning of the fall semester.

Table 3 also illustrates the difference in assumptions on plug loads compared to actual. The modeler may have used defaults for multi-family dwellings, however students don't necessarily behave as a cohesive family unit. The design team may have lacked a clear sense of responsibility about plug loads. Anecdotal observation reveals several mini fridges per apartment (despite a well-equipped kitchen), gaming devices, and in general more plug loads than designers anticipated. Most designers would probably agree with the West Village electrical engineer:

> *A higher level debate is if we provide fewer receptacles will that reduce the plug load in space? No. All it does is create a fire hazard. It's about lifestyles. We don't see anyone having a different lifestyle in ZNE building or different level of consumption. The way to address residents with excessive plugs loads is through an intervention or education, not design or the number of outlets. It is out of the electrical engineer's wheel house.*

Yet the design team tried, unsuccessfully, to provide residents feedback on their plug load usage as described by the energy modeler:

> *It is the Wild West out there. They tried to use a smart power strip (Greenwave) but pulled it. The builder said when they were installed resident internet connections slowed or were not working. The problem was either Comcast or smart power strip. Problem solved but not sure of cause.*

For appliances, the modeler assumed almost twice the loads compared to actual. The difference illustrates industry's need for rich, end-use data of typical residential behavior, that is, how often they use appliances, their settings, and the energy consumed.

A weakness of the design process is current modeling tools. Intended to determine Title 24 compliance, current modeling tools are not well-suited to modeling ZNE performance. Energy modeling tools need to be modified so they are more oriented to modeling ZNE performance. According to the electrical engineer:

> *Current tools are designed for different purposes. To quickly model a 2 bedroom house, the current software is a bit cumbersome and not available to everyone. If we want to predict the energy consumption it couldn't be easily modeled. You want to add PVs to software so you'd want a feature to plug in latitude and longitude of location; that product doesn't exist. You want software to figure out how to offset gas if you're going all electric. That software doesn't exist. Or what is the implication of an 800 watt microwave compared to a 1200 watt microwave? That tool doesn't exist either. The tools aren't concise or specific to this challenge.*

## Designer Assumptions About Operations

Compared to typical projects, the energy performance of ZNE buildings may require an effective bridge between design and operations. There appears to have been effective coordination between designers and the building operator on some aspects of the Recreation Center design. The building has a thermal chimney consisting of east and west facing louvers on the top floor. As warm air rises, it is exhausted by louvers, which are manually controlled. Operable windows on the first floor introduce cool air along the perimeter. Based on our observations and discussions with the building operator, he is opening louvers and windows to achieve cooling successfully. Carmel's in-house operations expertise contributed to this effective bridge, as expressed below. However, lighting and swimming pool loads challenge the ZNE performance of the Recreation Center.

> *Our company has a team that is mindful of operations during design. The construction director has worked on operations and construction; he can comment on equipment suggestions that don't work as anticipated.*

## Resident Engagement

### EMPOWER Launched

As part of our pilot work in the fall of 2012, SD+B designed and implemented an energy conservation competition. SD+B utilized an existing national program, *Do It in the Dark.* Twelve units competed against each other; 12 others formed a control group. At the launch of the competition residents received an energy-efficiency tip sheet. Each week of the three week competition the 12 units received a tailored message (e.g. *Your HVAC usage is high. Consider using your ceiling fan*.), their weekly ranking, and a website with information on their unit's energy consumption. A door to door visit was conducted the last week of the competition to cheer them on and deliver their tailored message. The winning unit reduced their energy consumption by 56% and received a pizza party prize.

The pilot revealed issues in terms of loads specifically, among the 24 units, plug loads and lights are the largest end use, accounting for almost half (47%) of all energy consumption. HVAC makes up one-third (32%) of all energy. Appliances are a smaller portion of total energy use (21%). The pilot also revealed the challenge of capturing residents' attention about energy, the limitation of email-only as the mode of communication, and implementing experimental design (e.g. control group). The pilot also revealed thermostats set at "on" instead of "auto", which turns the fan on and off as needed.

A development-wide engagement program, EMPOWER, is now underway. An engagement workshop among Carmel staff, AEC, SD+B, University of California-Davis researchers, Resource Refocus, and PG&E generated numerous ideas to engage residents. An EMPOWER committee has been formed to build a community around energy efficiency and water conservation. SD+B designed interventions based on end-use and the results of the pilot.

SD+B's first intervention, a one-time behavior, was reprogramming thermostats to auto "off" and setting restrictions on temperatures, specifically, 75 degrees maximum for cooling and 70 degrees maximum for heating.

The second intervention, Figure 1, a plug load pledge to address habitual behaviors, was implemented at a move in event; over 200 students signed the voluntary pledge. The target behaviors in the pledge were selected based on the results of the pilot and anecdotal observation. While mini fridges are a violation of the resident's lease agreement, numerous fridges have been observed from apartment walk-throughs. Most students were receptive to the plug load pledge, stating "*Oh, I already do these things*"; only a handful declined to sign the pledge. The sub metering also revealed phantom loads. While the pledge did not include a phantom load strategy, we will be implementing stickers or other interventions in the future targeting phantom loads.


Figure 1.

SD+B created strategies around high users which include a letter and door to door visits. A third intervention is letters from Carmel to residents with excessive loads. The letter included energy efficiency tips and a normative message *Your energy consumption is more than most residents.* The letter illustrates a low cost, easy to implement intervention. We conducted door to door, or face to face interactions with a handful of high HVAC users.

## Findings

Based on 7 months of data, thermostat reprogramming appears to be working; the energy savings on average is 16%. The plug load pledge also appears to be working, with an average savings of 7%, again over a 7 month period. Lastly, the letter to excessive users is also generating savings. Some residents appear to have taken immediate action in response to the letter in the first month; they were 8% higher than a typical user compared to 14% higher the previous month (pre-letter). The next month they were only 3.5% higher than an average user.

## Experimental Design

Isolating the control group or not touching them with an intervention remains a challenge. Residents are informed of West Village news by Facebook postings, posters, and other public forms of communication, yet those channels also influence the control group. We have limited exposure of the control to interventions but some have received an intervention.

## Future Work

In many ways our work with Carmel is still in the pilot phase. We are testing, evaluating, and refining each intervention until the end of 2014. Future interventions will target passive cooling, lighting, and domestic hot water. We are about to provide free shower timers and launch messaging around water conservation. Future strategies are tailored messaging, prompts (stickers) and possibly an energy budget. A three-week long competition to celebrate Earth Day is planned for April 2014. While residents do not receive a utility bill, Sunpower has created an app, as shown in Figure 2, which Carmel is publicizing at EMPOWER committee meetings and events.

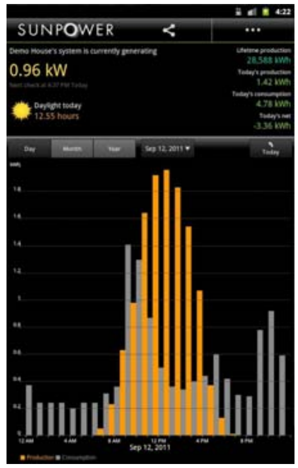


Figure 2.

Other future work may include studying the behavior of “typical” residents, which the control group would profile. The energy efficiency community lacks sub metered data by end-use. Our work contributes to understanding what people typically do in terms of using energy, when they do it and how much energy they are using. For example, phantom loads are ranging from 50-200 watt per apartment (AEC 2013). This information helps designers, especially modelers, use more accurate assumptions about people’s energy behavior.

## Conclusion

This paper, as previously mentioned, has three target audiences, designers, social scientists studying or designing behavior change programs, and the larger ZNE community.

For designers, the performance of West Village suggests they incorporate and/or think about building operations and occupants in ways they haven’t before. If passive cooling is integral to achieving state goals, designers may need to adjust their energy model assumptions and/or explore user behavior explicitly (e.g. ceiling fan operation) in their design with owners. Designers may also need to think about HVAC in different ways as well, specifically the selection of thermostats, installation and default settings of thermostats. Designers may need to revise their assumptions about the number of plug loads, their settings, and phantoms loads. For some designers, who offer plug loads aren’t their responsibility, they may need to support better management of plug loads during operations.

Carmel Partners and the design team were effective at creating better bridges between design and operations which may be essential for ZNE projects. ZNE design teams can bridge the profession’s poor handoff from design team to operations by, for example, incorporating operations staff during the design process and working with them to establish efficient temperate set points and confirm occupancy schedules.

The zero net energy performance of West Village is impressive but it is not quite there in terms of achieving ZNE. The behavior and habits of residents appears to be necessary to maintain and achieve ZNE. Interventions are reducing energy consumption and persisting. However, residents turn over every year or two years, requiring Carmel to engage new residents on an ongoing basis. By providing Carmel with 3-4 interventions, it may be easy for them to achieve ZNE year after year. The results also suggest it is possible to engage residents that don't receive a utility bill. Still, capturing resident attention about energy efficiency is not easy.

West Village provides the CPUC, IOUs, the behavior community, energy modelers and others with much needed information on *typical* behavior, such as when people use energy, how much energy they use and in what ways (by end-use). This information is an opportunity for the modeling and behavior community to collaborate to provide more accurate assumptions on resident behavior.

Lastly, West Village, as a case study, provides feedback to the ZNE community on the feasibility of achieving the state's goals technically and the role of occupant behavior. The performance of West Village suggests the habits and behavior of residents plays a role, especially in terms of HVAC.

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## References

Architectural Energy Corporation (AEC), 2013, Prepared for Pacific Gas & Electric.

Arup, "The Technical Feasibility of Zero Net Energy Buildings in California", 2012, Prepared for Pacific Gas & Electric.

Cortese, A. and C. Higgins, 2014, "Getting to Zero Status Update, New Buildings Institute.

Daniel, P., C. Aragon, A. Meier, T. Peffer, and M. Pritoni, "Making Energy Savings Easier: Usability Metrics for Thermostats." *Journal of Usability Studies*, 6 (4): 226-244.

Hammer, C., "Evaluation of ZNE Design Process at West Village in Davis, California," 2013, for Pacific Gas & Electric.

Parker, D., M. Mazzara, and J. Sherwin, "Monitored Energy Use Pattern in Low-income Housing In a Hot and Humid Climate." *Proceedings of the Tenth Symposium on Improving Systems in Hot and Humid Climates*, Fort Worth, TX, May 13014, 1996.

University of California- Davis (UC Davis), 2013. "West Village Energy Initiative Annual Report 2012-2013".