West Village: A Process & Business Model for Achieving Zero-Net Energy at the Community-Scale

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ABSTRACT

Achieving Zero Net Energy (ZNE) buildings at the building scale has been a challenging goal, especially from an economic standpoint. Increasingly, community-scale development of ZNE infrastructure is being considered a more economically viable approach. There are few actual demonstrations of ZNE communities to-date, however. West Village – a compact, mixed-use community in Davis, programmed on over 200 acres of university property providing residential, commercial, retail and community college facilities – is well its on its way to becoming a signature demonstration of such a ZNE community. Despite the many unique assets and constraints associated with the project, both the West Village Energy Initiative's business model, and the process by which the business model was developed, offer lessons to other future ZNE communities. The model ultimately advanced because: all key players participate in its design and development; unique resources and barriers specific to the project are being acknowledged and leveraged; and, stakeholders' respective goals and requirements are being addressed. Construction for the community is underway, and the design and engineering for the energy infrastructure is taking place. As of May 2010, the financing solution for the energy infrastructure and the final billing mechanisms are still being evaluated. As the community is built-out (first buildings to open doors in September 2011), the neighborhood, its occupants, and the underlying business model will serve as a "living laboratory" and demonstration for ZNE community business models, strategy, and technology.

Zero Net Energy Buildings Are Economically Challenging to Achieve

In 2008, the California Public Utilities Commission unveiled its "Big Bold Energy Efficiency Strategies" which included goals for achieving Zero Net Energy (ZNE) buildings in all residential and commercial new construction by 2020 and 2030. These goals, which are mirrored at the national and international level as well, are designed to transform both the market and the traditional outputs of the construction industry (CPUC 2008). There are multiple definitions of ZNE, though they tend to all be similar; the National Renewable Energy Laboratory (NREL) (Carlisle, Van Geet and Pless 2009; Torcellini, Pless, and Deru. 2006) defines a zero energy building as 'a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies;' For the purposes of this paper, we are choosing not to include embodied energy in the consideration and calculation of ZNE ("the quantity of energy required to manufacture and supply to the point of use, the materials utilized for its building.")

Achieving Zero Net Energy for Buildings Has Significant Potential at the Community-Scale

While there are a number of demonstration ZNE homes and offices in California and elsewhere, there are currently very few examples of large-scale deployments of ZNE residential and commercial buildings. In order to meet the aggressive ZNE goals at the state, federal and global level, ZNE buildings will need to be produced at significant quantities within the framework of a feasible business model for all parties involved in the real estate development process. Designing ZNE at the community-scale allows for economies of scale that increase the likelihood of both cost-effectiveness and large market impacts. It is also consistent with current goals -- the CPUC (2008), for instance, considers ZNE "at the level of a single "project" [not just at the level of a single building] seeking development entitlements and building code permits in order to enable a wider range of technologies to be considered and deployed, including district heating and cooling systems and/or small-scale renewable energy projects <u>*that serve more than one home or business*</u> (emphasis added)."

Despite the promise of ZNE at the community-scale, there are precious few examples of ZNE communities that have been achieved in practice. There are existing communities worth mentioning like Hammrby Sjostad (2010) in Sweden and Beddington Zed (2010) in the UK, and Z-Home (2010), a small-scale (10-unit) development in Issaquah, Washington currently under construction, but no large-scale ZNE communities have yet been built in the US.

West Village Is a Targeted ZNE Demonstration Community under Construction

The West Village Community Development (West Village) is programmed as a compact mixed-use neighborhood project designed to provide affordable housing to staff and faculty in a sustainable community on the University of California, Davis campus. From its inception, the University has designed the development with the goal of being environmentally responsive and reducing energy consumption and emissions, reducing transportation emissions and congestion, water conservation, and waste and water reuse. The project site, adjacent to both the campus core and Davis neighborhoods, was selected for its access and proximity to the campus and greater community. The physical location allows for easy and efficient pedestrian, bicycle and transit connections to these destinations. Table 1 below provides key facts about the scale and scope of the community.

The West Village Energy Initiative (WVEI) evolved as a natural outgrowth of the environmentally responsive principles that guided the conceptualization of the development. At an estimated cost of $65 million, the initiative aims to make West Village one of the first large scale communities in the US to be ZNE through energy efficiency and on-site renewable energy generation. As the WVEI evolves and progresses toward implementation, it will serve as a model for developers across the country as they are expected to build ZNE communities. The community will showcase the technical methodology, cost benefit analysis, and potential business models for integrating solutions that reduce energy consumption with a diverse array of indigenous Distributed Energy Resources in an economic and technically optimal manner. West Village's holistic approach will also serve to demonstrate and facilitate the future elimination of barriers that have historically made it difficult to design and build ZNE buildings and communities.

Table 1. The West Village: Key Facts

Area	205 acres
Project Type	Compact Mixed-Use, Net Zero Energy
Location	UC Davis, California
Est. Cost	280 million USD
Status	Phase – I (Aug 2009 – Sept 2011)
Developer	West Village Community Partnership LLC (Carmel Partners, San Francisco & Urban Villages, Denver)
Core Principles	Housing Affordability, Environmental Responsiveness, Quality of place

Program	**Total**
Faculty/Staff Housing	475 units
Student Housing Beds	3,000 beds
Retail/Office Space	up to 45,000 sf
Los Rios Community College District	60,000 sf
Recreation Fields	21.90 acres

Achieving ZNE Requires Efficiency and Conservation Measures First

In pursuing the overall ZNE goal of the WVEI, the team recognized that only after demand was managed and reduced as much as possible at the building-scale, should the focus shift to generating enough renewable energy on-site to off-set the developments' annual energy demand. Details regarding the Energy conservation measures and renewable energy infrastructure selected for the project can be found in an accompanying ACEEE 2010 Summer Study report entitled 'Zero Energy Communities: UC Davis' West Village Community' authored by Dakin, et al. (2010). Below, Table 2 shows the baseline projected electricity consumption for the community and the revised expected load, based on the deep energy conservation measures that will be installed.

While these deep energy conservation and efficiency measures are designed for each building scale category, the renewable sources of on-site energy are designed at the community scale (rather than at the individual units). Among the solutions proposed and adopted as part of the plan to achieve the ZNE goal is the use of a diverse array of indigenous renewable resources consolidated across public spaces, including a ~5MW community based Photovoltaic array, 300kW equivalent of fuel cells, a biogas digester fueled by community waste that produces biogas for the fuel cell, and a 1MW battery. Figure 1 below shows an early iteration of how the various parts of the renewable energy infrastructure would be designed into the community.

ZNE Requires Diverse Set of Community-Scale On-Site Renewable Resources

The benefits of installing Photovoltaic installations at the community-scale instead of roof top by roof top allows for a number of advantages including reliable, ease and cost-effective maintenance of systems, increased cost-effectiveness of ratepayer incentive programs (lower transaction cost to process 12 applications for community Photovoltaic installations versus 500+ installations of building by building projects and reduced liability and cost of upkeep since not on degradable and structurally sensitive rooftops. PV placed over parking garages, bike paths, and recreational areas also offers the benefit of providing shade. Despite these benefits, there is not enough space on-site to cost-effectively install enough Photovoltaic panels to meet the remaining demand.

Table 2. Community-Wide Energy Consumption Estimates

Category	Base Case 2008 T24		Proposed Package		Reduction
	kWh/yr	**kWh/sq ft/yr**	**kWh/yr**	**kWh/sq ft/yr**	
Single Family	9,863,100	16.2	3,484,500	5.7	65%
Multifamily (Ramble/Townhouse)	9,781,500	13.8	4,067,900	5.6	58%
Commercial / Mixed Use	1,967,100	12.4	1,090,500	6.9	45%
Leasing / Rec. Building	347,000	26	225,500	16.9	35%
Community College	1,036,400	18.5	785,400	14	24%
Common Area Lighting	299,500	n/a	149,800	n/a	50%
Totals	**23,294,600**		**9,803,600**		**58%**

The waste-to-renewable-energy (WTRE) system, which is to be built within a Community Energy Park in West Village and combined with other components of the project, will utilize a biodigester to produce onsite renewable biogas from the community and nearby campus green waste streams. An advanced 1MW storage battery and 300kW worth of fuel cells will be powered by the on-site biogas. The integrated system is designed to produce approximately 2.6 million kWh of baseload power for the community on an annual basis. This represents approximately 25% of the required renewable energy, without which West Village would not be able to meet its ZNE goals.

Figure 2 depicts both the modeled baseline MWh/year consumption of the community, based on the local building codes (Chrisman 2008), and the projected energy savings and production that will be used achieved ZNE.

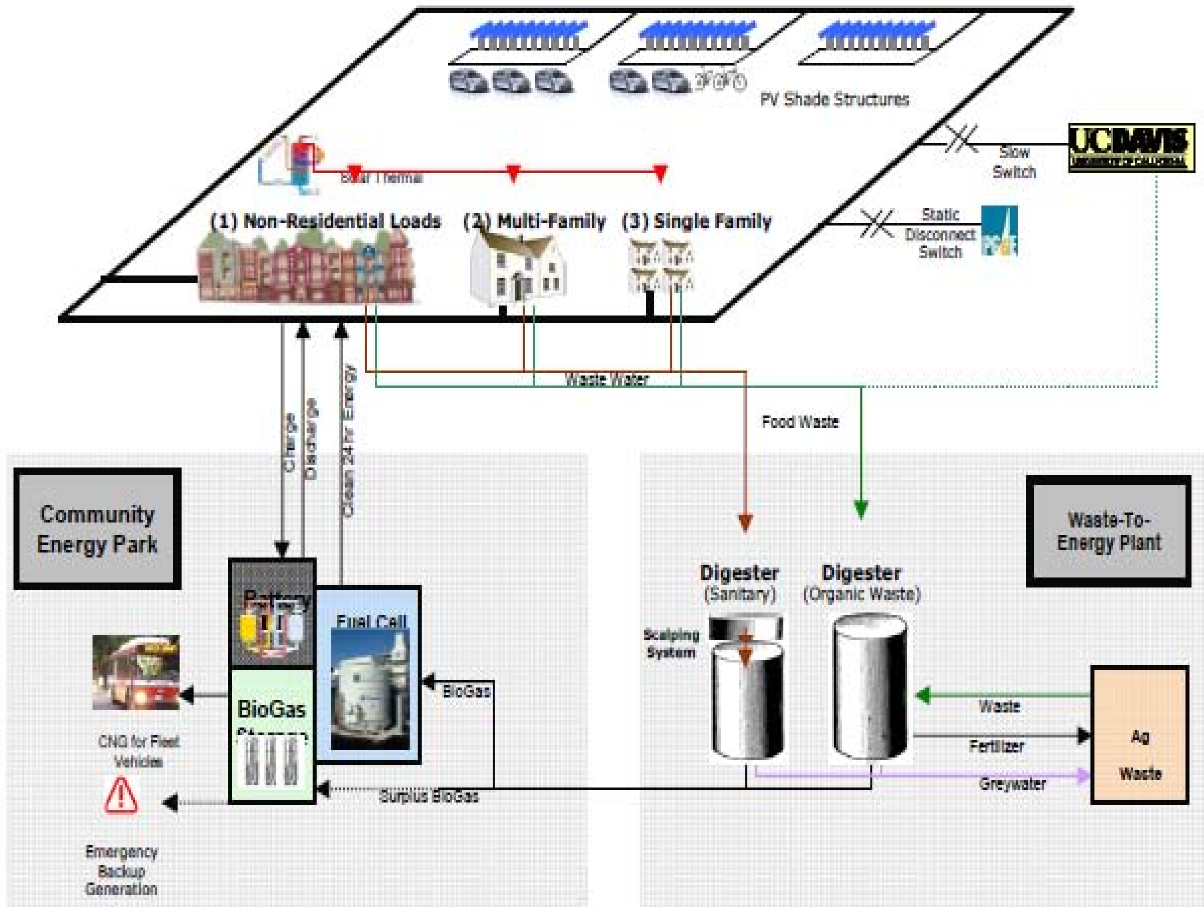
Process Used to Develop the West Village ZNE Business Model Is Applicable Elsewhere

There are several lessons to be learned from the planning and design process of the WVEI and its goal of developing ZNE community. The planning and design team used an integrative systems approach and leveraged public-private partnerships to design technology packages and a business model that ultimately achieves ZNE in a cost-effective manner. They decided on a design that maximizes demand-side management at the building scale, and on-site renewable resources at the community-scale. Implementation required the ZNE leadership team to accomplish three tasks:

1. Engage Key Players in the Design of the Business Model
2. Consider and Address Unique Assets and Constraints Specific to Project

3. Develop a Business Model that Addresses All Stakeholder Needs & Requirements

Figure 1. Integration of the Various Components in the West Village Community

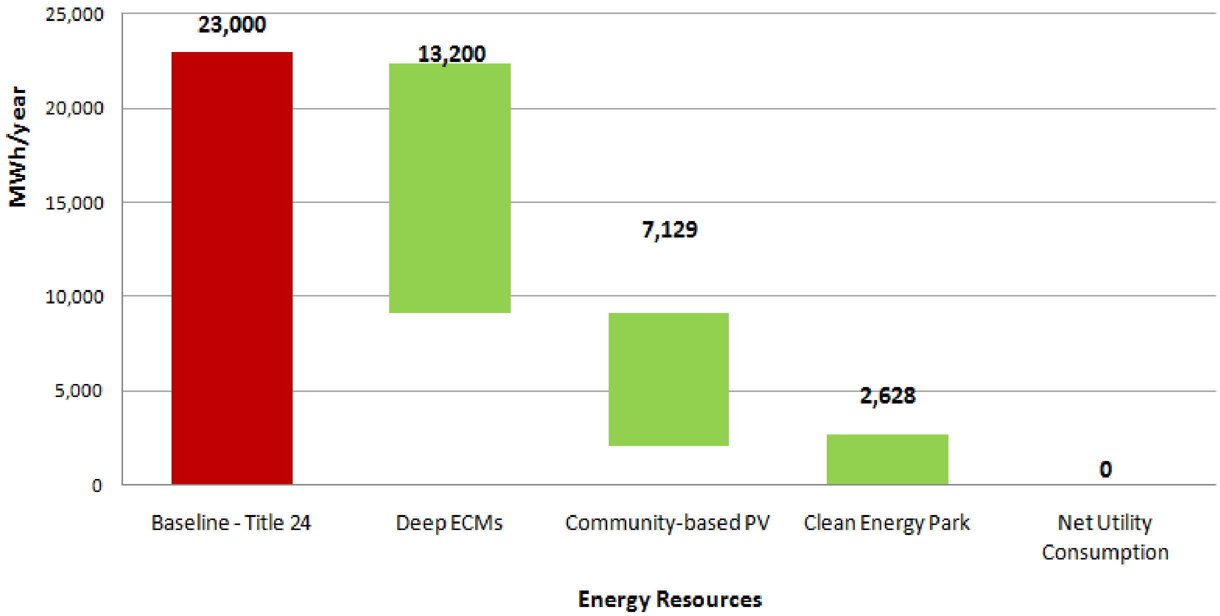


Process Task 1: Engage Key Players in the Design of the Business Model

The WVEI started as an offshoot of the design process for the West Village neighborhood. During the design development process, UC Davis and its developer partner, West Village Community Partnership agreed to explore the feasibility of including deep energy conservation measures at the building level throughout West Village. The UC Davis Energy Efficiency Center (EEC), in combination with Davis Energy Group, prepared a study of various energy conservation measures that could be adopted in the project (Hargadon 2007). As part of the study, the EEC convened a project advisory committee of key representatives of various segments of the energy market, including the local Utility, a leading energy service provider, a large solar installer, financing institutions, consulting firms, and University research centers. The EEC's report outlined various energy efficiency packages that could be used in the multi-family units, single family residences and the commercial buildings. More importantly, the dialogue fostered among the project advisory committee led UC Davis and WVCP to adopt a larger goal – making West Village a ZNE community. Table 3 shows a list of the key roles that were required to be engaged in the ZNE Community process.

Over the course of the initiative, team members brainstormed and explored the world of possible solutions for integrating energy efficiency and distributed energy technologies into the West Village project. In addition to activity delineated in Figure 3, the History and Timeline of the WVEI, the implementation team of the WVEI hosted a West Village Technology Contributor's Forum in 2008 to interview an array of potential technology vendors that could potentially incorporate their products into the development. The team looked closely at a list of promising commercially-available (or soon-to-be available) energy efficiency products and considered incorporating these solutions into the project on different scales (research, demonstration, and deployment).

Figure 2. Modeled Path to Net-Zero Energy



Process Task 2: Consider and Address Unique Assets and Constraints Specific to Project

The deployment of renewable energy supply at a community scale faces several regulatory barriers with respect to energy storage and net-metering. Hence the technologies have had to be considered in the context of not only product maturity, builder acceptance, estimated energy benefit and cost-effectiveness but also within the existing regulatory constraints. There are prohibitive up-front cost barriers for the university and the developer to incorporating distributed energy technologies into the community infrastructure while trying to maintain the required level of affordability for the home-buyer. Adding to challenges associated with the infrastructure costs and the related financial challenges is also the issue of organizing the implementation of the technical and financial solutions.

Several obstacles were overcome throughout the planning process, including financial, technical, operational and regulatory hurdles. West Village has several unique attributes that set it apart from other, more traditional developments. These attributes have made it easier for the community to develop towards creating a ZNE community. First, it is a mixed use community. This provides for space to deploy community scale solar photo-voltaic on site and it affects and moderates the shape of the community energy load. Second, it is a community that is being developed from the ground up. This allows for the inclusion of the deep energy conservation measures from the beginning, thereby cost-effectively reducing the generation needs for the community. This would be far more difficult in an existing community where each building would need to be retrofitted one by one to achieve the same energy savings. Third, the University has access to research expertise and advocates for pursuing such a project. The WVEI will be a valuable resource to the Universities academic community. Finally, the University will continue to own the fee title to the West Village neighborhood and all of the residents of the neighborhood will be University affiliates. This provides a unique opportunity for control and continuing research in the energy efficiency and renewable energy generation fields. Table 4 lists key constraints facing the achievement of the ZNE goal, as well as unique assets available to the implementation team.

Table 3. Key Roles and Players Engaged in Achieving ZNE Goals

Land Owner	UC Davis
Developer	Carmel Partners and Urban Villages (combined to form West Village Community Partnership LLC)
Energy Efficiency Consultant	Davis Energy Group, funded in part by the US Department of Energy Build America Program (2004)
Renewable Energy Integration	Chevron Energy Solutions (leading Energy Service Company)
Utility partner	Pacific Gas & Electric Company (PG&E)
Advocate/Catalyst	UC Davis Energy Efficiency Center
Initial Advisory Committee	Lewis Group, California Energy Commission, California Lighting Technology Center, Western Cooling Efficiency Center, Graduate School of Mgmt, First Northern Bank, Bank of America, Mertitage Homes, John Laing Homes, AKT Devp. Co., Cunningham Engineering, Powerlight

Process Task 3: Develop Business Model that Addresses all Stakeholder Requirements

The project team explored several conceptual schemes for implementable business models. Ultimately, the team generated a list of criteria for the project that they applied to the design of the model. The top three criteria were: 1) to incur zero new first capital costs to the developer; 2) to achieve zero net cost to customer (equivalent or better than a PG&E annual bill for a similar customer living in a standard community); and, 3) to generate on-site renewable electricity in West Village to offset the community's electrical demand on an annual basis. Based on the above criteria, the technology solutions that would be identified for deployment to reach ZNE would need to be financed independent of the already established home prices, and financed outside of the existing master development construction loans. In other words, neither the homeowner, nor the developer, nor UC Davis, would be able/willing to provide the up-front capital for the solutions to occur. This was a challenging yet worthy hurdle to overcome.

A fundamental project design hypothesis was that it is essential to have proper allocation of cost and value between the Utility, the Developer, the landowner and the third party owner/distributor of the energy infrastructure in order to result in net savings for all parties involved. Thereby, the current business model, the Loop model (Figure 4) was created, where PG&E controlled the net- metering of the entire community (excluding the single family homes) in three separate loops of ~ 1MW each This overcomes the net-metering regulatory barrier which allows for a maximum capacity of 1MW. Within each loop, that served the multi-family housing and the mixed use buildings, the university would then enter into a PPA with the organization that leased and distributed the renewable energy and demand side management infrastructure.

The single-family units on the other hand will be direct customers of PG&E, and PG&E will enter into a separate PPA agreement between PG&E and the organization that owns the SFH portion (~2.6 MW) of community Photovoltaic installation. This arrangement allows for the utility provider to use energy produced under this PPA to contribute towards the state's Renewable Portfolio Standard (RPS) goals, and also avail the financial benefits by claiming Renewable energy credits (RECs) for the project.

While this model has been developed to be first and foremost implemented in a timely manner and to be conducted under the existing regulatory structure, it is worth noting that alternative business models would be more cost-effective and more appropriate under different and more Community ZNE friendly regulatory and tariff structures. Such a model might not only maximize cost-effective on-site renewable energy generation and storage, but also make certain that the inhabitants of the community continue to demonstrate energy-conscious behavior to maximize the savings from energy efficiency.

Figure 3. History and Timeline of the West Village Energy Initiative

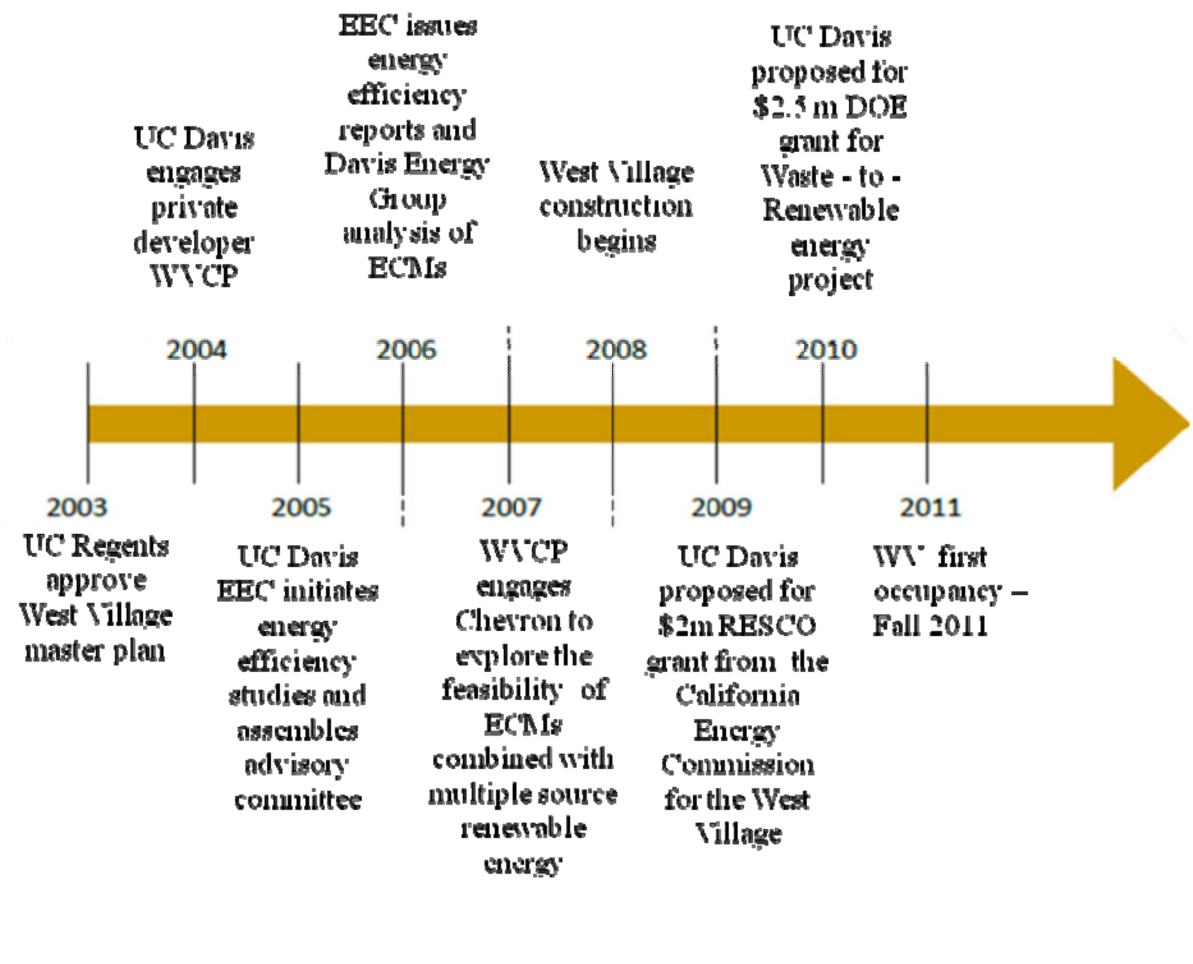


Table 4. Overcoming Key Constraints During the Development of the Business Model

Constraints	Assets
First cost of project to Developer	Engaged key partnerships and stake holders, including local utility and willing developer
Principle Agent Challenge (Developer does not enjoy in savings from energy conservation measures that benefit homeowners/tenants)	Mixed-use community
Affordability Requirement for Homeowner (same or lower average annual energy bill)	Greenfield development
Limited types of on-site renewable energy sources available (no wind, hydro)	Relative high cost per kWh
Limited space available for solar PV arrays	Availability of relatively generous Incentives and Rebates for Energy Efficiency, Demand Response, Self-Generation
Advanced Building Codes Results in Challenging Baseline	Entitlement Exemptions and Utility Regulatory Exemptions due to University Status of Landowner
Regulatory Constraints Regarding Size of Net-Metering	Strategic/Academic Interest and Strong Public Relations Benefit of Project
Incentives and Rebates Designed for Building Scale, not Community Scale	Ability of Utility/Land Owner to conduct on-bill financing or billing
Incentives and Rebates do not holistic account for Integrated Demand Side Management	Land Owner's Strong Credit Status and Access to Public Sector financing Options
	Access and Control of Nearby Biomass

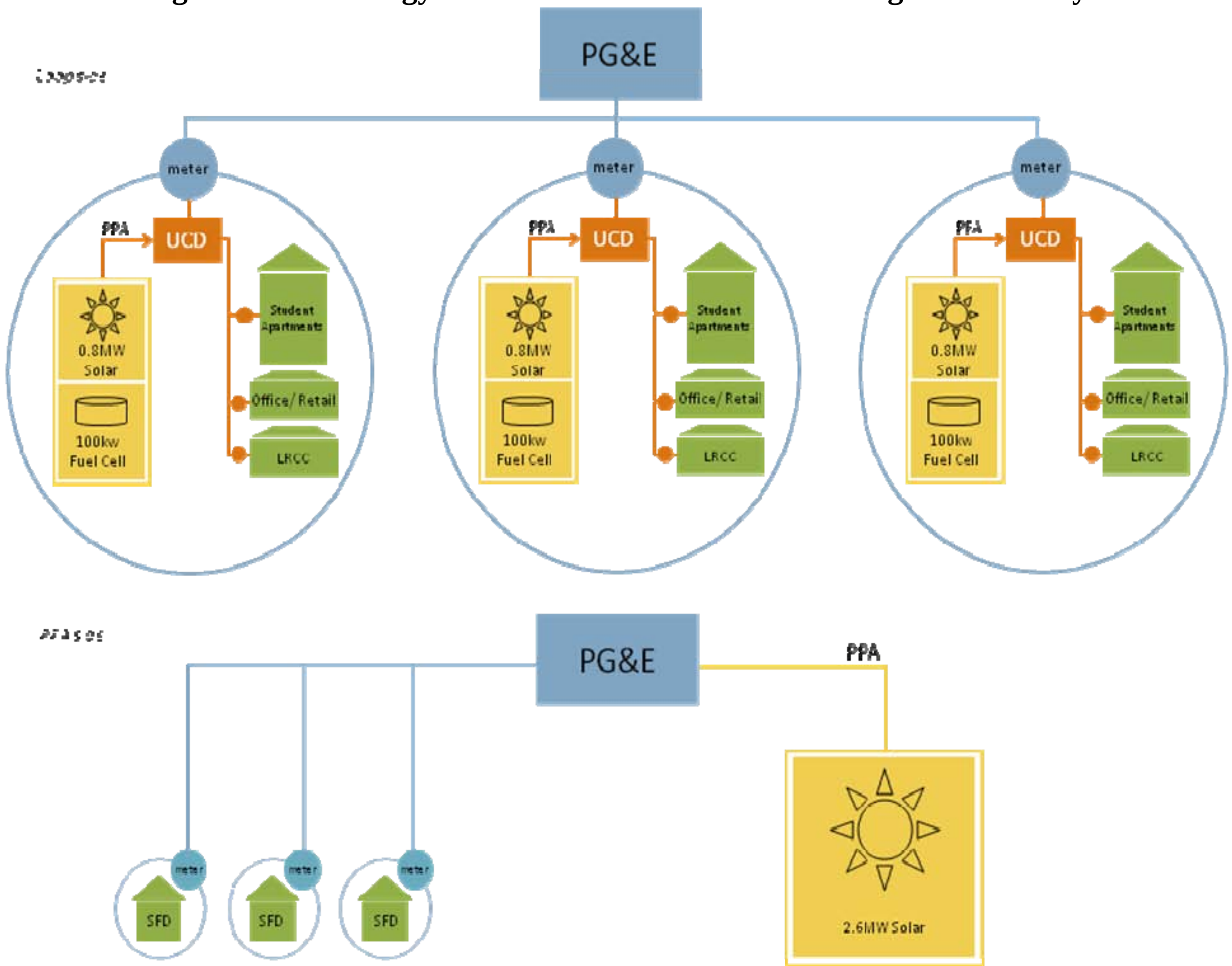
West Village Final Financing and Billing Mechanisms Are still Being Determined

As of May 2010, the final financing for the energy infrastructure has not been finalized, but all key parties are engaged in identifying the appropriate ownership entity and financing infrastructure. Billing mechanisms are also being explored for cost recovery of up-front investments in deep energy conservation measures. On-bill financing and on-bill billing is being considered by the PG&E and also UC Davis through the Home Owner's Association billing it will manage. Construction of the early phases of the development is under currently underway. First occupancy for the first set of multi-family (student) housing units is on track to occur in September 2011.

West Village Neighborhood, its Occupants, and the Underlying Business Model will Serve as a "Living Laboratory" for Future ZNE Communities

By serving as a pilot for these innovative utility and business models, the lessons of West Village will provide policy makers and community developers with an increasingly-defined and lower-risk model for including energy efficiency, renewable energy and storage capacity into future developments. The West Village Community Energy Park will include an Outreach center, specifically planned to educate researchers, policy makers and industry leaders about ZNE communities. In addition, the research opportunities provided and education mission of the project will allow for a wider public outreach allowing for more opportunities for incorporating and studying developing technologies for future phases and expansion of the West Village Energy Initiative. Among several strategies incorporated into the Outreach plan for commercialization of demonstrated technologies is collaboration with researchers (both in and outside of UC Davis) to create opportunities for West Village to function as a "living laboratory" and to benchmark performance, develop new technologies, observe behaviors, and report out to stakeholders. The University intends to develop a public-use case study outlining the community planning and implementation process and share feasibility models that other developers can use to understand how their communities can achieve ZNE.

Figure 4. The Energy Business Model of the West Village Community



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