Chapter 4 Energy

The integration of energy efficiency measures and on-site renewable energy generation with other sustainable design strategies is an important component of this sustainability implementation plan. The focus of this chapter is on implementation actions that work towards achieving zero net energy (ZNE) by project build-out by minimizing on-site non-mobile[1] source energy demands, offsetting those remaining demands with renewable energy sources, and enhancing overall comfort and building occupant experience within the built environment.

ZNE as a goal for new development has gained considerable interest as a strategy to save energy and cut greenhouse gas (GHG) emissions. California agencies have set ambitious goals for all new residential homes to be ZNE by 2020 and commercial buildings by 2030, and the State is pursuing various policies and strategies to achieve those goals[2]. A ZNE building or community is one that uses a combination of improved efficiency and distributed renewable generation to cover 100 percent of its net annual energy use.

While there are different definitions of ZNE, for the purposes of this plan for the Nishi development, two approaches to ZNE evaluation are applied:

1. Zero Net Energy – Time Dependent Valuation (ZNE-TDV): The California Energy Commission currently proposes using the time dependent valuation (TDV) energy metric to evaluate ZNE and determine compliance with California's ZNE goals. TDV values electricity during peak periods of the summer much more than electricity used during off-peak periods. If grid demand during summer peaks can be reduced, then costly additional capacity (e.g., new power plant needed only for peak demand) can be avoided. TDV was developed to reflect the societal value of energy. It includes long-term projected costs of energy, including the cost of peak demand, and other societal costs such as projected costs for carbon emissions. With this definition, 100 percent of on-site TDV energy consumption (electricity and natural gas) is offset with on-site TDV energy production in a year.

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[1] The term "energy" in this chapter focuses exclusively on energy consumption within stationary sources such as buildings or streetlights. Transportation-related energy (e.g., motor vehicle fuels such as gasoline or diesel, or electricity usage for electric vehicle battery charging) is addressed in the Transportation chapter of this plan.

[2] California Energy Efficiency Strategic Plan: January 2011 Update' (California Public Utilities Commission, 2011) <http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf>.

2. Zero Net Electricity (ZNE-Elec): Offset 100 percent of on-site electricity use only with on-site renewable electricity production in a year. Natural gas consumption can be offset by delivery of biogas or purchase of biogas offsets from the energy utility or other sources.

The implementing actions defined in this chapter were developed consistent with the results of a ZNE Feasibility Study prepared by Davis Energy Group that was conducted specifically for the Nishi development. Key findings from this study are incorporated into various portions of this chapter; however, please refer to the technical study in Appendix C for details.

4.1 Goals and Objectives

The core principles underlying the energy-related goals and objectives are based on integrating highly-efficient design standards throughout both the horizontal and vertical infrastructure within the plan area, paired with renewable energy generation, as a means of working towards achieving ZNE for the development as a whole by development build-out. The following goals and objectives are a subset of those identified in Chapter 1 and relate specifically to this chapter.

- **Goal 1:** Serve as a model for low-carbon, climate-resilient development that also enhances the fiscal and equitable sustainability of the broader community.
  - **Objective 1.2**: Encourage innovative site and building design that encourages a healthy and interconnected natural and built environment, conserves natural resources, and promotes equitable and efficient communities.
  - **Objective 1.4:** Promote and demonstrate resiliency to the effects of climate change and other challenges through project design.
- **Goal 3:** Design and construct high-performance buildings, public lighting, and on-site renewable energy systems that work towards achieving ZNE by Nishi development build-out.
  - **Objective 3.1:** Achieve high-performance buildings at a minimum 30 percent compliance margin relative to the 2013 Title 24 Building Energy Efficiency Standards, or equivalent. High-performance buildings will also incorporate energy consumption feedback mechanisms in order to encourage resident and employee engagement and minimize wasted energy use.
  - **Objective 3.2:** Other building loads not covered by Title 24 will also achieve high levels of efficiency, (i.e. 100 percent high-efficiency lighting, ENERGY STAR appliances and equipment), and lighting will be adaptive where practicable.
  - **Objective 3.3:** Design the Nishi development to achieve ZNE such that all site energy use is offset with renewable energy generation on an annual basis. To the extent possible, on-site generation will be used to meet this objective; however, off-site

generation and purchase of renewable energy offsets will also be considered. Site energy use to be offset includes building energy use, all street and area site lighting, and other community related energy uses such as pools and community buildings. It does not include mobile sources / transportation-related energy use.

4.2 Implementing Actions

The following are recommended strategies for the project to achieve the energy related sustainability goals and objectives outlined above. The intent of this implementation plan is to define particularly important design components while still allowing for flexibility as architectural design and engineering progresses during later stages of the development. For example, an ambitious but achievable performance target for the buildings relative to the 2013 Building Energy Efficiency Standards (California Building Code, Title 24, Part 6 [hereinafter referred to as "Title 24" or "2013 Title 24"]) is set at 30 percent; however, this may be achieved with infinite combinations of efficiency measures depending on what is determined to be most cost effective and project appropriate during the design phase.

4.2.1 Energy Efficiency: High-Performance Buildings and Infrastructure

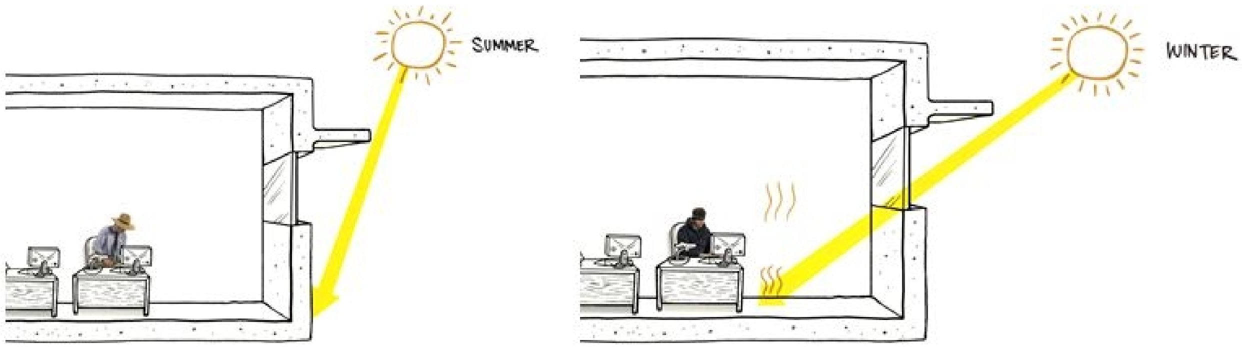
Site & Passive Building Design

To the extent possible, the shape and orientation of the buildings will be designed for passive solar optimization to reduce heating and cooling energy use and encourage daylighting. It is recognized however, that this property configuration has certain constraints that make optimization challenging. Additionally, there are other considerations including road access and central courtyard accessibility that may take precedence. Provided that these buildings will incorporate high performance envelope designs, the goals and objectives for this project can still be accomplished if certain passive design elements must be compromised.

Action 4.1: Passive Design

Incorporate passive design features into the site and buildings. The following measures shall be incorporated into the project design guidelines to maximize the potential for passive design:

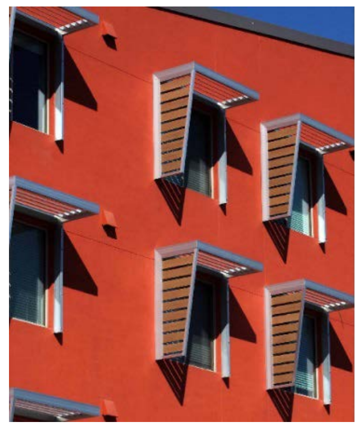
- Orient buildings to minimize east and west facing glass. Buildings with elongated footprint(s) will be oriented with the long axis east-west such that the majority of glazing is south and north facing.
- Provide exterior shading to southern glazing to minimize unwanted solar heat gains during the summer and maximize solar gains during the winter, while also allowing for windows to provide natural daylight, thus minimizing the need for artificial lighting during the day (see Figure 4-1).



(Courtesy of www.Autodesk.com)

Figure 4-1 Sun Angle during Summer and Winter

- Provide appropriate exterior shading on east and west glass to address direct solar gains at low sun angles (see Figure 4-2).
- Limit building heights to six stories or less for residential buildings and three stories or less for the commercial/R&D buildings. Adding additional floors to the buildings will increase building energy loads without providing additional area for photovoltaic (PV) systems, ultimately lowering the percent of building energy use that can be offset by renewables within the building footprint.
- A Declaration of Solar Energy Covenants, Conditions, and Restrictions (CC&Rs) will be developed and recorded against the property to protect the solar access of the property over time.



(Courtesy of University of California at Davis)

Figure 4-2 Shading on West Facing Glass

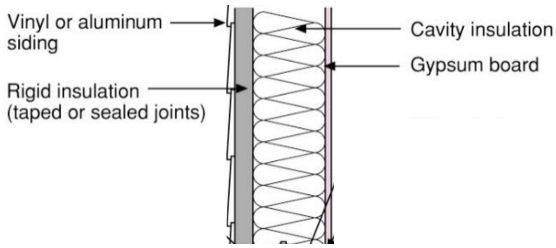
Multi-family Residential Housing

The following guidelines and performance specifications shall be integrated within the multi-family residential building designs to meet the objective of a minimum compliance margin of 30 percent relative to the 2013 Title 24 code:

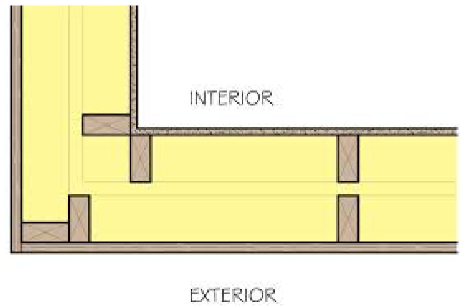
Action 4.2: High-Performance Building Envelopes – Multi-Family

Design and construct all multi-family residential buildings to include high-performance building envelopes to reduce heating and cooling loads and subsequently minimize space conditioning energy use. High performance building envelopes provide improved resident comfort and reduce indoor temperature fluctuations. The following specifications are important related aspects that will be considered:

- High-performance walls with a minimum U-value of 0.051. To the extent possible, minimize thermal bridging at framing. This is often accomplished through the use of 1 inch or more of continuous exterior insulating sheathing (left image in Figure 4-3); however, other options include double stud walls (right image in Figure 4-3) or structurally insulated panels. Addressing thermal bridging is especially important with the for-sale condominiums where concrete and steel is proposed for structural purposes. Depending on the method employed, there may also be acoustic benefits with a reduction in sound transmission.



(Courtesy of the Building America Solution Center www.basc.pnnl.gov)



(Courtesy of oyesterriverhouse.blogspot.com)

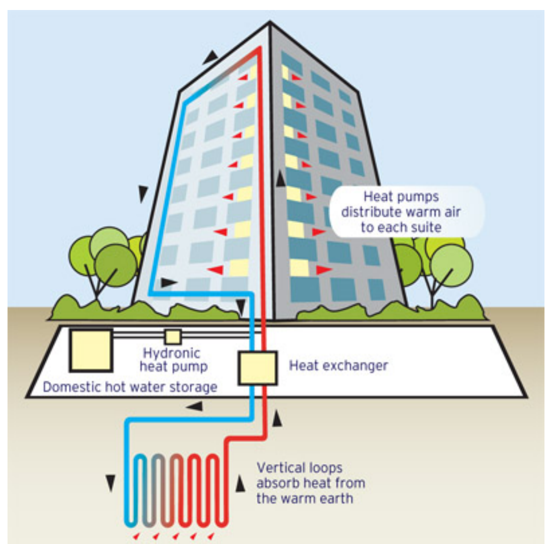
Figure 4-3 Left Image: Rigid Insulation at the Wall Exterior. Right Image: Double Stud Wall.

- High-performance glazing with a U-factor ≤ 0.20 and solar heat gain coefficient ≤ 0.20. This can be accomplished with non-metal framed windows, selective coating and insulated glazing assemblies. High-performance glazing will minimize heat loss during the winter and solar gains during the cooling season.

Action 4.3: High-efficiency HVAC – Multi-family

Incorporate high-efficiency heating, ventilation, and air conditioning (HVAC) systems in multi-family residential buildings. Cooling energy can be a significant component of total energy use in buildings located in this climate. Peak summer cooling demand also has a large impact on electric utility loads. The following are important related aspects that will be considered:

- Minimize distribution losses. Duct losses can be as high as 15-20 percent of HVAC energy use. This can be minimized or eliminated through the use of ductless distribution systems or by properly sealing and locating ductwork and equipment within conditioned space.



(Courtesy of www.fortisbc.com)

Figure 4-4 Ground Source Heat Pump with Community Loop

- Consider alternative HVAC systems that minimize or eliminate the space requirement for rooftop equipment and increase system efficiency. These include but are not limited to the following: 1) ground source heat pumps with a community loop shared between buildings. Figure 4-4 demonstrates this concept for a single large building in heating mode; 2) a central plant configuration with high-efficiency chillers, boilers, cooling towers, fans, and pumps; 3) nighttime ventilation cooling using outdoor air (see Figure 4-5), and 4) radiant heating and cooling delivery to minimize distribution system energy.

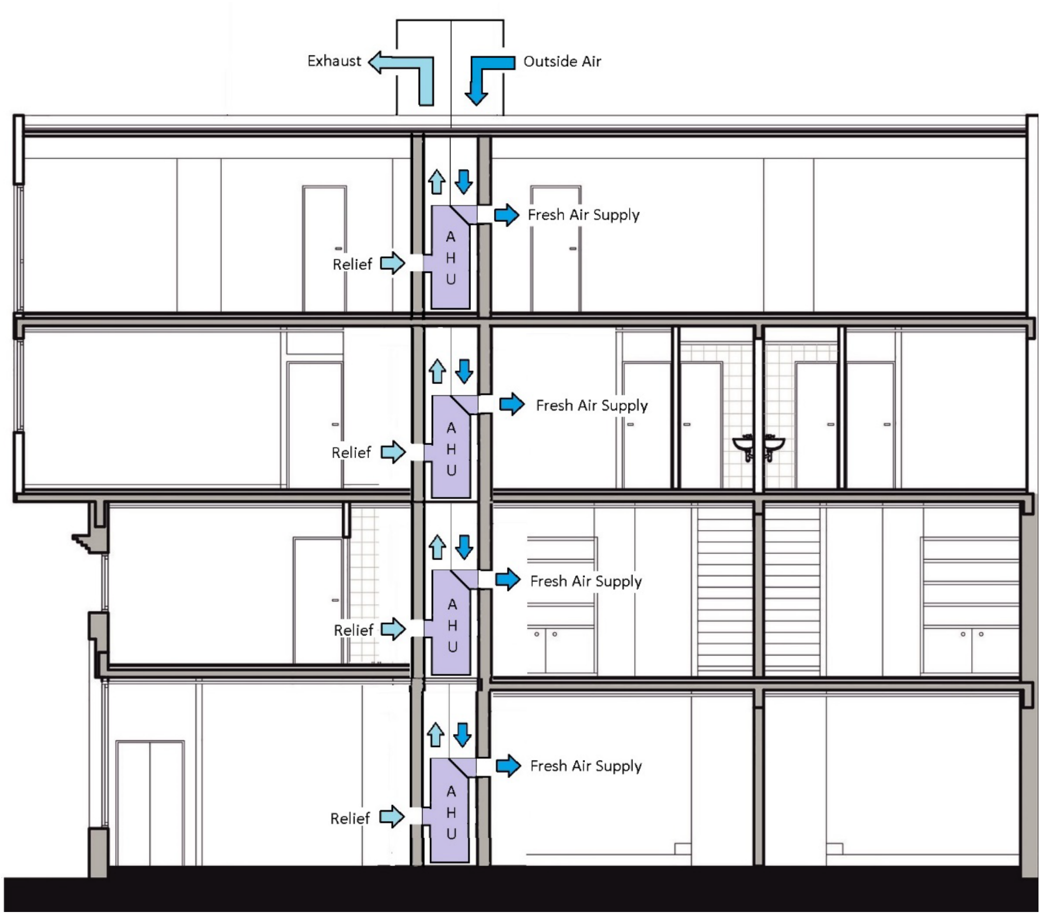


Figure 4-5 Nighttime Ventilation Cooling (AHU = Air Handler Unit)

- Install smart communicating thermostats. This technology is in a process of rapid advancement and products which provide more reliable and consistent HVAC energy savings will be on the market over the next couple of years. The smart communicating capabilities also allow for integration with other automated building systems and demand response signals from the utility, as well as provide resident feedback mechanisms.

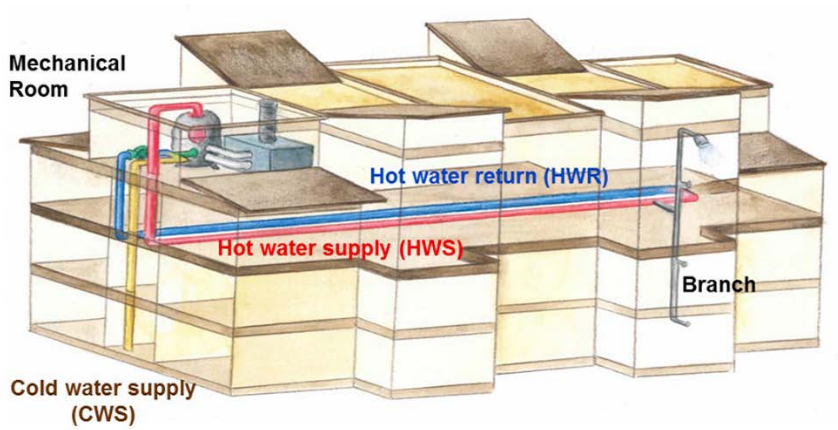
Action 4.4: Fresh Air Ventilation – Multi-family

Use supply ventilation with filtration systems for fresh air ventilation in multi-family buildings. To maintain indoor air quality and help protect public health, positive pressurization (using supply fans) of buildings as opposed to negative pressurization (using exhaust fans) shall be incorporated into system designs to reduce the chance of introducing air pollution from the nearby freeway and railroad tracks. Distribution design and filtration components will follow best practices that meet filtration needs and minimize system pressure drop, while also maintaining energy efficiency of mechanical systems. Consider heat recovery ventilation (HRV).

Action 4.5: High-efficiency DHW Systems – Multi-family

Incorporate high-efficiency domestic hot water (DHW) systems in multi-family buildings. The following are important related aspects that will be considered:

- Central DHW systems with efficient recirculation controls (see Figure 4-6). In large buildings, a central system is often more cost effective and if designed properly will use less energy than individual water heaters. The recirculation system will minimize total pipe length to the extent possible, use demand based controls, and incorporate pipe insulation beyond code minimums. Gas condensing boilers or water heaters as well as electric heat pump water heater options will be considered.



(Courtesy of TRC Companies)

Figure 4-6 Central Domestic Hot Water System

- If there is available rooftop space, solar thermal systems will be considered. Solar thermal tied to central DHW systems can be cost effective but needs to be evaluated with the other competing needs for rooftop space. This measure may also be important to include in order to meet the 30 percent better than Title 24 goal.

- Incorporate demand recirculation controls into all hot water recirculation loops. Recirculation losses can be a significant component of central DHW systems. Demand recirculation substantially reduces these losses. All hot water supply and recirculation lines can be heavily insulated to reduce hot water losses and minimize the resident discomfort issues.

Action 4.6: ENERGY STAR Appliances

Install ENERGY STAR appliances in multi-family buildings using the latest certification standard for both in-unit appliances and at central laundry facilities. When available, select equipment with demand response capability which enables communication between the electric utility and the appliance for demand shedding during peak events on hot summer afternoons.

Action 4.7: High-efficacy Lighting Systems – Multi-family

Design and install high-efficacy and functional lighting systems in multi-family buildings. Room-by-room lighting designs will be developed for the residential units which address illumination levels and consider ambient, accent and task lighting to focus light where it is needed and further reduce energy demands. Lighting design will be based on recommendations from the most current "High-Efficacy Residential Lighting Guide" [3] produced by the UC Davis California Lighting Technology Center, including the following:

- 100 percent solid-state light emitting diode (LED) technology
- Occupancy controls in all rooms, and dimming controls where applicable. These further reduce lighting energy use and are a part of high-efficacy lighting design.
- Evaluate opportunities to incorporate daylighting strategies. This can be challenging in multi-family buildings but there may be certain spaces such as living/kitchen areas where this is feasible.
- Utilize adaptive light layering for task, accent and ambient lighting. This will allow for lighting levels to be safely reduced under multiple circumstances.
- Consider correlated color temperature (CCT) and the color rendering index (CRI) in the lighting design. Selecting light sources with consistent CCTs & CRIs helps maintain consistency in how objects appear. Light sources with a CRI of 90 or greater and CCTs between 2700 and 4000 Kelvin will be used.
- Consider circadian sensitive lighting design guidelines. Choose appropriate CCT light sources to minimize circadian disruption based on time of day. Circadian lighting design does not inherently save energy but recent studies have shown the benefits to improve resident health and well-being.[4]

Action 4.8: Electricity Load Control and Feedback

Incorporate miscellaneous load controls and resident feedback mechanisms in multi-family buildings. In high-performance buildings where heating and cooling loads are minimized, and the density of consumer electronics is increased, miscellaneous plug loads have become an increasingly larger component of total building energy use. It is recommended that in-home and remotely controlled devices be incorporated to manage some of these loads in conjunction

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[3] High-Efficacy Residential Lighting Guide. http://cltc.ucdavis.edu/publication/high-efficacy-residential-lighting-guide
[4] http://cltc.ucdavis.edu/sites/default/files/files/publication/150212-ashrae-light-health-design-strategies-technologies-papamichael.pdf

with a feedback loop to the resident (see example in Figure 4-7). Active controls for the engaged resident can be coupled with passive controls such as occupancy sensors to optimize the energy savings potential. It is expected that the strategies and options available to accomplish this will be substantially expanded by the time the Nishi development is built.

Figure 4-7 ecobee Remote Communicating Thermostat and Honeywell Home Energy Use Dashboard

Action 4.9: Third-party Energy Verification

Conduct third-party verification of multi-family building envelope and mechanical measures to ensure quality installation that meets design expectations. Third-party Home Energy Raters or qualified building commissioning agents will be employed to ensure that the multi-family building components and systems are installed and operating properly before occupancy. Building commissioning is essential to any successful ZNE building or community.

Non-Residential R&D / Office Buildings

The following guidelines and performance specifications shall be integrated within the commercial building designs to meet the objective of a minimum compliance margin of 30 percent relative to the 2013 Title 24 code:

Action 4.10: High-performance Building Envelopes – R&D/office Buildings

Design and construct all R&D/office buildings to include high -performance building envelopes to reduce heating and cooling loads and subsequently minimize space conditioning energy use. High performance building envelopes provide improved comfort and reduce indoor temperature fluctuations. The following specifications are important related aspects that will be considered:

- High performance glazing with a U-factor ≤ 0.36 (prescriptive for fixed) and solar heat gain coefficient (SHGC) ≤ 0.22. This will be accomplished with double-pane, low-e glass and thermally broken frames, or triple-pane windows. All glazing will also meet the minimum visible transmittance values required by code.

- Total window area will not exceed 40 percent of gross exterior wall area.
- Incorporate operable windows so that users have the ability to bring in fresh air and better regulate room comfort conditions as necessary during favorable outdoor conditions. Incorporate sensors on operable windows that lock out HVAC equipment when windows are open.

Action 4.11: High-performance HVAC – R&D/office Buildings

Incorporate high-efficiency HVAC systems in the R&D/office buildings. Peak summer cooling demand has a significant impact on total building energy use as well as electric utility loads. The following are important related aspects that will be considered.

- Variable speed fans with controls. Fan energy in commercial buildings can be substantial. Efficient fan motors with variable fan flow capability allow for air delivery that is better matched to instantaneous loads.
- Consider alternative HVAC systems that eliminate the space requirement for rooftop equipment. These may include but are not limited to the following: 1) ground source heat pumps with a community loop shared between buildings; 2) a central plant configuration with high efficiency chillers, boilers, cooling towers, and pumps; 3) nighttime flushing of building using filtered outdoor air, 4) radiant heating and cooling delivery to minimize distribution system energy, and 5) indirect evaporative cooling to cool supply air delivered to the conditioned space (see Figure 4-8) along with direct evaporative cooling to cool air at the condenser inlet.

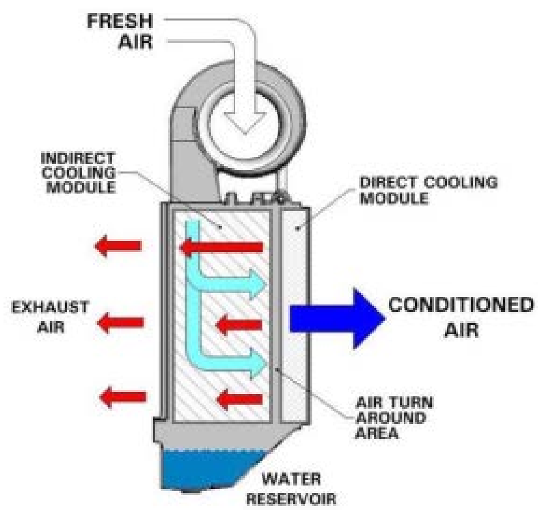
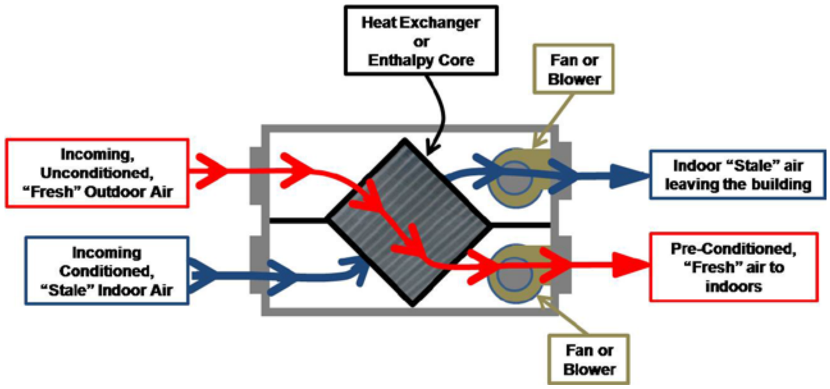


Figure 4-8 Indirect/Direct Evaporative Cooling

Acton 4.12: Fresh Air Ventilation – Non-residential Buildings

Use supply ventilation and filtration systems for fresh air ventilation in non-residential buildings. Positive pressurization (using supply fans) of buildings as opposed to negative pressurization (using exhaust fans) is recommended to reduce the chance of introducing air pollution from the nearby freeway and railroad tracks. For spaces with higher ventilation rates, heat exchangers will be incorporated to reduce building heating and cooling loads (see Figure 4-9). Distribution design and filtration components will follow best practices that meet filtration needs and minimize system pressure drop. Occupancy or carbon dioxide controls will be used in all intermittently occupied spaces. Ventilation will be scheduled and turned off during unoccupied hours in spaces with regular occupancy schedules.



(Courtesy of the Building America Solution Center www.basc.pnnl.gov)

Figure 4-9 Heat or Energy Recovery Ventilator

Action 4.13: High-efficacy Lighting Systems – R&D/office Buildings.

Design and install high-efficacy and functional lighting systems at the R&D/office buildings. The most current "Lighting for Office Applications Guide"[5], "Retail Lighting Guide"[6], and any other applicable guides for non-residential spaces produced by the UC Davis California Lighting Technology Center (CLTC) will be consulted. The following are important related aspects that will be considered:

- 100 percent solid-state LED technology
- Optimize the building shell design and space configuration for daylighting strategies. Install controls for both primary (directly adjacent to windows) and secondary (adjacent to primary space opposite the windows) day lit spaces with continuous ramping capability. Consider the use of light shelves (see Figure 4-10) to extend the range of daylighting into the building. Limit skylight to max 5% of roof area (prescriptive code requirement).

(Courtesy of Judi Schweitzer + Associates)

Figure 4-10 Example of Light Shelves in Commercial Building

- Use light layering to direct light where it is needed for task, accent lighting and ambient lighting. This results in energy load reductions and allows for lighting levels to be safely reduced under multiple circumstances.

5 California Lighting Technology Center Lighting Guide for Office Applications: http://cltc.ucdavis.edu/publication/2013-title-24-part-6-lighting-office-applications-guide

6 California Lighting Technology Center Retail Lighting Guide: http://cltc.ucdavis.edu/publication/2013-title-24-part-6-retail-lighting-guide

- In open office environments use a combination of low ambient lighting with the space sub-divided into smaller zones for lighting control purposes, and high-quality task lighting with personalized controls.

- CCT and CRI in the lighting design. Selecting light sources with consistent CCTs & CRIs helps maintain consistency in how objects appear. Light sources with a CRI of 80 or greater will be used for most applications; where color discrimination is important light sources with a CRI of 90 or higher will be used.

Action 4.14: Whole-building Energy Management System

Incorporate a whole-building energy management system (EMS) and plug load controls in the R&D/office buildings. When mechanical systems are properly commissioned and instrumented with diagnostics, and the EMS is regularly monitored, such systems can provide increased operational and energy efficiency. An EMS allows for building level monitoring and control of mechanical systems, particularly HVAC and lighting, and provides diagnostic flags and assistance with troubleshooting. A building or facility manager will also be appointed and properly trained to monitor, manage, diagnose, and analyze this data.

Install hardwired circuit controls for 120-volt receptacles. This is now mandatory for office spaces under the 2013 Title 24 code. We recommend expanding this to all commercial spaces in the building. The controlled outlets will be automatically switched OFF via an occupancy sensor or timer. For lab spaces where this may be undesirable, there will be override capability at the building EMS level.

Action 4.15: Commissioning – R&D/office Buildings

Conduct building-wide commissioning of the R&D/office buildings to verify building systems performance and ensure quality installation that meets the design expectations. Prior to permit issuance, a commissioning plan shall be completed to document how the project will be commissioned and shall be started during the design phase of the building project. During the schematic design phase of the building project, the owner or owner's representative, design team and design reviewer must meet to discuss the project scope, schedule, and how the design reviewer will coordinate with the project team.

Commissioning measures or requirements shall be clear, detailed and complete to clarify the commissioning process. These requirements shall include the list of systems and assemblies commissioned, testing scope, roles and responsibilities of contractors, requirements for meetings, management of issues, the commissioning schedule, operations and maintenance manual development and of training, and checklist and test form development, execution and documentation. Reference ASHRAE Guideline 0-2013, the California Energy Code and the California Green Building Standards Code for information regarding the Commissioning Process.

Site Energy Loads

Site energy loads include all street, path and public area lighting, community pools and spas, and any covered parking areas not part of the residential or commercial buildings. While installing electric vehicle charging stations on site will affect community electricity use, such charging was not considered under site energy consumption as part of total energy demand and renewable energy offsets required to meet ZNE goals and objectives. Implementing actions related to electric vehicles and associated energy and GHG emission reduction benefits they provide relative to fossil fuel powered vehicles are addressed in the Transportation section of this plan.

Action 4.16: Smart Lighting Strategies

Smart lighting strategies shall be integrated for site illumination. The most current Outdoor Lighting Guide[7] produced by the UC Davis California Lighting Technology Center (CLTC) will be consulted. Site lighting design shall integrate the following guidelines and recommendations in order to minimize site energy loads, reduce light pollution and enhance safety:

(Courtesy of CLTC, UC Davis)

Figure 4-11 LED Outdoor Fixture

- Incorporate 100 percent solid-state outdoor LED lighting technology (see example in Figure 4-11).
- Incorporate smart controls on outdoor lighting. Switching or dimming lights based on time-of-day, available daylight, or occupancy, and networking lighting control systems will reduce lighting energy use. Bi-level occupancy controls will be used at all pathway and parking lots. On the low level, light levels will be reduced to at least 50 percent of maximum illumination. Investigate the potential for further lighting reductions in parking lots during unoccupied periods. In some areas where occupancy is expected to be very low, lighting may be completely turned OFF as long as safety is not adversely affected. Consider occupancy bi-level controls for roadway lighting. Currently, the technology is not quite mature but it may be by the time the Nishi development is under construction.
- Where feasible, install PV-powered light fixtures. Products are currently available for parking lot, pathway, and roadway lighting. This will reduce the need to offset site lighting electricity use with parking lot and other facility PV systems.
- Follow dark sky guidelines in fixture selection to minimize light pollution. Select fixtures that limit backlight, uplight and glare.

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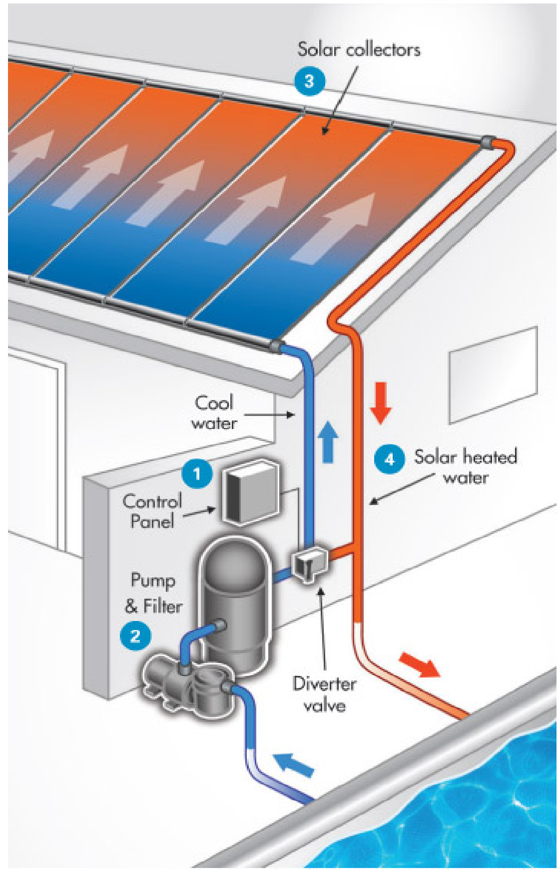
[7] California Lighting Technology Center Outdoor Lighting Guide: cltc.ucdavis.edu/publication/2013-title-24-part-6-outdoor-lighting-guide.

Action 4.17: Efficient Pool and Spa Systems

Design pools and spas with efficient pumping and heating systems. Pools and spas can use a significant amount of energy for pumping and heating. Design and installation shall incorporate efficient pumping and heating systems, using the following as guidelines.

- Properly design pumping systems to minimize the pressure drop between the pump and pool or spa.
- Use variable speed pumps and controls. This allows for pumps to be programmed to turn down flow rates during unoccupied periods as allowed by the local health and safety code.
- Use high efficiency heating systems; either condensing heaters if fueled by natural gas or heat pump pool heaters if electric.
- The community pool, as proposed, will not be heated. Solar pool heating (see Figure 4-12) can be incorporated to add heat in the swing seasons and extend the use of the pool a couple of months, but will not allow for year-round use.



(Courtesy of Fafco Solar Water Heating)

Figure 4-12 Solar Pool Heating

Action 4.18: High-efficiency Lighting and Ventilation – Parking Garages

Design parking garages with high-efficiency lighting and ventilation systems. Underground and fully or partially enclosed parking garages will require additional lighting and mechanical ventilation. Garage lighting will follow the same guidelines as site lighting above regarding technology and lighting controls. Following are additional recommendations that shall be considered.

- Zone lighting circuits appropriately such that adjacent groups of light fixtures are controlled independently to reduce lighting energy use.
- Use high efficiency, variable speed fans for garage ventilation. The ventilation rates shall be automatically controlled based on contaminant levels per the California Energy Code. The CO levels will be monitored by sensors ensuring that the space is not unnecessarily over-ventilated.

4.2.2 Renewable Energy Generation & Offsetting of On-site Energy Loads

On-site Energy Production

Solar PV systems on building rooftops and central PV installations at surface parking areas are the most cost effective means of generating on-site renewable energy to offset energy consumption at the Nishi development. The following are guidelines to maximize energy generation. Incorporation of PV at the Nishi development needs to be carefully coordinated with the developer's design team, including architects, landscape designers, and engineering trades. To maximize solar production generation potential, the location of vertical elements needs to be factored to minimize shading of the PV arrays. This is especially true with tree plantings, figuring in mature tree height and tree species that may shade PV arrays in the future.

Action 4.19: PV Array Installation

Install both rooftop and surface PV arrays to maximize annual PV production. Both rooftop and surface parking PV arrays will be installed at a minimum tilt sufficient to encourage natural cleaning and removal of debris (typically 10 degrees) while minimizing self-shading issues. Low-slope installations in these applications provide the maximum production per square foot. Arrays will be oriented South (180 degrees azimuth) to the extent possible, but with a near flat array the impact of azimuth is not as critical as with steeper installations. When arrays cannot be situated directly south, they will be located within the azimuth range of 110 degrees to 270 degrees clockwise from north. Tracking arrays are not advised when there are space constraints such as is the case at the Nishi development, because they result in lower specific power production.

Action 4.20: Building Rooftop Design for PVs

Design building rooftops to allow for PV to cover 75 percent of total rooftop area for the multi-family buildings and 50 percent for the R&D buildings. To maximize ZNE potential for each building, PV arrays shall be installed on building rooftops to the maximum extent possible (see Figure 4-13 for an illustrative example). The total available rooftop area will be reduced based on offset requirements, space necessary for HVAC equipment, and space

(Photo Courtesy of Sun Light & Power)

Figure 4-13 Maximizing Building Rooftop Area for PV

desired for other functional uses such as rooftop gardens and community social spaces, or solar thermal panels. Increasing the available area for PV will allow for more of the building energy use to be offset by renewables within the project footprint. The following are important related aspects that will be considered to help maximize PV coverage potential:

- Minimize rooftop equipment, penetrations through the roof, and shading from rooftop elements and adjacent building or trees. When possible locate mechanical equipment in mechanical rooms instead of on rooftops. Equipment that must be located on the rooftop can be strategically located where PV panels aren't feasible because of shading or other concerns. If allowed by the local codes and fire marshal, PV systems can be installed on structures that put the modules above rooftop equipment (see Figure 4-14). This strategy can also allow for multiple uses of the roof with PV modules acting as shade structures above rooftop gardens and community social spaces. Installation costs tend to be higher and building structural requirements and loads will be impacted. This strategy may also be affected by building height restrictions.

(Photo Courtesy of Sun Light & Power)

Figure 4-14 System Installed over Rooftop HVAC Equipment

- Consider creative mounting strategies to increase PV production and maximize space efficiency. On low-sloped roofs, PV can be mounted in an East-West sawtooth arrangement (see Figure 4-15) to yield higher energy production and improve grid-tied performance factors. This strategy eliminates the need to space each row of modules and increases specific production. PV modules are installed in rows along a North-South axis to increase the amount of modules on a roof and avoid self-shading. The modules are tilted at 10° to the East and West to reduce soiling.

(Photo courtesy of Mounting Systems)

Figure 4-15 Sawtooth PV Installation

Action 4.21: PV Shade Structures

Provide PV shade structures over all open parking lots and parking garage rooftops. Parking lots shall be designed to provide PV shade structures over at least 50 percent of the total hardscape area. Parking lots are an ideal location for siting PV as there is no other competing use for this area, and the canopy systems provide desirable shading for parked cars (see Figure 4-16).

(Photo courtesy of Solaire Generation)

Figure 4-16 Parking Lot Shading PV System Installations

Action 4.22: Alternative PV Sites

Consider other areas in the Nishi development for siting PV in order to increase renewable energy generation and meet project ZNE goals. In addition to building rooftops and surface parking lots, there are other potential sites in the Nishi development for locating central PV arrays. These locations will need to be considered carefully, as placement of PV arrays can conflict with other project goals and objectives related to open space and parks (see Chapter 6).

- Community Parks. The active use areas within designated parks and open space is not expected to be large in the Nishi development and therefore the production potential is small. However, parks are a high profile location to site PV and can considerably add to community messaging as well as contribute towards meeting ZNE goals. PV can also provide shading where it cannot be provided by trees. Arrays can be in the form of a shade canopy, creatively integrated into play structures, or sited on top of a gazebo. Consider PV in the design of the parks; attention will be paid to eliminating shading because of adjacent trees or structures at locations where PV may be situated. If the PV array is owned by the City it can be connected to a dedicated meter and be used to offset any public loads at the Nishi development or elsewhere in the city[8]. Alternatively, it can be directly connected to the nearest commercial or multi-family building; however, this may be challenging due to the distance between the park and buildings.

[8] This will be accomplished through the Renewable Energy Self Generation Bill Credit Transfer (RES-BCT) net metering program.

- Detention Basin. There is potential to generate substantial electricity from PV systems elevated over the stormwater detention basin, which is proposed in an area of approximately 4 acres in the southern tip of the site. Installation costs at this location are expected to be higher than a typical ground mount system because of the additional elevation requirements; however, other detention basin installations have been found to be less expensive than typical carport installations[9] (which are also more costly than ground mount systems). If final programming of the basin for habitat enhancement or joint recreational use is desired, placement of PV in this location may not be appropriate.

- Railroad Setback. To the extent possible, locate PV along the eastern edge of the railroad setback along the southwestern boundary of the property. The section from the southern open space parking lot travelling southwest to the bottom corner of the property represents an open and unused portion of the property. This area will be carefully coordinated with open space and the need for a sound barrier between the community and the tracks. Existing trees lie along portions of the setback and there may be a desire to increase the vegetation in this area for air quality mitigation and, to a lesser extent, noise attenuation.

- Building Integrated PV. If fixed building shading is used to shade south and west windows, consider incorporating PV panels on these shades. This strategy will typically not be cost effective on its own, but may be if shading is already being incorporated into the project.

At the moment, alternative renewable applications such as wind energy are not as cost effective as PV solar at the Nishi development. However, this may change in the near future with how rapidly this industry is evolving. Project design teams will keep these alternatives in mind in case they become more feasible down the road, and potential synergies may point to other technologies or applications.

Off-site Energy Production

Action 4.23: Off-site Renewable Energy Strategies

Consider off-site renewable energy strategies for offsetting on-site natural gas use and for supplementing on-site renewable production to meet community ZNE goals.

- To offset on-site natural gas consumption, the most cost effective method currently is to purchase biogas offsets from the utility. This arrangement can be negotiated with PG&E. Other options include directly piping biogas into the community if there is a nearby source. While the Nishi development won't have a significant source of feedstock for biogas generation, there may be an opportunity to utilize biogas through collaboration with UC Davis. This will be evaluated in the future.

[9] http://www.pv-magazine.com/news/details/beitrag/solar-on-storm-water-detention-basins_100002682/#axzz3W17LGUXV

- Renewable electricity offsets can also be purchased from the utility if on-site PV isn't sufficient to offset 100 percent of electricity loads.

Future Off-site Energy Production Strategies

Current net energy metering arrangements with the utility limit the cost effective path to ZNE for the Nishi development. However, this is evolving rapidly and flexibility needs to be incorporated into the Nishi development in order to allow the development to take advantage of new policies that occur between now and ground breaking. As the community design takes shape, net energy models will be re-evaluated to capture changes in community energy consumption and identify the most feasible options available to the project. Some potential strategies for supplementing on-site renewable energy with local off-site source include:

- Green Tariff Shared Renewables Program. California Senate Bill (SB) 43 (Chapter 413, Statutes of 2013) established the Green Tariff Shared Renewables Program, which allows utility customers to purchase up to 100 percent of their energy from off-site, small to medium-sized renewable energy projects. Development of this program is still being finalized by the CA Public Utilities Commission (CPUC) and stakeholders, so details are unknown at this time. If the Nishi Gateway project is accepted by the voters of Davis and the Nishi property is annexed into the city, ratepayers within the community will be able to participate in any project made eligible for the residents of Davis.

- Community Choice Aggregation (CCA). This program 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 investigated by the City of Davis, and if such a program is adopted, there is an opportunity to use CCA to offset energy consumption that cannot be directly offset on-site. A local CCA can benefit both the Nishi development and the greater community of Davis by providing more local control of the type of energy production available to the community as a whole and where it is produced.

4.3 Evaluation and Monitoring

4.3.1 Evaluation

The following summarizes results from the Nishi development ZNE Feasibility Study (see Appendix C), which evaluated the project against applicable project objectives as described above (and reiterated below).

- **Objective 3.1:** High-performance buildings will achieve 30 percent or greater energy efficiency than the 2013 Title 24 Building Energy Efficiency Standards.

The assumptions used in the study assume that all buildings will perform at least 30 percent better than the current Title 24 code. This is very achievable, as there are projects accomplishing this today. By the time this project pulls building permits, it's likely that the 2016 code will be in effect which is expected to be 15 percent to 20 percent[10] more stringent than the current 2013 Title 24; and, based upon an assumed minimum seven year build-out scenario, much of the project may fall under the following 2019 Title 24 code.

- **Objective 3.2:** Other building loads not covered by Title 24 will also be high efficiency.

Table 4-2 below compares projected energy use at the Nishi development with a "business-as-usual" (BAU) base case scenario reflecting a 2013 Title 24 energy code compliant project. By employing the best practices in energy efficiency described previously in this report, the Nishi development is predicted to save over 4,700 megawatt hours (MWh) of electricity and 75,000 therms of natural gas annually relative to the business-as-usual scenario. After taking into account electricity production from the 4.9 MW PV capacity referenced in Table 4-1, estimated net electricity savings for the Nishi development are almost 13,000 MWh and 82 percent TDV savings.

Table 4-1 Impact of Projected Energy Savings for the Nishi Development Relative to a Business-as-Usual Scenario

	Electricity Consumption (MWh)	Natural Gas Consumption (therms)	Energy Use Intensity ($kBtu/ft^2$)[2]
Business-as-Usual Scenario[1]	13,979	267,932	58.6
Nishi project without solar PV[3]	9,265	192,320	40.0
Savings	*4,714*	*75,611*	*18.6*
Nishi project with 4.9 MW PV	1,188	192,320	18.3
Savings	*12,791*	*75,611*	*40.3*

Notes: MW = megawatts; MWh = megawatt hours; PV = photovoltaic; $kBtu/ft^2$ = 1,000 British Thermal Units per square foot

[1]Business-as-usual case is based on 2013 Title-24 code compliant construction and pool/spas with constant speed circulation pumps and no covers.

[2]Energy use intensity is calculated by including all estimated energy use at the Nishi development, including site and outdoor loads such as lighting and pools. The area applied is the indoor conditioned floor area only. If only indoor energy load are taken into account the energy use intensities will be slightly lower.

[3] Assumes 30 percent better than 2013 Title 24 standards, per the project objectives and implementing actions outlined in this chapter, excluding the benefits of solar PV

[10] http://www.energy.ca.gov/title24/2016standards/rulemaking/documents/2015-06-10_hearing/2015-06-10_Adoption_Hearing_Presentation.pdf

- **Objective 3.3:** To the extent possible, design the project to achieve zero net energy (ZNE).

  Based on results of the ZNE Feasibility Study, solar PV proposed on building rooftops and proposed surface parking areas are not sufficient to offset all of the community's energy needs. Approximately 5.6 MW of PV is required to offset the estimated annual community energy needs to meet the ZNE-Elec target. Slightly more capacity at 6.7 MW is required for offsetting 100 percent of TDV energy use to meet ZNE-TDV. Using the available area on-site (building rooftops and surface parking areas), 4.9 MW is available, resulting in a 13 percent to 27 percent (0.7 – 1.8 MW) shortage in meeting ZNE-Elec and ZNE-TDV, respectively.

  The following alternatives can provide additional PV capacity, resulting in meeting the community ZNE targets exclusively with on-site renewables (see Table 4-1 for comparison of proposed solar PV generation with additional maximized solar PV generation).

  - Maximize the available area on building rooftops for PV such that 90 percent of total rooftop space at the multi-family rental and the R&D buildings and 60 percent at the for-sale condominium buildings (to allow for roughly 33 percent of total rooftop area for garden terraces) is made available for PV arrays. The results presented above are representative of only 50 percent-75 percent of rooftop space dedicated to PV. This additional area increases total community PV capacity to 5.9 MW or 105 percent of ZNE-electric and 88 percent ZNE-TDV.
  - Use additional areas on-site for ground-mounted PV arrays. With a 0.7 – 1.8 MW shortfall, installing additional PV at the detention area and along the southern section of the railroad setback will be sufficient to make up the difference in order to achieve ZNE-TDV.

The shortfall can also be made up with the acquisition of additional renewable energy sources or offsets from off-site.

Table 4-2 Solar PV Energy Generation and ZNE Evaluation

ZNE Target	Baseline Solar PV Energy Generation[1] (MW)	Total Solar PV Energy Generation Required to Achieve ZNE Targets (MW)	Additional Solar PV Required to Achieve ZNE Targets (MW)
ZNE-Elec	4.9	5.6	0.7[2]
ZNE-TDV	4.9	6.7	1.8[3]

Notes: ZNE = zero net energy; ZNE-Elec = 100 percent of electricity offset by on-site renewable generation; ZNE-TDV = 100 percent of TDV energy use (electricity + natural gas) offset by on-site or off-site renewable energy or other credits; MW = megawatts; PV = photovoltaic.

[1]Baseline includes surface parking and rooftop coverage, assuming building configurations and parking lot layouts shown on site plan in Figure 2- (see Chapter 2), with between 50 to75 percent of rooftop space dedicated to PV.

[2]Additional PV generation based on maximizing available area on building rooftops for PV such that 90 percent of total rooftop space at the multi-family rental and R&D buildings and 60 percent at the for-sale condominium building sites

[3]Assumes 0.7 MW from increasing rooftop coverages to meet ZNE-Elec, plus using additional areas on-site for ground-mounted PV arrays (i.e., coverage of stormwater detention area and railroad setback adjacent areas).

Source: Appendix C, Davis Energy Group 2015; compiled by Ascent Environmental.

4.3.2 Monitoring

Monitoring Plan

Following are a list of actions that will allow for project progress to be tracked, analyzed and understood, with lessons learned disseminated to the broader community. These actions will be coordinated with energy performance metrics noted in Table 4-2.

Action 4.24: Disaggregate Electric Loads

Disaggregate electric loads by major end-use at the electrical panels. This will allow for verification of consumption by end-use (heating, cooling, lighting, appliances, etc.) to provide useful feedback to consumers and the community as a whole regarding where energy is used. This applies to both the residential and commercial buildings. For residents and employees, real-time disaggregated energy use can be a useful tool for understanding where energy is used and where it can be saved. For building owners, this can serve as a valuable tool to identify operational problems or equipment failures. It also allows for performance to be tracked, refinement of recommendations, and improvements on energy usage estimates for future projects. Disaggregating electric loads requires coordination with the electrical designer for each building so that lighting loads, plug loads, HVAC, water pumps, elevators and escalators, and loads associated with renewable powers sources are wired separately.

Action 4.25: Energy Management Systems Monitoring

Closely monitor the Energy Management Systems (EMS) at the R&D buildings to identify any issues post commissioning. Data will be reviewed more frequently during the first month of general operation and then during the first month of start-up of any subsequent mechanical equipment. Flags and warnings will be appropriately defined in the system such that ongoing diagnostics can be relatively automated, increasing operational efficiency.

Action 4.26: Continuous Energy Tracking

Continuously track and store energy data. Collect energy production and consumption data at a minimum interval of one hour. For some building systems and applications, 15 minute data is useful for building commissioning and troubleshooting. Depending on who the utility account owner is, it may be necessary for building managers to coordinate directly with residents/owners and tenants to request access to data.

During the first six months of occupancy, data will be reviewed and analyzed to identify any major areas of concern and necessary course corrections. After the first full twelve months of occupancy, community energy use will be reviewed and analyzed. At that time a performance report will be developed and made public as well as distributed and publicized throughout the community. A similar report will be generated annually thereafter.

Action 4.27: Automated Data Collection

Automate data collection and integrate into the data analysis process, to the extent possible. This may require coordination with the utility, tenants, and building owners. Significant time can be wasted with inefficient data collection processes and this is important to resolve as early as possible. Automated data collection and analysis processes can be used to identify and address high energy uses quickly.

Action 4.28: ZNE Performance Verification

Consider developing the project using a Design/Build contract with detailed performance and commissioning specifications, carefully drafted, negotiated, and executed to maintain quality and compliance throughout the construction process. Include in the contract specified building performance goals (i.e., buildings must perform under a specified kilo British thermal unit / square feet per year), and overall community-scale project ZNE goals. Through this approach, the developer can build performance requirements and goals into the process in an incentive-based fashion, while still complying with the necessary contracting standards. This strategy was used in the design and construction of the National Renewable Energy Lab (NREL) Research Support Facility in Golden, Colorado, completed in 2012. The NREL design/build contract included a specific, fact-based Energy Use Intensity (EUI) along with a voluntary incentive program built into the contract to incent the builder to meet the stated EUI goals.[11]

Energy Performance Metrics

Table 4-3 below identifies various measures and metrics the City of Davis can use to ensure that the Nishi development achieves sustainability goals related to energy use and production. These metrics may be monitored by building owners and reported to the City so that energy use and production trends are observed and potential issues are addressed quickly.

[11] http://www.nrel.gov/sustainable_nrel/rsf.html

Table 4-3 Energy Performance Metrics

Measure/Metric	Timing	Desired Outcome
Average kWh generated by solar PV or other renewable energy systems on-site	Monthly and annually	On-site renewable energy generation meets or exceeds annual electricity generation estimates
Average kWh of electricity and therms of natural gas used per housing unit	Monthly and annually	Average energy use per unit does not exceed estimated energy demand for residential portion of the project, and/or decreases over time
Average kWh of electricity and therms of natural gas used per square foot of nonresidential space (Energy Use Intensity [EUI])	Monthly and annually	Average energy use and EUI does not exceed estimated energy demand for nonresidential portion of the project, and/or decreases over time
Ratio of total energy demand from both on-site kWh of electricity used (excluding transportation) and therms of natural gas used, to total on-site electricity production (kWh) from solar PV systems and any required off-site credits or offsets	Annually, once project is fully built out	Achieve zero net energy for the site as a whole