Willow Court's Retrofit Addresses Climate Change and Health:

First existing multifamily building fully electrified in San Mateo County

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Executive Summary

Immediately adjacent to the 101 Highway in the Belle Haven community of Menlo Park lies Willow Court, the multifamily affordable housing units owned and operated by MidPen Housing. In partnership with the local climate nonprofit, Menlo Spark, and the Association for Energy Affordability (AEA), Willow Court became the first existing multifamily building to ever undergo full electrification in San Mateo County. In doing so, Willow Court now operates with 100% clean energy, free of climate pollution and hazardous air pollution. Moreover, this full electrification retrofit occurred without any major electrical service upgrades, eliminating the extra costs and delays often incurred during electrical panel upgrades.

In all six housing units within the Willow Court buildings, every single gas appliance has been removed, recycled, and replaced with new, up to 3-4 times more efficient, zero climate pollution appliances. Unlike their previous gas counterparts, these new electric appliances – including heat pump water heaters and heat pump HVAC systems – no longer generate nor leak chemicals deemed hazardous to human health, like nitrogen oxides (NOx), benzene, and carbon monoxide. Given the acute environmental justice issues facing the Belle Haven neighborhood described in more detail later in this case study, the elimination of this chemical pollution greatly benefits a community already vulnerable to significantly higher levels of disease, like asthma and other respiratory and cardiac illnesses.

Moreover, the new two way heat pump HVAC systems, unlike the old gas furnaces that provided only home heating, will provide air conditioning for the very first time within these residences. This air conditioning will enable crucial resilience (and air filtration for particulate matter) during increasingly frequent heat waves and poor air quality days due to wildfire smoke emergencies. Willow Court residents – who pay their own utility bills – will no longer receive a monthly gas bill.

To incentivize MidPen housing to undertake gas appliance replacements a few years earlier than scheduled, Menlo Spark provided, with support from the Hewlett Foundation, a one-time grant to cover a substantial portion of upfront capital costs. In partnership with AEA, MidPen also obtained subsides from the BayREN Bay Area MultiFamily Building Electrification (BAMBE) program, California's Low Income Weatherization Program (LIWP), and some rebates from San Mateo County's electricity provider, Peninsula Clean Energy. As consistent with Menlo Spark's project goals, MidPen spent zero dollars out of pocket on this project, not including its staff time.

Below are key quotes from California State Senator, Josh Becker, from our partners at AEA and MidPen Housing, and from the City of Menlo Park on the successful outcomes of this Willow Court project:

"The complete electrification of Willow Court marks a groundbreaking precedent for our region, as the first existing multifamily property in San Mateo County to provide a full suite of climate pollution reductions via healthy, clean, more efficient electric appliances. Willow Court residents will benefit greatly from the significant air pollution reductions achieved by removing gas combustion from the property. I commend Menlo Spark and MidPen Housing for their efforts to successfully complete this vital project." ***– Josh Becker, California State Senator, 13th District***

"Willow Court's upgrades were implemented to deliver significant benefits to residents, enhancing energy efficiency, improving indoor air quality, and reducing greenhouse gas emissions. In Belle Haven, where poor air quality disproportionately affects lower-income communities, eliminating gas-burning appliances helps lower disease risks. The new heat pump systems also provide vital cooling during heat waves. Our programs' partnerships demonstrate how incentives for electrification make advanced, health-focused technologies accessible while fostering a more sustainable and equitable future." ***– Sheetal Chitnis, Senior Manager, Programs at Association for Energy Affordability***

"MidPen Housing is grateful to Menlo Spark and the Association for Energy Affordability for their collaboration on the full electrification of Willow Court. This retrofit will reduce pollution inside and outside of the units, improving families' health. New air conditioning from the heat-pump HVAC units will help keep residents safe and comfortable during increasingly intense heat waves. We hope that Willow Court's retrofit will inspire similar work at affordable housing properties up and down the state." ***– Nigel Felix, Associate Asset Manager, Real Estate Transactions, MidPen Housing***

"43% of Menlo Park's greenhouse gas emissions come from burning natural gas to power space heating, water heating, and cooking appliances in buildings. While many of us spend a significant part of our days inside, we don't always have the ability to remove natural gas from the buildings we live and work in to take advantage of the 100% greenhouse gas free electricity provided by Peninsula Clean Energy. The Willow Court project provides an example for how community can come together to transform existing multifamily buildings across the city from gas guzzlers to clean energy homes for the health of our residents. This will serve as a model as

the City explores programs, grants, policies, and other solutions to support the electrification of all buildings across Menlo Park.” – ***Rachael Londer, Sustainability Manager, City of Menlo Park***

Scope of Work

Full electrification: replacement of all gas appliances with high efficiency electric versions
In each of the six dwelling units within Willow Court, the following gas appliances were removed and replaced with clean, healthy, more efficient electric appliances:

- Gas furnaces replaced with Mitsubishi electric heat pump HVAC units (M-Series; SEER 18, HSPF 10.4);
- Gas water heaters replaced with Rheem electric heat pump water heaters (80 gallon; UEF 4.07);
- Gas ranges replaced with Frigidaire induction electric ranges (30 inches; 5.4 cu feet);
- Gas clothes dryers and washing machines replaced with electric 120-volt plug-in GE Profile Washer/Dryer Combos with ventless heat pump technology (4.8 cu feet, Energy Star).

Unlike multifamily buildings that contain shared energy-related appliances like water heaters, HVAC systems, or boiler systems that service multiple dwelling units, Willow Court’s six units each operate independently. Each unit has its own full set of appliances. While the replacement of all appliances in each unit minimized some opportunities for economies of scale during construction, this building configuration helped Willow Court qualify for additional rebates from Peninsula Clean Energy’s residential rebate program, more commonly directed to single family residences.

The outdoor compressor portions of the new heat pump HVAC systems were placed on each unit’s exterior patio. Because compressors require ample air flow, and residents may sometimes place personal items on the patio, durable compressor cages were inexpensively acquired to provide compressor protection and ensure sufficient air flow at all times.

Although water heaters are often located in garages, Willow Court has outside parking only. The existing gas water heaters were originally housed within relatively small utility closets, adjacent to the kitchens and underneath the staircases. Heat pump water heaters, typically upsized in tank capacity from their previous gas counterparts, are often taller (with slightly larger tank diameters). However, the Willow Court utility closets involved uniquely low, angled ceilings, making it challenging to fit a new, slightly taller heat pump water tank within the existing space. As a result, the project team decided to move the new heat pump water heaters a few feet away to exterior storage closets near the back patio doors, enabling more room for the slightly bigger tanks. To make these closets viable for a heat pump water heater, which require ample air flow, door vents in each closet door were added to meet programs’ technical requirements.

Quantifying Climate Pollution (or Greenhouse Gas Emissions) Avoided

The following table represents the climate pollution (synonymous with Greenhouse Gas or GHG emissions) avoided in MTCO2 (or Metric Tons of Carbon Dioxide) by removing all gas appliances in Willow Court with more efficient, electric versions. The table tabulates the totals over a 15 year period, the typical lifetime for the new appliances. Note that the old washing machines, while less efficient than the new washing machine component of the combination units, were electric. Therefore, the table leaves out the washing machine replacement for the purpose of this table. However, the previous stand alone clothes dryer (gas-operated) has been replaced with a heat pump electric version as part of this new combination unit, warranting its inclusion below. All figures were taken directly from the LIWP Multifamily Energy Efficiency Incentive Reservation & Participation Agreement Form for Willow Court, dated 10/19/23 (on file with AEA and LIWP; not available online). These projections are based on the estimated savings derived from the energy modeling process.

Willow Court's Climate Pollution Avoided
from gas to electric appliance replacements

Gas to Electric Replacements	Energy Savings %	Annual GHG Savings (MTCO2)	15 Year GHG Savings (MTCO2)
Install Heat Pump Water Heater	32.1%	4.06	60.9
Install Ducted Heat Pump HVAC	18.20%	2.15	32.25
Install Induction Range	0.60%	0.07	1.05
Install Heat Pump Laundry Dryer (part of new Washer/Dryer unit)	3.00%	0.39	5.85
	53.9%	**6.67**	**100.05**

Note that the energy savings associated with removal of all gas appliances to electric versions is more than half of the original energy demand, 54%. These energy savings do not yet include the additional, efficiency savings achieved from efficiency upgrades (like new dishwashers and LED lighting) undertaken that do not involve gas removal but that still reduce total energy and water demand (described in more detail in the next section).

Willow Court's climate pollution savings (or GHG Savings) over the 15 year period totals 100.05 MTCO2. According to the United States EPA Calculator, 100.05 MTCO2 is equivalent (in terms of greenhouse gas emissions or "climate pollution") to 255,855 miles driven by an average gasoline-powered vehicle. For comparison purposes, the distance around the Earth (or circumference) at its widest, the equator, is 24,901 miles. Thus, the climate pollution savings

reflects the equivalent of a hypothetical gas-powered car driving around the Earth at the equator roughly ten times.

Not including the additional efficiency upgrades described below, the construction costs associated with removal, recycling, and replacement of all gas appliances with electric versions totaled approximately $21K+/unit (after public subsidies). Note that this figure includes all contractor costs (including labor and overhead) and contractor profit associated with the work. A more detailed cost breakdown is provided below.

Additional energy and water efficiency upgrades

These units already had double pane vinyl windows and insulated building envelopes. Thus, in addition to the removal of gas appliances, the LIWP and BayREN BAMBE programs recommended the prioritization of remaining energy efficiency opportunities in these units. Accordingly, each dwelling unit received a new, more efficient GE Energy Star Dishwasher, replacement of non-LED to LED lights, replacement of high flow water fixtures with low-flow aerators/showerheads, and new smart thermostats that give residents easier control over their home heating and cooling usage. Though peripheral to the project's climate and health goals from gas appliance removal, these additional upgrades will further improve units' overall efficiency, add to residents' comfort and quality of life, and help keep monthly electricity and water bills down.

Solar, batteries, and EV charging can come next

Once a building like Willow Court has achieved full electrification, the addition of solar panels will further reduce resident monthly utility bills substantially. Pairing the solar panels with storage (batteries) can not only enable properties to "go off the grid" during outages, enabling reliance during storm-related outages or brownouts, but also allows for energy arbitrage. In this context, free solar energy obtained during daylight hours can be stored for use in the evening hours.

Building owner participation in incentive programs like SOMAH for low income multifamily building owners can minimize capital costs associated with solar installation. The California Public Utility Commission's Self-Generation Incentive Program (SGIP) currently offers subsidies to residential and nonresidential buildings for energy storage capabilities. Willow Court's contractor has confirmed sufficient remaining space on current electrical panels to add EV charging, solar, and maybe battery storage in the future without necessitating further panel upgrades.

Note that part of the reason MidPen chose not to include solar panels at this time involves the partial shade created by several large trees near the property. Long before Menlo Spark's involvement in this project, MidPen received a solar estimate for Willow Court, uncovering that, due to the partial shade, offsets created by solar were lower than MidPen desired to justify the cost of installation at that time. However, MidPen could reconsider solar at Willow Court in the future, especially by acquiring an additional grant to cover upfront installation costs. Note that

Willow Court has only two stories; higher rise multifamily buildings are unlikely to be impacted by tree shade in this context, making solar an increasingly attractive option for taller properties.

Although MidPen chose not to add EV charging to Willow Court at this time, MidPen may choose to do so in the future, with ample space remaining on its electrical panels for Level 1 or Level 2 EV charging infrastructure. At the time of this case study, local incentives from Peninsula Clean Energy remain available to provide free EV technical assistance and to help subsidize the upfront costs of EV charging infrastructure in multifamily units. Note that Level 1 chargers (just a typical outlet) can be installed at multifamily properties at a much lower cost than that for Level 2 chargers, still adding meaningful vehicle charging capabilities for residents. Level 1 outlets can charge an EV up to 40-50 miles overnight; this capacity exceeds the average daily commute for most Bay Area residents.

Free induction-ready cookware sets

Finally, Menlo Spark provided each unit with a full set of induction-ready cookware, including numerous pans/pots/skillets compatible with induction stoves. In doing so, Menlo Spark purchased durable cookware brands free of perfluorinated chemicals (PFCs). Much, but not all, cookware typically used on gas stoves can still be compatible with induction cooktops. However, for residents whose previous cookware did not work readily on induction technology, Menlo Spark wished to cover the hassle and expense of sourcing new pieces.

Total costs

The table below provides the Willow Court retrofit total cost, including all items described above, before and after subsidies.

Willow Court Retrofit Costs		
Total Payments to Contractor (incl installation and profit)	$	255,991
BAYREN BAMBE Incentive	$	52,500
LIWP Incentive	$	37,656
Peninsula Clean Energy Incentive	$	39,000
Total Less Public Incentives	$	126,835
Number of Housing Units at Willow Court	$	6
Cost per Housing Unit After Public Subsidies	**$**	**21,139**
Menlo Spark Grant to Acheive Total $0 Costs to MidPen*	$	126,835
** In addition, Menlo Spark provided funds (a few thousand dollars) to cover induction cookware sets for residents, lunch vouchers to residents during construction, and some nominal MidPen soft costs.*		

Why Now: The Era of Building Electrification

We have entered a compelling moment in our nation's history, with massive, previously-unseen public funding levels available to meet the ever-escalating climate crisis. The convergence of this crisis with new funding opportunity is amplified by manufacturing advancements that have thrust us into the "era of the heat pump" to electrify buildings and reduce buildings' corresponding climate pollution.

Menlo Spark's Executive Director, Brian Schmidt, summarizes the following details below about the myriad benefits of heat pumps, specifically as they relate to Willow Ct: *"Cleaner, safer, cools during heatwaves, and helps protect our planet – what's not to love?"*

"Natural" gas is methane, a greenhouse gas significant to global warming
Energy used by buildings comprises approximately one-third of climate pollution across the globe (over 40% in the City of Menlo Park) due to buildings' large consumption of the fossil fuel, methane (also known as "natural gas", an industry term). Methane fuels buildings' combustion appliances: furnaces, water heaters, clothes dryers, and ovens/stoves. The United Nations Intergovernmental Panel on Climate Change (IPCC) reports have repeatedly identified methane as an essential priority for drastic reductions under any scenario designed to avoid global temperature increases beyond 1.5 degrees Celsius (per the Paris Accord).

Methane usage creates three major challenges to health and safety: 1) its combustion presents health hazards from leaked benzene and combustion pollutants like nitrogen dioxides and carbon monoxide; 2) its combustion consumes oxygen and converts it to planet warming carbon dioxide (CO_2); 3) its drilling wells, processing, storage and pipelines all leak methane that is, for each molecule, about 25 times more climate disrupting than even the molecules burnt to form CO_2 As timelines to avoid global climate catastrophe shrink, we must target the fossil fuels (e.g., methane) that cause the most damage in the short-term or otherwise risk irrevocable global damage (IPCC reports).

Methane and public health: pollution inside and outside of buildings
Eliminating gas (methane) consumption in buildings also yields enormous public health benefits, especially for young children. Peer-reviewed, scientific studies now show that burning methane to fuel appliances causes outdoor and indoor air pollution that contributes significantly to asthma, cardiac, and other diseases and fatalities due to NOx, benzene, and carbon monoxide exposures. Gas appliances in California homes and buildings generate four times more lung-damaging NOx pollution than the state's gas power plants. Moreover, gas appliances in *Bay Area* homes and buildings generate more NOx pollution than amounts generated by all of the region's passenger vehicles combined. Recent analyses demonstrate that these gas appliances leak significant levels of methane inside and outside of homes and buildings, even when the appliances are turned off.

Especially noteworthy are the related and now well-documented environmental justice concerns, given that communities of color often suffer much more so from pollution than their wealthier counterparts. These same communities lack resources for in-home air filtration and adequate health care to address health concerns caused by this pollution, further exacerbating disparities. More details on these environmental justice issues are provided below in the context of Menlo Park's Belle Haven community.

Building electrification generates immediate climate pollution reductions
Building electrification immediately reduces climate pollution by eliminating gas appliances and replacing them with more efficient versions that use electricity instead. In our region, our local electricity providers (Peninsula Clean Energy, Silicon Valley Clean Energy, and others) provide 100% climate-pollution free, clean energy. The rest of the California and national electric grids are already becoming much cleaner (and at rapidly increasing rates from investments in new renewable energy sources), making building electrification a crucial priority to address climate change.

Building electrification eliminates safety hazards from gas combustion
The combustion of gas via appliances within homes and buildings poses significant risk to occupants from potential gas leaks, improper ventilation, and general fire risk. In fact, in 2021, AEA documented combustion safety data from 99 buildings served by the BAMBE and LIWP programs, concluding that 23 of those buildings failed about 10% of the time. Of the 1,209 dwelling units inside the buildings tested, 49% failed combustion safety standards. The removal of all gas combustion in multifamily buildings thus not only improves occupants' overall safety but also reduces MidPen's tenant liability.

Electric heat pump technology: proven and highly efficient
Thanks to decades of manufacturing advances, electric heat pump technology (for HVAC systems and water heaters, which generate the most climate pollution from burning gas in buildings) have now been fully mainstreamed into leading manufacturer brands. These heat pumps provide durable appliance solutions far healthier and more efficient than their older gas versions. In fact, heat pump water heaters and HVAC systems are 3-4x more efficient than their gas counterparts. Thus, building residents using heat pump, electric appliances need significantly less energy to achieve the same amount of power in their homes.

Pending regional/state regulation will necessitate building electrification very soon
Pending regional and state regulation further reinforces that building electrification is likely to scale by orders of magnitude in the very near future, once replacement mandates take effect. The Willow Court project enables early compliance with these regulations and goals while demonstrating the myriad benefits of doing so.

The Bay Area Air Quality Management District (BAAQMD) recently passed groundbreaking regulation that will mandate (at time of replacement only) the conversion of gas water heaters and furnaces with zero NOx versions (residential water heaters in 2027, furnaces in 2029, and commercial water heaters in 2031). Since all gas appliances generate NOx pollution, compliance

with these regulations will necessitate non-gas, electric versions. Note that these regulations come into play only at "burnout", when a building owner needs to or chooses to replace an appliance. No existing gas appliances will be removed from buildings until a building owner elects to replace it.

In 2022, the State of California also announced its six million heat pump deployment goal, and the California Air Resources Board (CARB) is scoping zero emission water and space heating equipment standards for implementation in 2030.

Merging Climate Solutions with Social Justice

As consistent with our mission to pursue climate solutions with equity, Menlo Spark chose its first multifamily electrification project in the city's Belle Haven community, a historically under-resourced, community of color. Belle Haven faces widespread poverty rates, higher incidence of asthma and other disease, and other factors that place its residents at acute risk due to pollution from gas appliances and climate change-induced extreme heat.

"Willow Court's completion demonstrates Menlo Spark's commitment to solving the climate crisis while prioritizing social justice. Instead of leaving people behind, we want our Belle Haven community to be amongst the first to reap the benefits of a cleaner, healthier, more comfortable home. May Willow Court inspire the movement to electrify more multifamily buildings up and down the state." – Angela Evans, Director of Electrification, Menlo Spark

Poverty levels in Belle Haven preclude personal funds for new cooling equipment
A previously redlined community, Belle Haven residents have been largely unable to recoup lost equity due to discriminatory housing practices decades ago (*The Color of Law*, Rothstein, 2017). Many residents work multiple jobs to make ends meet and do not have funds leftover to cover additional cooling supplies or whole home air conditioning. Since heat pump HVAC systems inherently include home heating and cooling in its technology, the replacement of Willow Court's gas furnaces with heat pump HVAC systems not only delivered more robust, efficient home heating systems, but doing so also provided air conditioning to residents for the first time.

Less tree canopy worsens "heat islands", making air conditioning an urgent necessity
Belle Haven has significantly less tree canopy (7% of total surface area) than the canopy in adjacent areas, making the need for air conditioning in an increasingly warm climate even more dire. Neighboring Atherton has 42%-89% of the town blanketed with trees. In comparison, the portion of Menlo Park west of Belle Haven has 23%-41%. Trees provide not just immediate shade but also decrease urban temperatures by absorbing heat and releasing water vapor. As a result, communities with low tree canopy become increasingly warm "heat islands".

Belle Haven already faces significant air pollution levels, poorer health outcomes
Embedded with major roadways and near a major highway, Belle Haven faces constant vehicle exhaust exposure. Diesel particulate matter, a major cause of asthma cases in young children,

reaches levels in Belle Haven that rank amongst the highest 88% of California census tracts. Based on CalEnviroScreen data, the rest of Menlo Park records levels closer to the lower 40% of census tracts.

Alarmingly, Belle Haven resident life expectancy is seven years lower than the San Mateo County average. Asthma rates in Belle Haven are likewise more than four times higher than those in other Menlo Park neighborhoods. Pollution from gas appliances, as described above, greatly exacerbates health concerns (especially asthma and other respiratory and cardiac disease), adding increased pollution inside and outside of buildings in a community already disproportionately burdened by poor air quality.

For all these reasons and more, Menlo Spark felt strongly that the Belle Haven community warranted its first investment in multifamily electrification. Choosing Willow Court for this project gave Menlo Spark an opportunity to serve community members that may benefit most from the healthier living conditions created.

Project Convenience, Rental Protections, Electrical Panel Efficiencies

Speed and convenience

In addition to climate pollution reductions, public health and safety benefits, and increased appliance efficiencies achieved at Willow Court, the project's construction plan and execution achieved a level of speed and resident convenience worth amplifying for future projects.

To minimize disruption to Willow Court residents, the contractor – in partnership with MidPen Housing and Menlo Spark -- designed a construction plan that prioritized the retrofit of one family's unit at a time, each completed over the course of approximately seven business days. Rather than undertaking work on several units in tandem, focusing on only one unit at a time meant less total in-unit disruption time per resident family.

Moreover, despite the complete electrification undertaken in all six units, the entire Willow Court retrofit, start to finish, was completed by one contractor (and its subcontractors) in approximately three weeks per triplex, or a total of six weeks for both triplexes.

Retrofits were designed so that residents could stay inside their units during construction if desired, with bedrooms remaining clear of construction. Note that project partners coordinated with residents well in advance of construction to confirm that no individuals worked night time shifts, necessitating quiet daytime sleep. If some residents had reported nighttime work schedules, additional, temporary relocation costs, such as hotel stays, would have likely been necessary to ensure resident well-being.

To further protect residents during construction, the removal and replacement of the gas range occurred in one day, ensuring that residents would never be without a stove/oven to prepare

dinner and breakfast. (For residents that wished to purchase food for lunch outside their units, food vouchers were provided, adding a nominal but important cost to the total project.)

The contractor made sure to turn water heaters on at the end of each construction day, ensuring access to hot water for residents in the evening, nighttime, and early morning hours. Construction occurred in late summer, when residents didn't need access to home heating; however, if construction had occurred during colder weather, the contractor was prepared to temporarily provide portable space heaters as requested.

Rental rate protections

As a recipient of public housing assistance subsidies, including the California Department of Housing and Community Development (HCD), MidPen must ensure that residents' rental payments (or "affordable housing cost") do not exceed 30% of tenant income. The total "housing cost" in this context includes rent and utility costs from gas, electricity, water, and garbage bills. Evaluated at least annually, rents are calculated to ensure compliance with these cost caps. In the case of Willow Court, gas bills will immediately go to zero, and electricity bills will reflect the newly-installed, more efficient electric appliances plus additional water and energy efficiency measures undertaken. These regulated arrangements can help to ensure rental rate protections not only for electrification retrofits but also for other general property upgrades and capital improvements.

According to Nigel Felix, Associate Asset Manager of Real Estate Transactions for MidPen Housing, "*As a mission-driven non-profit, MidPen is committed to keeping rents affordable for residents. Additionally, Willow Court has a number of layers of financing from local all the way to up to state sources; these financing layers include regulatory agreements which define how rents are assessed. Willow Court specifically, has a loan from HCD which not only restricts rents based on loan program regulations, but also requires us to obtain their approval for any rent increases. Generally, rent increases are only approved to cover normal increases in operating expenses, so elective projects like this are not an applicable reason for an increase.*"

As described in more detail below, the California Equitable Building Decarbonization program is developing renter protections for the low- and moderate-level income buildings served in its statewide program.

Electrical panel efficiencies

Despite the conventional wisdom of prior decades linking home electrification to costly, time consuming electrical panel upgrades, the "panel upgrade myth" has now been successfully debunked. While many contractors and building owners previously assumed that home electrification would require panel upgrades up to 200 Amps, the now widely understood "Watt Diet" demonstrates that most homes can electrify all appliances (including water heaters, furnaces, stoves, washer/dryers, plus EV charging) without upgrading panels beyond 100 Amps. Local electricity providers such as PCE and SVCE have featured electrical panel resources and design guides on their sites to help customers avoid unnecessary panel upgrades. SPUR also recently published a policy brief on avoiding panel upgrades in this context, "Solving the Panel

Puzzle: Avoiding and streamlining electric panel and service upsizing to accelerate building decarbonization."

Willow Court's electrification further reinforces that 100 Amps per housing unit is often more than enough for a fully electrified home. With all new electric appliances, Willow Court's electrical load calculations demonstrate a per housing unit load of 50 Amps according to National Electric Code calculations article 220.84 (with room for Willow Court to add EV charging later). As a result, Willow Court's retrofit did not necessitate any new electric panel upsizing or service wire upsizing costs, keeping total project costs down. *"The final electrical load calculations show the project has capacity to add large EV chargers and large solar arrays as future proofing for further electrification, all while staying within the existing service wire capacity. This helped the project go smoothly without needing extra utility attention,"* reports Tom Kabat, energy engineer.

Willow Court's detailed load calculations are provided below. Note that Willow Court used NEC code 220.84, optionally available for multifamily dwellings with three or more units. NEC 220.84 allows for more electrical capacity flexibility than does NEC 220.54, which may also be used in this scenario but which creates more capacity limitations.

Willow Court TriPlex Load Calculations (with NEC 220.84 for Multifamily 3+)					
	Sq Feet	**#**	**VA Each**	**VA**	
General lighting (SQFT X # VA/SQFT)	2,569	3	3 VA/ sqft	7,707	
Small Appliance Circuits (1500VA per circuit, min 2)		6	1500	9,000	
Laundry Circuit (1500 VA per Circuit): 120v washer/dryer heat pump combo		3	1500	4,500	
Fixed Appliances					
Garbage Disposal		3	600	1,800	
Bathroom Fan		3	15	45	
Built-in Microwave		3	1200	3,600	
Dishwasher		3	1200	3,600	
Other Loads					
Induction Electric Range (8,000 VA or Nameplate)		3	7200	21,600	
HVAC (heat pump)		3	2270	6,810	
Electric Dryer (5,000 VA minimum)		No		-	
EV Electric Vehicle Charger		No		-	
Water Heater (heat pump)		3	4500	13,500	
				-	
Total Service Load Volt-Amperes (VA) =			Subtotal	72,162	All non-HVAC items
			Demand Factor	45%	VA Counted
				32,473	VA Counted
			Total	32,473	VA Counted
Total VA / 240 volts				135	Total VA/240 volts
				45	**Amps needed/unit**

Calculations show 151 amps needed across three units or 50 amps needed per unit. Note that Willow Court contains two triplexes, each with three units (six total across both triplexes). The calculations above were computed for one triplex but are relevant to both triplexes within the property. NEC 220.84 treats all loads at 45% or even less if the number of apartments rises above three. For comparison NEC 220.54 (also for Multifamily) treats space heating/cooling plus a number of other items at 100% in its calculations, thereby requiring substantially more amperage needed for code compliance.

Interestingly, Willow Court had underground service wires for 125 Amps, years before Menlo Spark's involvement in this project. Prior to the retrofit, one of the Willow Court triplexes had unit panels at 70 Amps; the other triplex had unit panels of 100 Amps. During this retrofit, the contractor and electrician were able to increase amperage capacity of the panels with only nominal costs (no underground wiring upgrade costs) to 125 Amps, taking advantage of the wire sizes already in place. The Willow Court units will not need this incremental 25 Amps capacity unless it chooses to add large solar arrays or large EV chargers in the future. Tom Kabat added, *"The selection of 125 Amp breaker boxes to match existing service capacity while using power efficient electrification appliances just gives the buildings future flexibility to add more electrification loads and solar if wanted down the road."*

Willow Court demonstrates that multifamily buildings can successfully electrify while keeping individual housing unit demand below 100 Amps and without expensive panel upgrades. As multifamily electrification scales, the avoidance of panel upgrades will prevent undue stress on the state's electrical grid.

Scaling the Willow Court Precedent

While retrofits to existing multifamily buildings can offer meaningful sources of climate pollution reductions and quality of life improvements for residents, multifamily electrification has historically faced some perceived challenges, including substantial upfront costs and split incentives between tenants and building owners. The split incentive, in which the building owner pays for energy efficiency and other upgrades while tenants pay the utility bills and reap the health and safety gains from gas removal, can decrease motivation for energy retrofits in tenant-occupied buildings.

Even though Willow Court residents pay their own utility bills, this project avoided the split incentive dilemma by sourcing enough public subsidy and grant funds to cover almost all upfront capital costs. To replicate Willow Court's successful precedent, multifamily building owners may wish to engage in California's upcoming Equitable Building Decarbonization Program, designed to create no- or low upfront electrification retrofit costs for buildings occupied by low- and moderate-income residents. This program will provide building decarbonization upgrades for single-family, multifamily, and manufactured homes in under-resourced communities while simultaneously offering renter protections developed by state working groups.

As of October 2024, multifamily building owners in the Silicon Valley Clean Energy (SVCE) territory are eligible for SVCE's multifamily direct install program. This program offers no cost retrofits up to $450,000 for existing multifamily remodels that replace gas appliances with energy efficient electric versions. SVCE has partnered with AEA to execute this program, which will offer energy and water savings plus free EV charging.

Although the state and SVCE programs described above are designed to cover upfront costs, multifamily buildings that do not qualify for these programs can still make the upfront economic costs of electrification work in their favor. In other words, for well-planned electrification retrofits, the split incentive described above need not always preclude building owner engagement.

One example involves a multifamily building that wishes to replace its gas furnace (or gas boiler system) while simultaneously replacing or newly acquiring air conditioning. In prioritizing both heating and cooling needs during the same retrofit, building owners can choose to do so with one installation (a heat pump HVAC system, which provides both heating and cooling) or with two installations, a new gas furnace and a new, standalone air conditioning system. More often than not, the upfront costs of installing two new systems will far outweigh the upfront cost of installing one heat pump HVAC system. These cost savings are discussed further in Menlo Spark's example from the "approaching building owners early" section below. Current subsidies for replacement of gas appliances with heat pump versions will only further enlarge this cost savings associated with choosing electric heat pump solutions. Education about well-planned retrofits that prioritize both heating and cooling will go a long way in helping multifamily building owners invest wisely in building upgrades that save money, protect public health, and reduce climate pollution.

Moreover, installation costs for heat pump water heaters, when combined with currently available incentives for multifamily affordable housing, often come to zero or very low cost, making the decision to replace a gas water heater with a heat pump water heater a financial win.

Andy McNamana, co-founder and principal at Carbon Zero Buildings, explains how to make these installation economics work well for affordable and other multifamily housing owners, even if the buildings do not quality for the state's Equitable Building Decarbonization Program or Silicon Valley Clean Energy multifamily program mentioned above:

"As the co-founder and principal at Carbon Zero Buildings, I have overseen the electrification of over 50 large multifamily properties throughout the State of California, replacing gas-driven, polluting appliances with higher efficiency, electric versions.

Heat pump water heaters receive the most incentives and can frequently be installed at low- to no- out of pocket cost to affordable housing owners. Heat pump HVAC systems make heating and cooling buildings simpler, providing both heating and cooling with one system instead of

with two separate systems. The installation costs for heat pump HVAC systems are often much lower than the installation costs for gas furnaces plus standalone air conditioning systems. This is consistent with common sense: newly installing one highly efficient system should cost less than newly installing two separate systems that provide similar services. Moreover, the installation cost savings for heat pump HVAC described here almost always holds true even without the public subsidies currently available to lower income multifamily properties. For multifamily building owners seeking new heating and cooling systems (or replacing aging gas furnaces and newly acquiring cooling), it's often a financial "no brainer" to do so with a heat pump HVAC system. Combining with a heat pump water heater adds in much more potential for incentives and carbon savings."

To read more case studies on multifamily building electrification in different cities across the country, both for new construction and for retrofits to existing buildings, see Redwood Energy's 2019 Zero Emissions All-Electric Multifamily Guide and its Consumers Energy All Electric Multifamily Design Guide 2021.

Additional Takeaways

Pairing electrification with additional efficiency measures, keeping monthly bills down
The removal of gas appliances with heat pump electric versions will automatically improve building energy efficiency, as heat pumps for water heaters and space heating generally operate at 3-4 times the efficiency of their previous gas counterparts. The newly installed 120 volt combination washer/heat pump dryer also creates significant energy savings from the old, separate washer and drying machines. In fact, according to Willow Court's contractor, the reduced energy demand from these combination units more than covers the energy demands of newly installed heat pump water heaters.

As described above, the heat pump HVAC two-in-one system delivers both heating and cooling; in the case of Willow Court and many other older multifamily properties that lack cooling, brand new air conditioning can introduce new increases in monthly utility bills in the summer or early fall. However, some of this cost can be offset by the usage of more efficient heating in the winter months. To further offset any utility bill increases from the usage of new air conditioning, the inclusion of Willow Court's additional energy efficiency measures – new LED lights, more efficient dishwashers, and low-flow water fixtures – can further keep total energy bills down.

To minimize unexpected costs associated with new air conditioning at Willow Court, Menlo Spark provided MidPen site staff with recommendations on how residents could consider using air conditioning judiciously, providing recommendations to residents in English and Spanish. Recommendations included budget-conscious ideas such as reserving air conditioning usage for extreme heat days to protect vulnerable residents, including those at risk of heat stroke. Residents were also encouraged to use their newly-installed smart thermostats to make

personal decisions about how much cooling to use and when. For example, during the summer, a resident could consider capping cooling at indoor temperatures like 78 degrees (as opposed to 70 degrees, for example) when home or at 85 degrees (or off) while away for short periods.

Directing residents to consider new electricity delivery rates

Once dwelling units are fully electrified, residents may benefit financially from choosing new electricity delivery rate plans offered by PG&E (or other utilities, if outside of PG&E territory). PG&E offers a number of different rate plans, including E-ELEC, which may reduce monthly bills for residents based on a number of variables, including historic usage totals, time of usage, and California Alternative Rates for Energy (CARE) enrollment. PG&E offers the Home Intel program to help existing PG&E customers choose an appropriate rate plan. The program will work with individual residents (in English or Spanish) to examine prior Smart Meter power usage and determine the lowest cost rate plan for future usage. Though the program typically requires 12 months of prior Smart Meter data, energy coaches can work with residents to make decisions with partial year data. Paid by PG&E, Home Intel does not sell products or services and provides advice free of charge. MidPen has agreed to work with the Home Intel Program to help educate its Willow Court residents about rate plan choices.

Approaching building owners early, addressing retrofits with both heating *and* cooling

Before proceeding with the Willow Court project, Menlo Spark contemplated an additional multifamily retrofit serving low income seniors in the community. Though Menlo Spark did not yet have an existing relationship with the building's owner, Menlo Spark learned from another source that the building was embarking on the replacement of its failing gas boiler system with a new gas boiler system. The gas boiler system fueled both the water heating and home heating needs of the entire building. In the absence of city regulation requiring the building owner to replace gas with electric versions, the building owner did not yet realize that cleaner, healthier, more efficient heat pump alternatives existed. Nor did the building owner realize that heat pumps could offer its residents much needed air conditioning, saving substantial costs associated with the building owner's plan to likely install air conditioning at a later date.

In coordination with AEA and another project consultant specializing in the electrification of multifamily buildings, Menlo Spark provided the building owner with a revised cost estimate, including the BayREN BAMBE and LIWP incentives available for replacing its gas boiler system with electric heat pumps. Considering the subsidies available and avoided cost of adding air conditioning at a later date, Menlo Spark's proposal would have saved the building owner significant sums while providing meaningful climate pollution reductions and public health benefits to its residents. In response, the building owner expressed some interest in changing direction to include heat pump systems instead of replacing gas with gas. However, the contractor selected had already received permit approval from the city and placed an order for large components of the new gas boiler system. To make a large shift at that juncture, the building owner would have had to be willing to start anew, despite significant project momentum already in place. The building owner would also have been required to cover some of its contractor's early costs. The confluence of these two factors precluded the building owner's decision to change course. Simply put, it was too late.

Though regulation and education can help to avoid this kind of problem in the future, it's essential to proactively approach building owners with electrification solutions early, before gas appliances fail and before replacement plans solidify. Early identification of multifamily buildings with aging gas infrastructure can help organizations plan ahead while optimizing for cost savings, resident health, and climate pollution reductions.

Encouraging cities to adopt electrification permit incentive waivers

At the time of this case study, the City of Menlo Park currently offers Electrification Permit Fee Waivers for permit costs related to existing building electrification, including the removal of gas systems followed by installation of heat pump water heaters, heat pump HVAC systems, and associated electrical work. The sum total of electrification permit fees waived for Willow Court totaled more than $3,000. While some may perceive this number as a relatively small amount, these cost savings made a meaningful difference when formalizing the decision to move ahead with the Willow Court project. In the final weeks prior to determining if the project could move ahead, MidPen and Menlo Spark spent time ensuring a workable budget. Some small to moderate cost reductions were made without sacrificing the main electrification objectives and installation goals. Nevertheless, the gap between total costs and funds available persisted by a few thousand dollars even after exhausting other viable cost reductions. Upon confirmation, however, that the City would waive relevant permitting costs, MidPen and Menlo Spark finalized a workable budget. The avoided permitting costs took Willow Court over the metaphorical finish line, providing the financial flexibility to proceed.

Menlo Spark recommends that other cities consider similar incentive programs for all building types that waive permitting fees related to the removal of gas appliances with electric versions. While it's possible that some waived fees may end up subsidizing electrification projects that would have moved forward even without the added incentive, it's helpful to understand that waived permitting fees can, in fact, make a difference in overall decisions to proceed. Cities like Menlo Park can incentivize meaningful building electrification projects by allocating an ongoing budget for relevant permit fee waivers, enabling a number of desired projects to move forward successfully.

Encouraging cities to streamline heat pump permitting processes

The Willow Court contractor experienced significant permitting delays during plan checks with the City of Menlo Park, delaying the start of construction. Permitting "plan checks" involve the process between permit application submission and permit issuance. Plan checks involve a separate process from final inspections, which occur post installation.

In the case of Willow Court, the plan checks involved several, unanticipated back and forth processes with the city, whereby the city asked the contractor to make a series of edits to plans and then resubmit. These resubmissions delayed the project's start date by multiple weeks. After initial delays, the contractor decided to visit the city permitting desk in person every week to help move the process along. Though some of the requested edits by the city reflected important omissions on the part of the contractor, other requested edits may have been

minimized or avoided with more efficient permitting systems in place. Menlo Spark often hears similar stories from other heat pump installation contractors in Menlo Park and in cities outside of Menlo Park, reinforcing the need for widespread permitting reform for heat pump water heaters and heat pump HVAC systems. Meaningful reform will help to reduce contractor soft costs associated with delays, improve building owner experiences, and minimize city staff time involved.

Menlo Spark recommends that cities identify heat pump permitting challenges and allocate internal resources to resolve these issues. Once BAAQMD and other relevant state regulations come into effect, Bay Area municipal permitting desks are likely to receive large increases in permitting demand for heat pump appliances.

Menlo Spark served as one of several stakeholders to inform a series of permitting reform recommendations in SPUR's October 2024 brief, "Smoothing the Transition to Heat Pumps - Part 2: Permitting and Inspections." This brief identifies a variety of heat pump permitting challenges across Bay Area cities with recommendations to resolve those issues. In addition, the brief mentions SVCE's permit modernization program plans for its member agencies, BayREN's resources (electrical load estimator tool and a building code assistance sheet) for contractors, and San Mateo County's request for proposal for a countywide heat pump water heater permit simplification pilot. All of these resources may help cities upgrade and streamline heat pump permitting processes.

Expecting speedbumps, staying nimble

As with any project involving staff from multiple organizations and a large construction budget, unexpected variables inevitably emerge, requiring thoughtful, sometimes creative solutions. Nonprofit organizations often seek large positive change with limited staff and resources, requiring a certain amount of grit to complete projects. For example, the respective legal teams of Menlo Spark and MidPen had somewhat varying approaches to drafting the final contract that governed Menlo Spark's grant to MidPen for the Willow Court project. The process of agreeing to a final written contract involved increased time and internal resources from MidPen to correspond with its legal team. This increased demand on MidPen came at a time when the organization had an exceptionally large project portfolio, making it challenging for MidPen staff to process edits quickly. In response, Menlo Spark worked with its own legal team to expedite some language compromises and offered to cover a portion of the added internal soft costs MidPen incurred from this work. Eventually, a workable final contract emerged, and both Menlo Spark and MidPen remained flexible to achieve this result.

In general, Menlo Spark recommends approaching multifamily electrification with a combination of unwavering due diligence, robust project management, and early partner conversations about staying nimble in the face of some inevitable "speedbumps". Accordingly, the allocation of a meaningful contingency budget can help to soften the blow of unexpected costs. A certain amount of patience and goodwill with partners can also help in maintaining positive relationships and moving projects to completion.

Conclusion

The climate crisis necessitates urgent solutions. Chief among them is the removal of gas appliances in buildings for healthier, more efficient electric alternatives. As San Mateo County's first ever existing multifamily housing property to undergo full conversion from gas to electric appliances, MidPen's Willow Court can serve as a successful example for other multifamily building owners seeking similar retrofits.

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