Nishi – Gateway Project
Zero Net Energy (ZNE) Feasibility Study
Task 2D - Technical Memo

Prepared for:	**City of Davis & Ascent Environmental**
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1. Introduction

Zero net energy (ZNE) as a goal for new development has gained considerable interest as a strategy to save energy and cut greenhouse gas (GHG) emissions. While there are a number of definitions for ZNE, in this report all definitions assume that a ZNE building or community is one that uses a combination of improved efficiency and renewable generation to cover at least 100 percent of its net annual energy (electricity and gas) use. California agencies have set ambitious goals for ZNE in all new homes by 2020 and commercial buildings by 2030 and are pursuing various policies and strategies to achieve those goals[1].

According to the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC), "a Zero Net Energy Community refers to an adjacent group of buildings that individually are ZNE Ready Buildings and where the societal value of the amount of energy provided by a community-scale renewable energy source associated with the community is equal to the value of the energy consumed by the buildings in aggregate".[2]

In this study, Davis Energy Group (DEG) evaluates the potential to achieve ZNE and minimize GHG impacts at Nishi/Gateway. Community wide energy load estimates have been made and strategies for onsite generation are discussed as well as their policy implications. A case study, the West Village project on the University of California (UC) Davis campus, is reviewed in detail, to identify lessons learned that may be applied to this project.

2. Background & Overview of Policies & Challenges

Generally speaking a ZNE community is one that produces as much energy from renewable sources (i.e. solar or wind electricity) as it consumes, on a net, annual basis. However, ZNE can be defined in several different ways, and how it is defined may affect both strategies to achieve it and ultimate performance over the long term. Previously, at the national level, the US National Renewable Energy Laboratory (NREL) had four main categories of ZNE that can be used to assess performance (*Torcellini 2006*):

1. <u>Zero Net Site Energy:</u> Produce as much energy as is used in a year when evaluated at the site. This definition is easy to evaluate and verify through on-site measurements, but is the most challenging definition to meet with on-site renewable electricity generation when natural gas use needs to be offset on site. With projects using natural gas onsite, significant amounts of on-site electric renewables are needed to offset gas usage, and there are no direct means of using on-site electric renewables to offset the costs of natural gas use. Direct use of biogas on site can be used for natural gas consumption.

2. <u>Zero Net Source Energy:</u> Produce as much energy as is used in a year accounted for on a source basis. Source energy refers to primary energy used to generate and deliver energy to the site. The source value of electricity is about 3.5 times the site value to account for the generation, transmission, and distribution of electricity to the site. Electricity generated on site by PV uses the same factor because PV generation offsets the need for electricity generated from other sources.

3. <u>Zero Net Energy Cost:</u> Where the net cost for energy use is equal to the net amount that the utility pays the customer for energy generated in a year. Because net metering customers are credited for the full retail value of the electricity they generate on site, net-zero electricity and net-zero cost would be the

[1] 'California Energy Efficiency Strategic Plan: January 2011 Update' (California Public Utilities Commission, 2011) <http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf>.
[2] California Energy Efficiency Strategic Plan: New Residential Zero Net Energy Action Plan 2014---2020' (CPUC, CEC, 2013) < http://www.cpuc.ca.gov/NR/rdonlyres/D8EBFEE4-76A5-47AC-A8F3-6E0DAB3A9E5D/0/DRAFTZNE_Action_Plan_Comment.pdf >.

same for customers on a standard residential electricity rate. Customers on a time-of-use utility rate may be able to be ZNE cost and use more electricity than they generate in a year, if they generate when power is more expensive and consume when power is less expensive.

4. Zero Net Energy Emissions: The amount of emissions-free renewable energy generated is equal to the amount of emissions-producing energy used in a year. This amount would vary depending on the mix of electricity sources provide by the local utility. Hydroelectric and nuclear energy are considered emissions free and the portion of electricity used from these sources would not need to be offset using this criteria.

The California Energy Commission (CEC) currently proposes using the time dependent valuation (TDV) energy metric to evaluate ZNE and determine compliance with California's ZNE goals. TDV has been used since the 2005 Title-24 energy code for code compliance and values electricity during peak periods of the summer much more than electricity used during off-peak periods. TDV was developed to reflect the societal value of energy including long-term projected costs of energy including cost of peak demand and other societal costs including projected costs for carbon emissions.

This study looks at the feasibility of ZNE from two operational definitions as follows:

1. Zero Net Energy – TDV (ZNE-TDV): 100% of onsite TDV energy consumption (electricity and natural gas) is offset with onsite TDV energy production in a year. TDV energy use is calculated using the CEC's 2013 hourly TDV multipliers.
2. Zero Net Electricity (ZNE-Elec): Onsite electricity production equals electricity consumption only (measured in kWh) in a year. Natural gas consumption offset by delivery of biogas or purchase of biogas offsets.

ZNE-TDV was selected because it aligns with the proposed definition for ZNE set forth by both the California Energy Commission and the Public Utilities Commission. The ZNE-Elec metric was selected to estimate the amount of on-site renewable energy needed to offset electricity use only and rely on the delivery of biogas from off-site or the purchase of off-site biogas to offset all natural gas use on site.

While it is best to meet the ZNE goals with on-site renewables when at all possible, due to site constraints, high density development, and competing uses for the limited availability of land and rooftops, off-site renewable sources are also considered in this report.

ROAD TO ZNE - MAPPING PATHWAYS TO ZNE BUILDINGS IN CALIFORNIA

A California Public Utilities Commission (CPUC) funded study developed by TRC (formerly Heschong Mahone Group (HMG)), and published in December 2012, addresses the opportunities and pathways required to meet the state of California's ZNE goals (*Heschong Mahone, 2012*). The focus of the report was on ZNE buildings and not necessarily community-scale ZNE; however it identifies important conclusions, and characteristics of ZNE, which are important to for any ZNE development. They are as follows:

1. Deep energy efficiency should be the foundation of ZNE.

2. Further reductions in costs of renewables are necessary.

3. A single ZNE metric may not prevail but a common goal is critical.

4. ZNE buildings should be efficient, both in the way they are designed and operated.

5. Understanding social science perspectives on ZNE is critical for success. Key elements include:

   a. Better understand how occupants use buildings and how to influence building users to use energy more wisely
   b. Better understand how building operations and maintenance affect building energy use.
   c. Use observation and experimentation to improve building automation and find balance between automatic versus manual controls of building systems.
   d. Occupant satisfaction and ensuring that energy savings measures do not affect occupants' comfort and productivity.
   e. Pay attention to the market. Designs have to fit with what occupants and users want in a building.

CHALLENGES OF EVALUATING ZNE FEASIBILITY

Additional design and modeling efforts are necessary to accurately evaluate both the range of efficiency options to be considered and how to effectively size onsite generation systems. Typical non-ZNE communities do not allot time and budget for detailed energy modeling for projects. ZNE communities require additional efforts to develop annual energy consumption estimates in order to properly size on-site renewable energy systems. Estimating these loads can be time intensive and speculative in new-construction projects when actual load consumption profiles are unknown. In many cases where commercial spaces are built before tenants are known, estimating actual use and loads accurately can be very speculative.

Another challenge relates to the uncertainty in the effects of climate change on long-term ZNE performance, affecting both heating and cooling energy use and PV performance. Modeling assumptions are typically based on historical weather files, not future trends.

REGULATORY FRAMEWORK & CHALLENGES

Net Energy Metering (NEM)[3] is a tariff arrangement that enables customers to trade energy consumption and energy production at a single meter over the course of 12 months. That is to say if a customer consumes the same amount of electricity as the PV system connected to the building produces over the year, there would be no energy related utility charges. NEM puts renewable energy (RE) systems "behind the meter" where a utility has no access or control over production. NEM regulations state that only renewable generation systems smaller than or equal to the estimated annual energy consumption of the electric meter are eligible for NEM arrangements. This precludes the utility customer being reimbursed for excess generation, even if the property is a net energy generator. This is particularly challenging when energy demand is unknown and/or variable, because an oversized generator does not provide any economic benefit.

In June 2011, a revision to the NEM tariff (-Net Surplus Compensation) was implemented which allows for compensation of excess generation by the utility customer at year's end at a rate calculated by the utility (currently $0.04/kilowatt hour [kWh]). While this now allows for compensation for excess generation, it results in a low rate of return for the investment in generating capacity beyond ZNE. This net effect discourages builders from installing larger systems to account for variability in use.

Current incentives and NEM structures are set up for individual meters. Virtual Net Energy Metering (VNEM), *which allows the electricity produced by a single solar installation to be credited toward multiple tenant accounts*

[3] *www.gosolarcalifornia.ca.gov/solar_basics/net_metering.php*

in a multifamily building without requiring the solar system to be physically connected to each tenant's meter, improves upon NEM by aggregating within a single building but is not designed for community ZNE.

Net Energy Metering Aggregation (NEMA) is another NEM structure which went into effect February 20, 2014, which allows a single customer with multiple meters on the same property, or on the customer's adjacent or contiguous property, to use renewable generation and NEM to serve their aggregated load behind all eligible meters. NEMA was made possible with the approval of Senate Bill 594 (Wolk), and was designed to assist farmers and growers in utilizing renewable energy systems in their farm operations. Under NEMA, a customer can install an RE system up to 1 megawatt (MW) for aggregated loads behind the meter. All of the properties where the accounts are located have to be solely owned, leased or rented by that same customer and all of the accounts have to be for the same customer of record. Similar to other NEM structures, the RE system cannot be sized larger than the aggregated load which it serves over the course of the year.

None of these NEM structures allow for the planning of PV output degradation over time. Systems are designed for year one (1) performance. Another significant challenge is that there is no mechanism for offsetting natural gas consumption with on-site renewables. This is in direct conflict with state's goals whereby natural gas in TDV units must be offset to achieve ZNE. Electrification of a ZNE project is one option but developers and builders are resistant, and implementation is more challenging, for projects with limited site capacity for renewables. Developers and builders are reluctant to design all electric projects because of market limitation concerns. Customers are accustomed to gas, especially for cooking, and the cost to operate electric appliances are still higher than gas.

California's Rule 18 creates a direct relationship between the utility company and the end user of electricity. It prohibits owners of multi-family residential buildings from charging building occupants for electricity. Under this regulatory rule, neither building owner nor developer can act as an intermediary agent between the utility and the customer. Developers who choose to be the utility account owner have no method of providing a financial signal to the tenant to conserve.

AB 327 – Net Energy Metering Laws

Assembly Bill 327 (Perea) was approved by the Governor on October 7, 2013 and became law on January 1, 2014. AB 327 affects NEM regulations and allows the CPUC to consider revisions to tiered utility rate structures, specifically those of low-income customers as well as the rates of the largest users of electricity. The current NEM regulations were extended to July 1, 2017. This bill provides specific NEM caps for each of the major investor-owned utility companies (IOU), and states that the IOUs must offer NEM agreements to their customers until these caps have been met, or until the NEM expiration date (July 1, 2017), whichever occurs first. After that date, a NEM Successor Program will begin, with several significant departures from current NEM regulations. A CPUC Rulemaking (R.14-07-002) has been opened for public comment and debate, and analysis has begun on evaluating alternative proposals to the current NEM rules. Some of the proposed changes include:

- Elimination of the 1 MW size limit of individual generation systems. Removal of this limit could make community-scale systems easier to accomplish.
- Removal of utility caps on renewable energy systems and aggregate generating capacity.
- New rate structure to replace current NEM tariffs. Utilities as well as other organizations are currently involved in influencing the CPUC decision; the effect of which is unknown at this time.
- Residential rate structure changes. Currently, non-participating NEM utility customers of the IOUs are subsidizing fixed costs for the delivery and distribution system to NEM customers of the IOUs. To create a more equitable financial environment for utility companies and non-participating utility customers,

current tiered rates would be flattened, resulting in higher rates for small users and lower rates for large users of electricity. The effect of this change is unknown at this time.

- Allows the CPUC to consider a uniform charge of up to $10.00 per month for all ratepayers to offset the fixed costs for the delivery and distribution system.

Depending on the outcome of this process, this could significantly influence decisions on which onsite generation model is optimal for Nishi/Gateway.

UTILITY COORDINATION ISSUES

With a new development, the utility company works with the developer to ensure services are available and the infrastructure exists to serve the new loads of the development. Utilities typically provide the following:

- Grid infrastructure analysis and upgrades as needed.
- Review of utility plans and inspections during construction.
- Supply and installation of all gas and electric meters on-site.
- Pulling of all conductors to each meter (developer is responsible for trenching, conduit installation, transformers and other equipment on site).
- Operation, maintenance and repair of utility infrastructure up to, and including each building meter.

Utilities charge for these interconnection services but 50-60% of these costs are reimbursed to developer as meters come on-line. Costs associated with the purchase and installation of the RE systems are the responsibility of the developer. As community-scale ZNE projects come on-line, the utilities will become increasingly concerned with net effects on the existing grid and infrastructure. ZNE projects have very different load profiles which may or may not create constraints with the existing infrastructure.

3. West Village Review & Lessons Learned

As an early project trying to achieve ZNE on a community-scale, West Village provides both valuable lessons learned from the development of the energy generation, distribution and management systems for a newly-developed community; and tools to accelerate ZNE community development to other communities in California. One goal of the West Village project was to serve as an early example for community-scale ZNE, providing guidance for policy-makers and other stakeholders to improve policy and practice with regard to the adoption of ZNE construction; in line with the published goals of the California Energy Commission, California State Legislature, and the Governor's office. It is also the intent of West Village to provide a partial road map to future project teams attempting to develop community-scale ZNE projects, and by doing so, help to reduce obstacles and lower costs of future ZNE construction.

PROJECT DESCRIPTION

The West Village project at UC Davis is the largest planned ZNE community in North America. The planned land uses include privately developed market-rate apartment housing for 1,980 students, 343 single-family homes for UC Davis faculty and staff, and approximately 42,000 square feet of commercial and academic space. The $300 million project is designed to be an environmentally-responsive community within the university campus; developed on UC owned land with a long-term ground lease to the developer, through a public-private partnership. The project includes 4.2MW of PV serving the student housing and mixed-use portion of the project. The multi-family portion of the project was fully occupied as of fall 2013, and construction of the single-family home component is pending.

PROJECT CHALLENGES

West Village was the first community-scale ZNE project of its kind with no prior case study or lessons learned to leverage. In addition, the developer had no previous experience with ZNE or high-performance construction.

An initial requirement was that all units be leased or sold at competitive market rates and therefore it was crucial to identify cost effective and proven approaches to sustainable design. During planning and design, West Village faced multiple challenges to meet community ZNE goals while maintaining affordability and quality of design. Planning and coordination between developer, UC Davis, and both the design and construction teams were necessary to achieve deep efficiency gains and provide adequate renewable generation while maintaining competitive market rates.

Initial ZNE design strategies at West Village included a community-scale micro-grid model with the use of multiple community-scale PV arrays, each sized under 1MW (per NEM regulations), and connected to a portion of the community's loads. While this configuration would have captured the benefits of a community-scale installation with regard to overall balancing of energy generation and demand on the site, the utility would not provide the traditional services to the community where it would support the design, installation and maintenance of the grid infrastructure within the property boundaries. Under this option, the utility would terminate service at the edge of the property boundary. The developer or university would then be required to provide all dry utility infrastructure within the community, and be responsible for ongoing operation and maintenance of the lines and equipment. Essentially, this would have required the developer or university to be in the power production and distribution business within the community, which neither entity was interested in doing. They would also not be eligible for any cost reimbursements from the utility. The developer calculated that this strategy would add approximately $2 million in costs. As a result, the developer chose not to pursue this option, and instead installed the RE systems based on the traditional NEM model.

Additional disincentives for the community-scale micro-grid model were due to reduced incentives for PV under the California Solar Initiative (CSI) program. Because of high enrollment in the CSI program, per kW incentives were significantly lower than the incentives under the New Solar Homes Partnership (NSHP) program. For these reasons, the developer installed individual PV systems for each meter under the NSHP program. Each apartment has its own meter, PV array, inverter, and utility account. Under this scenario, there is no ability to aggregate production and loads.

The following is an overview of the challenges and lessons learned at West Village.

- Higher energy use assumptions should be assumed for student housing. Since historical data did not exist for housing specific to student housing, original modeling assumed typical multifamily energy consumption, which was found to be significantly lower than actual energy use in the apartments at West Village. Part of the reason for this is the high saturation of occupant supplied plug loads and electronic devices.
- Split incentive dilemmas: The builder/owner invests in efficiency and renewable energy (RE) systems up front, but unless they are the utility account ratepayer (end user), they can't recover their investments through savings in operating costs overtime. If the builder/owner is the utility account ratepayer, under Rule 18 regulations, they cannot act as a utility and charge tenants for electricity used. Utilities have to be included in the tenant's rent. In this scenario, there is no financial motivation on the tenants' part to conserve or use energy responsibly, and high energy users are subsidized by other tenants.

- Energy consumption displays should be installed in all apartments to provide tenants with real-time feedback on energy use. At West Village, tenants do not have tools to understand the effects of behavior on energy use they are not provided any financial signals to conserve energy.
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- There were challenges with implementation and operation of some of the new energy efficient technologies.
  - Central heat pump water heaters installed at the student housing buildings. There have been operational issues with the water heaters due to unfamiliarity with and reliability of the equipment. Some of these issues were resolved with the next generation of water heaters from the manufacturer. Other issues had to do with improper application of equipment and absence of ongoing monitoring.
  - Energy use displays and controls. The strategy proposed for providing occupant feedback and control of plug loads in the apartment created conflicts with other wireless communication devices and was not installed in the end. Not providing the occupants with any feedback on actual energy use may have a significant impact on expected performance.

WEST VILLAGE RECOMMENDATIONS

There were a number of policy and development design recommendations that came out of the experiences at West Village, both during design and development, as well as post occupancy monitoring and evaluation.

Policy

1. Revise and clarify utility rules that currently limit the methods that can be used by owners and operators of ZNE communities to be able to charge residents for electricity use. This is needed to provide both adequate cost recovery of renewable and efficiency investments for owner/operators, and to provide a motivating signal for residents to use energy more efficiently.
2. Utilities should provide reasonable and fair compensation for 'over-generation' above and beyond the ZNE goal on an annual basis. This will create the incentive for ZNE systems to be sized adequately and to take into account the uncertainty inherent in real vs. modeled usage, system degradation, and future climate change.
3. Address the issue of increasing and inefficient plug-loads. The state should continue to develop and implement technically feasible and cost-effective standards for plug-loads including for set-top boxes, computers, and other consumer products. Development of easy to use plug-load control devices is also needed.
4. Provide a clear roadmap for ZNE including the timing of regulations and availability of incentives. Community-scale ZNE projects typically span multiple years from concept to completion. Changes to programs and incentives during the development phase can change the optimal design and project financials creating difficulties for developers. Where possible and useful, consider providing opportunities for developers to reserve or 'lock-in' the value of certain programs and incentives.

Development Design

1. In spaces where the tenants will not be the utility bill owners, strategies to encourage the responsible use of energy should be considered. For example, in apartments energy

consumption meters could be installed which display real time energy use and provide feedback to tenants on whether or not targets are being met.

2. Occupants should be provided easy to understand training on proper operation of appliances, space conditioning equipment, and controls in the spaces that encourage efficient use and behavior.
3. In marketing the community, the efficiency and sustainability aspects of the project should be highlighted. Simple yet effective strategies need to be identified to communicate the benefits of living in a ZNE community to potential occupants.
4. Integrated Design: Close coordination between all project team members is crucial from project commencement all the way through completion.
5. Close attention should be paid to system commissioning before building occupancy. It's recommended that more complex mechanical systems be equipped with monitoring systems combined with a management plan to be able to quickly identify system problems during operation.
6. During and after construction and prior to occupancy, building systems should be inspected to ensure that the installed systems meet the design and performance criteria.

4. Nishi Evaluation Methodology

PROJECT ENERGY USE ASSUMPTIONS

Community level energy consumption was estimated based on general specification assumptions for building and site loads, performance targets and energy intensities from previous studies. The main categories for community energy loads are listed below:

- **Building energy use**
  - Multifamily (MF) for sale
  - Multifamily rental
  - Community space for the residential occupants
  - Commercial Research & Development / Office (R&D)
  - Retail spaces
- **Outdoor site lighting and other end uses**
  - Roadway lighting
  - Walk/bike path lighting
  - Open parking lot lighting
  - Lighting for enclosed garage parking areas
  - Enclosed garage parking ventilation systems
  - 1 community pool (no heating)
  - 3 spas heated year-round

The following have NOT been included in this analysis: Water features (i.e. fountains), electric vehicle charging, and water supply, conveyance or irrigation pumping. Since energy use related to transportation is not included in this analysis, the effects of electric vehicle charging is not included. Additional renewable energy capacity, above what is required for other on-site uses, would be necessary if electric vehicle charging is considered.

Building energy use was evaluated based on the characteristics described in Table 1 with energy intensities relative to building floor area. Estimates for the multifamily and retail spaces primarily relied upon results from a 2012 study conducted by Pacific Gas & Electric (PG&E), *The Technical Feasibility of Zero Net Energy Buildings in California*[4]. Actual energy use for the commercial R&D buildings is highly variable depending on the tenant mix occupying the buildings and the actual use for the buildings. Current energy estimates were based on assuming 50% would be used primarily as office space, the energy use for which was based on the PG&E study. The other half would be more energy intensive laboratory space and a sample of monitored buildings on the UC Davis campus was used to identify average energy use per floor area. Included in these averages are process steam and chilled water loads, the degree to which these will be present in these buildings is unknown at this time. The ultimate occupancy and use of the R&D spaces may have a significant impact on annual energy use.

Table 2 describes assumptions used in this analysis for the pool and spa energy use. Sizes were identified based on other recreational systems that have been installed or planned recently at residential facilities in the Davis area. Pumping for filtration purposes is driven by an efficient variable speed motor and filtration rates are reduced during unoccupied times to 35% of design flow per provisions in the California Health & Safety Code[5]. Both pool and spas are assumed to have pool covers and covered during unoccupied periods. If covers are not used, water consumption due to evaporation will increase and spa heating energy use will go up by over 50%.

LED lighting is assumed throughout the Nishi project for both interior building lighting and exterior site lighting. Roadways, pathway, and garage lighting estimates were based on a combination of case studies of similar applications, the 2013 Title 24 energy code, and assume occupancy and bi-level lighting controls on all pathway and garage lighting. Lengths and areas presented in

Table 3 were either measured from the site plan or, in the case of parking areas, calculated according to a vehicle density of 400 ft2 / vehicle[6]. Ventilation loads in the enclosed garage areas were also calculated and estimates were informed by the 2013 Title-24 code, assuming the use of efficient variable-speed exhaust fans, and demand controlled ventilation.

[4] PG&E, 2012. *The Technical Feasibility of Zero Net Energy Buildings in California*. December, 2012. http://www.energydataweb.com/cpucfiles/pdadocs/904/california_zne_technical_feasibility_report_final.pdf

[5] The local health and safety office will need to be consulted to determine if this is allowable in Davis. http://www.cdph.ca.gov/HealthInfo/environhealth/water/Documents/RecHealth/Title%2022,%20Chapter%2020,%20Sections%2065501-65551.pdf

[6] The density was calculated from the 200,000 ft^2 Southwest parking lot with a capacity of 500 cars.

Table 1: Building Level Assumptions for Energy Calculations

	MF For Sale	MF Rental	R&D	Retail
Occupancy Description	Res. Hi-Rise w/ common area	Res. Hi-Rise w/ common area	Commercial R&D, varied	Coffee shop, conv. store, small retail, daycare
# of Buildings	2	3	5	Included in R&D bldgs
# of Res Units	210	440	N/A	N/A
Avg Unit Size (ft^2 / Unit) [7]	1,402	1,058	N/A	N/A
# of Bedrooms (Total)	420	1,500	N/A	N/A
% Student Housing	0%	85%[8]	N/A	N/A
# of Stories	5	5	3	N/A
Total Residential Space (ft^2)	274,300	485,800	N/A	N/A
Common Area & Corridor (ft^2)	50,900	118,400	N/A	N/A
Total Conditioned Floor Area (ft^2)	325,200	604,200	325,000	20,000
Performance Target	ZNE Ready (30%+ above code)	ZNE Ready (30%+ above code)	ZNE Ready (30%+ above code)	ZNE Ready (30%+ above code)
Lighting	100% LED	100% LED	LED, Daylighting	LED, Daylighting
EnergyStar Appliances/Electronics	Yes	Yes	Yes	Yes
Space Heating Fuel	Gas	Gas	Gas	Gas
DHW Type Configuration	Individual	Central	N/A	N/A
DHW Fuel	Gas	Gas	Gas	Gas
Laundry Configuration	In-Unit	Central	N/A	N/A
Dryer Fuel	Gas	Gas	N/A	N/A
Cooking Fuel	Gas	Gas	N/A	N/A

Table 2: Pool & Spa Assumptions for Energy Calculations

	Pool	Spa
Volume (gal)	80,000	2,500
# of Units	1	3
Seasonal Operation	8 months	Year-round
Hours Open	8am-10pm	8am-10pm
Pump control	Variable Speed Pump	
Heating	None	Gas, >= 90% efficient
Pool Cover	Cover on at night	

[7] Average unit sizes differ slightly than figures provided by the developer of 1,306 ft^2 for the units for sale and 1,104 ft^2 for the rental units. Floor areas presented in the table are based on the site plan, building design and area calculations provided by consultant MIG. Total residential space at the project level has not changed

[8] Additional loads were assumed for these apartments based on results from the West Village community.

Table 3: Site Assumptions for Energy Calculations

	Community-Wide
Lighting Technology	LED
Roadway Length (ft)	4,200
Walk/Bike Path Length (ft)	6,100
Surface Parking Lot (ft^2)	344,000
Garage Parking (ft^2)	433,000[9]

RENEWABLE ENERGY OVERVIEW & ANALYSIS ASSUMPTIONS

Davis has abundant solar resources for generating electricity locally with PV. On-site PV generation is the easiest and simplest source for offsetting energy consumption at Nishi and it can be used to directly offset on site electricity use. The major challenge is that it cannot currently be used to directly offset natural gas use. PV is the focus of the quantitative resource potential analysis; however, other electricity generation technologies and strategies to directly or indirectly offset natural gas are also reviewed.

Wind Energy

Mean wind speeds at 30 meters (98.4 feet) elevation for the local region are 10-12 mph[10]. Typical heights for building integrated turbines will be slightly lower than this elevation (~ 70 feet). Many micro-wind turbines will not start generating below 6-8 mph, and rated outputs are based on higher wind speeds than typical in this area, so annual production will be below rated. Return on investments (ROI) on wind turbine generators will be much lower than that of PV. Prices on PV equipment and installations have dropped significantly and continue to do so. Micro-wind turbines have not seen the cost reductions of PV and also will require more maintenance and servicing over time. More reliable wind resources may exist nearby in the rural areas around Davis.

There may still be a desire to include wind generation on site for demonstration and marketing purposes. They can function as a visual iconic focus and messaging for the community and can also function in a kinetic sculptural purpose.

Biogas

Biogas is a renewable strategy that allows for natural gas consumption to be directly offset. The use of on-site biogas generation was investigated at West Village, utilizing the abundant feedstock available from agricultural operations and food waste from the dining halls. In the end, the biogas project was installed at the old UC Davis landfill and not directly tied to West Village. The proposed strategy for the single family homes at West Village is to offset natural gas use with biogas offsets.

While the Nishi community won't have a significant source of feedstock for biogas generation, there may be an opportunity to utilize biogas through collaboration with UC Davis or through a potential future biogas source with the city of Davis. Biogas offsets can also be purchased from PG&E. Purchase of biogas offsets should be considered for all natural gas consumption on site. Because of the current limitations for offsetting natural gas

[9] Includes podium parking at residential buildings and the 3 enclosed levels of the 845-car garage adjacent to the R&D buildings. The top level of the 845-car garage is treated as surface parking for lighting purposes and is included in the surface parking total.

[10] California Wind Resources Maps, California Energy Commission, PIER funding. http://www.energy.ca.gov/maps/renewable/wind.html

use with on-site PV generation and the limited capacity for onsite generation, it is currently more cost effective to design the community to offset as much electricity use through onsite PV and purchase biogas offsets for all gas use.

Cogeneration / Combined Heat and Power (CHP)

Combined heat and power (CHP), also known as cogeneration, is the simultaneous production of electricity and heat from a single fuel source. CHP provides onsite generation of electrical and/or mechanical power, and waste-heat recovery for heating, cooling, dehumidification, or process applications. A gas turbine or engine with a heat recovery unit is the most common CHP system configuration for these applications. Gas turbine or reciprocating engine CHP systems generate electricity by burning fuel (natural gas or biogas) to generate electricity and then use a heat recovery unit to capture heat from the combustion system's exhaust stream. This heat is converted into useful thermal energy, usually in the form of steam or hot water. Gas turbines/engines are ideally suited for large industrial or commercial CHP applications requiring ample amounts of electricity and heat.

Preliminary evaluation of the CHP feasibility at Nishi found limited applicability due to minimal need for waste heat on site. Prior CHP evaluations for projects of this scale in this climate found that there needs to be a significant need for the waste heat generated in projects to justify the infrastructure costs associated with CHP systems. This technology is best suited where there are industrial applications with large requirements for hot water or steam, or in climates with larger seasonal heating loads.

Photovoltaics (PV)

PV solar electric systems were assumed to estimate the renewable potential at Nishi. Following is an overview of assumptions and calculation methodology.

PV module density (DC Watts/ft^2) and specific production (kWh/kW) were provided by solar module vender, SunPower, based on Sacramento weather. These values are representative of SunPower's latest module technology and micro-inverter systems. PV systems are assumed to be oriented directly South (180^o azimuth) and at a 10^o tilt. This small tilt is typical of systems installed on flat roofs and as parking shade structures, allowing for improved natural removal of debris and increased density of installation relative to steeper pitches. For the South facing configuration the specific production applied in this evaluation is 1,651 kWh/kW. Also evaluated is the impact of orienting PV south-southeast, which is reflective of the site configuration for certain buildings and surface parking areas at Nishi. The specific production at this azimuth is 1,586 kWh/kW.

Table 4 describes the available areas for siting PV. Available areas include roof space on all buildings as well as ground-mounted systems installed as shade structures at proposed surface parking areas. PV utilization areas account for required offsets and spacing due to other rooftop equipment. At the MF for-sale buildings about one-third of the total roof area has been dedicated to garden terraces or other community space. Of the remaining area, a 25% reduction is applied at all the MF buildings to account for offsets and mechanical equipment. A 50% reduction is applied at all the R&D buildings because more space is expected to be required for mechanical equipment due to the lab spaces. An additional 28% reduction in area was applied to the utilization areas to account for module spacing to avoid shading from adjacent rows[11]. Carport PV shade structures densities in the parking lots are based on typical existing PV carport installations. Total roof areas were measured from the site plan and provided by the consultant team[12]. Higher PV densities are possible if modules are installed above the rooftop HVAC equipment, but would result in much higher installation costs.

[11] Except for the carports where this spacing was already included in the 50% density assumption.
[12] Site plan developed by MIG, dated 6.11.15.

Flat roof PV installations are typically ballast-mounted with minimal roof penetrations. Installing PV above HVAC equipment requires more expensive mounting and also will affect the structural loads on the buildings.

Additional areas on the site were also considered for PV. These include:

- Siting PV along the 80 foot setback strip on the property boundary adjacent to the railroad tracks. The section of the setback strip considered for PV extends from the southern open space parking lot 1,200 feet to the bottom corner of the property. Other areas along the 80 foot setback, including the open space parking areas behind the residential buildings, were not considered due to shading conflicts with adjacent 5 to 6 story buildings directly to the east.

- A pole-mounted system installed within the retention pond at the south-west end of the site. The area over the retention pond is measured as the area directly over the basin and doesn't include the surrounding recreation areas.

These areas were not initially discussed as sites for locating PV, as they present certain challenges. For example, there may be shading concerns from trees adjacent to the railroad track setback, and there may be aesthetic concerns locating PV arrays on poles located in the retention pond. However, these areas represent significant renewable production potential to meet on-site ZNE requirements and the trade-offs should be thoroughly discussed. Originally, the podium / courtyard areas around the apartment buildings were also considered; however, based on the proposed site plan it's expected that shading from adjacent buildings would have too much of an impact to locate PV production in the podium/courtyard areas.

The core area of the site separating the housing and commercial buildings and the park areas were also not considered for siting of PV due to shading and conflicts with other uses. Vertical PV installations on building facades are another potential application, but are much more susceptible to shading. These were not included because they are typically not cost effective unless incorporated as part of the architectural façade for other reasons.

Table 4: Site Assumptions for Available PV Production

	Total Available Area	PV Utilization % / Area
PV on Building Rooftops		
MF For Sale – North Bldg	42,000 ft^2	54% / 22,500 ft^2[13]
MF For Sale – South Bldg	46,750 ft^2	50% / 23,375ft^2
MF Rental (3 Bldgs)	121,000 ft^2	75% / 90,750 ft^2
Commercial / R&D (5 Bldgs)	132,250 ft^2	50% / 66,125 ft^2
Ground Mount PV		
Canopies at Surface Parking	237,500 ft^2[14]	50% / 118,750 ft^2
Canopies at Top Level of Parking Garage	87,000 ft^2	50% / 43,500 ft^2

[13] The area and location for the rooftop gardens were designed and incorporated by MIG for this building. 30,000ft^2 is the area available for PV.
[14] This doesn't include the parking lots to the northwest of the residential buildings. These weren't considered appropriate for siting PV due to the shading impacts from the adjacent buildings.

Table 5: Site Assumptions for Additional PV Production Areas

	Total Available Area
Railroad Setback	96,000 ft^2 (80ft wide, 1,200ft long)
Retention Pond	30,900 ft^2

Single or dual-axis tracking PV arrays incorporate automatic controls and motors to change the tilt and/or orientation of the PV array throughout the day to optimize solar energy collection. While tracking systems increase production for a given array, they also require more physical space to prevent self-shading. For this reason, PV tracking arrays actually have lower production within a given area, than non-tracking arrays. For a project such as Nishi where space is a limiting factor, tracking systems are not advantageous and are not recommended.

Solar Thermal

Solar water heating for the multi-family buildings should also be considered, as it is now a prescriptive component of the Title-24 energy code. The challenge is that these systems compete for valuable rooftop space with PV and other mechanical equipment. The balance to strike is very dependent on systems costs and energy savings. Solar water heating was not explicitly evaluated in this study, because solar thermal offsets natural gas use and would eliminate space for PV which directly offsets electricity use. From a TDV perspective, offsetting electricity has much higher value than offsetting natural gas.

5. Energy Use & ZNE Feasibility Results

Meeting ZNE goals on the Nishi Gateway site with on-site renewables alone is challenging. The site is proposed for high density urban housing and R&D commercial space resulting in high energy use intensities (EUIs). The site is also relatively small, bounded by Interstate 80, the Union Pacific railroad tracks, and an urban portion of Davis (e.g., the West Olive Drive area). Much of the available open space is also reserved for community parks, open space and greenbelts, limiting the available area for renewable generation on site.

Table 6 presents projected total annual energy use for the community, disaggregated by major load category. To achieve zero net electricity almost 5.6 MW of PV is necessary. Slightly more capacity at 6.7 MW is required for offsetting 100% of TDV energy use.

Table 6: Results of Energy Consumption Estimates

		Estimated Annual Energy Use		
		Electricity (MWh)	Natural Gas (Therms)	TDV Energy (MBtu)
Buildings	*MF For Sale*	1,450	21,860	38,215
	MF Rental	3,092	61,480	82,444
	R&D	4,171	102,050	136,422
	Retail	107	1,800	3,351
Outdoor Lighting + Other Loads	*Roadway Ltg*	4	0	81
	Walk/Bike Path Ltg	65	0	1,183
	Open Parking Ltg	7	0	135
	Garage Ltg	131	0	2,365
	Garage Ventilation	195	0	4,187
	Pool	15	0	310
	Spa (x3)	28	5,130	1,479
	Community Total	**9,265**	**192,320**	**270,172**

Estimated onsite PV production is presented in Table 7. Using available area on the building roofs and carports at the open parking lots, enough energy is produced to offset 87% of the annual electricity consumption and 73% of annual TDV consumption projected for the community.

Table 7: Onsite PV Production Potential

	PV Capacity (kW)	Annual Electricity (MWh)	Annual TDV Energy (MBtu)
Building Rooftops	2,652	4,378	106,526
Carports	2,240	3,699	90,005
Community Total	**4,892**	**8,077**	**196,531**
% ZNE	**-**	**87%**	**73%**

In Figure 1, the approach to ZNE is evaluated for each building using total estimated building energy consumption and potential production from the rooftop only. In all cases, ZNE cannot be achieved with PV on the rooftops alone. Additional off-roof PV is necessary to meet ZNE goals. The higher ZNE targets achieved by the rental multifamily units are due primarily to the higher assumed density of PV of these roofs.

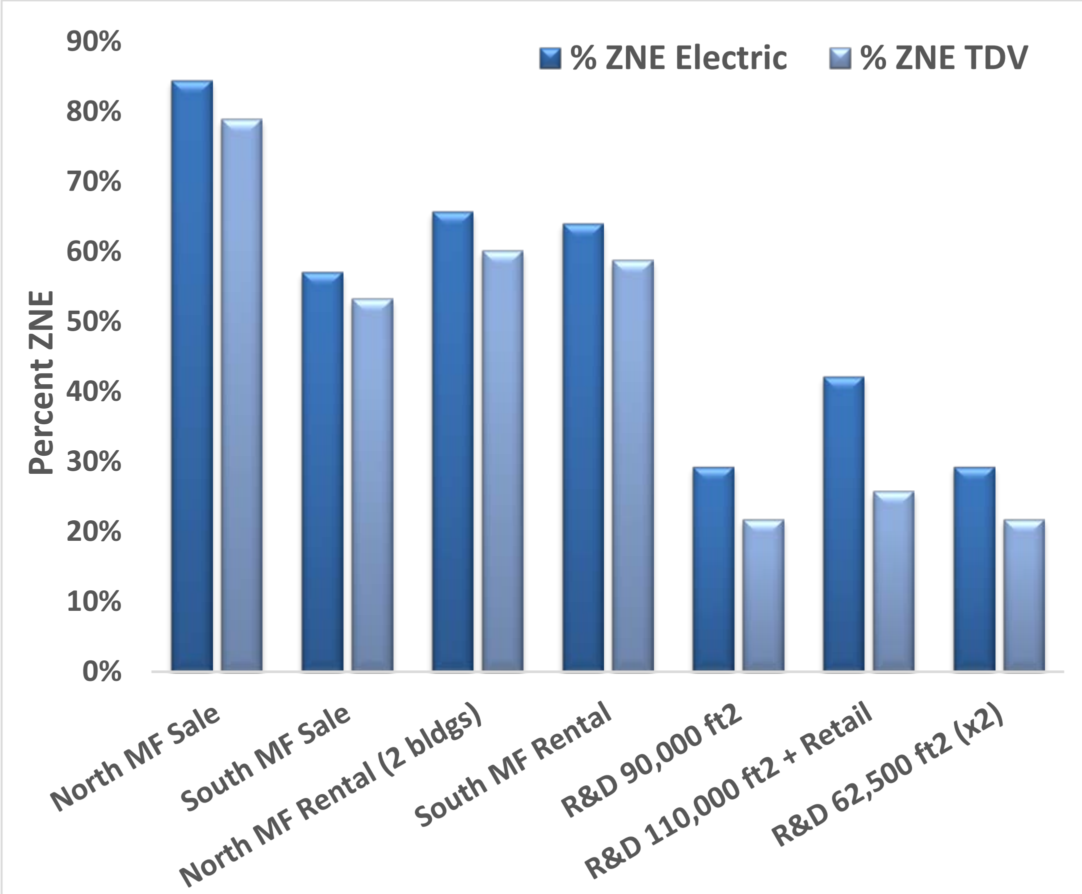

Figure 1: ZNE Potential per Building Typology

If the three additional areas discussed above (and summarized in Table 8 below) are considered for siting PV arrays, and these areas are utilized to the capacities assumed in this analysis, the project can meet zero net energy with on-site production. Total production would be 18% greater than estimated community electricity consumption and would fall just short of meeting 100% of predicted TDV energy consumption.

Table 8: Additional Onsite PV Production

	PV Capacity (kW)	Annual Electricity (MWh)	Annual TDV Energy (MBtu)
PV Capacity from Table 6	4,892	8,077	196,531
Railroad Setback	1,311	2,165	52,680
Retention Pond	422	696	16,945
Revised Comm. Total	**6,625**	**10,939**	**266,156**
% ZNE	**n/a**	**118%**	**99%**

ADDITIONAL PARAMETRICS

Electric Space Heating and Water Heating at Residential Units

The impact of shifting space heating and water heating loads in the multi-family buildings from gas combustion to electric heat pumps was evaluated. Results are presented in Table 9 and show a negligible impact on TDV energy use and an 8% increase in electricity use requiring an additional 442 kW of PV to offset.

Table 9: Impact of Shifting Water Heating and Space Heating Fuel Source at the MF buildings from Gas to Electricity Using Heat Pumps

	Annual Energy Use		
	Electricity (MWh)	Natural Gas (Therms)	TDV Energy (MBtu)
MF For Sale	1,638	8,950	37,426
MF Rental	3,633	27,910	83,745
All Other Loads	4,723	108,980	149,513
Community Total	**9,994**	**145,840**	**270,684**
% ZNE	**81%**	**n/a**	**73%**

Impact of Research & Development Buildings Use

There is potential for significant variation in energy use at these buildings depending on the mix of tenants and the energy use intensity of the spaces. Based on our engineering estimate, this range results in an increase or decrease of up to 24% of energy use at the R&D buildings and ±12% effect on community-wide energy use.

Impact of Rooftop Area Utilization on PV Production

Annual site electricity production can be improved if measures are taken to maximize the available building rooftop space for PV by locating mechanical equipment off the roof or under PV arrays and optimizing PV system design such as by incorporating creative mounting strategies that yield higher energy production. See the Energy Plan in the Nishi Gateway Sustainability Implementation Plan for more details. If 90% of total rooftop space at the multi-family rental and the R&D buildings and 60% at the multi-family for-sale (to allow for roughly 33% of total rooftop area for garden terraces) is made available for PV arrays, 105% of total predicted community electricity use and 88% of TDV energy use can be offset by onsite generation. If this strategy was combined with at least a portion of the additional evaluated areas (railroad setback, retention pond), it’s estimated that both ZNE-Elec and ZNE-TDV can be achieve at Nishi with onsite generation alone. Figure 2 demonstrates revised ZNE potential on a building basis.

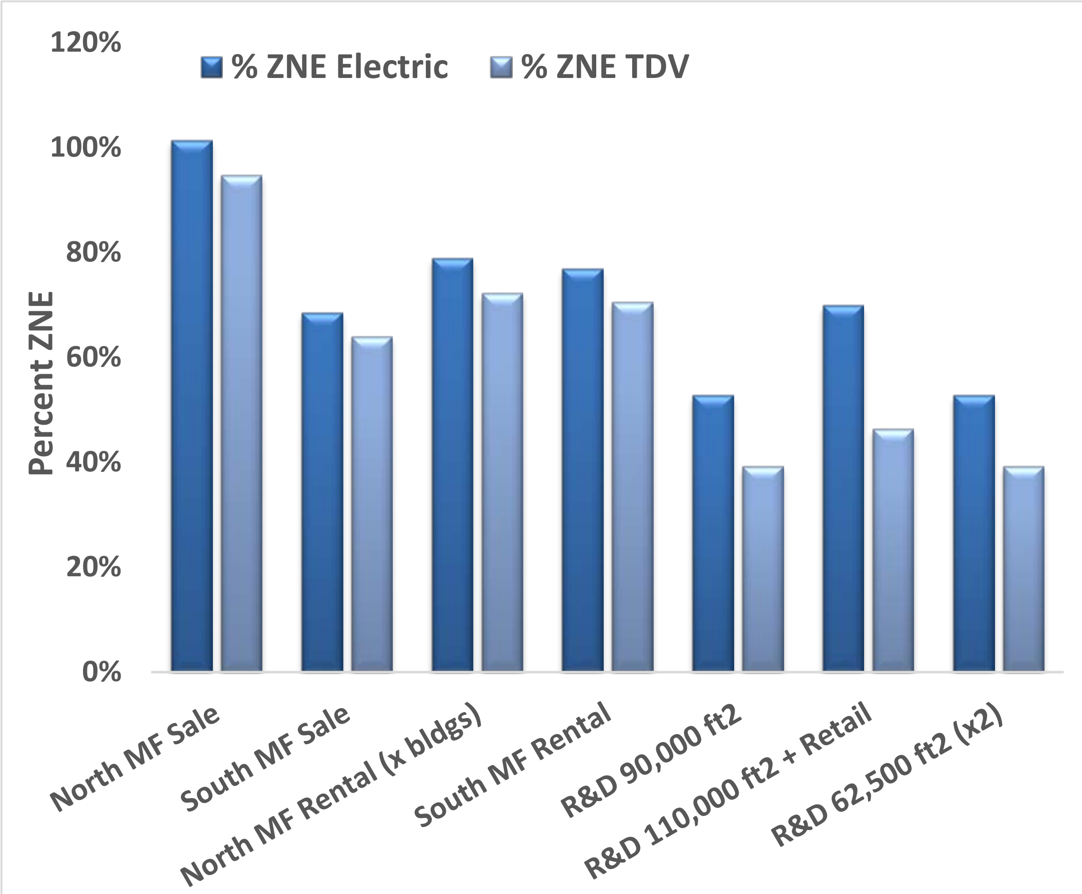

Figure 2: Updated ZNE Potential per Building Typology with Increased Building Rooftop Coverages

Impact of Orientation on PV Production

The long axis of the site is oriented 35° west of south, but the results above assume the PV arrays are facing south. If arrays are installed facing either east or west of south (125° - 215° azimuth) because of building or parking lot orientation, annual PV production will decrease. In order to achieve the same annual electricity production to meet ZNE goals as a south-facing array, up to 3% more capacity will be required to meet the ZNE-Elec target and up to 7% more to meet the ZNE-TDV target.

6. Opportunities & Conclusions

DEG's energy consumption analysis predicts community level electricity and gas use at the Nishi project to be slightly over 9,200 MWh and 192,000 therms annually. PV production utilizing building rooftops and parking areas is estimated to cover 87% of project electricity use and 73% of TDV energy. 100% of the energy used onsite can be offset with onsite electricity generation if additional locations for PV siting are utilized.

This analysis provides a first look at ZNE feasibility at Nishi, including the realities and challenges along with opportunities and options. It's acknowledged that there are various competing public policy objectives for available space and onsite resources, and dedicating them all to PV or other on-site renewables may not be feasible. These trade-offs should be discussed and evaluated collaboratively amongst project team members and stakeholders to determine the optimal approach at Nishi.

DISTRIBUTED GENERATION POLICY MODELS

One of the lessons learned from West Village was that creative community solutions to ZNE are a challenge working with the current California regulatory framework. Since that time there have been certain updates to policy which allow for additional solutions; however limitations still exist, and utility policies that allow flexibility for community-scale projects, without penalizing developers for creating atypical arrangements, are still needed.

There are significant advantages to community-scale renewable systems over the traditional NEM model utilized on a building-by-building basis. These include but are not limited to:

- Lower installation costs
- Sharing of renewables across multiple buildings and uses
- For developer-owned rental properties:
    - More control over systems and appliances in buildings
    - Address Issue of split-incentives: Developer finances renewable energy and energy efficiency investments, and tenant reaps benefits of lower utilities

The following is a discussion of policies and new laws that could affect the Nishi/Gateway community.

Virtual Net Metering

Virtual Net Energy Metering (VNEM) allows the use of a single community-scale PV system to serve the needs of a multiple tenant building. The energy produced is allocated by the utility to both the building owners' and tenants' individual utility accounts, based on a pre-arranged allocation agreement. However, VNEM cannot be extended beyond the building.

This arrangement could be applied individually on each of multifamily buildings at Nishi/Gateway. Benefits include the following:

- Reduced cost of construction
- Better alignment of production with consumption - Allocations across tenants can be adjusted based on actual use

Net Energy Metering Aggregation

If several of the multifamily or commercial buildings are solely owned, leased or rented by one entity and that same entity is the utility customer of record, these properties may qualify for Net Energy Metering Aggregation (NEMA). The loads served must be on the same property as the generation system or an adjacent property and all utility accounts must be under the same customer of record. This could apply to the R&D buildings and rental apartment buildings if the property is owned, leased, or rented by the same entity who is the utility customer-generator.

SB 43 - Green Tariff Shared Renewables Program

California Senate Bill 43 (Wolk) was approved by Governor Brown on September 28, 2013 and became law on January 1, 2014. This legislation enacts the "Green Tariff Shared Renewables Program", which requires regulated utilities with more than 100,000 customers "to implement a program enabling ratepayers to participate directly in offsite electrical generation facilities that use eligible renewable energy resources."

The effect of SB 43 will be to allow utility customers to purchase up to 100% of their energy from off-site, renewable sources. The power would come from small to medium-sized renewable energy projects. Customer investments in these off-site sources would result in a credit on their utility bill. Following are some of the important characteristics of this program:

- Up to 600 MW in renewable energy projects can be allocated statewide.
- 20 MW is currently reserved for the City of Davis. How this is to be allocated is unclear at this time.
- 500 kW minimum project size up to 20 MW.
- Developers of eligible RE projects will be able to sell electricity directly to customers.
- Renewable projects need to be within some reasonable proximity to enrolled participants; currently defined as within the same municipality or within 10 miles of the project.
- RE project developer would have to apply to the utility for approval. If approved, the developer would enter into a power-purchase agreement (PPA) to sell electricity to utility. The RE developer must demonstrate the community members' interest prior to approval; defined as 30% of capacity enrollment or 51% expression of interest from community members.
- Customer will purchase a portion of the developer's project. Revenues from that purchase will be paid to the customer via a bill credit from the utility.
- Municipalities are not allowed to administer this program, but they can work with developers to bring proposals to the utility.

Development of the Green Tariff Shared Renewables Program is still being finalized by the CPUC and stakeholders, so some uncertainty does still exist. If the Nishi project is accepted by the voters of Davis and is incorporated into the city boundaries, ratepayers within the community should be able to participate in any project made eligible for residents of Davis.

Community Choice Aggregation (CCA)

CCA or CCE (Community Choice Energy) is a program which allows cities and counties to purchase and/or generate electricity as a community while continuing to use the existing transmission and distribution services of PG&E. This program is currently being discussed in the city of Davis, and if such a program is adopted there's an opportunity to use the CCA to offset energy consumption that cannot be directly offset onsite. CCAs have been successfully adopted in both Marin and Sonoma counties.

Purchase of Biogas Offsets for Natural Gas Use on Site

Due to current challenges with directly offsetting natural gas use with on-site electricity generation, it is recommended that biogas offsets be considered for all natural gas use in the project. As additional opportunities become available through changes in the regulatory structure, implementation of a local CCA, or availability of local biogas sources, these can be considered as other means for offsetting natural gas.

OTHER CONSIDERATIONS

Indoor Air Quality

Given the proximity of the community to both Interstate 80 and the Union Pacific railroad tracks, there are additional recommendations and assumptions for air filtration above what's required by code, including the following:

- All outdoor air supplied to buildings should be filtered adequately to remove pollutants. Minimum filtration media specifications still need to be determined.
- Supply ventilation should be used where outside air positively pressurizes the buildings (supply flowrate > exhaust flowrate). Supply only ventilation systems pressurize the building by pumping fresh air into the space and removing it through dedicated exhausts and natural leakage. Supply ventilation allows for the outdoor air to be filtered before entering the home and is a better design here because it

minimizes the amount of outside air pollutants from entering the building through infiltration. Exhaust ventilation strategies should be avoided since they negatively pressurize buildings causing make-up air to enter through leaks in the building where little or no filtration can occur.

NEXT STEPS

Conducting an early evaluation of ZNE potential at this current stage of design for Nishi is invaluable in that it brings together team members early, promoting enhanced collaboration and creative solutions. At this stage of design, there's a tremendous opportunity to optimize building layout and orientation for PV siting and passive solar design. The Nishi site has certain limitations based on shape, orientation, and programmatic requirements, but improvements could be made to optimize building massing, orientation and siting to reduce building energy use and optimize PV production. In particular, the following should be considered and discussed:

- Coordination of PV on building rooftops with other equipment and uses, especially with any rooftop gardens or urban farming activities. Typically, PV systems are secured on flat roofs using ballasting, to minimize installation costs and rooftop penetrations.
    - Initial discussions included providing rooftop garden space with PV installed on an open trellis structure above, thus still allowing natural light in for plants. This would increase the cost of PV installation and the associated structure. It would also have an effect on building structural loads due to wind and static loading.
    - Additional strategies could include location of the rooftop gardens to the north side of the PV modules to prevent shading of the PV.
    - How much space is required for rooftop gardens and potential locations on specific buildings needs to be explored further, in coordination with open space planning for the project.
    - Rooftop aeroponic towers have the potential for increased food production per square foot relative to traditional beds and use significantly less water.
- Orientation of courtyards to maximize solar access. Depending on how the courtyard spaces are used, shading of the courtyards from the adjacent buildings can adversely affect PV production if these areas are to be installed with PV. Relocating the buildings with courtyards facing southeast could also locate more of the apartments closer to the tracks and further from the central corridor which may be undesirable.
- As the project progresses, stationary battery storage and demand response (DR) strategies should be evaluated. Currently there is no methodology of crediting storage or DR strategies with TDV, and current utility rate structures or programs do not adequately support these strategies beyond R&D applications, but this is likely to change in the future, and there may be a benefit to minimizing the importing of grid electricity during certain periods of the day.

As the community design begins to solidify, it will be important to conduct detailed energy modeling of the buildings and other systems to better estimate onsite energy use. PV system efficiencies are continuously improving which will impact the production estimates in this analysis. Once the general system types and configurations are determined, an update should be conducted to better evaluate production based on actual system specifications.

7. Definitions

ARBI	Alliance for Residential Building Innovation
Btu	British Thermal Unit (3412.1 Btu = 1 kWh)
CAHP	California Advanced Home Program
CCA	Community Choice Aggregation
CCE	Community Choice Energy
CEC	California Energy Commission
CHP	Combined Heat & Power
CPUC	California Public Utility Commission
CSI	California Solar Initiative
CUAC	California Utility Allowance Calculator
DHW	Domestic Hot Water
DOE	Department of Energy
DR	Demand Response
EE	Energy Efficiency
EUI	Energy Use Intensities (Annual energy, i.e. kWh or kBtu, per square foot)
GHG	Greenhouse Gas
HVAC	Heating, Ventilation, Air Conditioning
IOU	Investor Owned Utility
kBtu	Kilo British Thermal Units
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light-emitting Diode
MF	Multifamily
MW	Megawatt ($1x10^6$ watts)
NEM	Net Energy Metering
NEMA	Net Energy Metering Aggregation
NREL	National Renewable Energy Laboratory
NSC	Net Surplus Compensation
NSHP	New Solar Homes Program
PG&E	Pacific Gas and Electric
PIER	Public Interest Energy Research
PPA	Power Purchase Agreement
PV	Photovoltaics
QII	Quality Insulation Installation

R&D	Research and Development
RE	Renewable Energy
ROI	Return on Investment
TDV	Time Dependent Evaluation
UC	University of California
UCD	University of California at Davis
VNEM	Virtual Net Energy Metering
ZNE	Zero Net Energy

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