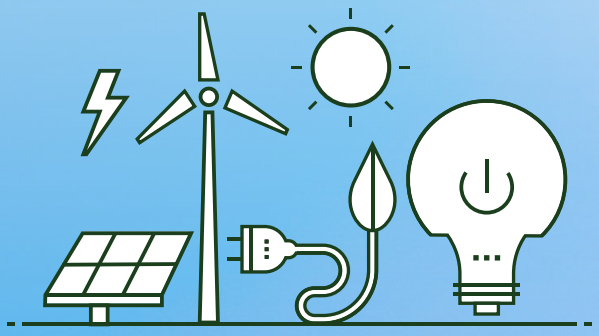

Optimized Strategic Plan

Pasadena's Path to 100% Carbon Free Electricity

PASADENA WATER & POWER DEPARTMENT

CLEAN POWER PASADENA

About this Document

On January 30, 2023, the Pasadena City Council adopted Resolution 9977, declaring a climate emergency and establishing "a policy goal to source 100% of Pasadena's electricity from carbon-free sources by the end of 2030" and to optimize for "affordability, rate equity, stability, and reliability of electricity while achieving this goal." The carbon-free goal set by Resolution 9977 is one of the most ambitious clean energy goals among utilities and corporate entities. Following the publication of Pasadena Water and Power's (PWP's) 2023 Power Integrated Resource Plan (IRP), City Council directed PWP to work with an independent consultant to develop an Optimized Strategic Plan (OSP) to achieve this ambitious milestone.

The foundation of the OSP is a series of technical studies conducted by Energy & Environmental Economics, Inc. (E3) under a consulting contract with the City of Pasadena. This series of studies – approved in scope by City Council – utilizes industry-leading analytics to provide a comprehensive evaluation of the combinations of resources that will enable PWP to meet the goals established in Resolution 9977. Highlights and key insights from those studies are presented herein, and additional detail is provided in a series of technical appendices provided by E3. The plan itself, as represented by this document, is the product of a collaborative effort between PWP and E3, guided by City Council and the Municipal Services Committee, and shaped by input from the City Manager's Office, the Environmental Advisory Commission, community stakeholders, and an independent Technical Advisory Panel to translate the technical analysis into a detailed action plan describing the key steps that PWP will take over the next five years and beyond.

The OSP charts a forward-looking path that is built to evolve. The electric industry is in a period of rapid change and uncertainty, and significant shifts have already occurred since the completion of the technical analysis. These recent changes are predominantly driven by external forces, ranging from global supply chain disruptions to shifts in state and federal policies. Recognizing this dynamic environment, the OSP is intentionally designed with flexibility. It allows PWP and the City to respond to challenges, adjust course when needed, and take advantage of new opportunities. PWP is committed to keeping City Council and the public informed, enabling the City to make timely, informed decisions.

A living, adaptive plan provides Pasadena with the best opportunity to balance key goals – delivering carbon-free electricity while maintaining affordability, reliability, stability, and rate equity. The plan is designed to evolve over time as new technology emerges, market conditions shift, customer needs change, and new developments arise in state and federal policy, among other factors. Implementation of the OSP will be directed by the policy leadership of City Council and their authorization of new resources, programs, and initiatives needed to move forward in these evolving conditions. While not every detail in this plan is guaranteed to unfold exactly as described, this roadmap helps us stay focused, flexible, and ready to take advantage of new opportunities as they arise to meet our goals.

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Acronyms

Acronym	Definition
710 Stub	710 Freeway Stub
AB	Assembly Bill
AMI	Advanced Metering Infrastructure
APPA	American Public Power Associations
APPLE	Assisting Pasadena People w/ Limited Emergencies
ARCA	Refrigerator Exchange & Recycling Program
BESS	Battery Energy Storage System
BRP	Business Rebate Program
BTM	Behind-the-Meter
BWP	Burbank Water Power
CAISO	California Independent System Operator
CALeVIP	California Electric Vehicle Infrastructure Project
Caltech	California Institute of Technology
CARES	California Alternative Rates for Energy
CEC	California Energy Commission
CEVSE	Commercial EV Charging Rebate Program
CIP	Customized Incentive Program
CMUA	California Municipal Utilities Association
CPCN	Certificate of Public Convenience and Necessity
CPUC	California Public Utilities Commission
DC	Direct Current
DEBA	Distributed Electricity Backup Assets
DEED	Demonstration of Energy & Efficiency Development
DER	Distributed energy resources
DR	Demand response
DSGS	Demand Side Grid Support
E3	Energy & Environmental Economics
EAC	Environmental Advisory Commission
EECBG	Energy Efficiency and Conservation Block Grant
ELCC	Effective Load Carrying Capability
ERS	Electric Rate Study
ESAP	Energy Savings Assistance Program
EUAP	Electric Utility Assistance Program
EV	Electric vehicle
EVSP	Electric Vehicles Service Provider
FEOC	Foreign Entity of Concern
FT	Feed-in-Tarriff
Glenarm	Glenarm power Plant
GRIP	Grid Resilience and Innovation Partnerships
GWP	Glendale Water and Power
HER	Home Energy Rebate Program
HIP	Home Improvement Program

Acronym	Definition
IPCC	International Panel on Climate Change
IRP	Integrated Resource Plan
LACI	Los Angelese Cleantech Incubator
LACI	Los Angeles Clean Tech Incubator
LADWP	Los Angeles Department of Water and Power
LDES	Long Duration Energy Storage
LiDAR	Light Frequency Detection and Ranging
LOLP	Loss of load probability
LSE	Load-Serving Entity
LTCE	Long Term Capacity Expansion
MOU	Memorandum of Understanding
MSC	Municipal Services Committee
NEM	Net energy metering
NERC	North American Electric Reliability Corporation
OBBBA	One Big Beautiful Bill Act
OSP	Optimized Strategic Plan
PCC	Pasadena City College
PCOC	Pasadena Center Opportunity Company
PDMP	Power Delivery Master Plan
POU	Publicly Owned Utilities
PPA	Power purchase agreement
PSPS	Public Safety Power Shutoffs
PUSD	Pasadena Unified School District
PWP	Pasadena Water and Power
RA	Resource Adequacy
RBOC	Rose Bowl Operating Company
RECs	Renewable energy certifications
REPU	Residential Electric Panel Upgrade Program
RFP	Request for Proposals
RNG	Renewable Natural Gas
RPS	Renewable Portfolio Standard
SB	Senate Bill
SCE	Southern California Edison
SCPPA	Southern California Public Power Authority
SMR	Small Modular Reactors
SMUD	Sacramento Municipal Utilities District
SoCalGas	Southern California Gas Company
TAP	Technical Advisory Panel
TM Goodrich	TM Goodrich Receiving Station
TOU	Time-of-Use
V2G	Vehicle-to-Grid
VLCP	Voluntary Load Curtailment Program
VPP	Virtual Power Plant
WeDIP	Water & Energy Direct Install Program

1 Executive Summary

For over a century, Pasadena Water and Power (PWP) has served the residents and businesses of the City of Pasadena and portions of San Gabriel and Altadena with a mission to provide safe and reliable water and power with superior customer service at competitive rates. As a municipally owned utility, PWP is accountable to the community we serve, allowing us to prioritize the long-term well-being of the community and tailor our services to meet local priorities. As the City has grown and changed, our role in supporting our City has grown as well. We are committed to continuing to adapt to meet the needs of our community while adhering to our mission and values.

Transitioning to clean, carbon-free energy is a clear community priority, and our approach as a utility has evolved over time to reflect that. Since the passage of California's first Renewables Portfolio Standard (RPS) in 2010, PWP has outpaced State mandates for renewable energy. More than a decade ago, the Pasadena City Council approved a voluntary RPS goal of 40% by 2020, which exceeded the State of California's mandated RPS of 33% by 2020. Our integrated resource plans have consistently produced portfolios that envision more aggressive pathways toward decarbonization than California's statewide greenhouse gas reduction targets. In 2018, we made the pivotal decision not to renew our participation in the Intermountain Power Project, a long-term coal and natural gas power resource, beyond 2027, eliminating the single largest source of carbon emissions from our power supply portfolio.

In 2023, Pasadena City Council adopted the landmark Resolution 9977, a declaration of the climate emergency and a commitment to source 100% of Pasadena's electricity from carbon-free resources by the end of 2030, while optimizing for affordability, reliability, stability and rate equity. This ambitious step thrust Pasadena into the vanguard of climate action, setting a goal far beyond the requirements of state policy and most voluntary utility and corporate goals and positioning us as a leader among California cities. The ambition behind Resolution 9977 demands more than incremental change, it calls for a fundamental transformation of our energy system that will reshape how electricity is generated, how it is delivered, and how it is used by our customers.

Meanwhile, the climate emergency continues to grow more severe. Globally, 2024 was the hottest year on record, and scientists at the Intergovernmental Panel on Climate Change (IPCC) warn of increasing severity and frequency of heat waves. The same warming trends observed at a global scale have impacted Pasadena's climate as well: seven of the ten highest recorded temperatures in our city's history have occurred since 2020.

The climate emergency calls for bold action and leadership, and the Optimized Strategic Plan (OSP) is our response to that call. Supporting the commitment of Resolution 9977, the OSP presents a forward-looking vision to achieve 100% hourly carbon-free energy, grounded in rigorous technical analysis and shaped by community values. The OSP charts a path to meet the City's carbon-free goal while prioritizing reliability, affordability, equity, and long-term system resilience. The OSP is designed to ultimately help reach the goal based on the most ambitious hourly accounting metric that matches electricity demand with carbon-free energy on an hour-by-hour basis, while first passing the milestone of meeting the City's energy needs with carbon-free resources on an annual

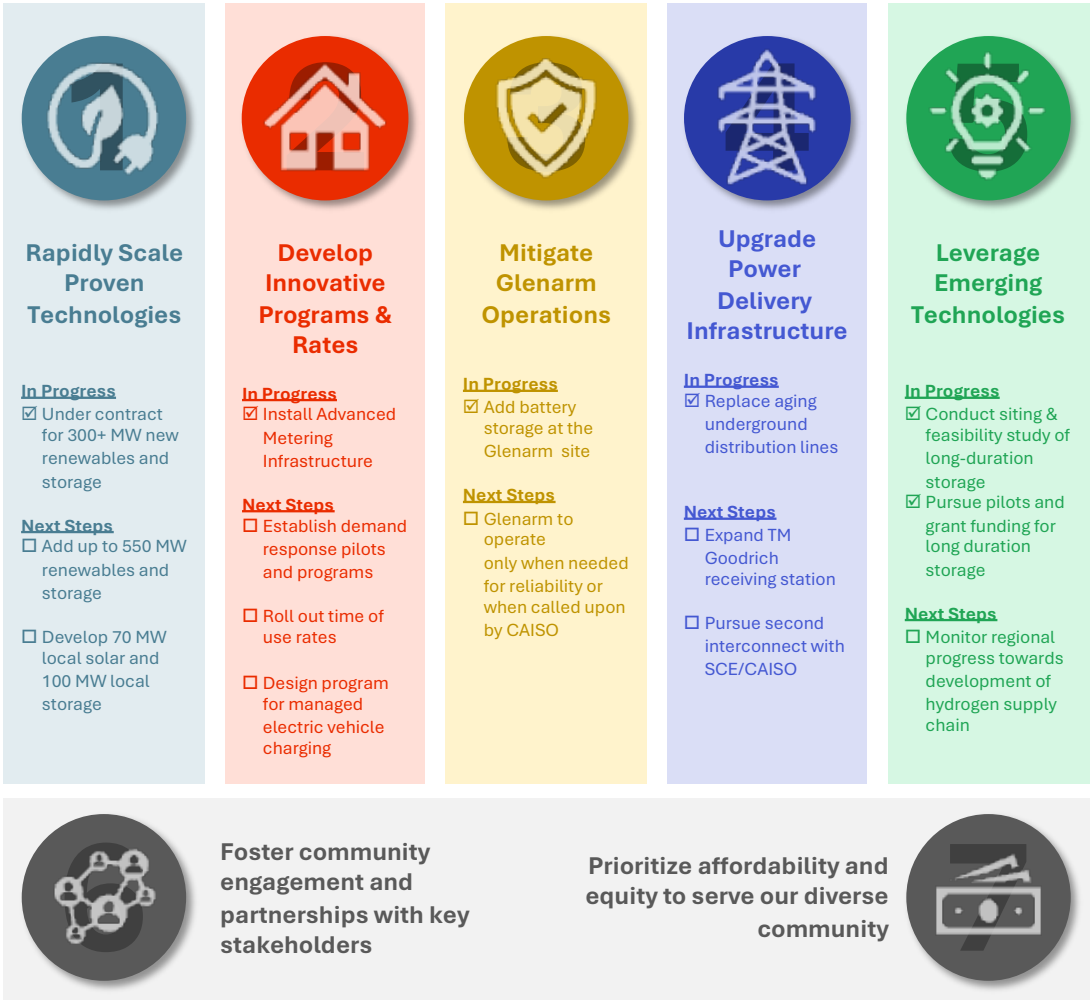
basis accounting metric. It reiterates our commitment to a cleaner future and provides a pragmatic strategy for achieving it. That strategy calls for aggressive actions in five areas shown in Figure 1:

1. Rapidly scale proven technologies, including renewables and energy storage, within Pasadena and across the broader region;
2. Develop innovative programs and rates to leverage customer-facing solutions;
3. Mitigate Glenarm Power Plant (Glenarm) operations, using it as a "reliability backstop" until another solution is available;
4. Upgrade our power delivery infrastructure to improve reliability, relieve import constraints, and enhance demand side innovation; and
5. Monitor and encourage emerging technologies to expand options to decarbonize.

These five pillars rest upon two additional foundational elements of our plan:

6. Foster community engagement and partnerships with key stakeholder and industry groups to collaboratively push forward the energy transition; and
7. Prioritize affordability and equity to serve our diverse community and maintain Pasadena as a vibrant economic hub.

Figure 1. Pillars of the Optimized Strategic Plan



1.1 Planning Targets Grounded in Technical Analysis

How to transition an electricity system to 100% carbon-free sources at least cost while maintaining reliability is a complex technical question, and one of the guiding principles that has shaped the development of the OSP is that the plan should be grounded in rigorous technical analysis. The scope of work to develop the OSP approved by City Council included a suite of technical studies that leverage advanced power system planning software (including loss of load probability and long-term capacity expansion modeling). Through this technical study process, E3 worked with PWP and the City Manager's Office to develop a collection of seven case studies illustrating various pathways to meet the City's goals.

After reviewing the results of all seven case studies, the Municipal Services Committee (MSC) directed PWP focus on the select four case studies presented in At the November 5, 2025, MSC meeting, PWP presented the draft OSP which included a planning target for local solar of 50 MW. This proposed planning target was informed by the technical analysis of the **Hourly Matching, Accelerated Local Resources** case study, would support PWP in achieving the carbon-free goal, and reduce reliance on Glenarm. MSC directed PWP to revise the OSP planning target for local solar from 50 MW to 70 MW, 50 MW of which should come from PWP customers.

Table 1 below, which shows the installed capacity of new resources added to PWP's portfolio (not including future resources that are already under contract) in these case studies. The four case studies shown are:

- **Annual Matching, Accelerated Local Resources:** a portfolio designed to meet 100% of PWP's annual energy needs with carbon-free resources, including an acceleration of local solar and storage resources to reduce reliance on Glenarm;
- **Annual Matching, Accelerated Local Resources:** a portfolio designed to meet 100% of PWP's annual energy needs with carbon-free resources, including a further acceleration of local solar and storage resources to reduce reliance on Glenarm and lessen reliance on external renewables and storage;
- **Hourly Matching, Accelerated Local Resources:** a portfolio capable of meeting 100% of PWP's hour-by-hour energy needs with carbon-free resources, including an acceleration of local solar and storage resources to reduce reliance on Glenarm; and
- **Hourly Matching, Accelerated Local Resources Plus:** a portfolio capable of meeting 100% of PWP's hour-by-hour energy needs with carbon-free resources, including a further acceleration of local solar and storage resources to reduce reliance on Glenarm and less reliance on external renewables and storage.

The planning targets for local and external renewables and storage adopted by the OSP are informed by the full suite of case studies evaluated but were determined based on the **goal of 100% hourly carbon-free energy**. The planning targets have several important implications for PWP's system:

1. Total resource additions at this scale would provide PWP with a portfolio of resources capable of meeting 100% of its hourly energy needs with carbon-free resources;[1]
2. Local solar and storage resources at this scale would provide PWP with internal carbon-free resources to serve peak loads when electricity demand exceeds PWP's ability to import electricity from CAISO, reducing reliance on Glenarm;
3. The resource additions would also be sufficient to meet PWP's resource adequacy requirement without the need for PWP's current minority ownership share of the Magnolia Power Project (6%, or 18 MW, expiring in 2036), putting PWP in a position to arrange for an early exit from the project if terms acceptable to the City can be negotiated with counterparties.

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Table 1. Nameplate capacity additions (MW) by resource type by end of 2030 across select OSP case studies and the OSP Planning Targets

Resource Type	Subset of Case Studies Evaluated by E3				Optimized Strategic Plan Planning Targets
	Annual Matching, Accelerated Local Resources	Annual Matching, Accelerated Local Resources Plus	Hourly Matching, Accelerated Local Resources	Hourly Matching, Accelerated Local Resources Plus	
Solar (External)	-	-	115	143	**125**
Solar (Local)	50	100	50	100	**70**
Storage (External)	-	-	95	113	**100**
Storage (Local)	75	100	75	100	**75**
Wind	74	53	175	175	**175**
Geothermal	-	-	26	4	**25**
Total					**570**

Note: All case studies include 15 MW of demand response and 20 MW of managed electric vehicle charging.

The four case studies highlighted above represent four possible paths forward but are best understood as points on a continuum of options rather than discrete choices. Quantifying every

[1] This result is based on a single deterministic year of normal weather conditions. Actual outcomes may vary due to impacts of natural year-to-year weather variability.

potential combination of resources that could meet the City's needs on an annual or hourly basis is an intractable computational problem; however, there are many other combinations of resources that could achieve similar results, and the OSP technical studies do not support a conclusion that any single technology is needed at a specific scale to meet PWP's needs. The real-world opportunities presented to PWP through competitive procurement processes and local resource development efforts may ultimately lead to a different portfolio of resources; such deviations from the planning targets are a natural and expected occurrence in the implementation of the plan.

Additional detail on the resulting changes to our electrical system – including new resource additions, customer programs, and improvements to the transmission and distribution – that will enable us to achieve **100% carbon-free electricity on an hourly basis** are shown in additional detail in Table 2 on a year-by-year basis through 2030.

Procurement targets presented in the table below for different types of local solar and storage resources are intended to be flexible. If procurement via one mechanism for local resources is lower than the presented target, that necessarily means that procurement via other mechanism must be greater to meet the overall local solar and storage planning targets. For example, if customer adoption of solar slows below the annual targets below, PWP will increase its efforts on municipal solar.

Table 2. Key elements of the Optimized Strategic Plan to achieve a 100% carbon-free system by the end of 2030[2]

		2025	Waypoint 2026	2027	Waypoint 2028	2029	Res 9977 2030	2035	2040
Divestment from Existing Resources	Intermountain Power Project (IPP)	-108 MW							
	IPP Natural Gas Repowering	+50 MW		-50 MW					
New Power Purchase Agreements Already Under Contract	CalWind	+20 MW							
	Glenarm BESS		+25 MW						
	Coso Geothermal			+10 MW					
	Geysers Geothermal			+25 MW					
	Grace Solar				+50 MW				
	Bonanza Solar					+105 MW			
	Bonanza Storage					+55 MW			
Additional External Resources	Utility-scale solar					Up to +125 MW		*(as needed)*	
	Utility-scale energy storage					Up to +100 MW		*(as needed)*	
	Wind					Up to +175 MW		*(as needed)*	
	Geothermal					Up to +25 MW		*(as needed)*	
	Other emerging technologies							*(as needed, as available)*	
Additional Local Resources	Customer-owned solar	+3 MW	+4 MW	+8 MW	+10 MW	+10 MW	+15 MW	*(as adopted)*	
	Solar on municipally-owned properties				+4 MW	+4 MW	+12 MW	*(as needed)*	
	Customer-owned storage	Up to 1 MW	Up to 1 MW	Up to 1 MW	+2 MW	+2 MW	+3 MW	*(as adopted)*	
	Storage at municipally-owned properties					+75 MW		*(as needed)*	
Customer Programs	Annual energy efficiency savings	~1% per yr	~1% per yr	~1% per yr	~1% per yr	~1% per yr	~1% per yr	*~1% per yr*	*~1% per yr*
	Load impact of commercial customer DR programs		+0.5 MW	+1 MW	+2 MW	+4.5 MW	+7 MW	*(as needed)*	*(as needed)*
	Number of residential customers enrolled in DR programs				500 homes	1,500 homes	3,000 homes	*(as needed)*	*(as needed)*
	Share of electric vehicles under managed charging		5%	20%	60 to 100%	80 to 100%	100%	*100%*	*100%*
Power Delivery Infrastructure	Internal 35 kV distribution upgrades								
	AMI deployment								
	Expansion of TM Goodrich Receiving Station							*Up to 420 MW*	
	Second interconnection to CAISO								*Sizing TBD*

Following this plan will put us in a position to achieve the objectives of Resolution 9977, but we recognize that progress is often not linear, and our path forward will not be without obstacles and challenges. The electric utility industry is experiencing dramatic and unpredictable changes across many dimensions – including volatile costs, supply chain disruptions and delays, policy uncertainty, and climate impacts on the electric grid – that create tension among our planning objectives. At the same time, continued technological advancement and evolving consumer behaviors and preferences will also create new opportunities for progress. The "Waypoints" framework established during the 2023 IRP process provides critical opportunities to assess progress, adapt our plans, and pivot toward new solutions as conditions change. Each Waypoint provides a chance to ensure that our plan appropriately balances the carbon-free, affordability, reliability, and equity objectives of Resolution 9977.

[2] PWP intends to reevaluate options to eliminate natural gas combustion at the Glenarm Power Plant (through either retirement or conversion) in future IRPs and at the 2028 Waypoint. PWP also intends to explore options for an earlier exit from its current ownership share in the Magnolia Power Project (which expires in 2036) through contract, sale, or renegotiation, provided that sufficient carbon-free resources have been procured to allow PWP to meet its resource adequacy obligations without Magnolia.

1.2 Pillars for a Transition to Carbon-Free Electricity

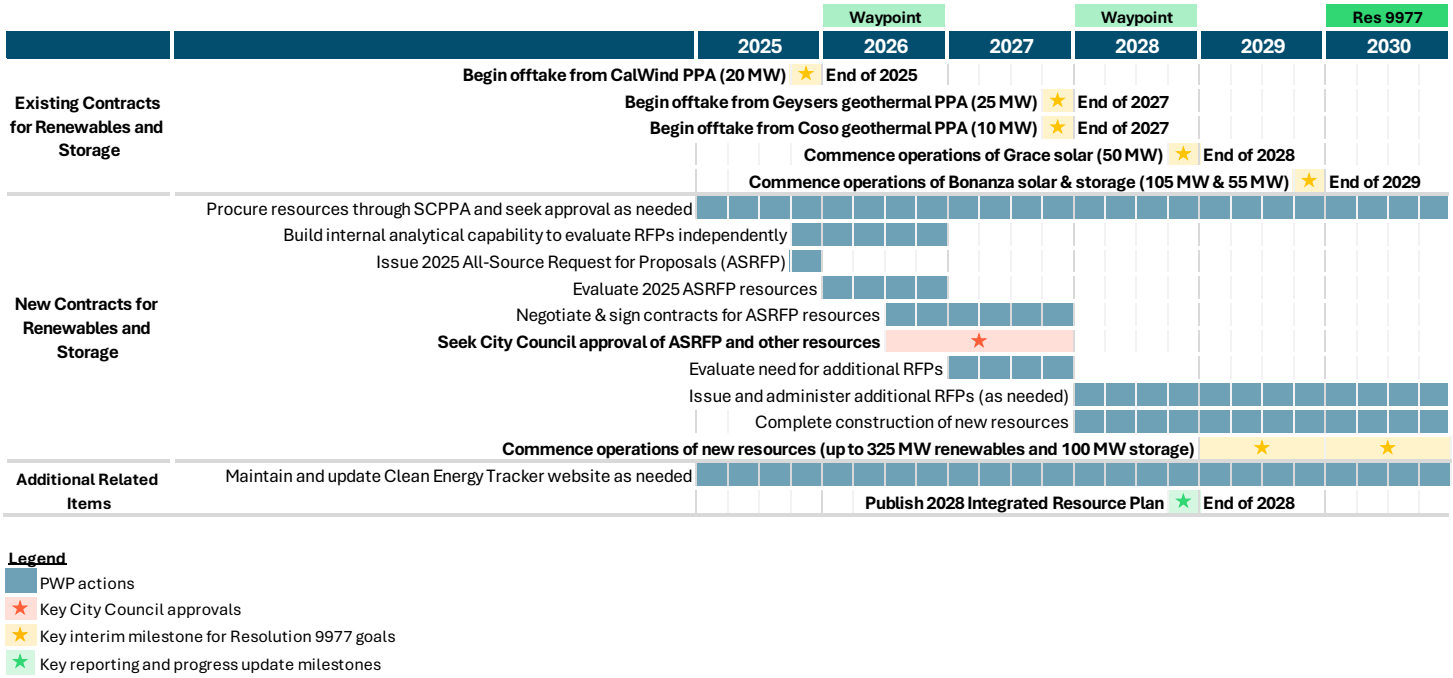
Rapidly Scale Proven Carbon-Free Technologies

Rapid development of renewables and energy storage resources forms the foundation for our transition to carbon-free electricity. Wind, solar, and battery storage have all emerged as scalable, low-cost resources over the past two decades, and geothermal offers another option for proven technology despite higher costs. Since the adoption of Resolution 9977, we have added significant quantities of these resources to our future portfolio, signing power purchase agreements for over 200 MW of renewables and 50 MW of storage, and beginning development of a 25 MW battery storage facility at the Glenarm Power Plant. These initial actions have already repositioned our supply portfolio; once all of these committed projects are online, our carbon-free resources will be capable of meeting 76% of our hourly energy needs and 83% of our annual needs.

Closing the remaining gap to meet 100% of energy needs with carbon-free resources on an hourly basis requires even more renewables and energy storage – up to 375 MW of additional renewables and 175 MW of additional energy storage by the end of 2030. These resources would be located throughout the State of California (and the broader Western region) and within the City of Pasadena itself. Outside the City, a broad pool of high-quality renewable and storage technologies can be developed at larger scale and lower cost; within the City, local solar and storage provide a unique locational value when the City's ability to import from the broader California grid is limited, notwithstanding land constraints that will constrain the scale and pace of development.

To meet planning targets for utility-scale renewables and storage, we intend to utilize competitive, all-source Request for Proposals (RFP) processes to identify and procure the most cost-effective resources through power purchase agreements (PPAs) with third parties. While we have historically and will continue to leverage our membership in the Southern California Public Power Authority (SCPPA) to facilitate procurement efforts, we also plan to conduct independent RFPs tailored to our specific resource and timing needs. These actions are shown below and reflect a plan for immediate action: because of the typical timelines for RFP processes and lead times for resource development, adding new resources to the portfolio by the end of 2030 will require that we issue an all-source RFP by the end of this year (2025).

Table 3 Implementation plan to procure utility-scale renewables and storage



Legend

- PWP actions
- Key City Council approvals
- Key interim milestone for Resolution 9977 goals
- Key reporting and progress update milestones

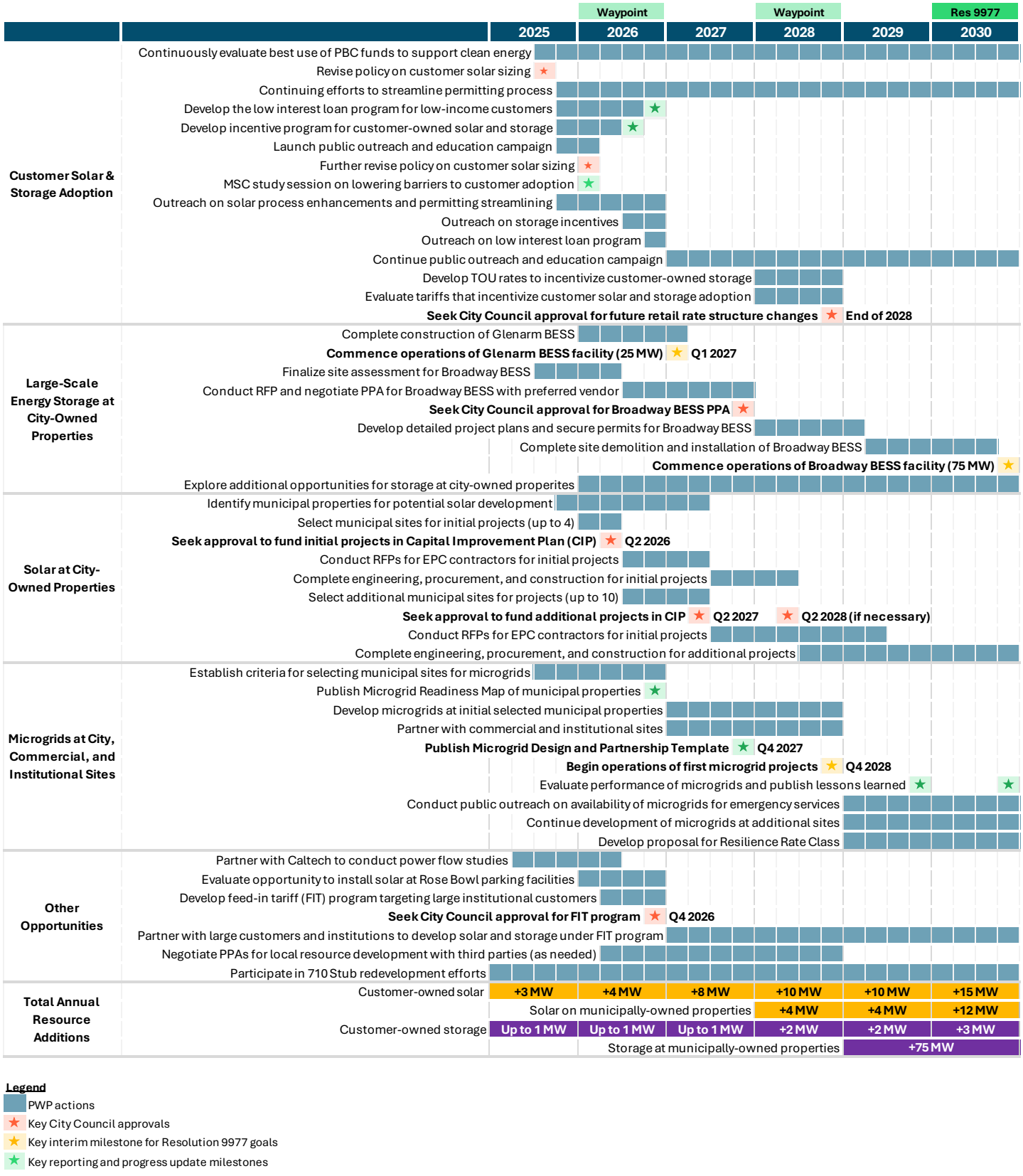
Our plan also calls for an aggressive acceleration of the development of solar and storage resources within the city to help relieve constraints on our power delivery infrastructure, reduce our reliance on the Glenarm Power Plant, and improve local resilience. Pasadena's dense urban environment will require that many of these resources be distributed across smaller-scale installations on rooftops, parking lots, and brownfield sites throughout the city. These projects will be highly visible, a symbolic everyday reminder of Pasadena's clean energy future imprinted upon the city itself. Achieving this outcome will require leveraging a wide range of options to take advantage of the opportunities that are unique to our city. These include:

- Near-term efforts to reduce barriers to customer adoption of solar and storage (for example, revising restrictions on system sizing and reforming permitting and interconnection processes) and increase public awareness through a marketing and outreach campaign.
- Financial support for customers seeking to install solar and storage in the form of upfront incentives on a $/Watt and $/kWh basis for qualified solar and storage installations, respectively, and the low-interest loan program to support our low-income customers with accessing solar and storage.
- Continual re-evaluation of the best use of public benefit charge (PBC) funds to maximize clean energy deployment, greenhouse gas reductions, and customer benefits.
- A plan to evaluate incentives for all customer-owned distributed energy resources, accounting for the implications for Pasadena's carbon-free objective and the cost and equity-related impacts, during the next rate study in 2028.
- Creation of processes to identify, study, and select municipally-owned properties as sites for solar development within the city in collaboration with all city departments; seek City Council approval of proposed projects in the Capital Improvement Plan; and work with contractors to construct projects, targeting projects with a scale of 500 kW and above online beginning in 2028.

- Plans to install 25 MW of lithium-ion battery storage on site at the Glenarm Power Plant, as well as an additional 75 MW of energy storage at the site of the decommissioned Broadway Power Plant once its demolition is complete.
- Efforts to identify high-value sites for potential microgrids at city-owned, commercial, and institutional properties.
- Development of a feed-in tariff (FIT) compensation option to provide additional options and flexibility to larger customers and institutions considering adoption of solar and storage technologies.
- Continued commitment to support and work directly with other City departments and large customers in their own efforts to develop clean energy projects within the City.

Our detailed implementation plan to accelerate local solar and storage development is shown in Table 4 below.

Table 4 Action plan for accelerating local solar and storage development



Legend

- PWP actions
- ★ Key City Council approvals
- ★ Key interim milestone for Resolution 9977 goals
- ★ Key reporting and progress update milestones

Develop Innovative Programs and Rates to Leverage Customer-Facing Solutions

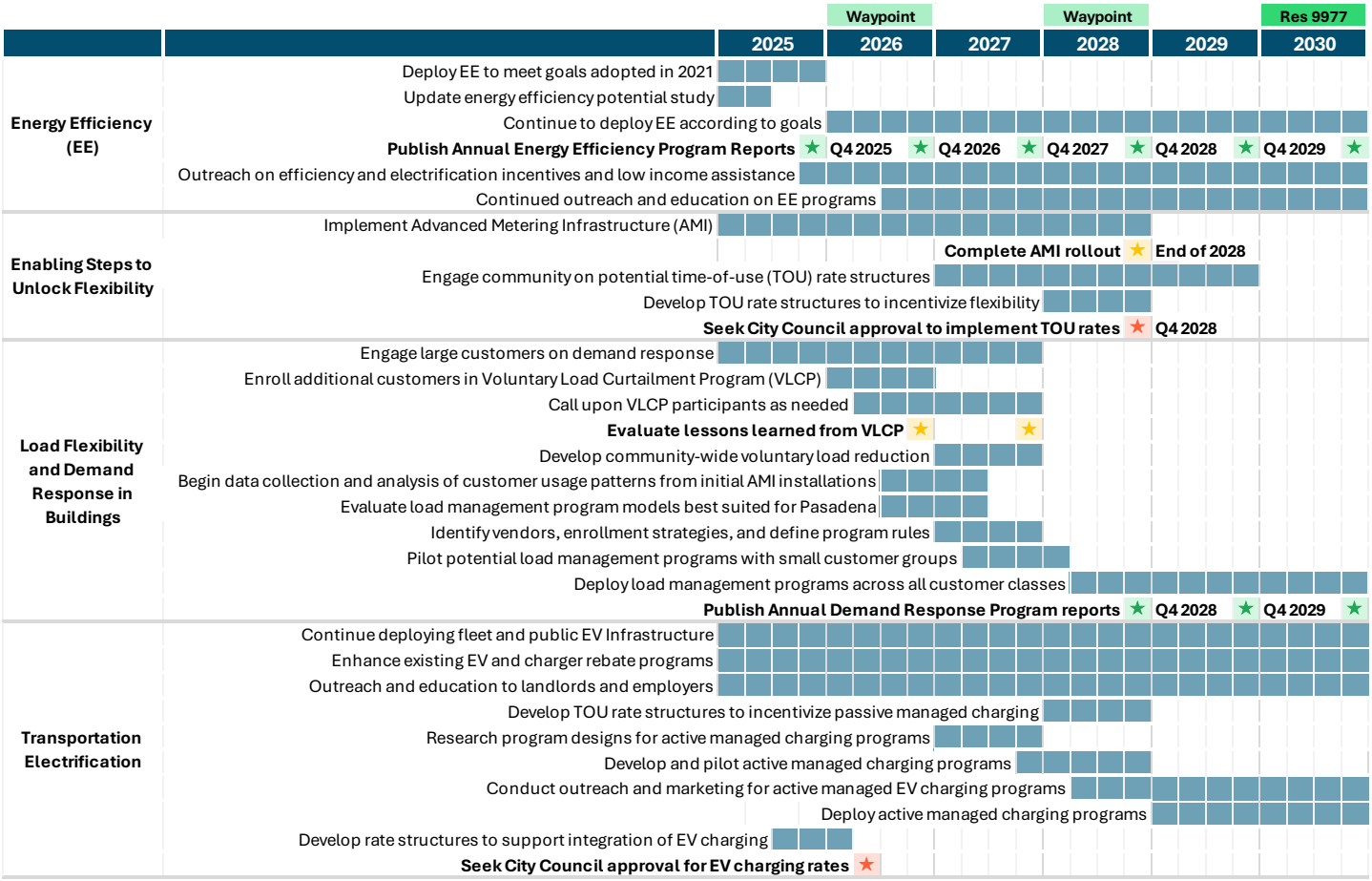
Enabling load flexibility and demand response through customer programs and rate structures is a critical element of our plan that can reduce PWP's peak load, support the integration of renewables and storage, and provide opportunities for our customers to participate actively in the energy transformation.

Maximizing the potential for these resources requires advanced metering infrastructure (AMI, or "smart meters"), which provides PWP a means to measure and verify customer load response on a sub-hourly basis and to provide compensation to our customers for that load response. As described in our 2022 Power Delivery Master Plan, we are currently working to deploy AMI throughout the City and expect to roll out AMI for all our customers beginning in 2028.

Our efforts to begin scaling this resource will occur prior to the completion of AMI deployment. We have and will continue to develop relationships with large commercial customers and engage them on demand response programs. We will continue our efforts to support the development of a robust electric vehicle charging network in the City and to enable managed charging as a resource. We will also begin designing demand response programs and third-party aggregators as potential partners to unlock the demand response potential of our customers.

Upon completion of the AMI project, we will rapidly scale our program offerings and enrollment and will bring a proposal to City Council for time-of-use rates for all customer classes.

Table 5 Implementation plan to develop innovative rates and customer programs



Legend

- PWP actions
- Key City Council approvals
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Mitigate Glenarm's Operations Until Replacement is Possible

Alongside our goal to transition to carbon-free energy, reliability is a cornerstone of Resolution 9977 and a foundational principle of power system planning. The OSP technical studies have shown that it is infeasible to maintain the same level of reliability that our community has come to expect by replacing the Glenarm Power Plant with carbon-free technologies that are available today. Accordingly, we are planning for a path forward that preserves Glenarm as a backstop for reliability and for maintaining compliance with California Independent System Operator's (CAISO) Resource Adequacy requirements until a longer-term solution can be identified.

Over the past several years, Glenarm has operated at an annual capacity factor[3] of 3% to 5%. By the end of 2030, we are planning to operate Glenarm even less frequently than today. Complementary actions described elsewhere in the plan - including additions of local carbon-free resources, development of innovative demand-side programs, and replacement of aging distribution infrastructure - will allow us to limit reliance on Glenarm to two specific circumstances: (1) situations where the Glenarm is needed as a last resort to maintain local reliability, and (2) instances where the CAISO calls upon Glenarm to dispatch.

We recognize that under the goals of Resolution 9977, maintaining Glenarm as a reliability resource is an interim solution, not the final endpoint for the City's clean energy transition. The OSP technical studies point to three potential pathways for a longer-term plan to end combustion of natural gas at Glenarm entirely:

1. **Transmission Expansion:** Secure a second point of interconnection to CAISO and a replacement for the resource adequacy capacity provided by Glenarm today;
2. **Local Emerging Technology:** Develop a "clean firm" resource within the City of Pasadena as a local replacement for Glenarm; and/or
3. **Hydrogen Conversion:** Convert Glenarm to green hydrogen *should a broader regional network to produce, store, and transport the fuel become available*.

The timing and feasibility of each of these options depend on many factors beyond PWP's control. The timelines for emerging technologies to reach commercial readiness; for the necessary transmission planning, permitting, and construction; and for development of upstream and midstream infrastructure for a hydrogen supply chain are difficult to predict - but each almost certainly requires a decade or more. Nonetheless, we recognize the importance of a longer-term transition plan for Glenarm and intend to take proactive steps to preserve each of these potential opportunities - so that when one becomes available, we are in a position to take action.

Table 6 Key actions for mitigating Glenarm operations

		Waypoint			Waypoint		Res 9977
		2025	2026	2027	2028	2029	2030
Complementary OSP Actions to Reduce Operations of Glenarm	Meet energy efficiency goals	■	■	■	■	■	■
	Accelerate development local solar and storage resources	■	■	■	■	■	■
	Upgrade internal distribution infrastructure	■	■	■			
	Develop and implement TOU pricing				■		
	Deploy demand response in buildings					■	■
	Implement managed electric vehicle charging programs					■	■
Other Glenarm-Related Actions	**Provide annual reporting on Glenarm operations**			★ **Q1 2027**	★ **Q1 2028**	★ **Q1 2029**	★ **Q1 2030**
	Reevaluate options for long-term Glenarm transition				■		
	Assess renewable natural gas supply options				■	■	■

Legend
- PWP actions
- ★ Key City Council approvals
- ★ Key interim milestone for Resolution 9977 goals
- ★ Key reporting and progress update milestones

[3] Capacity factor is the ratio of a power plant's actual energy output over a given time period to the maximum energy output it could have produced had it operated at full capacity continuously over that time period.

Upgrade Power Delivery Infrastructure

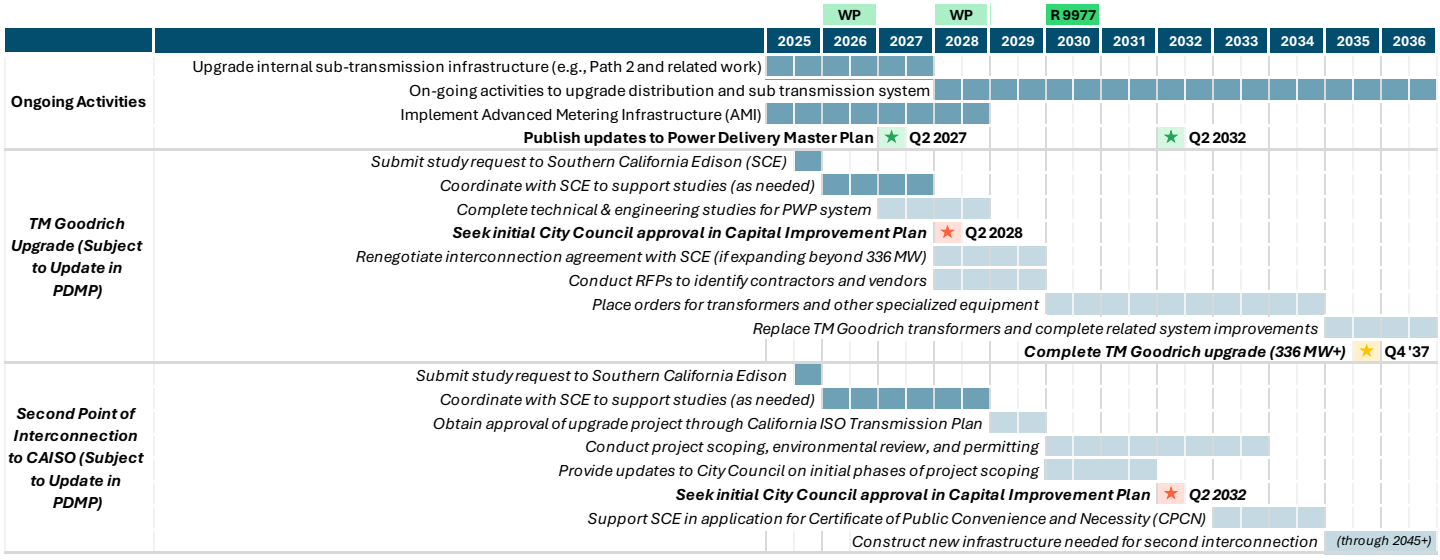
Current and future efforts to upgrade Pasadena's power delivery infrastructure are complementary to the changes in our electricity supply described above. We seek not only to transition our resource mix to 100% carbon-free, but also to optimize the electric system to meet the changing needs and preferences of our community. Several major internal infrastructure projects currently underway will be completed over the next several years and are important components to our carbon-free vision:

- Once installed, **advanced metering infrastructure (AMI)** will enable time-of-use rates (TOU) and allow us to send price signals and coordinate with our customers to encourage behavioral shifts in consumption to benefit the grid and the carbon-free objectives.
- We are currently replacing **underground 35kV sub-transmission lines** that were originally installed in the 1970s to transmit power from one side of the City to the other. These replacements will harden our sub-transmission system, reducing the frequency of line outages that sometimes result in calls for the Glenarm Power Plant to operate.

Additionally, our plan calls for an expansion of our interconnection to CAISO. These two projects are likely to take a decade or more to complete – but, if successful, will unlock long-term opportunities to continue our decarbonization journey.

- As described in the 2022 Power Delivery Master Plan, we have begun planning for the replacement of the transformers at the **TM Goodrich Receiving Station (TM Goodrich)**, which is currently PWP's only point of interconnection to CAISO. The transformer replacement provides an opportunity to increase our ability to import electricity, relaxing a key physical constraint present in our system. The current transformers at TM Goodrich were installed in the 1970s and will likely remain in service into the 2030s. Replacement transformers are expected to have similarly long lifetimes. Therefore, the expansion of intertie capability at TM Goodrich will have lasting impacts on the City throughout much of this century, providing benefits and creating opportunities to import additional carbon-free electricity for decades to come.
- In parallel, we have also submitted a request to Southern California Edison (SCE) to study the feasibility of adding a **second point of interconnection to CAISO**. While adding a second interconnection is a considerably more complex undertaking requiring coordination with SCE, CAISO, and multiple state and local agencies, it would provide several key additional benefits compared to upgrades at TM Goodrich. These include increased resilience to transmission-related contingencies either at TM Goodrich or on the SCE transmission system, which is especially important in light of the prospect of SCE's Public Safety Power Shutoffs (PSPS) to mitigate wildfire risk, and opening a long-term pathway to a potential permanent replacement of the Glenarm Power Plant.

Table 7 Implementation plan to upgrade power delivery infrastructure



Legend

- PWP actions
- PWP actions (to be updated in 2027 PDMP)
- ★ Key City Council approvals
- ★ Key interim milestone for Resolution 9977 goals
- ★ Key reporting and progress update milestones

Monitor Emerging Technologies

Our plan embraces technological innovation and anticipates that as emerging technologies reach commercial readiness, they will create new opportunities to build out our carbon-free portfolio while mitigating costs. While we cannot predict which technologies will reach this important threshold or when, our plan positions us to take advantage of opportunities created by technological innovation.

- **Long duration energy storage (LDES):** we will proactively identify opportunities to support and develop pilot long-duration storage projects. Thus far, PWP has received two grants for feasibility studies for siting LDES projects within the City and has issued an RFI/RFP for projects development. Several utilities across the county and in California are pursuing LDES pilots. For example, the Sacramento Municipal Utility District (SMUD) has received a grant from the State to install a 3.6 MW, 8-hour battery, and Burbank Water and Power (BWP) has recently commissioned a 75 kW/500 kWh iron flow battery.
- **Hydrogen:** the conversion of Glenarm to operate using green hydrogen fuel is one of several long-term options to eliminate combustion of natural gas; the principal barrier to implementing this solution by the end of 2030 is the lack of upstream and midstream infrastructure necessary to produce, store, and supply the fuel to the Glenarm site. Neighboring utilities in the region, including the Los Angeles Department of Water and Power (LADWP) and Glendale Water and Power (GWP), have identified green hydrogen in their plans to meet future clean firm resource needs, and the Southern California Gas Company (SoCalGas) has begun early stages of development of the proposed Angeles Link, a potential dedicated hydrogen pipeline serving the Los Angeles Basin. While it would be premature to make financial commitments to pursue conversion at Glenarm today given the lack of supporting infrastructure, we intend to monitor the activities of neighboring utilities

and the industry as a whole. If others' efforts to develop *carbon-free* hydrogen production storage, and transportation infrastructure within the region are successful, PWP may reevaluate options in the future.

- **Other emerging technologies:** a wide range of other carbon-free technologies are currently in various stages of research, development, and early deployment, including advanced nuclear, enhanced geothermal, and offshore wind. The characteristics of each of these opportunities – and by extension, the roles they may play in our portfolio – vary considerably. At this stage, we intend to monitor the evolving landscape for these potential carbon-free alternatives.

1.3 Additional Foundations for the Five Pillars

Supporting the pillars of our plan to achieve 100% carbon-free electricity is two of our core commitments to our community: (1) creating opportunities for community engagement, enabling our customers to participate in the energy transitions and leveraging partnership with key stakeholders to accelerate the transition and (2) providing competitive rates to support a thriving economy in Pasadena.

Foster Community Engagement and Collaborative Partnerships with Key Stakeholders

As a municipally owned utility, we are committed to fostering community engagement and developing key partnerships with our large commercial customers. Given the pace of action needed to meet the climate emergency and the goals of Resolution 9977, customer engagement and collaboration is more important than ever. We are taking key steps to promote education and awareness of the City's goals and the corresponding opportunities they create for our community through public outreach and marketing campaigns. Many of our large commercial customers share our commitment of sustainability and decarbonization, and together we can accelerate the transition by sharing resources and technical expertise. A few key partnerships we will continue to foster include or collaborations with the Pasadena Unified School District, Pasadena City College, California Institute of Technology, the Rose Bowl Operating Company, and the Pasadena Center Operating Company. In addition, we plan to continue active engagement in several industry groups we are a member of including SCPPA, California Municipal Utilities Association (CMUA), and Los Angeles Cleantech Incubator (LACI).

Identify Financial Strategies to Maintain Affordability

We are committed keeping energy bills affordable to support our diverse community of customers and promote the prosperity of Pasadena businesses, which have made our City a thriving economic hub. We will use all tools available to us as a municipally owned utility to make bills affordable and provide opportunity for our customers to directly participate in the clean energy transition in a financially stable way. To maintain affordable electric rates, we will continue build on an all-encompassing strategy that has served to keep Pasadena's rates competitive for nearly 120 years. The strategy includes leveraging municipal financing, pursing grants, identifying opportunities to lower lifetime operational costs, and pursuing innovative financing strategies for securing new contracts. We will continue to develop budgets and capital improvement plans that integrate cost efficiency measures along with ensuring investments are strategic to reduce the overall lifetime costs of the infrastructure and avoid costly emergency work. We will continue to leverage our

creditworthiness to reduce borrowing costs and seek opportunities that are available to us as a municipality, such as prepaid energy savings and a lower cost of borrowing. By saving money utility-wide, we are reducing the overall impact to all ratepayers.

1.4 Action Plan

Our Action Plan to achieve the goals of Resolution 9977 comprises a suite of bold and innovative measures, including contracting for new PPAs, customer program development, outreach and marketing campaigns, and pilot programs for new and emerging technologies, as well as a continuation of already planned activities, such as upgrades to our power delivery infrastructure and planned divestments from fossil fuel resources.

We will take a multi-pronged approach to rapidly scaling proven carbon-free technologies. To procure additional large-scale renewables and storage, we will issue an all-source RFP by the end of 2025. We will continue to leverage our membership in SCPPA to procure utility-scale resources and participate in other RFPs with other utilities. In addition to the RFP for utility-scale resources, we plan to issue an RFP for the development of solar and storage projects on municipal properties in 2026, following our initial assessments of site suitability. We currently offer one of the most generous incentive programs in the State to our customers for rooftop solar development. We will continue to support our customers seeking to install solar and storage through a new outreach and marketing campaign, loan assistance programs, and new incentives for battery storage. We intend to evaluate the impact of all incentives for all customer-owned distributed energy resources on local solar and storage adoption as well as affordability and equity for all our customers at the 2028 Waypoint.

To leverage customer-facing solutions and enable load flexibility, we will develop a comprehensive suite of demand response programs that encourage customers to shift energy consumption to hours in which it is beneficial to the grid and helps the integration of renewables and storage. The completion of the planned AMI project will be foundational to developing DR programs and instituting time-of-use rates with the approval of City Council.

Reducing the frequency with which Glenarm operates is supported by the actions described above to enable load flexibility and scale local solar and storage in addition to planned upgrades to our distribution system. To support the emergence of one or more of the pathways to retire or cease fossil fuel combustion at Glenarm, we will seek to expand our import capacity, expanding TM Goodrich and pursing a second point of interconnect, and monitor the landscape for emerging technologies, including long-duration energy storage and hydrogen. As part of our commitment to ceasing combustion of natural gas at Glenarm in the long-term, we will provide annual reports on Glenarm's operations and reevaluate options for long-term transition at the 2028 Waypoint.

Table 8 Summary of OSP Action Plan

Action Plan Item (Organized by OSP Pillars)	Applicable OSP Pillars	Timeline
0 General reporting and progress updates		
Provide quarterly progress updates to Municipal Services Committee	1 2 3 4 5	2025-2030
Maintain Clean Energy Tracker website	1 2 3 4	2025-2030
Publish 2028 Integrated Resource Plan	1 2 3 5	2028
1 Rapidly scale proven technologies (utility-scale renewables & storage)		
Integrate new contracted resources into portfolio (210 MW renewables & 55 MW storage)	1	2025-2029
Continue to procure resources through SCPPA and seek approval (as needed)	1	2025-2030
Conduct all-source RFP for new utility-scale renewables and storage	1	2025-2027
Reassess cost impacts to continue procurement above 100% annual matching	1	2026-2028
Evaluate need to issue additional RFPs for renewables and storage	1	2028
Issue and administer additional RFPs (as needed)	1	2029-2030
Integrate additional contracted resources into portfolio (up to 325 MW renewables and 100 MW storage)	1	2029-2030
1 Rapidly scale proven technologies (local solar & storage)		
Revise policy on customer solar sizing	1 3	2025
Reevaluate best use of Public Benefit Charge funds	1 2 3	2025-2030
Launch public outreach and education campaign	1 3	2025-2026
Identify municipal sites for solar development	1 3	2025-2026
Conduct studies to identify potential microgrid sites	1 3	2025-2026
Develop Glenarm BESS project (25 MW, online 2027)	1 3	2025-2027
Bring proposal to further revise policy on customer solar upsizing to City Council	1 3	2026
MSC study session on lowering barriers to customer adoption	1 3	2026
Develop feed-in tariff (FIT) program for solar & storage targeting large institutional customers	1 3	2026
Streamline permitting and interconnection processes	1 3	2026
Develop the low interest loan program for low-income customers	1 3	2026
Develop incentive program for customer-owned solar and storage	1 3	2026
Develop municipal solar installations at initial high priority sites	1 3	2026-2028
Explore other opportunities for solar and storage development (e.g. Rose Bowl, 710 Stub)	1 3 5	2026-2030
Develop Broadway BESS project (75 MW, online 2030)	1 3 5	2026-2030
Develop microgrids at initial selected municipal properties	1 3	2027-2028
Partner with commercial and institutional sites for microgrid development	1 3	2027-2028
Continue public outreach and education campaign	1 3	2027-2030
Develop municipal solar installations at additional sites	1 3	2027-2030
Partner with large customers and institutions to develop solar and storage under FIT program	1 3	2027-2030
Evaluate tariffs that incentivize customer solar and storage adoption	1 3	2028
Continue development of microgrids at additional sites	1 3	2029-2030
2 Develop Innovative Programs and Rates to Leverage Customer-Facing Solutions		
Continue to deploy energy efficiency resources to meet energy efficiency goals	2 3	2025-2030
Enroll large customers in Voluntary Load Curtailment Program (VLCP)	2 3	2026
Evaluate building load management program models best suited for Pasadena	2 3	2026-2027
Evaluate program design for active managed charging of electric vehicles	2 3	2026-2027
Pilot building load management programs with small customer groups	2 3	2027-2028
Develop and pilot active managed charging programs	2 3	2027-2028
Develop TOU rates to incentivize load management, flexibility, and energy storage	1 2 3	2028
Deploy building load management programs acorss all customer classes	2 3	2028-2030
Deploy and scale active managed charging programs	2 3	2029-2030
3 Additional Actions Related to Mitigating Glenarm Operations		
Provide annual reporting on Glenarm operations	3	2026-2030
Reevaluate options for long-term Glenarm transition	3	2028
Assess renewable natural gas supply options	3	2028-2030
4 Upgrade Power Delivery Infrastructure		
Upgrade internal distribution infrastructure	3 4	2025-2027
Implement Advanced Metering Infrastrcuture (AMI) throughout the City	3 4	2025-2028
Publish 2027 Power Delivery Master Plan	3 4	2027
Increase import capability at TM Goodrich Receiving Station	3 4	2025-2035
Develop second point of interconnection with CAISO	3 4	2025-2040
5 Leverage Emerging Technologies		
Montitor emerging technology status	3 5	2025-2027
Coordinate with neighboring utilities to planning for hydrogen conversions	3 5	2025-2030

Notes

Items are categorized according to the most directly relevant area, but secondary linkages to other pillars are shown in "Applicable OSP Pillars"
Additional detail on schedule and milestones for action items are provided in detailed action plan schedules

1.5 Transparency, Accountability, and Adaptability

City Council and members of our community have shown a resolute commitment and keen interest in the goals established by Resolution 9977. Our plan includes multiple checkpoints, milestones, and reporting opportunities that will allow stakeholders to monitor progress and track the evolution of the plan. These include:

- PWP plans to provide **quarterly progress updates to the Municipal Services Committee** and **annual progress updates to the Environmental Advisory Commission** to report on progress toward the goals and inform the committees on new challenges and opportunities that arise over time.
- PWP will maintain the **Clean Energy Tracker webpage**, showing key metrics related to our expected carbon-free energy share and customer adoption of technologies like solar, storage, and electric vehicles.
- The **2026 and 2028 Waypoints**, established in the 2023 IRP process, provide prescribed opportunities to report on PWP's progress toward all goals of Resolution 9977 and reassess the plan going forward in response to changing conditions.
- PWP will continue to provide **annual reports on the status of customer-facing programs**, including energy efficiency and demand response.
- PWP will seek **City Council approval for each new power purchase agreement** with utility-scale carbon-free resources, providing information to show how each resource impacts carbon-free metrics and cost. Inflationary pressures, global supply chain constraints, and shifting federal trade and tax policy have created an environment where negotiating and securing PPAs will be more challenging and may come at a higher cost in the future. We will endeavor to provide City Council with as much information about the state of the market as we bring forward contracts for approval and in our quarterly progress updates.
- On the path to supplying 100% of the City's energy needs with carbon-free resources on an hourly basis, PWP will first pass the milestone of meeting the City's energy needs with carbon-free resources on an annual basis. PWP will reach this milestone many years in advance of the State as a whole. Once PWP has contracted with carbon-free resources sufficient to meet 100% of the City's annual energy needs with carbon-free resources, PWP intends to provide City Council with **an updated analysis of the expected costs to meet 100% of annual and hourly needs with carbon-free resources**. At this point, PWP will have considerably more certainty into the costs, and plan to provide an update to City Council on those impacts

These updates fulfill multiple purposes simultaneously: (1) they will provide the general public with transparency into our progress toward our goals; and (2) they will allow us to seek the necessary guidance and approvals from City Council and MSC to adjust, adapt, and reshape our plan as needed in response to new information and changing conditions in the world around us. Working collaboratively and openly with our community provides us with the most realistic opportunity to reach the ambitious goal to provide the City with carbon-free electricity by the end of 2030.

2 Introduction

2.1 Background

For over a century, Pasadena Water and Power (PWP) has served the residents and businesses of Pasadena with a mission to provide safe and reliable water and power with superior customer service at competitive rates. As a municipally owned utility, PWP is accountable to the community it serves, allowing us to prioritize the long-term well-being of the community and tailor our services to meet local priorities. As the City has grown and changed, our role in supporting our city has grown as well/We are committed to continuing to adapt to best meet the needs of our community while adhering to our mission and values.

On January 30, 2023, the Pasadena City Council adopted Resolution 9977, which declares that climate change is an emergency that threatens the health and welfare of the city, region, state, nation, and the environment. Resolution 9977 set a policy goal to source 100% of Pasadena's electricity from carbon-free sources by the end of 2030 and directed the City Manager to plan multiple approaches to "optimize affordability, rate equity, stability, and reliability of electricity" through PWP's 2023 Integrated Resource Plan (IRP).

On December 11, 2023, the Pasadena City Council unanimously approved PWP's 2023 IRP, a 25-year planning roadmap to provide the local community with safe, reliable, and environmentally responsible electricity services at competitive rates. In addition to meeting State regulatory requirements, the 2023 IRP also incorporated the objectives of Resolution 9977. In its approval of the IRP, City Council directed the City to engage a third-party consultant to advise in the development of an "Optimized Strategic Plan" (OSP) to define and outline actions needed to achieve the objectives of Resolution 9977. The City worked with Energy & Environmental Economics (E3), an industry-leading clean energy policy and strategy consulting firm, to develop a proposed scope of work to develop the OSP based on rigorous technical analysis. This scope of work was reviewed and approved by City Council, and the City entered a contract with E3 to support PWP in the development of this OSP.

The City Council-approved scope of work for the OSP includes a series of detailed technical studies that leverage best-in-class power system modeling tools and explore all technology options to achieve the objectives of Resolution 9977. E3 conducted the technical analysis for the OSP from 2024 to 2025 and solicited feedback from various stakeholder groups through an open and transparent process throughout the course of the study. E3 and PWP met regularly with an external Technical Advisory Panel (TAP), provided updates to the Municipal Services Committee (MSC), the Environmental Advisory Commission (EAC), and City Council; and hosted several open meetings with the community at large. These technical analyses, input and feedback from the TAP, and the guidance and direction provided by Pasadena's City Council ultimately informed the development of this Plan.

2.2 Resolution 9977 Objectives

Resolution 9977 set an ambitious policy goal for the transition to carbon-free energy and articulated multiple key objectives and planning priorities for PWP as it pursues this goal, including reliability, affordability, stability and rate equity.

Carbon-Free

Resolution 9977 reaffirmed Pasadena's commitment to environmental stewardship and leadership to address the climate emergency. In the Resolution, City Council set "a policy goal to source 100% of Pasadena's electricity from carbon-free sources by the end of 2030." This policy goal makes Pasadena a leader in the State of California, which itself has ambitious decarbonization goals. Resolution 9977 will put Pasadena on a path to achieve the State's 100% clean energy standard 15 years in advance of the State requirement to reach this milestone by 2045. Resolution 9977 also sets a policy goal more ambitious than those of many neighboring municipal utilities, including Glendale Water and Power (100% clean energy by 2035), Burbank Water and Power (100% zero-carbon resources by 2040), and the Los Angeles Department of Water and Power (100% carbon-free power by 2035).

The leadership and level of ambition set by City Council in 2023 when it passed Resolution 9977 was critical then and has only grown in importance since. The impacts of the climate emergency that Resolution 9977 declared have become increasingly acute and immediate in the years since its adoption. The various wildfires in California starkly demonstrated the threat of climate change to the City of Pasadena and the need for swift action to respond to this "new normal." Uncertain federal policy environment supporting clean energy technology have also made local and state action more important than ever.

Reliable

A reliable electricity grid is essential for the functioning of modern society, as it ensures the consistent and safe delivery of power to homes, businesses, hospitals, and critical infrastructure. Without a stable grid, everyday activities – from charging devices and refrigerating food to running businesses and maintaining public safety systems – would be severely disrupted. For PWP, maintaining reliability requires three distinct activities:

1) Planning, maintaining, and operating the City's distribution system (35kV and below) according to industry standards and North American Electric Reliability Corporation (NERC) requirements to allow delivery of electricity to each customer while minimizing service disruptions;
2) Ensuring sufficient local generation resources within the City are available to serve loads when transmission constraints limit the amount of PWP's load that can be served with imports from CAISO; and
3) Procuring enough capacity to comply with resource adequacy requirements set forth by the California Independent System Operator (CAISO) tariff, which establishes requirements for all members to ensure enough resources are available at all times throughout the year to meet the needs of the CAISO system.

While maintaining reliability has always been core to our mission as a utility, this objective is increasing in complexity. Historically, the highest reliability risks have occurred during peak periods when electricity demand is highest; as the resource mix shifts toward renewables and storage, reliability risks begin to shift toward other times of the day or year when generation availability is lower (e.g. during the "net peak" after sundown). Meanwhile, multiple factors are contributing to greater uncertainty on future electricity demand, including climatic uncertainty that drives extreme weather events, and the changing patterns of electricity use due to electrification and other changes in customer behavior.

Multiple high-profile, real-world examples serve to highlight the increasing complexity of reliability planning and the consequences of failing to meet those standards:

- The **Western Heat Wave of August 2020** resulted in tight supplies of electricity resources across the Western Interconnection. On two consecutive days, California experienced shortfalls and instituted rolling blackouts affecting hundreds of thousands of customers. Notably, the load shedding events occurred in the early evening hours – after the load peaked and as the sun set – highlighting the importance of reliability planning practices designed to ensure resource adequacy across all hours, not only during the traditional peak periods.
- **Winter Storm Uri in February 2021:** Texas experienced a catastrophic power crisis triggered by Winter Storm Uri, which brought record-breaking cold temperatures and severe winter weather. During this event, demand for electricity surged while nearly half of the grid's generating capacity failed due to frozen natural gas infrastructure and inadequately winterized equipment. The impacts of this event were catastrophic: over 4.5 million customers were affected by blackouts across multiple days of extreme cold weather.

Planning a reliable electricity system to avoid such events amidst the challenges described above requires rigorous technical modeling of system conditions across a broad range of weather conditions. Our planning practices are evolving to ensure that we can meet these challenges.

Affordable

While pursuing ambitious clean energy goals, PWP is committed to keeping energy bills affordable for our customers. As illustrated in the figure the below, PWP currently has the lowest electricity rates amongst many of our neighboring utilities including the Los Angeles Department of Water and Power, Glendale Water and Power, and Southern California Edison.

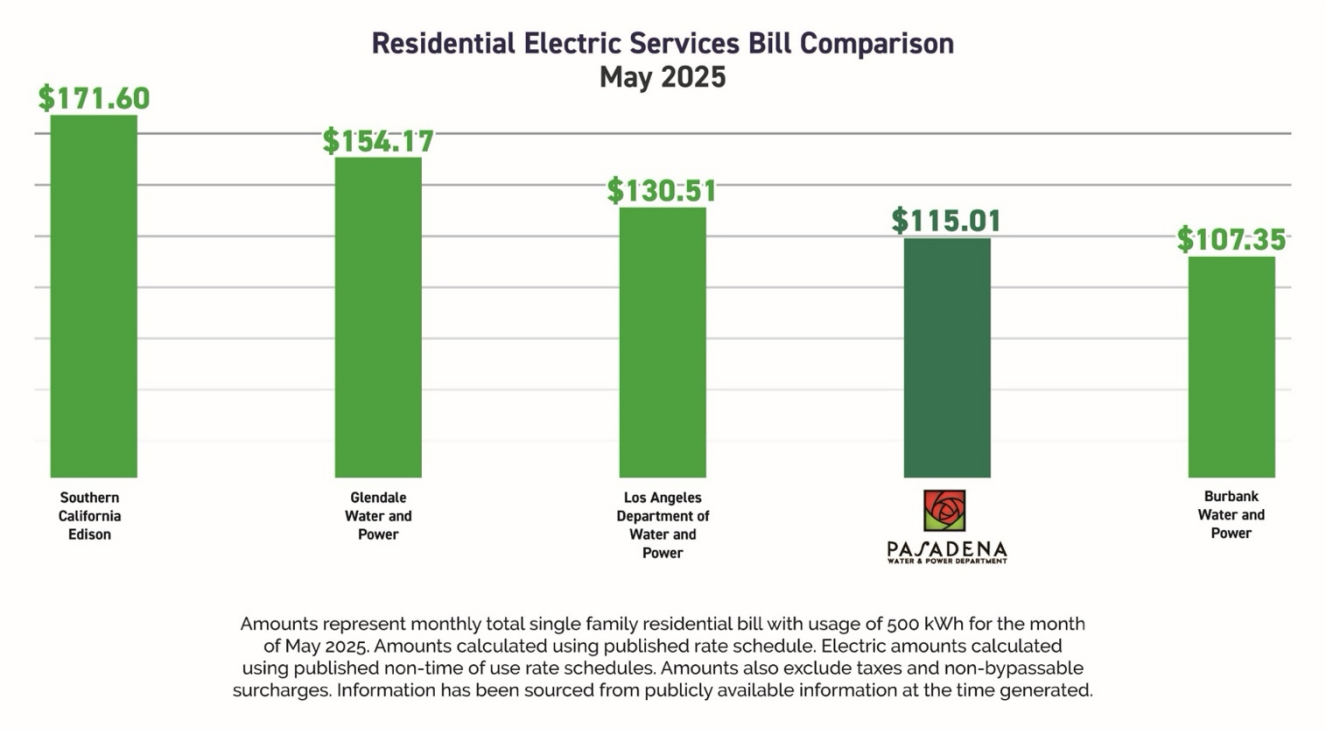


Figure 2 Residential electricity bill comparison with neighboring utilities

Affordability is core to our mission as a utility and is critical for multiple reasons:

- Access to affordable electricity directly impacts quality of life, health, and economic opportunity. As our residents, who span a diverse range of socio-economic backgrounds, depend upon electricity for everyday needs, providing affordable electricity service is essential for our community to thrive.
- Maintaining affordable and stable electricity rates is critical for attracting new businesses to Pasadena and keeping Pasadena a vibrant commercial hub in the region, as rate stability is essential for businesses to grow and make long-term investment decisions.
- Affordable electricity rates are also important for advancing broader economy-wide decarbonization efforts, as many other sectors of the economy will rely on the electric sector to decarbonize. Electrification of vehicles and buildings has emerged as a key pillar in the State's plans to achieve economy-wide decarbonization goals; these measures depend on broad customer adoption of new electrified technologies (e.g. electric vehicles (EVs), heat pumps). Rising electricity rates will increase the operational costs for customers of these alternatives, discouraging uptake and slowing the pace of adoption. PWP recognizes the critical role it plays in helping our customers electrify to support decarbonization and sees maintaining affordability as a key part of our efforts to support the energy transition.

Equitable

The equity objective of Resolution 9977 is closely related to the affordability objective. An equitable approach to meeting the objectives of Resolution 9977 should ensure that the incremental costs to transition to carbon-free electricity are fairly apportioned among customers – in their classes

(residential and commercial) and as individuals. This will require careful consideration of how electricity rates are structured, what incentives are made available and to whom, and what bill assistance programs are provided to low-income households.

Of particular importance is the impact of our actions upon low-income households and disadvantaged communities, who often spend a disproportionately higher share of their income on energy bills. For these customers, rising electricity costs can force difficult trade-offs between paying for power and meeting other essential needs like food, housing, or healthcare. High energy costs can deepen financial hardship and widen existing inequalities. In communities like Pasadena that experience extreme heat, low-income customers may reduce their use of air conditioning, potentially leading to unsafe conditions in the home, if they cannot afford their electricity bills or do not have access to opportunities to make their homes more energy efficient. The U.S. Census Bureau's Pulse Survey found that 30% of low- and moderate-income households nationally kept their homes at temperatures that felt unsafe or unhealthy to save money on energy bills.[4] Ensuring affordable electricity helps promote energy justice, supports vulnerable populations, and enables more universal access to the resources needed for full participation in modern life.

Safety

While not referenced explicitly in Resolution 9977, public safety is an omnipresent power system planning objective. The goal of designing a safe power system is to prevent accidents and events that can pose harm to human life, property, and the environment. Safety pervades all other power system planning objectives including affordability, reliability, and equity.

Mitigating the risk of electrical equipment igniting a wildfire has emerged as a key safety challenge for utilities. As climate change creates conditions that increase the potential for large wildfires, reducing risk of sparking of wildfire from electric system equipment will be increasingly important and challenging. Utilities are taking several mitigating measures including:

- **Infrastructure hardening** through undergrounding lines, covered conductors, or high-temperature rated equipment,
- Better **vegetation management** through routine brush clearing and Light Frequency Detection and Ranging (LiDAR) or drone-assisted line patrolling, and
- **Grid operations and controls** such as fast trip settings and remote monitoring to shut off power when faults are detected, dynamic line ratings to prevent overheating while maximizing line capacities, and public safety power shutoffs (PSPS) to pro-actively de-energize power lines in wildfire-prone areas during high wind conditions.

[4] National Energy Assistance Directors Association, Energing Hardship Report, 2024, https://neada.org/wp-content/uploads/2024/08/August-Summer-Hardship-Report-Final.pdf

2.3 Tracking Progress Toward Carbon-Free

Historical Greenhouse Gas Emissions

PWP's greenhouse gas emissions have declined over 65% since 2011. Emissions reductions have been driven by the addition of new renewable resources to our portfolio as well as the declining emissions intensity of market purchase from CAISO. Both of these factors will continue to drive our greenhouse gas emissions downward as Pasadena and the State pursue decarbonization.

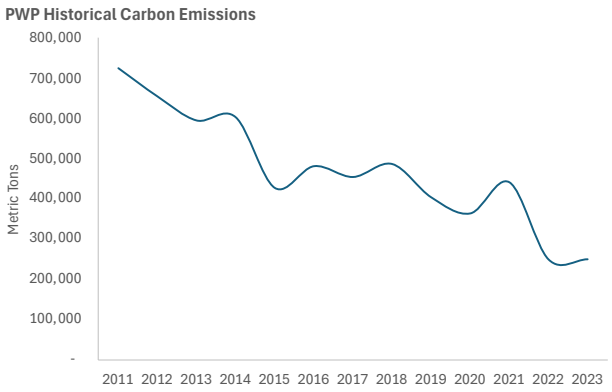


Figure 3. PWP Historical Carbon Emissions

Carbon-Free Metrics for Resolution 9977

PWP developed an online, public Clean Energy Tracker, in collaboration with E3, to establish key metrics to track our progress toward achieving our goals. PWP will continue to evaluate the relevance of key metrics and modify the tracker, as needed, to best report progress updates and new information related to Pasadena's transition to clean energy. Currently, PWP tracks progress on our transition to clean energy using two metrics, which were also used in the OSP to evaluate how various actions or resource portfolios could contribute to PWP's clean energy transition.

The first metric, an annual carbon-free metric, tracks PWP's progress toward Senate Bill (SB) 100[5] and 1020[6], which requires renewable and zero-carbon resources to supply 100% of electric retail sales in California by 2045. The annual carbon-free metric is defined as:

$$\frac{\text{Forecasted annual carbon} - \text{free generation}}{\text{Forecasted annual retail sales}}$$

The second metric, hourly carbon-free, measures PWP's progress toward matching customer demand for electricity with carbon-free generation on an hour-by-hour basis. While the annual carbon-free metric considers the total amount of carbon-free generation over an entire year, hourly carbon-free does not count carbon-free generation in an hour if it exceeds PWP's load. The hourly carbon-free metric is defined as:

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[5] Senate Bill No. 100 California Renewables Portfolio Standard Program (2018) https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB100

[6] Senate Bill No. 1020 Clean Energy, Jobs and Affordability Act (2022) https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB1020

$$\frac{Forecasted\ carbon-free\ generation\ (capped\ at\ hourly\ load\ for\ each\ hour)}{Forecasted\ annual\ load}$$

Current Outlook

The table below summarizes PWP's current performance on these carbon-free metrics and forecasted performance (as of August 12, 2025) by 2031. The projection for 2031 includes all resources currently under contract to PWP, including resources whose contracts for delivery to PWP have not yet commenced but will be in PWP's portfolio by 2031.

Table 9 Clean energy metrics for owned/contracted resources

Metric	2025	2031
Annual Carbon-Free	61%	83%
Hourly Carbon-Free	34%	76%

2.4 Purpose of an Optimized Strategic Plan (OSP)

Pasadena's OSP provides a roadmap to achieve the goals of Resolution 9977, enumerating the key steps and future decision points that will best position Pasadena to achieve its goal to source all electricity from carbon-free sources by the end of 2030, while maintaining reliability and limiting cost impacts to customers. Recognizing that Resolution 9977's ambitious objectives touch on all aspects of the power system, the OSP considers how new generation resources, investments in transmission and distribution infrastructure, and customer programs can facilitate transition to Pasadena's carbon-free goal. By defining a vision for the power system, and enumerating the steps necessary to realize that vision, the OSP serves as a roadmap and guidebook for implementation and execution.

Flexibility and Adaptive Planning

The electric industry at large is in the midst of transformational changes. The rapid pace of change serves to create new opportunities and to increase uncertainty in the planning process. Key vectors of change that impact utility planning and decision-making include:

- Transition in **resource mix:** For PWP and the State of California as a whole, the mix of electricity generation resources is rapidly shifting away from aging fossil-fueled plants toward renewables and energy storage. The operational characteristics of these carbon-free resources is rapidly changing how the grid operates on an hour-to-hour basis and corresponding wholesale market price signals, which in turn impacts the relative economics of new resource options.
- **Changing technology costs:** Since 2020, the costs to develop new generation resources have increased in significant and largely unanticipated ways due to inflation, supply chain constraints, and other factors – a reversal after many renewable and storage technologies experienced significant cost declines over the previous decade
- **Policy developments at the federal level:** Recent legislation to roll back key provisions of the Inflation Reduction Act and Executive Orders enacting higher tariffs on international trade are likely to cause further upward pressure and perturbations in the costs to develop new

resources; however, it is difficult to predict whether these measures will have enduring or transient impacts on resource pricing due to the unpredictability of federal policy changes

- **Emerging technology:** Multiple new technologies such as long-duration storage and green hydrogen are progressing toward commercial readiness and could play a key role in supporting the energy transition; however, when these technologies might be ready for deployment at grid scale – and at what cost – are speculative uncertainties
- **New types of electric loads driving growth:** After many decades of flat-to-declining load growth driven by increasing energy efficiency, load is forecasted to increase in the coming decades, driven by electrification to support economy-wide decarbonization, on-shoring of manufacturing, and growth in data centers
- **Customer preferences and innovation at the customer meter:** Many customers are becoming "prosumers" (producers and consumers) of electricity, and energy services companies and aggregators are finding new ways to help customers manage their usage actively
- **The impacts of climate change** are resulting in increased frequency of extreme weather events (including extreme heat, cold, and storms) in ways that place new stressors on the electricity grid; while industry best practices are evolving to incorporate climate-informed data into planning, short- and long-term climatic uncertainty still presents a challenge

Against this landscape of rapid change, the OSP seeks to balance specificity with adaptability and flexibility, which are features of robust planning for the future. The ability to make adjustments and respond quickly to changes in market conditions and unforeseen events will be critical to maintaining a balance among environmental, economic, and reliability objectives. Some uncertainties are large enough that they could shift the solution landscape – either creating obstacles to the deployment of solutions that appear promising today or presenting new opportunities that may not appear attractive or feasible at this time. Tools to mitigate risks associated with these uncertainties and adjust plans accordingly are, therefore, considerations in the development of the plan, and our Waypoints in 2026 and 2028, established in the 2023 IRP process, provide prescribed opportunities to assess progress, reevaluate the landscape, and pivot toward solutions.

2.5 Process for Developing an OSP

The OSP has been developed through a one-year study process that began in May 2024, following a scope of work that was jointly developed by the City Manager's Office, PWP, and E3; informed by public comment; and approved by the City Council. The process was designed and executed with three guiding principles in mind:

1) that it should be **comprehensive** in its consideration of resource options to achieve the City's goal of a 100% carbon-free electricity system;
2) that it should be grounded in **rigorous technical analytics** to co-optimize for carbon-free energy, affordability, and reliability; and
3) that it should follow a **transparent process** to allow for public input to the development of the plan.

Comprehensive Scope

Meeting the goals of Resolution 9977 requires a complete transformation of the power system, including when, where, and how electricity is generated, how it is stored and delivered, and how it is consumed by our customers. Developing a robust plan to guide this transformation requires a comprehensive assessment of resource options. The OSP process reflects this philosophy and includes a sequence of nine supporting studies designed to build upon one another to produce a vision for the electric sector transformation.

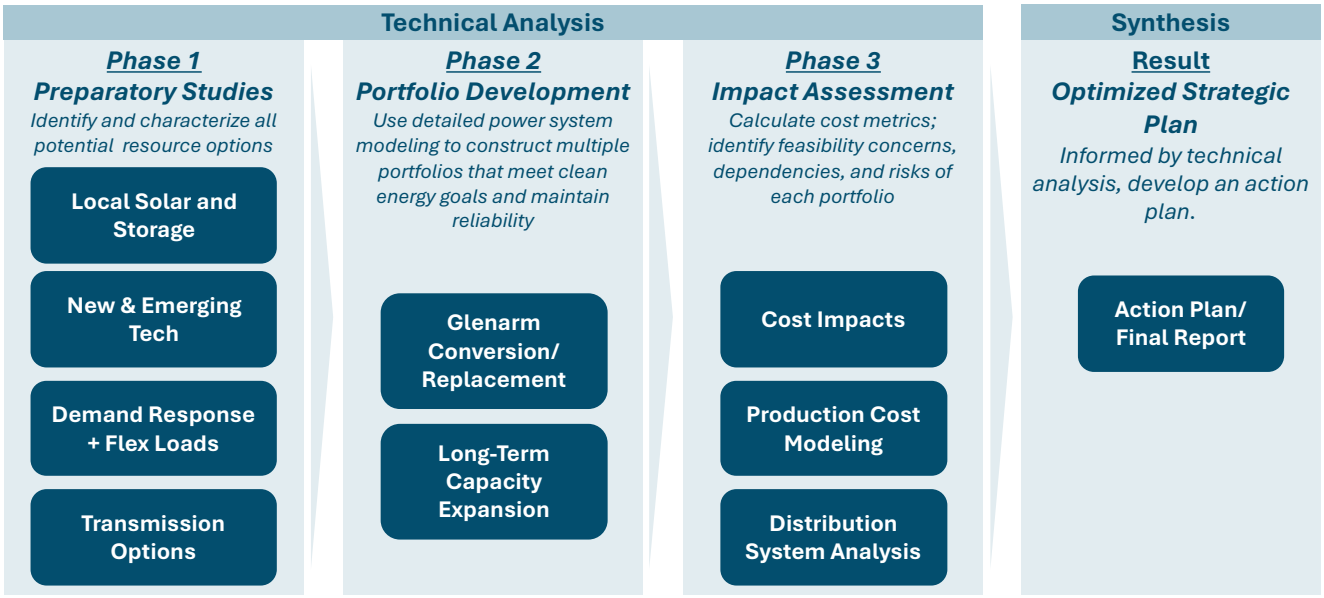


Figure 4 OSP scope of work

Rigorous Technical Analysis

Developing a plan to guide the transformation to a carbon-free electricity system – while balancing objectives of affordability, reliability, and equity – is a multifaceted problem. The development of the OSP relies on a range of industry-leading tools and techniques to characterize the needs of the electric system and the options to satisfy those needs. As the transition to a carbon-free electricity supply accelerates, the challenges facing the grid – from integrating intermittent renewables to ensuring reliability and affordability – become increasingly complex.

Collaboration and Transparency

In recognition of the importance of Resolution 9977's carbon-free electricity goal to the Pasadena community, the OSP development process has included multiple channels for outreach and engagement with various stakeholders and decisionmakers.

- PWP and E3 met with a "Technical Advisory Panel" (TAP) 14 times over the sixteen-month study process to provide updates and solicit feedback on interim modeling results. The input from the TAP, which included representatives from Pasadena 100, California Institute of Technology (Caltech), the Pasadena Chamber of Commerce, and the community at large, was invaluable to the study process. PWP is grateful to these individuals for volunteering their time to assist in the development of the Plan.

- During the study process, PWP and E3 provided five updates to the Municipal Services Committee and three updates to the City Council. Each of these updates provided councilmembers with an important opportunity to provide guidance to PWP on policy-related issues – guidance that heavily shaped the final plan.
- PWP and E3 met three times with the City's Environmental Advisory Commission, providing updates that allowed commission members to understand how the achievement of Resolution 9977 goals could support the City's broader Climate Action Plan.
- PWP and E3 hosted a community forum, PWP Open House and office hours with PWP Power Supply staff to provide general education around the OSP and Resolution 9977, offering a forum for the general public to voice questions and comments.
- PWP also created and maintained an OSP webpage containing all materials presented to TAP, EAC, MSC, and City Council.

Feedback and guidance received through each of these channels have shaped many elements of this plan and have been essential to ensuring that the OSP reflects the needs of the power system and the needs of our community.

2.6 Complementary Planning Efforts & Ongoing Studies

2022 Power Delivery Master Plan

In 2022, PWP developed the Power Delivery Master Plan (PDMP) to provide a high-level guide for planning, operating, and maintaining the electric distribution system over the next 20 years. The PDMP also identifies the long-term outlook of the electric utility, assesses the system's current operating conditions, and provides an ambitious capital improvement plan to address current and future challenges - all designed to increase reliability and safety and to improve cost effectiveness. Multiple elements of the PDMP – including the city-wide deployment of AMI, replacement of aging underground sub-transmission lines, and future upgrades to at TM Goodrich – have impacts on the opportunities available to PWP and are incorporated into the OSP.

2023 Integrated Resource Plan

As a municipal utility in California, PWP has an obligation to file an integrated resource plan with the California Energy Commission (CEC) every five years. PWP has voluntarily administered additional, interim studies. This OSP is one of them. Integrated resource planning is a common exercise within the electric industry used by utilities to develop long-term resource plans that ultimately inform near-term procurement decisions and strategy.

The 2023 IRP was PWP's first opportunity to study how to achieve a carbon-free electricity system following the adoption of Resolution 9977. The IRP satisfied all regulatory requirements set forth by the CEC and resulted in a final product that led to several important outcomes:

- Through its analysis of a range of scenarios, the 2023 IRP provided an indication of the scale of resources needed to achieve a fully carbon-free electricity system and highlighted a number of constraints and challenges that subsequently became focus areas and study questions that informed the development of this OSP.

- The 2023 IRP established "Waypoints" in 2026 and 2028 – explicitly defined checkpoints to assess progress toward the Resolution 9977 goals and to adjust implementation strategies as needed. By allowing for fine-tuning and refinement of ongoing activities, the Waypoint framework allows for adaptive planning in response to changing market and regulatory conditions.

2024/2025 Electric Rate Study

In 2024 and working in parallel with OSP, PWP began work on an Electric Rate Study (ERS). The purpose of the ERS is to evaluate and develop a recommended rate plan that aligns with established City Council policies and legal constraints. The ERS is the first step toward a new rate plan, which ensures that the utility collects sufficient revenue to maintain infrastructure, fund utility resiliency efforts, and cover all operational costs; and provides a price signal to customers that incentivizes behaviors that are beneficial to the community and utility. While the ERS development includes a 10-year financial outlook model in order to make prudent long-term financial decisions, the rate plan will initially propose rates for a two-year time period based on Council guidance.

The basis for the rate plan was established through the financial forecast, which includes projections of revenues, expenses, capital spending, debt service, and changes in reserves over a four-year Study Period (Fiscal Year (FY) 2026–FY 2029). To develop the financial forecast, the City's consultant New Gen used PWP's FY 2026 budgeted expenses, load forecast documents, records of operations, customer billing data, and other detailed information and data compiled and provided by PWP's management and staff. We used the FY 2026 budgeted expenses as the base year in the financial forecast. Any projected non-recurring expenses or revenues were identified and incorporated in the financial forecast, as appropriate.

The ERS is different from the OSP *incremental* cost impact analysis (see 4.2) in that it considers all aspects required to provide electric services and the costs. The goal of the ERS is to align rates with PWP's cost of service and maintain stable and affordable rates for our customers. In addition to the incremental costs considered in the OSP, there are other significant uncertainties with costs such as tariffs and inflation among a few. PWP is working in a coordinated manner to ensure that rate increases consider the ability to use all tools available to mitigate them and the impact to individual budgets on rates, creating stability and transparency with the rate plan.

3 Our Evolving System

For over a century, PWP has supplied electricity to the residents and businesses of Pasadena. From the first 250 kW generator installed at Glenarm in 1906, our power system and generation portfolio have grown and expanded to meet the changing needs of the City. Today, the electricity that supplies the City comes from three sources:

1) The Glenarm Power Plant, a gas-fired peaking plant located within the City that plays a critical role in ensuring local reliability;
2) A diverse portfolio of fossil-fueled and carbon-free generation resources located in California and across the broader western region; and
3) Purchases of "unspecified" power from the CAISO wholesale energy market.

Electricity sourced from outside the City must be delivered to Pasadena through the **TM Goodrich Receiving Station** (TM Goodrich), PWP's sole point of interconnection to the broader CAISO. The construction of TM Goodrich in 1970 represented an important milestone for PWP, unlocking access to a much broader pool of resources outside the City to meet its rapidly growing needs. On a day-to-day basis, nearly all electricity supplied to Pasadena homes and businesses flows through TM Goodrich (typically over 95% of annual energy supplies). However, under rare circumstances, Pasadena's demand for electricity can exceed the physical or operational limitations at TM Goodrich, and when this occurs, PWP's local generation resources are essential to maintaining reliable electric service for the City.

Whether sourced from outside the City or generated at Glenarm, all electricity that supplies our customers is delivered to homes and businesses over PWP's **sub-transmission and distribution system**. PWP has owned, maintained, and operated this sub-transmission/distribution grid since the utility's inception and continues to modernize the system to provide reliable service.

The system, as it exists today, is the cumulative result of decades of careful planning and provides the foundation for our transformation to a carbon-free electricity system. This section of the OSP describes these various components of our system as it exists today and the transitional steps already underway that will advance the City toward the goals of Resolution 9977. These include:

1) Expectations for how **customer electricity needs** will shift over the next five to 10 years (Section 3.1);
2) The current composition and anticipated changes to **our generation resources**, including local and external resources (Section 3.2);
3) The role of the **CAISO wholesale market** in our power supply portfolio (Section 3.3);
4) The **transmission interconnection** at TM Goodrich that provides access to CAISO (Section 3.4); and
5) Our **sub-transmission and distribution system** and the steps already in progress today to modernize how we deliver power to our customers (Section 3.5).

3.1 Our Customers' Needs

PWP currently serves approximately 57,000 residential customers and approximately 8,000 commercial customers and delivers over 1,000 GWh of electricity annually. A new all-time peak demand of 330 MW was set for the utility on September 6, 2024, during an extreme six-day heat event.

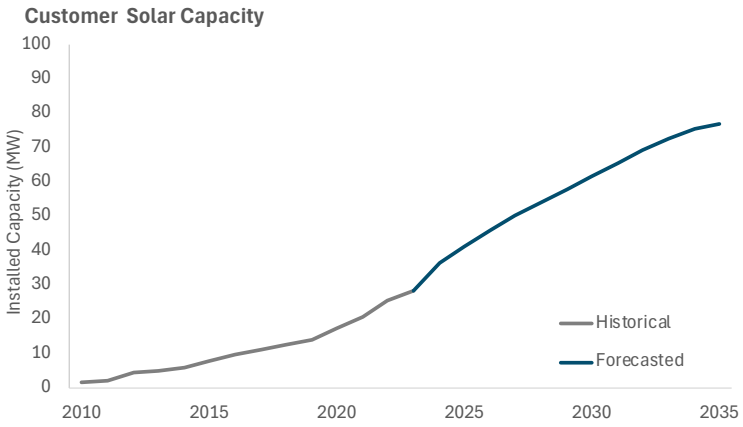


Figure 5 PWP historical and forecasted annual load

In the future, customer demand for electricity is expected to increase due to transportation electrification and continued population and economic growth. Between 2025 and 2031, transportation electrification is the primary forecasted driver of growth, adding 130 GWh to PWP's annual net system consumption. An additional 36,000 light-duty EVs are expected in Pasadena by 2031. However, PWP's net annual load is forecasted to increase only 100 GWh in the same time period due to customer solar adoption and aggressive investments in energy efficiency.

Forecasting future customer energy demand is highly uncertain due to several factors. A significant source of uncertainty stems from potential changes in state and federal policy. For example, elimination of federal tax credits, supply chain constraints, and tariffs could change the economics for technologies like electric vehicles and solar, thereby slowing down the pace of adoption. Customer attitudes toward EVs and solar are also difficult to predict and may shift over time. Additionally, it is difficult to predict how new large commercial and institutional customers looking to locate their business in the City, or existing customers looking to expand their businesses, could increase demand for electricity. PWP is committed to supporting the economic development of Pasadena by providing power to these customers as well.

Energy Efficiency, Demand Response, and Electrification Programs

The current energy efficiency (EE) and demand response (DR) goals for Fiscal Years 2022 to 2025 are 11,720 MWh and 1.8 MW, respectively. The California Municipal Utilities Association's (CMUA's) consultant GDS Associates, Inc. recently completed its 2025 Energy Efficiency Potential Forecasting Study, which identified an average annual efficiency program target for the next 10 years of 0.9% of total projected energy sales for Pasadena.

PWP currently uses funds collected through the electric public benefits charge (PBC) to support a variety of customer energy efficiency programs as well as electrification, low-income bill assistance, and demand response programs. Programs supported by PBC funds are summarized in the table below.

Table 10 Current PBC fund supported customer programs

Program	Sector	Description
Business Rebate Program (BRP)	Commercial	Deemed rebate, focusing on LED lighting, motor controls, commercial restaurant equipment/appliances & HVAC measures. Max rebate of $24k/metered comm. electric account, capped at 25% of project cost.
Customized Incentive Program (CIP)	Commercial	Customized rebate, 5¢/kWh on above code energy savings for lighting, non-lighting & new construction projects. 15¢/lb. of CO2 reduced for non-lighting & new construction projects. Max rebate of $50k/metered comm. electric account, capped at 25% project cost.
Water & Energy Direct Install Program (WeDIP)	Commercial	Comm. customers using ≤50kW in electric demand can receive up to $7,500 worth of water & energy-efficient equipment, installed at no cost (Ex: low-flow toilets, LEDs).
Commercial EV Charging Rebate Program (CEVSE)	Commercial	$3,000 rebate/port for the installation of qualifying smart L2 EVSE for comm. electric customers, four double bonus categories, max $75k/site or address served by PWP.
Home Energy Rebate Program (HER)	Residential	Rebate program for the purchase of qualifying energy-efficient products, energy star appliances, all-electric equipment, and EV/EVSEs.
Res. Electric Panel Upgrade Program (REPU)	Residential	Rebate program for customers upgrading to a 200amp electric panel, encourages electrification
Refrigerator Exchange & Recycling Program (ARCA)	Residential	No-cost recycling of refrigerators/freezers for PWP electric customers. Refrigerator exchange for low-income customers.
Home Improvement Program (HIP)	Residential	Any residential electric customer can receive up to $7,000 of water & energy savings equipment, installed at no cost.
Energy Savings Assistance Program (ESAP)	Residential	Low-income direct install program, in partnership with SoCalGas (LEDs, Toilets, HVAC Tune-Ups, Room ACs).
Home Energy Reports (Opower)	Residential	Behavioral Program, with neighborhood energy comparison reports and marketing modules sent via mail/email.
Energy Education Program (Livingwise)	Residential	Educating students & teachers/parents about responsible energy use (FY 21 8 schools/13 teachers/440 6th graders)
Electric Utility Assistance Program (EUAP)	Bill Assistance	Low-income customers between the ages of 18 and 61 can receive $13.46 per month credit on their bill.
California Alternative Rates for Energy (CARES)	Bill Assistance	Low-income seniors (ages 62 & up) or low-income customers with a permanent disability may receive $13.46 per month bill credit and their Public Benefits Charge (PBC) charges waived. Average monthly benefit is approx. $14/month.
CARES Plus	Bill Assistance	Low-income seniors (ages 62 & up) or low-income customers with a permanent disability at the lowest income level receive may receive $13.46 per month bill credit, PBC charges and Utility Users Taxes waived. Average monthly benefit is approx. $18/month.
Assisting Pasadena People w/ Limited Emergencies (APPLE)	Bill Assistance	One-time credit, up to $200 per year to help eligible low-income residential electric customers keep their lights on. Customer must have final notice from PWP to qualify.
Medical Assistance Program	Bill Assistance	Res. electric customers w/ qualifying electric-powered medical equipment can receive a $13.46/monthly bill credit.

In addition to these programs, PWP helps enroll customers in the CEC's Demand Side Grid Support Program, which offers incentives to customers to reduce load during extreme events stressing the State's grid.

Customer Solar Resources

As of the end of 2023, PWP customers collectively installed 28 MW of solar capacity. Of that installed capacity, approximately 17 MW is located on single-family housing, 1 MW on multi-family housing, and 10 MW on commercial buildings. Customer solar has grown steadily since the first installations in Pasadena in the 2000s. In the previous 5 years, an average of 3 MW of customer solar has been installed each year. Analysis conducted for the OSP – prior to the passage of the One Big Beautiful Bill Act (OBBA) (FY2025 Congressional Reconciliation Bill) – indicates that, under our existing Net Energy Metering (NEM) compensation structure, customer solar adoption would accelerate in the future and could exceed 60 MW of installed capacity in 2031; however, the elimination of federal tax credits for residential solar installations under OBBBA is likely to dampen the rate of customer adoption.

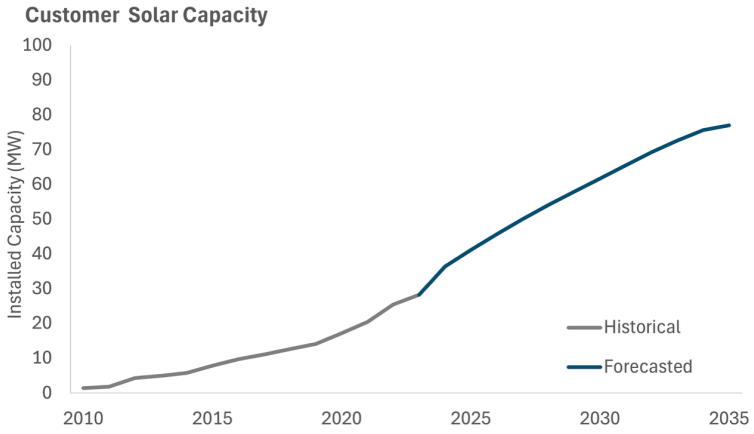


Figure 6 Historical and forecasted customer solar installed capacity

3.2 Generation Resources

PWP currently serves electricity demands with a portfolio of generation resources and purchases of unspecified power from the CAISO wholesale market, managed in five-minute intervals. PWP's energy mix has shifted over time:

- Through 2010, PWP relied primarily on local gas-fired generation and contracted shares of a small number of power plants located across the western United States, including the Intermountain Power Project, Hoover Dam, and Palo Verde Nuclear Generating Station.
- Over the subsequent decade, PWP began to add long-term power purchase agreements for renewable generation and purchased unbundled renewable energy certificates (RECs) to meet the RPS obligations codified by the State of California and to reduce carbon emissions in its generation portfolio. PWP also retired the gas-fired Broadway Power Plant in 2016 and laid plans in motion to divest from its share of the coal-fired Intermountain Power Project in this period.
- Since 2023, following the adoption of Resolution 9977, PWP has accelerated the transition toward carbon-free electricity, adding a significant quantity of long-term contracts for new renewable resources expected online between 2025 and 2030.

The changes to PWP's portfolio from the present day through 2030 based on current plans is shown in Figure 7, which highlights (a) PWP's shrinking reliance on fossil resources following the exit from Intermountain Power Project in 2027, and (b) the rapid increase in renewable energy in the portfolio due to contracts for new resources already under development. Table 11 The table below lists the characteristics of individual resources currently in PWP's energy portfolio.

Figure 7. Installed capacity (MW) & annual generation (GWh) for resources currently in PWP's portfolio

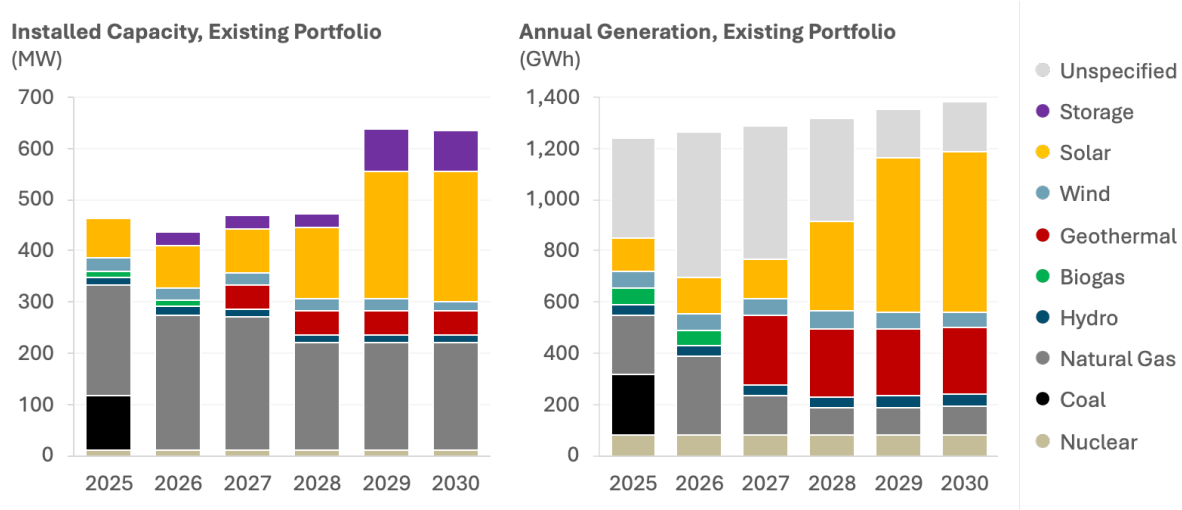


Table 11. List of resources in PWP's generation portfolio

Fuel	Resource	Carbon Free	Online Date	Retirement Date	Capacity (MW)
Nuclear	Palo Verde Nuclear Generating Station	Y	1986	2047	10
Coal	Intermountain Power Project	N	1987	2025	108
Natural Gas	Intermountain Power Project Repower	N	2025	2027	54
	Glenarm Power Plant	N	Existing	TBD	198
	Magnolia Power Plant	N	2005	2036	18
Landfill Gas	Puente Hills	N	Existing	2027	7
Hydro	Hoover	Y	1987	2067	15
Geothermal	Coso	Y	2027	2041	10-19
	Geysers	Y	2027	2041	25
Wind	Milford 1	Y	Existing	2029	5
	Wind Resource II	Y	2025	2035	20
Solar	Antelope Big Sky Ranch Solar	Y	2016	2041	6.5
	Big Sky Summer Solar	Y	2016	2041	6.5
	Columbia 2 Solar	Y	2014	2034	2.6
	Kingbird Solar	Y	2016	2035	20
	Grace Solar	Y	2027	2047	50
	Bonanza Solar	Y	2028	2047	105
Storage	Bonanza Storage	Y	2028	2047	55
	Glenarm BESS	Y	2026	2041	25

The remainder of this section discusses the key elements of this portfolio of resources, their roles, and how they are poised to change as PWP transitions toward 2030.

Glenarm Power Plant

The Glenarm Power Plant has been an integral part of Pasadena's power system for about 120 years. Over its history, the generators at the power plant have been retired, rebuilt, and refurbished to take advantage of technology improvements and changes in fuel supply. Currently, Glenarm has five generating units, totaling 198 MW of capacity, that operate using natural gas.

Table 12. Glenarm unit capacities

Unit	Unit description	Capacity (MW)
Unit 1	Gas Turbine (Gas/Oil)	22
Unit 2	Gas Turbine (Gas/Oil)	22
Unit 3	Gas Turbine	45
Unit 4	Gas Turbine	42
Unit 5	Combined Cycle	66

Today, Glenarm is the only large-scale power plant located within the City of Pasadena and plays a critical role in PWP's portfolio as a local reliability resource. While it operates rarely in this capacity, it is needed to ensure reliability within the City under a range of specific circumstances, including (1) peak demand conditions when PWP's load exceeds the ability to import power from CAISO; (2) transmission or sub-transmission system contingency events that reduce PWP's import capability; and (3) maintenance of internal sub-transmission and distribution system.

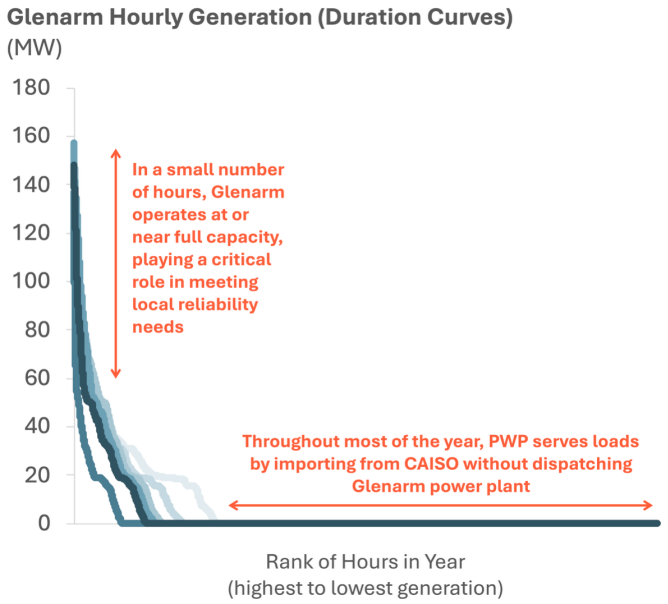


Figure 8 Historical Glenarm duration curves (hourly plant generation sorted from highest to lowest)

Figure 8 shows Glenarm's operating patterns in recent years. In most hours of the year, Glenarm does not operate, and PWP serves load by importing power from CAISO, but during select periods, the plant was dispatched at near full capacity. This operating pattern is typical of a resource whose primary purpose is to support reliability.

In addition to supporting local reliability, Glenarm plays a significant role in meeting PWP's resource adequacy (RA) requirements. As a load-serving entity in CAISO, PWP must demonstrate each year that it has sufficient resources to meet our share of local and system reliability needs. PWP is responsible for securing "capacity credits" from resources to demonstrate we have sufficient capacity to meet peak demand plus a planning reserve margin. Glenarm currently represents a significant share of PWP's RA capacity, fulfilling over half of PWP's requirement. Glenarm is a firm resource and is not subject to the same "saturation effects" that will reduce the capacity credits assigned to renewables and storage as their

penetration in the CAISO system continues to grow. The future decreases of capacity credits assigned to renewables and storage is one source of uncertainty that presents a challenge to the long-term replacement of the plant.

As a RA resource, Glenarm must be made available for dispatch in the CAISO markets and must follow CAISO dispatch instructions. CAISO dispatches generation resources across its footprint in "merit order" (from lowest to highest operating cost) subject to transmission constraints to meet load. CAISO calls upon Glenarm to dispatch when market prices exceed the operating cost for the power plant or when the grid is experiencing a reliability need.

Magnolia Power Project

The Magnolia Power Project is a 323 MW natural gas-fired combined-cycle power plant located in Burbank, California. Through SCPPA, PWP has a minority ownership stake (6%) in the Magnolia Power Project under an agreement that expires in 2036. At the termination of the agreement, each participant will have the opportunity to elect whether to continue participation in the project. Currently, PWP receives 6 MW of must-take generation; the balance of PWP's 18 MW share is dispatched economically. Under this ownership agreement, PWP does not control the plant's operations and does not have decision-making authority to decommission the plant.

While PWP's control over Magnolia's operations are limited, the carbon-free resource additions included in the OSP are designed to be sufficient to meet PWP's energy and capacity needs without the need for Magnolia. This is reflected by the fact that the hourly matching portfolios include sufficient carbon-free resources to meet PWP's energy needs on an hourly basis, meaning that Magnolia's exit strategy will be considered when sufficient progress is made to replace Magnolia in PWP's resource portfolio. Under these circumstances, there are at least three potential options for how PWP can proceed with its Magnolia ownership agreement beyond 2030:

1. Maintain its ownership share in the plant under current agreement and separately sell the associated energy and capacity to another party through a short-term power purchase agreement from 2030-2036,
2. Sell its ownership share to another party, or
3. Renegotiate the current ownership agreement to arrange for an early exit from the plant.

Which of these options are viable and which is most favorable to PWP customers are not questions that can be answered through power system planning studies but are instead commercial matters to be settled through negotiations and agreements with potential counterparties. While these three options may lead to different financial outcomes, PWP's small percentage share of 6% does not directly impact the actual operations of the Magnolia Power Project (and the corresponding consequential greenhouse impact associated with its operations).

PWP intends to investigate each of these options and will bring forward any viable commercial opportunities to exit Magnolia by the 2028 Waypoint to City Council, along with evaluations of (1) the costs to PWP customers, (2) PWP's ability to meet its resource adequacy obligations with other resources, (3) assessments of opportunities (or lack thereof) to participate in a future clean fuel conversion project.

Intermountain Power Project

Since the coal-fired Intermountain Power Project was commissioned in 1987 in Utah, PWP has received a share of its output through a forty-year power purchase agreement administered by SCPPA. In 2015, PWP was offered the opportunity to renew participation in the project, which owners were planning to convert from coal to natural gas in 2025, for an additional 50-year term. During the development of the 2018 IRP, PWP evaluated whether to renew the agreement and concluded that:

> "…it would be in the City's best interest to give notice to the [Intermountain Power Authority] terminating its participation in the IPP Renewal Project based on several economic and environmental considerations. PWP's long-term Power Integrated Resource Plan ("IRP"), although not finalized, analyzed the economics of remaining in IPP extensively. This analysis has clearly shown that the IPP Renewal Project is not an economic resource choice and it does not meet the greenhouse gas emission reduction requirements. As a result, it was not selected as a preferred resource under any of the energy portfolios shortlisted in the IRP analysis."[7]

The elimination of coal from PWP's energy mix after 2025, and the decision not to renew participation in IPP beyond 2027, represents a landmark milestone in the City's transition to clean energy. PWP's share of IPP, which corresponds to over 100 MW of generating capacity, has historically represented over 90% of the greenhouse gas emissions attributed to the City's electric generation portfolio.

Power Purchase Agreements for Renewables and Energy Storage

PWP contracts with third-party developers for the output of renewable and storage resources across California and the broader western region through power purchase agreements (PPAs). These agreements allow PWP to purchase the output from specified carbon-free facilities at a fixed price over a long-term period (typically 10-25 years). In today's portfolio, PWP holds PPAs with 35 MW of solar resources and 5 MW of wind generation; most of these contracts were signed over the past decade to help meet PWP's RPS obligations.[8] In the past two years, PWP has entered into a number of larger PPAs with renewable energy and storage facilities to replace energy from IPP and accelerate progress toward its carbon-free goals. These include over 200 MW of renewable capacity and over 50 MW of energy storage capacity:

- **Bonanza Solar and Storage**, a new hybrid project with 105 MW of solar capacity and 55 MW of four-hour lithium-ion battery capacity located in Nevada expected online by the end of 2028;
- **Grace Solar**, a 50 MW solar project located in Riverside County, California, expected online by the end of 2027;
- **Geysers Geothermal**, a 25 MW contract for output from an existing geothermal facility in Northern California;

[7] City of Pasadena, Agenda Report (2018) https://ww2.cityofpasadena.net/2018%20agendas/oct_29_18/AR%209.pdf

[8] To meet RPS requirements, PWP also contracts for unbundled RECs not discussed here.

- **Coso Geothermal**, a contract for output from an existing geothermal facility that will initially provides PWP with 10 MW of capacity beginning in 2027 and expanding to 19 MW in 2037; and
- **Wind Resource II**, a 20 MW contract for output from an existing wind facility in California.

In aggregate, these new resources are capable of producing up to 813,000 MWh of carbon-free electricity per year - roughly 70% of total annual energy needs. Beyond these projects, PWP is actively negotiating with developers for additional carbon-free resources not included in this list.

Battery Storage at Glenarm Site

PWP is currently working with a special purpose entity to develop a 25 MW four-hour battery energy storage system (BESS) at the Glenarm Power Plant site. The project, financed in part by a $9.66 million grant from the CEC, will be contracted to the City through an energy storage agreement (a similar structure to a PPA) over a 15-year period beginning in 2027. Once operational, this resource will be PWP's first large-scale storage resource within the City and will be used to store excess renewable energy and meet peak load.

3.3 CAISO Wholesale Market

Since 2004, PWP has participated in the wholesale electricity market administered by CAISO, a non-profit public benefit corporation that manages the flow of electricity across the high-voltage, long-distance power lines that make up 80% of California's power grid. CAISO ensures grid reliability, balances real-time electricity supply and demand, and operates wholesale electricity markets where power is bought and sold. Participants in CAISO include investor-owned utilities, publicly owned utilities (like PWP), independent power producers, demand response providers, and energy traders. Through its open market structure, CAISO facilitates competition, grid innovation, and integration of renewable energy resources to support California's clean energy goals.

Organized wholesale markets such as CAISO's are widely recognized as providing a range of benefits to market participants, many of which are the driven by the diversity that results from pooling together loads and resources across a broad geographic footprint. Participation in CAISO wholesale markets provides multiple benefits to PWP, including:

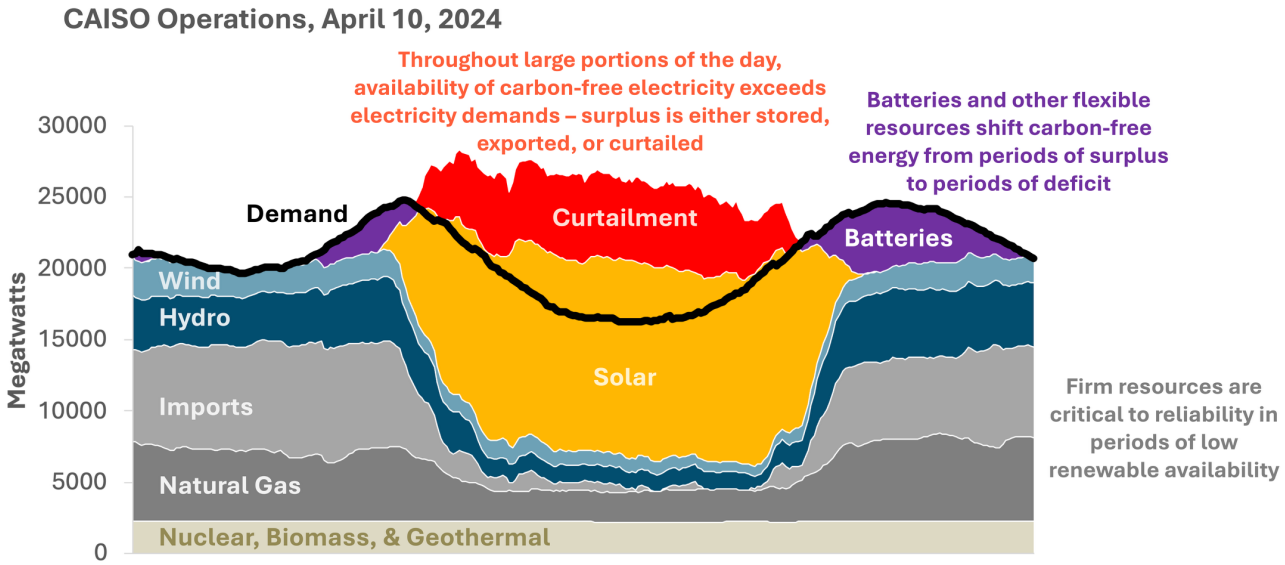
- The ability to maintain a lower reserve margin than would otherwise be needed to meet common industry standards for reliability, especially as a small system;
- Direct access to contract with a broader and more diverse pool of electric generation resources across the state of California (and beyond), including wind, geothermal, and utility-scale solar;
- The ability to buy and sell energy on an hourly basis in a deep, liquid market, allowing PWP to dispatch its own resources as part of a broader pool and purchase energy from the market when it is available at a lower cost than its own resources;
- The provision of balancing services, including contingency reserves and regulation.

In recent years, PWP has met a large share of its energy needs (about 25%) through market purchases from CAISO. These market purchases are "unspecified," meaning that they cannot be traced or tied to a single specific generating resource. In all pathways to achieving the goals of Resolution 9977,

PWP will reduce reliance on unspecified market purchases as it increases the amount of owned and contracted carbon-free resources in its portfolio.

At the same time PWP interactions with the market are changing, the CAISO market itself is in the midst of profound changes due to the rapid increase in development of renewables and storage resources. The transitioning resource mix is fundamentally reshaping the pricing patterns observed in wholesale markets: during periods of high renewable output – particularly during daylight hours in the spring – the system often experiences an "oversupply" of renewables, meaning that the availability of renewable generation at any moment is greater than electricity demand, and the surplus must either be sold externally, stored, or curtailed. Figure 9 provides a real-world example of this phenomenon, the belly of California's eponymous "duck curve," as observed in April 2024.

Figure 9. Snapshot of CAISO system operations on April 10, 2024



Under such circumstances, it is commonplace for wholesale prices to drop to zero or negative levels. Figure 10 shows the average day-ahead energy price for 2024 in CAISO for the SP15 pricing hub by month and time of day, clearly illustrating the incidence of low prices during daylight hours – particularly in the spring season when loads are low and solar output is relatively high. The number of hours with prices at or below zero in 2024 was 1,173, or approximately 13% of hours in the year. These pricing patterns have a direct impact on the relative economics of different types of resources: resources that produce during daylight hours provide relatively low energy value, whereas resources that produce outside of daylight hours (and particularly during the evening net peak) provide significantly higher energy value.

Figure 10. Average CAISO (SP15) day-ahead energy prices by month and time of day, 2024 historical in $/MWh

	Hour of Day																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	$72	$70	$69	$69	$70	$77	$85	$80	$57	$42	$36	$32	$29	$27	$32	$55	$83	$88	$88	$87	$86	$85	$80	$76
Feb	$41	$40	$39	$39	$40	$45	$51	$42	$21	$9	$6	$3	$2	$2	$4	$12	$42	$52	$52	$51	$51	$51	$46	$43
Mar	$35	$33	$32	$32	$34	$39	$45	$33	$7	-$13	-$22	-$25	-$27	-$27	-$27	-$22	-$6	$24	$42	$45	$44	$43	$40	$36
Apr	$33	$31	$31	$30	$32	$38	$42	$18	-$16	-$26	-$29	-$29	-$31	-$32	-$31	-$29	-$22	-$2	$36	$45	$43	$40	$36	$33
May	$28	$27	$26	$26	$27	$31	$28	$2	-$14	-$18	-$18	-$19	-$19	-$19	-$19	-$17	-$14	$0	$26	$39	$41	$37	$31	$29
Jun	$33	$32	$31	$30	$31	$33	$27	$10	$5	$4	$5	$4	$3	$4	$6	$10	$13	$23	$37	$51	$53	$45	$37	$34
Jul	$43	$41	$39	$39	$39	$41	$41	$32	$29	$28	$29	$29	$30	$32	$37	$39	$42	$48	$72	$137	$89	$64	$54	$47
Aug	$38	$37	$35	$34	$35	$37	$38	$30	$21	$20	$21	$22	$23	$25	$28	$33	$37	$46	$68	$96	$60	$51	$45	$41
Sep	$38	$37	$36	$35	$35	$38	$40	$33	$16	$14	$14	$14	$15	$16	$18	$24	$32	$54	$87	$87	$56	$48	$44	$40
Oct	$44	$42	$41	$41	$42	$44	$49	$45	$25	$16	$15	$15	$16	$16	$17	$22	$33	$54	$68	$55	$53	$52	$49	$45
Nov	$42	$41	$41	$40	$42	$46	$47	$34	$13	$10	$9	$8	$7	$6	$9	$33	$49	$51	$50	$50	$50	$50	$48	$45
Dec	$44	$42	$41	$41	$43	$47	$49	$45	$31	$25	$24	$24	$22	$20	$23	$39	$50	$51	$51	$50	$50	$50	$49	$47

The CAISO resource mix continues to evolve as utilities across the State procure resources to meet statutory and voluntary clean energy goals and carbon reduction targets. However, the incidence of negative pricing in wholesale markets is expected to persist and is likely to increase in frequency as the State progresses toward its long-term decarbonization and clean energy targets. For utilities like PWP, consideration of these patterns when making procurement decisions is critical to maintaining affordability, as each incremental resource impact PWP's interactions with the wholesale market.

3.4 Transmission Interconnection

Currently, PWP maintains a single point of interconnection through which it can import power from CAISO through the TM Goodrich Receiving Station. This interconnection allows PWP to import generation from owned and contracted resources located outside of the City and access the broader CAISO wholesale market.

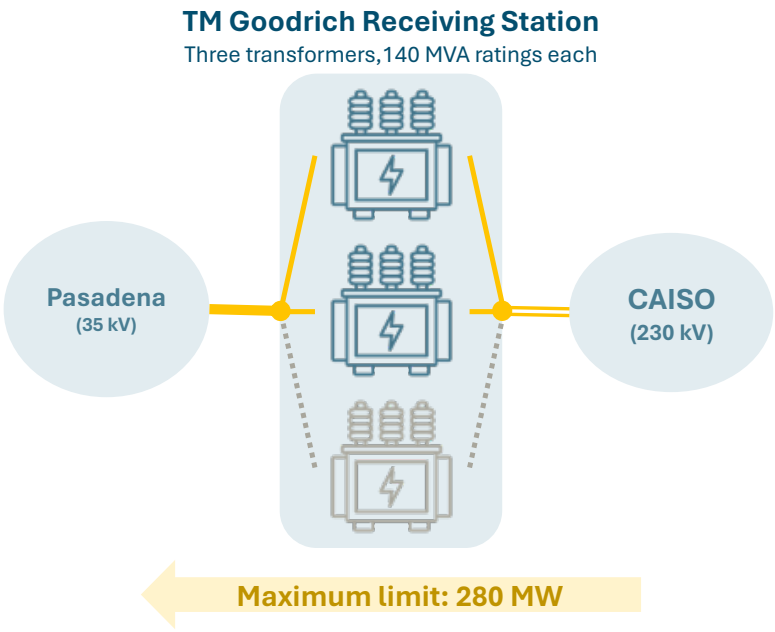


Figure 11. Representation of TM Goodrich under normal operating conditions

At TM Goodrich, power is received from SCE's transmission system at 230 kV where it flows through three step-down transformers, each rated 140 MVA, and is transmitted to PWP's 35 kV sub-transmission system. Under normal operations, PWP can import up to 280 MW through TM Goodrich. This reflects an "N-1" rating, where the receiving station cannot exceed the combined rating of two of the three transformers, allowing the system to remain in steady-state operation if one of the transformers were to fail. Derates to PWP's import capability can occur under multiple scenarios including a transformer failure at TM Goodrich, de-energized

SCE transmission line(s), and planned or emergency maintenance of TM Goodrich or the sub-transmission system.

The transformers at TM Goodrich were originally commissioned in the 1970s and will likely remain in service through the 2030s. As discussed further in Section 5.5, replacement, and potential upgrade, of the transformers at TM Goodrich has long-term implications for the future of PWP's electricity system, impacting the need for internal generation and the design and operations of the internal distribution system.

PWP is also connected to the LADWP sub-transmission network, but PWP cannot currently import power through this connection as the two electric systems are out of phase. PWP maintains this connection for "black start" capability in the event of an emergency where PWP's connection to CAISO is lost, but it cannot be used to regularly import power.

3.5 Sub-transmission and Distribution System

PWP's internal electrical distribution system consists of three receiving stations (TM Goodrich, Santa Anita, and Glenarm) and nine distribution substations. The 35 kV sub-transmission system forms a cross-town backbone that directly connects the TM Goodrich Receiving Station with Santa Anita (Path 1) and Glenarm (Path 2) and was originally installed in 1970. The distribution system utilizes a combination of overhead and underground 4 kV and 17 kV systems to deliver electricity to customers through the distribution substations.

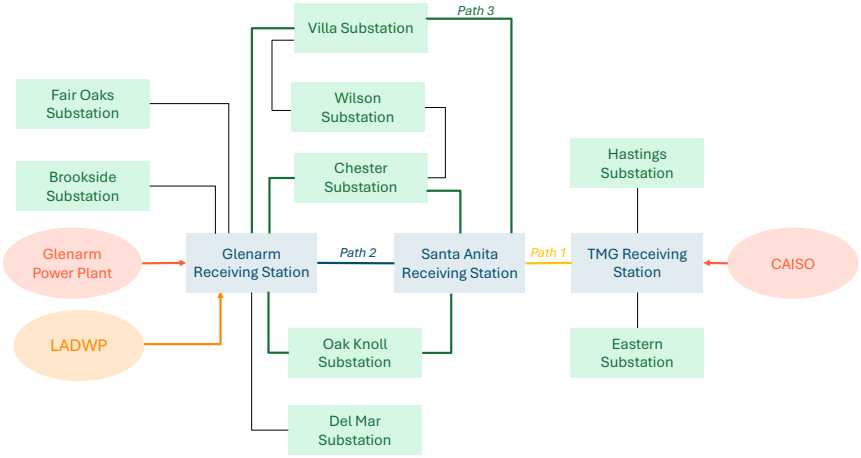


Figure 12. PWP sub-transmission system map

Replace and improve internal sub-transmission lines

The Power Delivery Master Plan (2022) identified the replacement and upgrade of internal sub-transmission and distribution lines as critical projects for maintaining and improving system reliability. These upgrades will enable us to expand import capability in the future, which will increase system reliability, reduce dependence upon internal generation (i.e. Glenarm), and allow access to a broader, more diverse set of carbon-free resources.

Currently, we are focused on upgrading the Path 3 lines to ensure that the grid remains reliable when we begin the larger Path 2 replacement. This preparatory work began a few years ago and is expected to be complete in fiscal year 2026. We have begun procuring new conductors and a labor contract to support the next phase of work on Path 2 upgrades. With anticipated load growth and increasing distributed energy resource adoption, upgrading our sub-transmission system, which is

currently is aging and undersized, is critical to providing safe and reliable service for customers during this transformative time.

Install advanced metering infrastructure

We are currently working on a multi-year initiative to replace existing customer meters with advanced metering infrastructure (AMI), which enables two-way communication between PWP and our customers. AMI will provide customers with greater control over their energy consumption and provide more detailed data on their usage. AMI is a foundational technology for enabling load flexibility through advance rate design (such as time-of-use rates), demand response (DR) programs, and managed EV programs. The OSP identified DR and managed EV charging as important carbon-free resources that can contribute to meeting our reliability needs. This multi-year initiative is expected to be completed by the beginning of 2028.

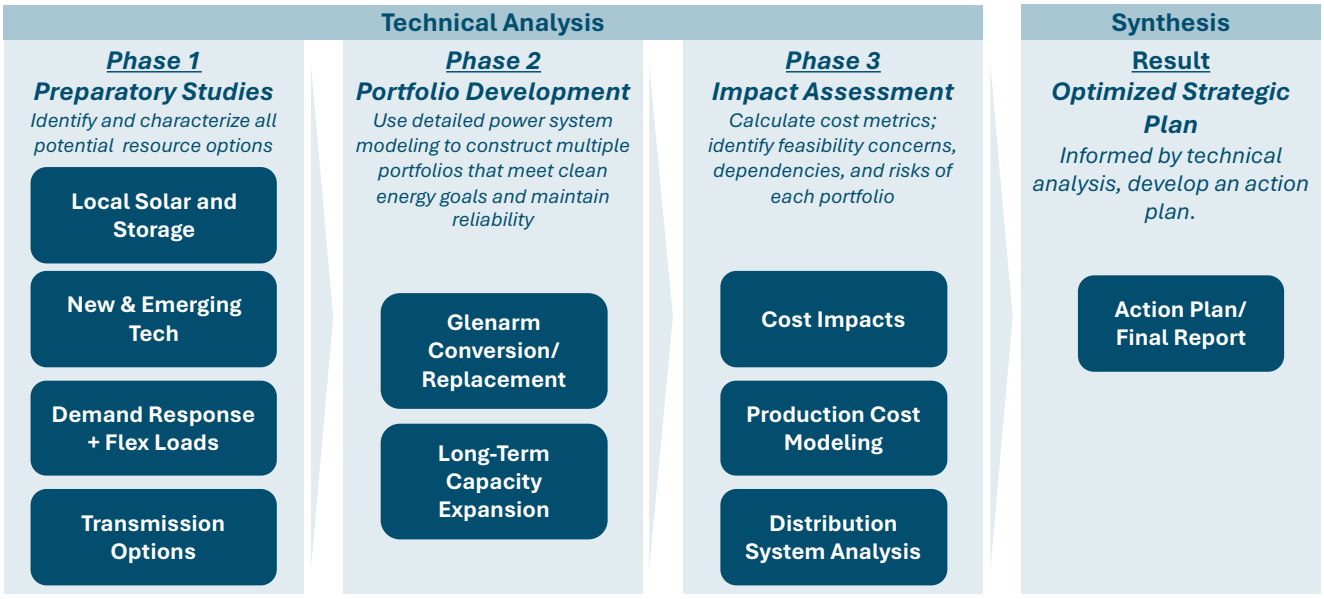
4 Study Process & Technical Findings

4.1 Scope of OSP Technical Studies

The OSP builds upon the City's existing plans established by PWP's 2023 IRP and 2022 PDMP. In accordance with a scope of work that was approved by City Council and received broad public endorsement, the OSP includes a series of comprehensive technical analyses designed to study all potential pathways to achieve the objectives of Resolution 9977. These analyses were conducted in three phases, illustrated in Figure 13:

1. **Preparatory studies:** a collection of four studies designed to identify the broadest set of potential technologies that could be leveraged by PWP in its efforts to meet Resolution 9977.
2. **Portfolio development:** a pair of studies in which complete portfolios of resources are constructed for a range of seven case studies to meet the Resolution 9977 goals while maintaining reliability and minimizing cost
3. **Impact assessments:** three detailed analyses to highlight the relative impacts of different case studies on PWP's clean energy metrics, costs of power supply, and distribution system.

Figure 13 OSP Scope of Work



Additional details on the purpose and key outcomes from each of the nine technical studies are provided in Table 13.

Table 13. Summary of technical studies conducted in support of the OSP

Phase	Study	Purpose & Key Outcomes
Preparatory Studies	Local Solar & Storage	• Quantify technical potential for local solar resources (rooftop, parking canopy, and ground mount) using detailed geospatial analysis • Develop cost and performance assumptions for local solar and storage using publicly available data sources and market intelligence. • Create forecasts of customer solar and storage adoption under different compensation structures using a Bass-diffusion model
	Demand Response & Flexible Loads	• Develop supply curve for "shed" and "shift" demand response in buildings by downscaling results from LBNL DR potential study • Create hourly demand profiles for "unmanaged" and "managed" electric vehicle charging using E3's RESHAPE-EV model used as a modifier to the load forecast
	New & Emerging Technologies	• Conduct technology survey to assess potential viability and suitability for emerging carbon-free technologies including mid- and long-duration energy storage and clean fuels • Characterize cost, performance, and resource potential assumptions for mature and emerging resources multiple, publicly available data sources and market intelligence. • Calculate projected PPA prices for new resources using fundamental cost projections and financial modeling using E3's RECOST model.
	Transmission Options	• Identify opportunities, challenges, and long-term considerations for expanding PWP's import capability based on previous studies. • Develop plausible timelines for transmission expansion options
Portfolio Development	Glenarm Conversion & Replacement	• Analyze options to replace Glenarm Power Plant with portfolios of local carbon-free resources while maintaining local reliability using E3's RECAP model for loss-of-load-probability analysis • Evaluate potential to convert Glenarm Power Plant to green hydrogen or an alternative clean fuel and develop a roadmap for conversion
	Long-Term Capacity Expansion	• Optimize resource portfolios across a range of case studies using PLEXOS LT for long-term capacity expansion modeling to identify potential options to meet Resolution 9977 goals and illustrate tradeoffs among technology options, balance of local and external resource investments
Impact Assessments	Hourly Resource Availability	• Conduct detailed hourly modeling for each case study to evaluate PWP's clean energy metrics, including (a) share of retail sales met by carbon-free energy, (b) share of total PWP owned & contracted generation supplied by carbon-free resources; and (c) share of hourly energy needs matched by carbon-free resources
	Cost Impacts	• Assess incremental cost on PWP's annual power supply cost for each case study relative to the least-cost reference case using the "Total System Cost" metric, representing the incremental cost of all new resources included in the portfolio net of the benefits that they provide
	Distribution System Impacts	• Develop geospatial forecasts of DER adoption under a range of scenarios • Calculate indicative cost ranges to upgrade the distribution system to accommodate DER growth

4.2 Case Studies

Overview of Case Studies

To provide Pasadena with a robust set of analyses to inform the OSP, E3 produced seven case studies exploring different options to meet 100% of energy needs with carbon-free resources by the end of 2030. By developing multiple case studies, E3 presented PWP and City Council with a range of possible pathways to achieve Resolution 9977 goals to inform the development of planning targets. No single resource portfolio constructed in this analysis is intended to represent a prescriptive resource portfolio at the end of 2030. Rather, the studies are intended to represent possible directions. Maintaining flexibility and adaptability will be critical to achieving all objectives of the Resolution. Pasadena may need to adapt to new technology developments, resource availability and cost, and customer preferences and attitudes. The 2026 and 2028 Waypoints will allow PWP to evaluate progress and adjust course relative to the OSP.

Each case study represents a portfolio of generation resources and demand-side measures that is optimized to minimize cost and meet reliability needs. Certain assumptions, including future customer energy demand, the characteristics of existing resources, import capability, and resource costs were held constant across case studies. The factors that distinguish the seven case studies from one another are summarized in Table 14 and are discussed in greater detail below.

Table 14 Summary of OSP case studies

Portfolio Type	Treatment of Glenarm	Technology Availability	Local Resource Portfolio
Designed to Meet 100% of *Hourly* Needs	Replaced	Mature Technologies Only	Glenarm Replacement (Solar and Battery)
		Mature Technologies + Long Duration Energy Storage	Glenarm Replacement (Solar, Battery, and LDES)
	Converted	Mature Technologies + Hydrogen	Minimum local resource requirement
	Reliability Backup	Mature Technologies Only	Accelerated Local Resources
			Accelerated Local Resources Plus
Designed to Meet 100% of *Annual* Needs	Reliability Backup	Mature Technologies Only	Accelerated Local Resources
			Accelerated Local Resources Plus

Hourly vs. annual matching: The OSP produced case studies to meet 100% of energy needs on an hourly and annual basis. The "hourly matching" cases, representing the most stringent interpretation of a 100% carbon-free target, require that PWP procure carbon-free energy to ensure a sufficient amount is available in any given hour to supply PWP's system load at that time. This would require PWP to eliminate all unspecified wholesale market purchases, meaning that all electricity serving the City would be sourced from specific carbon-free resources under contract to PWP in each hour. The

stringency of this target leads to excess carbon-free energy in many hours throughout the year. In the "annual matching" cases, short-term market transactions in the wholesale market are permitted if PWP has enough clean energy generation in its portfolio to serve load. This market flexibility would generally allow PWP to maintain a smaller portfolio of resources, due to the less stringent constraint on market interactions, and better optimize the value of its resources in the market, compared to the "hourly" case studies.

Technology Availability: Across all case studies, technologies classified as mature and commercially available were included as options; this included solar, wind, geothermal, lithium-ion battery storage, and a variety of demand-side measures. In addition to these options, select case studies examined the potential role of emerging technologies in supporting the City's transition, including green hydrogen (via the conversion of the Glenarm Power Plant) and long duration energy storage (with durations varying from ten to 100 hour). While it is uncertain when these emerging technologies may be available to PWP, these case studies were developed because a guiding principle of the OSP technical analyses was to explore all potential options to achieve 100% carbon-free energy.

Figure 14. Technology sets studied in OSP

Technology Sets	New Resource Options to Meet 2030 Goals					
Mature Technologies Only	Solar PV *(Distributed & Utility)*	Land-Based Wind	Geother-mal	Load Flexibility	Battery Storage	
Mature Technologies + Green Hydrogen	Solar PV *(Distributed & Utility)*	Land-Based Wind	Geother-mal	Load Flexibility	Battery Storage	Green Hydrogen (H_2) Conversion at Glenarm
Mature Technologies + Long-Duration Storage	Solar PV *(Distributed & Utility)*	Land-Based Wind	Geother-mal	Load Flexibility	Battery Storage	Long-Duration Energy Storage

Treatment of Glenarm: The seven cases captured three potential options for Glenarm: (1) that it would be replaced with a portfolio of local carbon-free resources capable of providing the same level of reliability as the system today (see discussion below); (2) that it would be converted to operate using green hydrogen as a fuel rather than natural gas; or (3) that it would remain in service as a reliability backstop, operated only when strictly needed to ensure local reliability or when called upon by CAISO to dispatch.

Local resource portfolio: Case studies also varied in the level of local carbon-free resources (including solar, battery storage, and demand-side load flexibility) included. Across the seven case studies, five different local resource portfolios were included. These sets of resources were

developed through a combination of (a) customer adoption forecasts developed in the Local Solar & Storage study and (b) detailed hourly modeling of the need for internal generation across a broad sample of weather conditions (over 10+ historical weather years) under normal and reduced import capability.

The portfolio development phase of the OSP consisted of two sequential studies leveraging advanced power system planning models to produce resource portfolios for each case study:

1. **Glenarm Replacement and Conversion:** Identified a range of local resource portfolios that could meet local reliability needs, given the limitations of the transmission system.
2. **Long-Term Capacity Expansion:** Created complete resource portfolios of local and external resources that optimize for the Resolution 9977 objectives of clean energy, reliability, affordability, and equity.

Local Resource Portfolio Modeling

In PWP's system today, local generation resources play an essential role in maintaining reliability due to the import constraint at TM Goodrich. The 200 MW Glenarm Power Plant ensures we can serve customer loads when demand reaches peaks in excess of the 280 MW import limit as well as when transmission and sub-transmission contingencies or system maintenance require that the intertie capacity be derated from its normal limit. In accordance with Resolution 9977's direction to consider reliability among other objectives, a wide range of options for local carbon-free resource portfolios are developed and tested for their ability to preserve the same level of local reliability as today's system.

The primary analysis used to create local resource portfolios that can ensure reliability while accounting for potential import constraints is loss-of-load-probability (LOLP) modeling, conducted using E3's RECAP model. LOLP modeling entails detailed hourly simulation of electricity demand and resource supply, typically on a stochastic basis across a range of weather years, to identify rare-but-consequential events where the demand for electricity may exceed available supply – a condition that would result in the need to shed load. This type of modeling is state-of-the-art, and it is widely used by utilities, regulators, and market operators across the country (including the California Public Utilities Commission (CPUC), which administers the resource adequacy program within the State of California) and has been recognized by thought leaders as best practice for robust planning as the resource mix evolves and the electric grid faces new stressors (for example, the Energy Systems Integration Group's *Redefining Resource Adequacy for Modern Power Systems*).

The OSP relies on a detailed representation of PWP's local system in LOLP modeling that incorporates the following components:

- Hourly profiles of electricity demand and solar production across a wide range of weather years (2006 to 2022);
- Characteristics of potential energy storage resources, including capacity, duration, and round-trip efficiency;
- Characteristics of each unit of the Glenarm Power Plant, including rated capacity and expected outage rates;

- Import limits at the TM Goodrich substation under "normal" (280 MW) and "contingency" (140 MW) conditions.

This modeling approach was used to develop sixteen different potential local resource portfolios, each a unique combination of local solar, storage, demand response, load flexibility, firm generation, and transmission upgrades. Four of these local resource portfolios were subsequently used directly in the creation of the case studies; in addition to the resources described below, all four local resource portfolios incorporated demand response, flexible loads, and managed electric vehicle charging.

1. **Minimum Local Resource Requirement:** A portfolio of local carbon-free resources that enables the PWP local system to preserve the same level of expected unserved energy under transmission or sub-transmission contingency conditions (i.e. when intertie capacity is derated by 50%) as today's system, accounting for load growth and assuming the Glenarm Power Plant remains in service.
2. **Accelerated Local Resources:** A portfolio of local carbon-free resources that is capable of serving electric demands that exceed 280 MW (the intertie limit under normal conditions), enabling the City to meet demand during peak conditions without necessarily operating Glenarm as required today.[9]
3. **Glenarm Replacement (Solar & Battery):** A portfolio of local carbon-free resources that enables the PWP local system to preserve the same level of expected unserved energy under transmission contingency conditions (i.e. when intertie capacity is derated by 50%) as today's system, assuming Glenarm is not available to generate.
4. **Glenarm Replacement (Solar, Battery & LDES):** A variation on the Glenarm Replacement portfolio described above (3) that incorporates emerging long duration storage technologies in addition to technologies that are commercially available today.

The composition of these four portfolios, as well as the "Accelerated Local Resources Plus" sensitivity case, is shown in Table 15 below.

[9] An "Accelerated Local Resources Plus" portfolio, which includes even larger quantities of local solar and storage, was also incorporated into the OSP case studies. The levels of solar and storage included in this portfolio were not a modeling result, but were instead specified exogenously to test the impact of further increasing local solar and storage development.

Table 15. Composition of local resource portfolios used in development of case studies

Portfolio	Total Local Solar	Total Local Storage	Portfolio Development Method
Minimum Local Resource Requirement	66 MW	26 MW	Minimum local resources needed for local reliability with Glenarm (plus naturally occurring adoption)
Accelerated Local Resources	81 MW	101 MW	Resources needed to meet peak loads when intertie capacity is at normal operating limit (280 MW)
Accelerated Local Resources Plus	130 MW	125 MW	Sensitivity analysis to investigate impacts of higher levels of local resources
Glenarm Replacement (Solar & Battery)	567 MW	319 MW	Resources needed to replace Glenarm while maintaining current level of local reliability
Glenarm Replacement (Solar, Battery, LDES)	396 MW	237 MW[1]	Resources needed to replace Glenarm while maintaining current level of local reliability (including LDES options)

1. The "Glenarm Replacement (Solar, Battery, LDES) portfolio includes a range of durations of storage technologies, including four-hour (25 MW), ten-hour (101 MW), and 100-hour (111 MW)

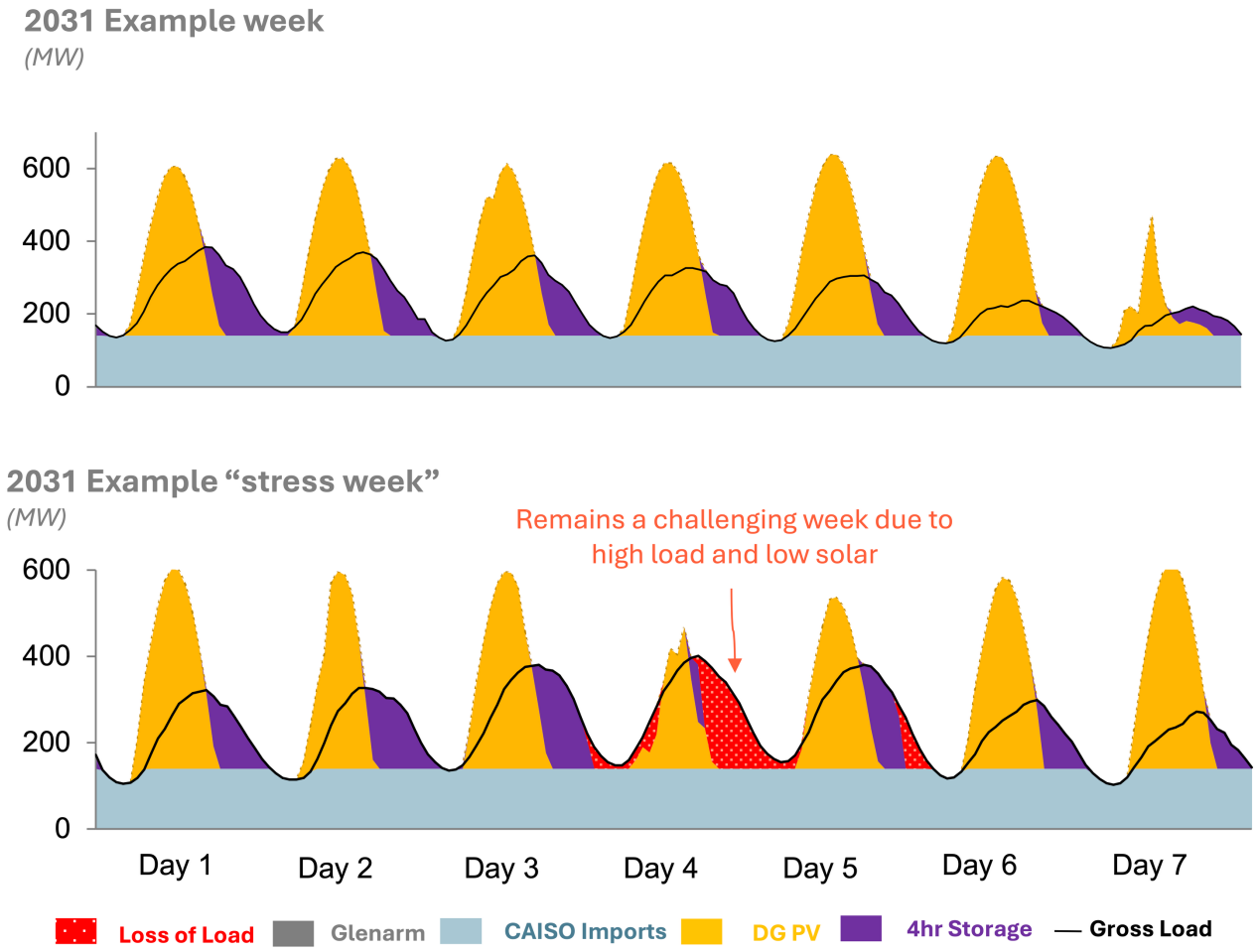
These results highlight a stark difference in the magnitude of local carbon-free resources needed to serve load during peak conditions when the CAISO intertie is at full capacity (as reflected in the "Accelerated Local Resources" portfolio) versus the local carbon-free resources needed to serve load reliably across all conditions, including potential transmission contingencies that could significantly reduce import capability.

The amount of additional solar (500+ MW) and storage (300+ MW) needed to ensure local reliability under peak and transmission contingencies is also much larger than the rated capacity of the Glenarm Power Plant (198 MW), an outcome that stems from differences in their capabilities and output profiles:

- Each unit at Glenarm, as a "firm" resource, can operate at full capacity for as long as needed, if it is not experiencing a forced outage;
- Solar resources only produce energy during daylight hours, vary in output across different seasons, and are subject to derates due to cloud cover, dirt, and high temperatures; and
- Storage resources have finite durations, meaning they can only be operated at full capacity for a fixed period of time before they must be recharged, and are also subject to forced outage risks.

To provide the same reliability value as a 200 MW firm resource, the solar and storage resources must be sized to account for the following dynamics: the solar resource must be capable of simultaneously (a) serving loads during daylight hours and (b) recharging storage resources, and the storage resource must be able to serve loads from sunset to sunrise – a span lasting much longer than the four hours at which commercially available battery systems are rated.

Figure 15. Hourly availability of solar and storage Glenarm replacement portfolios during contingency conditions



Portfolio Optimization

To develop portfolios that meet these criteria, the OSP uses long-term capacity expansion (LTCE) model to develop complete resource portfolios including local and external resources. These portfolios were optimized to meet system needs while minimizing costs, subject to constraints including hourly power balance, plant-specific operation limitations (e.g. maximum power for thermal resources, hourly availability for renewables), carbon-free targets, and resource adequacy requirements. E3 used PLEXOS, an industry-standard LTCE model produced by Energy Exemplar, to conduct this analysis. PLEXOS offers similar functionality to EnCompass, the primary model used in PWP's 2023 IRP.

To develop a broad set of case studies, E3 varied two key constraints in the LTCE model: the minimum local resource builds and the level of market interactions. Each case study included a minimum build requirement for local resource, summarized in the Table 15. The LTCE model uses mathematical optimization to select a least-cost portfolio of additional resources - local and external - to fulfill system needs and clean energy requirements.

While the case studies presented represent multiple potential pathways to achieve the objectives of Resolution 9977, it is important to note that these are not the only possible resource portfolios that would enable us to achieve our goals. Real world, market conditions will determine the amount of any resource that can be procured, and PWP will maintain flexibility to adapt to these conditions. There are a wide range of resource portfolios that would ultimately allow PWP to meet the carbon-free goal, and they may not match exactly with the portfolios developed through this planning exercise.

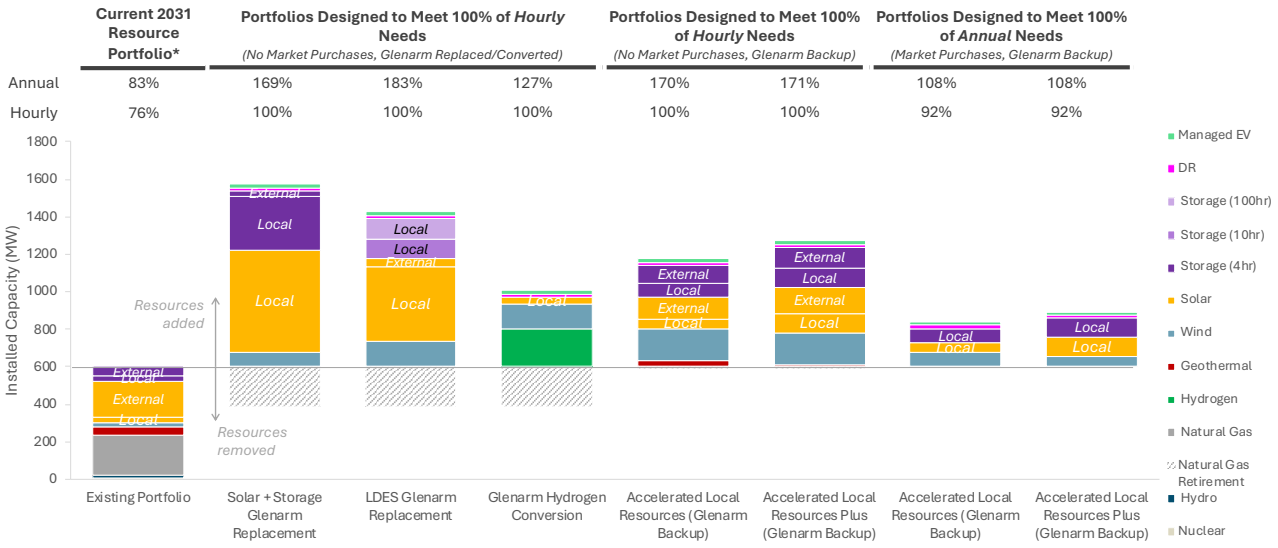
Figure 16 shows the differences in installed capacity[10] by resource type relative to PWP's existing portfolio for each of the seven case studies. The first five case studies are portfolios designed to meet PWP's energy needs with carbon-free resources in each hour of the year; the sixth and seventh case studies are portfolios designed to ensure PWP's portfolio produces enough carbon-free energy over the course of the year to meet annual electricity demands.

- **Case Studies 1 and 2**, in which Glenarm is replaced with carbon-free alternatives, each require very large quantities of local solar and storage to maintain local reliability during transmission contingency conditions. These local resources alone are not sufficient to ensure availability of carbon-free generation in each hour to meet PWP's needs; additional wind resources external to the PWP system provide additional energy outside of daylight hours to achieve this outcome.
- In **Case Study 3**, Glenarm is converted to green hydrogen fuel. This provides PWP with a "clean firm" resource that can be dispatched to fill gaps, contribute to resource adequacy needs, and support local reliability. In this portfolio, the quantity of additional renewables and storage needed is significantly smaller than Case Studies 1 and 2, as the hydrogen-fueled Glenarm plant is able to dispatch as a carbon-free resource when needed to fill gaps in the existing portfolio.
- **Case Studies 4 and 5** include Glenarm as a backup resource for reliability, negating the need for extreme buildouts of local carbon-free resources. In these portfolios, diverse combinations of local and external renewable and storage additions allow PWP to meet hourly energy needs with carbon-free resources and avoid utilization of Glenarm under a typical weather year and normal operating conditions (i.e. when TM Goodrich is available at full capacity). In comparison to Case Studies 1 and 2, these portfolios more effectively leverage the diversity of external resource options at larger scale to complement local solar and storage development.
- **Case Studies 6 and 7** also include Glenarm as a backup resource. The key distinction between these portfolios and the prior two (Case Studies 4 and 5) is the difference between annual and hourly matching: because Case Studies 6 and 7 include resources sufficient to meet PWP's annual energy needs, they require lower amounts of new capacity and allow PWP to leverage participation in the CAISO wholesale market to balance loads and resources on

[10] "Installed capacity" represents the size, or maximum output, of a power plant. This is different from its annual generation (how much energy it produces over the course of the year, which depends on how frequently and at what level of output it operates). The annual generation by resource type across the case studies, which corresponds to the reporting on the Power Content Label and is directly related to the absolute quantity of greenhouse gas emissions, is discussed below.

an hour-to-hour basis. These portfolios achieve 92% hourly matching with of PWP's load with carbon-free resources.

Figure 16. Installed capacity by technology for OSP case studies in 2031

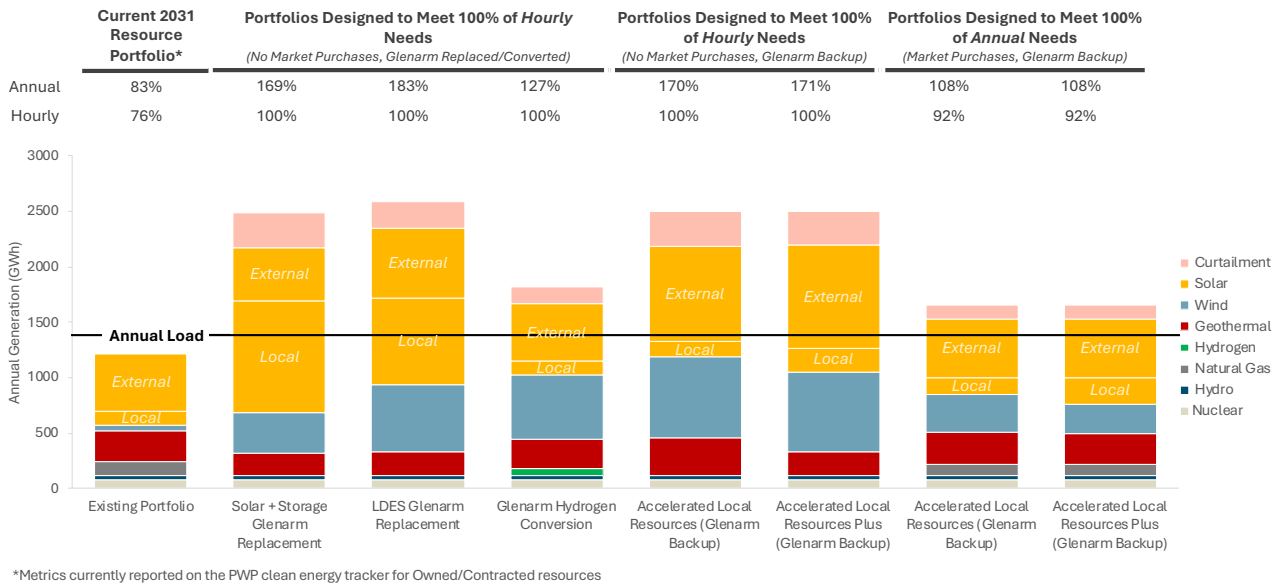


*Metrics reported on the PWP clean energy tracker for Owned/Contracted resources

The figure below compares the annual energy generation by resource type for each of the seven case studies.

- All portfolios designed to meet 100% of hourly energy needs (1-5) with carbon-free resources result in a large excess of carbon-free energy in PWP's portfolio, reflected in the figure where the stacked bars exceed the annual load. This dynamic is what drives results for the annual matching metric to range from 127% to 183%, significantly higher than California's 2045 100% Clean Electricity Standard requirement. The excess energy in these portfolios would either be sold in the wholesale energy market, making the cost impacts of these portfolios heavily dependent upon market conditions.
- In contrast, portfolios designed to meet 100% of annual needs (6-7) result in a balanced portfolio, where the amount of energy produced by carbon-free resources under contract to PWP aligns closely with its annual load. These portfolios do not include sufficient carbon-free resources to match loads in every hour, but deficits that occur during certain constrained periods of the year are offset by carbon-free surpluses in others. In other words, the amount of carbon-free electricity delivered to the CAISO system by PWP-contracted resources over the course of the year is the same as the amount of energy withdrawn from it.

Figure 17 Annual energy generation by technology for OSP case studies in 2031



*Metrics currently reported on the PWP clean energy tracker for Owned/Contracted resources

Cost Impacts Analysis

Cost impacts for each case study were evaluated as the change in total system cost in 2031 relative to a least-cost portfolio meeting 100% of PWP's annual energy needs. This metric reflects costs that are *incremental* to the existing system and captures the costs of the additional resources and the offsetting benefits that they provide to ratepayers:

- All-in costs for incremental resources, including capital, fixed and variable operations and maintenance, financing costs, and applicable tax credits[11,12];
- Changes to fixed and variable operations and maintenance (O&M) and fuel costs for existing utility-owned generation[13]
- Changes to wholesale market purchase costs (and revenues from off-system sales)[14]

[11] Resource costs were developed by E3 using its in-house discounted cash flow model, RECOST. Cost assumptions were developed based upon many publicly available studies released by national labs, utilities, research intuitions, and consultants as well as market intelligence gleaned from public filings and applications and E3's experience working with developers. More information on RECOST can be found in the OSP New and Emerging Technology technical appendix.

[12] Cost assumptions for this modeling were developed prior to the passage of the OBBBA which terminated tax credits for many clean energy resources that were assumed to be available during the OSP analysis. There have also been significant changes in federal trade policy since the development of these assumptions which impacts the cost of new resources.

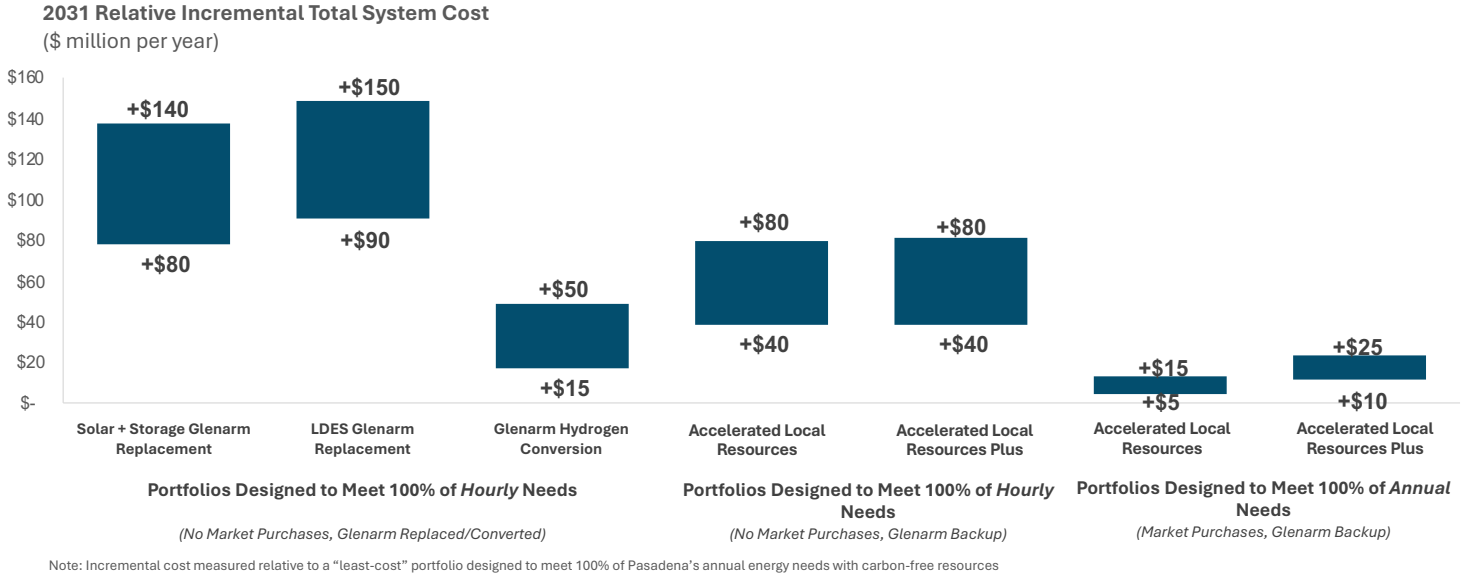
[13] Fixed and variable O&M cost assumptions for existing utility-owned generation for this analysis were provided by PWP and are aligned with assumptions used in the ERS.

[14] The CAISO market was represented based on E3's wholesale market price forecast developed using a fundamentals-based simulation approach. E3's market price forecasts are widely used by utilities and developers to support planning functions, asset transactions and diligences, and market assessments.

- Changes to the CAISO transmission access charge[15]

Costs are shown *relative* to a least-cost portfolio designed to meet 100% of PWP's annual energy needs with clean energy by 2031. These metrics were developed to highlight tradeoffs among case studies. These costs were used as an input into the PWP electric financial model to examine the impact of these case studies on revenue requirements and were presented to City Council as a part of the ongoing electric rate study.

The relative incremental total system costs of each of these case studies are summarized in the figure below. Portfolios retiring Glenarm are the most expensive due to the large scale of resource needs and the relatively high cost of distributed local resources compared to utility-scale alternatives. Portfolios retaining Glenarm while meeting hourly needs have lower costs but still increase PWP's power supply costs relative to today. The portfolios designed to meet 100% of PWP's annual energy needs are the lowest cost and show a much smaller range of uncertainty, driven primarily by the lower procurement cost for new resources.



Note: Incremental cost measured relative to a "least-cost" portfolio designed to meet 100% of Pasadena's annual energy needs with carbon-free resources

Figure 18 2031 relative incremental total system cost for OSP case studies

Other Considerations

In addition to the costs of each portfolio, E3 assessed each portfolio on several qualitative dimensions:

1. **Local Siting & Land Availability:** How feasible is the development of local resources in the case study when considering available land and rooftop area within the City?
2. **Technology Readiness:** To what extent does the case study rely on technologies that are mature and commercially available today?

[15] California ISO, Transmission access charge forecast model, https://www.caiso.com/library/transmission-access-charge-forecast-model

3. **Upstream Infrastructure Need:** Does the case study depend on the development of new infrastructure outside of PWP's service territory and beyond PWP's control?
4. **Wholesale Market Exposure:** To what extent are cost impacts of each case study dependent upon revenues from off-system sales to the CAISO market?
5. **Resource Adequacy Risk:** How robust is the case study relative to future changes in resource adequacy requirements and conventions?
6. **Local Resilience:** How will the resources in the case study impact the resilience of the local PWP system?
7. **Long-Term Optionality:** How well does the case study position PWP to take advantage of future opportunities beyond 2031, including emerging technologies and transmission?

The table below summarizes other considerations associated with each of the portfolios. Portfolios that replace Glenarm with local carbon-free resources have significant local siting and land availability challenges, as the quantity of local solar required in those portfolios strains the technical potential in the City. It should be noted that the "Accelerated Resources Plus" portfolios may face similar challenges, as they require PWP to significantly supplement naturally occurring customer adoption and identify viable rooftops and parking lots for development. Portfolios leveraging emerging technologies such as long-duration energy storage and hydrogen conversion introduce technology readiness risks, and hydrogen conversion at Glenarm in particular depends on upstream infrastructure that lies outside PWP's control.

Portfolios that meet 100% of PWP's hourly energy needs with carbon-free generation have significant wholesale market exposure because they require a significant amount of sales at wholesale market prices, due to the large surplus of energy required to meet the most constrained and challenging conditions. Portfolios that retain Glenarm generally face lower resource adequacy risk than portfolios that replace Glenarm with solar and storage, which may be subject to declining resource adequacy accreditation in the future. Portfolios with Glenarm are also likely to provide more local resiliency, and portfolios that accelerate local carbon-free resource development have additional resiliency benefits. Retaining Glenarm as a backup gives PWP the opportunity to identify a viable replacement option. Additionally, 100% annual matching provides more flexibility to add resources as load grows without increases in market risk.

Figure 19 Other considerations for OSP case studies

	Portfolios Designed to Meet 100% of *Hourly* Needs (No Market Purchases, Glenarm Replaced/Converted)			Portfolios Designed to Meet 100% of *Hourly* Needs (No Market Purchases, Glenarm Backup,)		Portfolios Designed to Meet 100% of *Annual* Needs (Market Purchases, Glenarm Backup)	
	Solar-Storage Replacement	LDES Replacement	Hydrogen Conversion	Accel Local Resources	Accel Local Resources Plus	Accel Local Resources	Accel Local Resources Plus
Other Considerations	Higher risk				Lower risk		
Local Resource Siting							
Technology Readiness							
Upstream H_2 Infrastructure							
Wholesale Market Exposure							
Resource Adequacy Risk							
Local Resilience							
Long-Term Optionality							

4.3 Key Findings

The technical studies conducted in the OSP provide useful insights and support a number of findings that help to shape the City's plan. These include:

A wide range of technologies, mature and emerging, can support Pasadena's clean energy goals. The OSP analyses highlight the wide range of technologies capable of contributing to meeting Pasadena's clean energy goals. Mature technologies such as local solar and storage, demand-side flexibility, and external renewables and storage play important roles in PWP's future resource portfolios across all case studies. Emerging technologies, including long-duration storage and hydrogen, may also provide technical solutions to fill gaps in PWP's portfolio if they reach commercial readiness.

All options to fully replace Glenarm by the end of 2030 face prohibitive feasibility challenges due to a combination of siting challenges, cost, and technology maturity. The OSP case studies explored a wide range of options to eliminate natural gas combustion at Glenarm by the end of 2030 while maintaining local reliability, but each of these case studies faces at least one practical prohibitive barrier to implementation. Due to the constraints on the transmission system, maintaining internal generation in 2031 is necessary for reliability. To fully replace Glenarm as a resource for reliability, large portfolios of local solar and storage would be needed that would be impractical to site and build in a distributed manner across the City. Leveraging long-duration storage or hydrogen to reduce the need for local solar would come with technology readiness risk, as those technologies are unlikely to reach maturity by 2031.

Through a combination of accelerated development of local carbon-free resources and procurement of utility-scale renewables and storage, PWP can meet 100% of hourly or annual needs with carbon-free resources under normal operating conditions while preserving the Glenarm Power Plant as a reliability backstop. In such a portfolio, each component supports the objectives of Resolution 9977. Utility-scale resource procurement provides the lowest-cost option to increase carbon-free energy in PWP's portfolio to address remaining gaps in the portfolio. Meanwhile, by developing a portfolio of local solar, storage, and innovative customer programs, PWP can reduce its reliance on the Glenarm Power Plant during peak periods when imports from CAISO have reached their limits. At the same time, preserving Glenarm as a backstop for reliability ensures that the City will have sufficient local resources to maintain reliability when intertie capacity is reduced during system maintenance or in the event of a severe transmission or distribution contingency. Together, these steps lead to portfolios that are technically feasible, result in considerably lower costs to the City than the Glenarm replacement options considered, and improve local reliability and resilience.

"Hourly" and "annual" matching procurement strategies lead to dramatic differences in procurement needs, with significant implications for cost and market risk. Meeting 100% of PWP's annual energy needs with carbon-free resources means that on average, over the course of the year, production from PWP's carbon-free resources is equal to its load; the OSP analyses indicate that approximately 220 MW of additional resources can satisfy this need and meeting 92% of PWP's energy needs on an hourly basis. This would result in a "balanced" position in the wholesale market, where purchases in some periods are offset by sales of surplus carbon-free electricity in others,

inherently limiting PWP's exposure to wholesale market conditions. In contrast, meeting 100% of PWP's hourly needs requires a portfolio of carbon-free resources that generate enough to serve loads under the most constrained conditions (i.e. when renewable output is lowest and/or load is highest). This necessarily requires "over-procurement" — that is, the amount of energy produced by PWP's portfolio over the course of the year would be higher than customer demands by as much as 70% (i.e. over the course of the year, PWP's portfolio of carbon-free resources could generate enough electricity to supply 170% of PWP's annual loads). That excess energy would either be sold into the CAISO wholesale market – likely at a price lower than what PWP would pay for it under long-term contract – or curtailed. This dynamic is the primary reason that hourly matching portfolios result in an estimated $30-60 million of increased costs per year for PWP customers each year relative to annual matching portfolios.

These key findings, rooted in detailed technical analysis of the electric system and specific to the City's needs and objectives, are also consistent with the general findings from an increasingly extensive body of literature on the decarbonization of the electricity system. These general findings and the studies that support them are summarized in the box below and corroborate the conclusions reached in the technical studies.

Summary of Literature Review: Decarbonization of the Electric Sector

Over the past decade, the question of what is needed to decarbonize the electricity system has been studied by a wide range of entities, including utilities, research laboratories, and academic institutions.

- Getting to Zero Carbon Emissions in the Electric Power Sector (Jenkins et al, 2018).
- The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation (Sepulveda et al, 2018)
- Long-Run Resource Adequacy under Deep Decarbonization Pathways for California (E3, 2019)
- Zero Carbon Plan (Sacramento Municipal Utilities District, 2020)
- LA100: The Los Angeles 100% Renewable Energy Study (LADWP and NREL, 2021)
- Net Zero America (Princeton University, 2021)
- Achieving 24/7 Renewable Energy by 2025 (Peninsula Clean Energy, 2023)

Despite differences in scope and methodology, the collection of studies cited here provide results that are consistent with the following three findings regarding the decarbonization of the electric sector:

1. Clean technologies that are readily available today can be scaled to high penetrations to enable deep reductions in electric sector emissions at relatively modest costs.
2. Ensuring reliability even under the most extreme events requires some form of "firm" capacity to complement variable (e.g. solar and wind) and energy-limited resources (e.g. storage, hydro)
3. Absent a breakthrough in clean firm technology, reducing electric sector emissions to zero requires investments at a scale that results in significant increases in costs that are likely prohibitive.

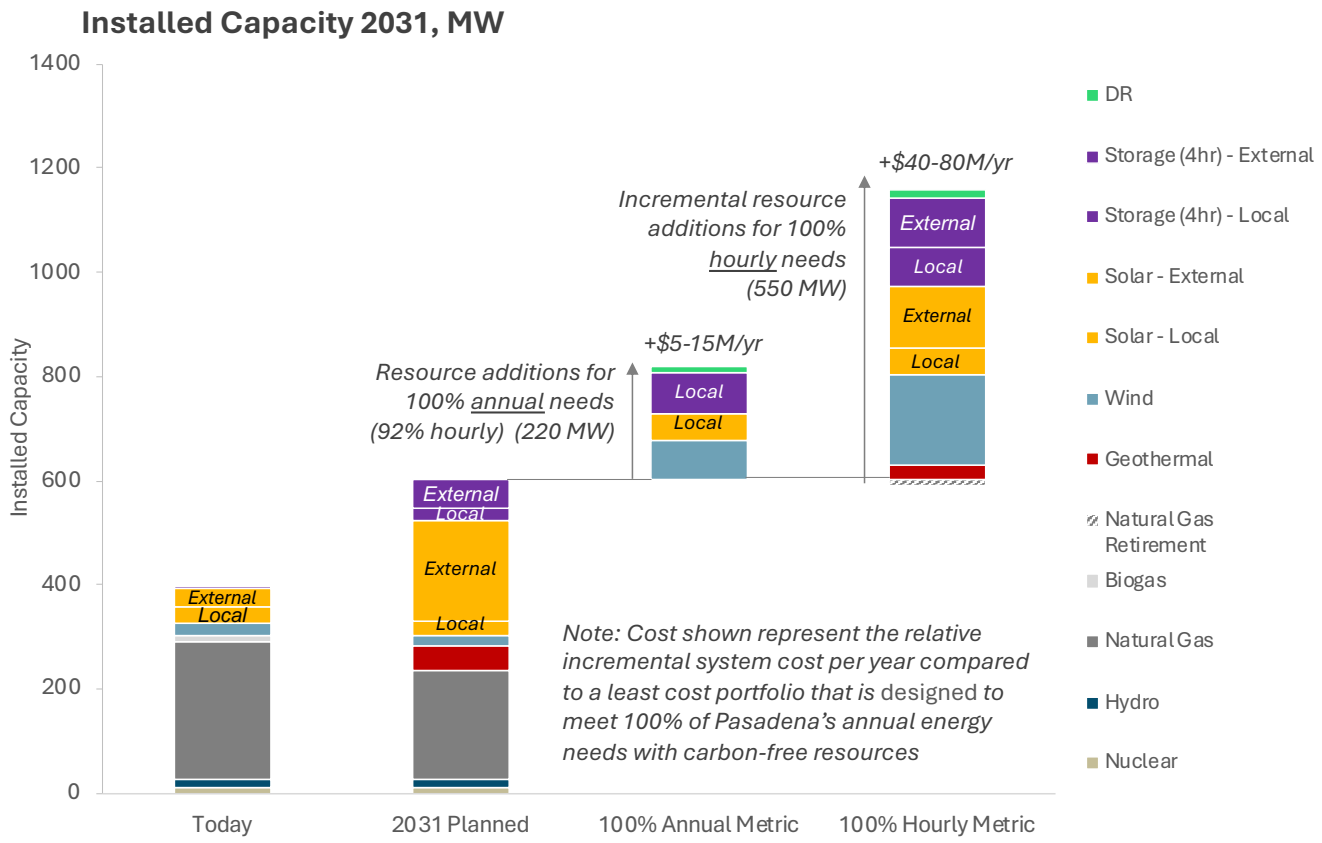
These general conclusions are consistent with the findings of the technical studies conducted in support of the OSP, which contributes an additional perspective to the growing body of literature of electric sector decarbonization studies.

4.4 City Council Direction and a Path Forward

At its June 24, 2025, meeting, the Municipal Services Committee directed PWP to pursue the goal of developing a portfolio that (1) can meet 100% of Pasadena's energy needs with carbon-free resources on an hourly basis, (2) accelerates local resource development, and (3) retains Glenarm as a backup resource to ensure reliability. This direction is aligned with the OSP case study of "100% Hourly Matching, Accelerated Local Resources." As illustrated in the figure below, achieving this goal

will require PWP to procure approximately 550 MW of new renewable and storage resources beyond what is currently contracted to be online by the end of 2030.[16]

Figure 20 Installed capacity for 100% annual matching and 100% hourly matching accelerated local resource portfolios



Resolution 9977 is one of the most ambitious decarbonization goals in the nation and will require an action plan that is living and dynamic. A plan to achieve this outcome must enable PWP to continue to progress toward the carbon-free goal while also evolving in response to technology advancements, shifts in the market, and changes in the state and federal policy landscapes. The Waypoint framework is intended to provide "guardrails" to track the progress toward the hourly carbon-free goal, monitor rate impacts, and preserve long-term optionality and flexibility.

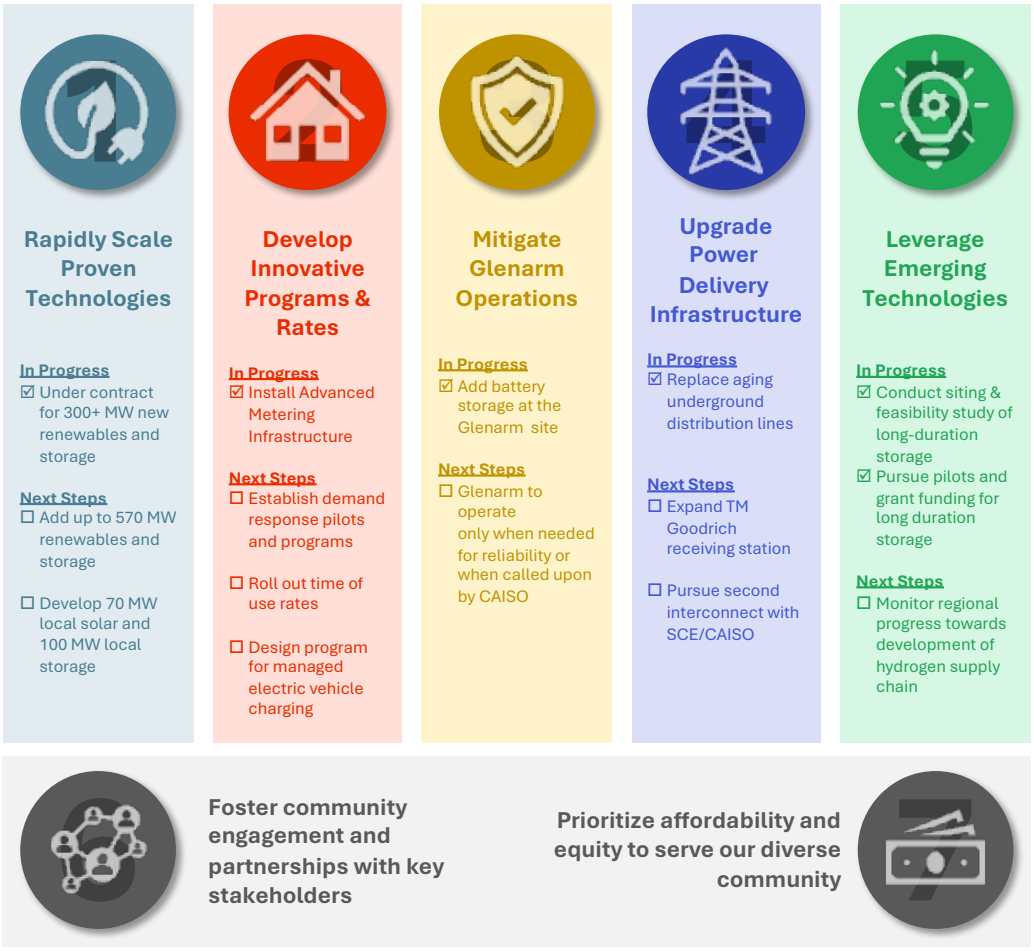
[16] Note that at the MSC meeting on November 5, 2025, the MSC directed PWP to establish a planning target for local solar of 70 MW, which is 20 MW greater than the amount of local solar modeled in the 100% Hourly Matching, Accelerated Local Resources case study.

5 Pillars of the Plan for Carbon-Free Electricity

Based on the results of the case studies, direction from City Council, and our own knowledge of our system and experience with our community, PWP has developed plans for the necessary actions that will allow us to meet our goals by the end of 2030 and beyond. These include:

- Rapidly Scale Proven Carbon-Free Technologies
  - Procure Additional Large-Scale Renewables & Storage (Section 5.1)
  - Accelerate Local Solar & Storage Development (Section 5.2)
- Develop innovative programs and rates to leverage customer-facing solutions (Section 5.3)
- Mitigate Glenarm operations, using it as a "reliability backstop" until another solution is available (Section 5.4)
- Upgrade Power Delivery Infrastructure to improve reliability, relieve import constraints, and enhance demand side innovation (Section 5.5)
- Monitor and encourage emerging technologies to expand options (Section 5.6)

Figure 21. Pillars of the OSP



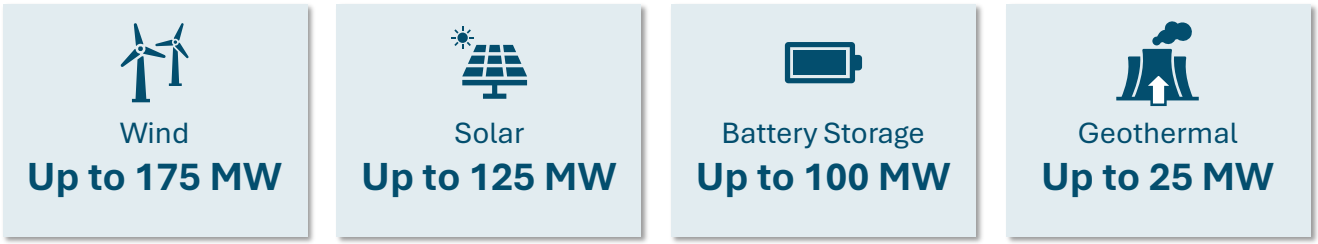
These strategies, and the necessary supporting activities that enable their execution, have been developed through careful consideration of corresponding opportunities and challenges.

5.1 Procure Additional Large-Scale Renewables & Storage

Growing utility-scale renewable and storage resources that are commercially available today is one of the backbones of PWP's plans to meet Resolution 9977 goals. Across all case studies, these resources represent the large majority of carbon-free energy added to PWP's current portfolio between today and the end of 2030 (between 60-90% of incremental resource additions by energy), and procurement of these types of resources offer the lowest cost, most scalable options available to PWP to increase carbon-free generation of electricity. These resources include solar PV, battery storage, wind, and geothermal.

Based on the results of the case studies, PWP has established planning targets for each of these technologies. The specific level of each resource added to the portfolio will depend upon a range of factors.

Figure 22. Planning targets for new renewables & storage resources by end of 2030



Insights from Portfolio Analysis

The technical analyses conducted in support of the OSP reached several notable conclusions regarding the role of utility-scale renewables and storage that directly influence PWP's action plan.

Procurement of utility-scale renewables and storage provides the most cost-effective pathway to increase PWP's clean energy metrics. Renewable and storage resources developed outside of the City are lower cost than those that can be developed within the City due to several factors: economies of scale for larger projects, cheaper cost of land, and higher capacity factors for renewable resources. While there is some avoided transmission and distribution cost with local generation, data shows that the economics favor external generation even with the associated transmission costs. Across all case studies, the resources selected through long-term capacity expansion modeling – which uses mathematical optimization to identify the least-cost combination of resources to meet clean energy and reliability needs – were utility-scale renewables and storage outside of the City. Further, cases with higher quantities of local resources included for reliability-related reasons resulted in higher costs – in some cases significantly so – than those with higher quantities of external resources.

Resource diversification plays an important role in the City's transition to a carbon-free portfolio. Across the OSP case studies, optimized portfolios leveraged a range of commercially

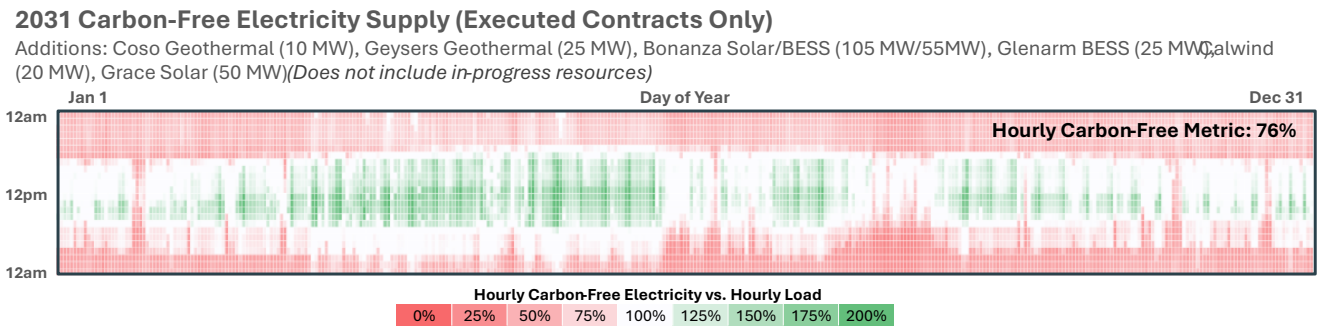
available technologies to meet the City's goals at least cost. There are specific considerations that will impact the scale, timing, and availability with which each can be developed:

- **Solar PV**, a lower-cost source of daytime energy. It has emerged over the past decade as the most scalable renewable resource in California due to its cost and siting flexibility: between 2010 and 2025, over 15 GW of utility-scale solar resources have been developed in the State of California. The relative low-cost and scalability of solar must be balanced against the potential for oversupply; at higher penetrations, the abundance of solar energy during daylight hours can exceed the needs of the grid, requiring either (a) curtailment of solar or (b) investments in additional storage resources to hedge against market volatility.
- **Battery storage**, a powerful tool to shift energy from periods of relative abundance to scarcity – and in so doing, supports renewable integration and grid reliability. A decade ago, the prospect of grid-scale storage appeared elusive, but rapid technological advancement has brough lithium-ion battery storage and a range of other chemistries to the market: over 10 GW are operational in California today.
- **Wind**, an energy resource whose output varies hour to hour and day to day with less predictable cycles – but often in patterns that are complementary to solar (e.g. higher in evenings and overnight). While remaining in-state wind resources are limited in potential and generally of lower quality, higher quality resources under development in other Western states (Wyoming, New Mexico) may present opportunities – though the availability and timing of these options is inherently linked to interregional transmission projects needed to deliver these resources to California.
- **Geothermal**, an energy resource with a stable, baseload output profile around the clock – and as such, the only practical option for a "clean, firm" renewable resource that is commercially available today. Despite the high value that a baseload resource provides, geothermal resources are likely to be limited by constraints on resource potential, relatively higher costs, and long lead times for development.

The importance of technological diversity in PWP's transition to a carbon-free portfolio is driven by two factors:

1. Across the California grid, oversupply, renewable curtailment, and negative pricing are increasingly frequent phenomena in CAISO during high solar output hours – particularly in the spring.
2. Between existing customer solar resources and utility-scale solar resources under contract, PWP's portfolio will already produce sufficient carbon-free energy to meet hourly electric demands during the daytime throughout much of the year. The times when PWP's existing portfolio of carbon-free resources will be insufficient to meet hourly needs are typically overnight periods when solar is not available (see Figure 23).

Figure 23. Hourly balance of carbon free energy in 2031 based on currently executed contracts



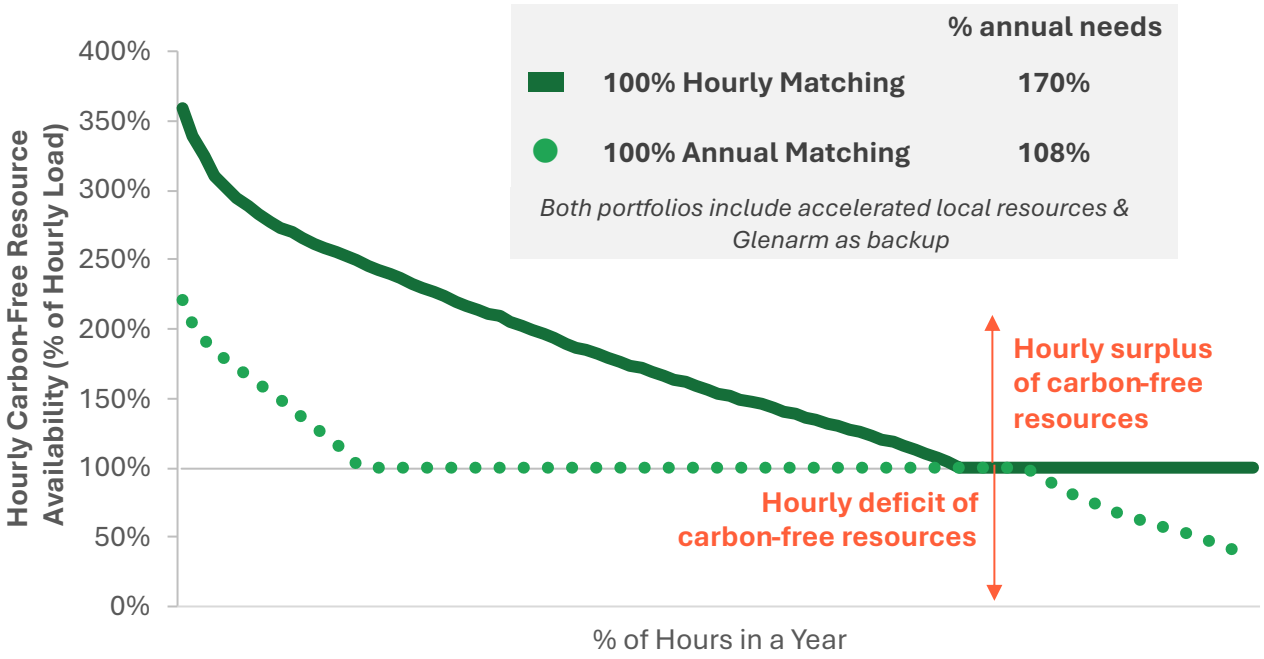
For these reasons, resources that can either produce or shift electricity supply to periods outside of daylight hours are important components of PWP's plan to meet Resolution 9977 goals.

"Annual" and "hourly" matching of carbon-free resources lead to dramatic differences in procurement of carbon-free resources and portfolio impacts. To meet 100% of PWP's annual energy needs with carbon-free resources would require the addition of approximately 220 MW of resources beyond those already anticipated to be operational by the end of 2030. With this portfolio, PWP would have some hours in which it purchases power from the market which are offset by sales of surplus carbon-free electricity in others. Eliminating all market purchases to meet 100% of PWP's hourly energy needs, would require a portfolio of approximately 375 MW of renewable resources and 175 MW of storage that can generate enough electricity to serve loads under the most constrained conditions (i.e. when renewable output is lowest and/or load is highest). This necessarily requires over-procurement – that is, the amount of energy produced by PWP's portfolio over the course of the year would be higher than customer demands by as much as 70% (i.e. over the course of the year, PWP's portfolio of carbon-free resources could generate enough electricity to supply 170% of PWP's annual loads). This contrast is illustrated in Figure 24, which shows duration curves of hourly carbon free energy availability for hourly and annual portfolios:

- 100% annual matching results in a portfolio where loads and carbon free resources can be balanced most hours of the year; in a small share of hours (<10%), carbon-free generation is lower than load, offset by a similar small share (<10%) in which carbon-free generation is above load.
- 100% hourly matching ensures that at least 100% of energy in each hour can be provided by carbon-free energy, resulting in a dynamic where the majority of hours (80%) exhibit some surplus.

Hourly matching portfolios result in much larger sales to the wholesale market, exposing PWP to higher levels of risk associated with the revenues from those sales (discussed further in Financial Exposure to Wholesale Market Conditions and Implications for Risk Management).

Figure 24. Duration curves for carbon-free energy availability under hourly and annual matching accounting constructs



Implications for Magnolia Power Project

PWP must maintain a portfolio of resources capable of meeting resource adequacy requirements within CAISO, and PWP's ownership share of the Magnolia Power Project (18 MW) currently contributes to that requirement. The planning targets for utility-scale renewables and energy storage are sized in a manner that would allow PWP to meet its resource adequacy requirement without the need for Magnolia's capacity. The potential for an early exit from the Magnolia Power Project is therefore dependent upon PWP's success in procuring carbon-free resources at this scale. If the resource adequacy capacity from Magnolia is no longer needed, the potential for an early exit from the plant becomes a commercial matter. PWP intends to explore multiple commercial arrangements that could allow for an early exit, including renegotiation of the current agreement, sale of PWP's ownership interest, and contracting with a third party for the energy and capacity provided by the plant. Whether any of these options present feasible and attractive alternatives to selling the surplus electricity generated by Magnolia into the short-term market until the current agreement terminates in 2036 will depend on counterparties' willingness to negotiate with PWP and the terms of such negotiations.

Contracting Mechanisms & Procurement Processes

Like most utilities, PWP procures renewable and storage resources using PPAs with third parties – contracts through which PWP purchases the energy, capacity, and environmental attributes from a specific power plant at a prescribed long-term price. Most PPAs in PWP's portfolio today have been procured through SCPPA, often sharing the offtake with other municipal utilities in Southern California. Going forward, PWP anticipates that conducting independent competitive solicitations – in addition to continuing to leverage SCPPA membership for procurement – will be necessary to

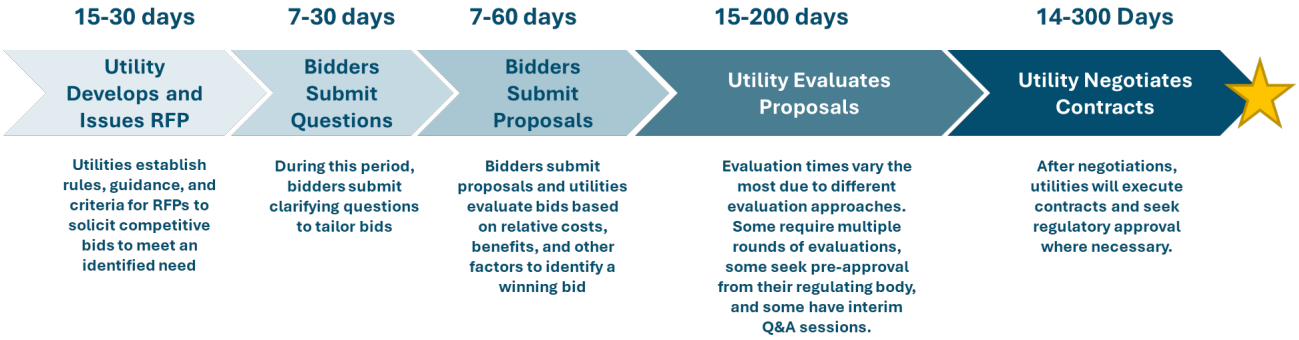
allow for the development of new resources at the appropriate pace and scale to meet Resolution 9977 goals. Doing so will require PWP to build the institutional capability to issue and administer competitive requests for proposals (RFPs), evaluate responses, and negotiate and execute contracts independently from SCPPA.

PWP has already taken the initiative to begin development of new utility-scale resources independently from SCPPA, most notably in the development of battery storage facilities on the site of the Glenarm Power Plant (discussed in Section 3.3).

Increasingly across the industry, the preferred approach for competitive procurement of new resources is the "All Source Request for Proposals" (All-Source RFP). In contrast to "targeted" RFPs, which might request bids for a specific technology or resource, an All-Source RFP establishes general parameters for conforming bids but places few limits on the types of resources that may be eligible to participate. This approach maximizes competition among bidders and encourages innovative solutions to meet a utility's needs, offering the broadest menu from which a utility may select resources to best meet its needs.

As illustrated in the diagram below, the timeframe between the issuance of an all-source RFP and new resources achieving commercial operations typically spans four to six years.

Figure 25. Typical timeline for resource procurement



Given typical timelines for RFP processes and resource development, adding new utility-scale resources to PWP's portfolio by end of 2030 requires immediate action to initiate competitive procurement processes. The table below sets forth an aggressive timeline for an all-source RFP process administered by PWP as a direct outcome of the OSP to bring new renewables and storage resources online to meet the 2030 carbon-free goal.

Table 16. Timeline for PWP's 2025 all-source RFP

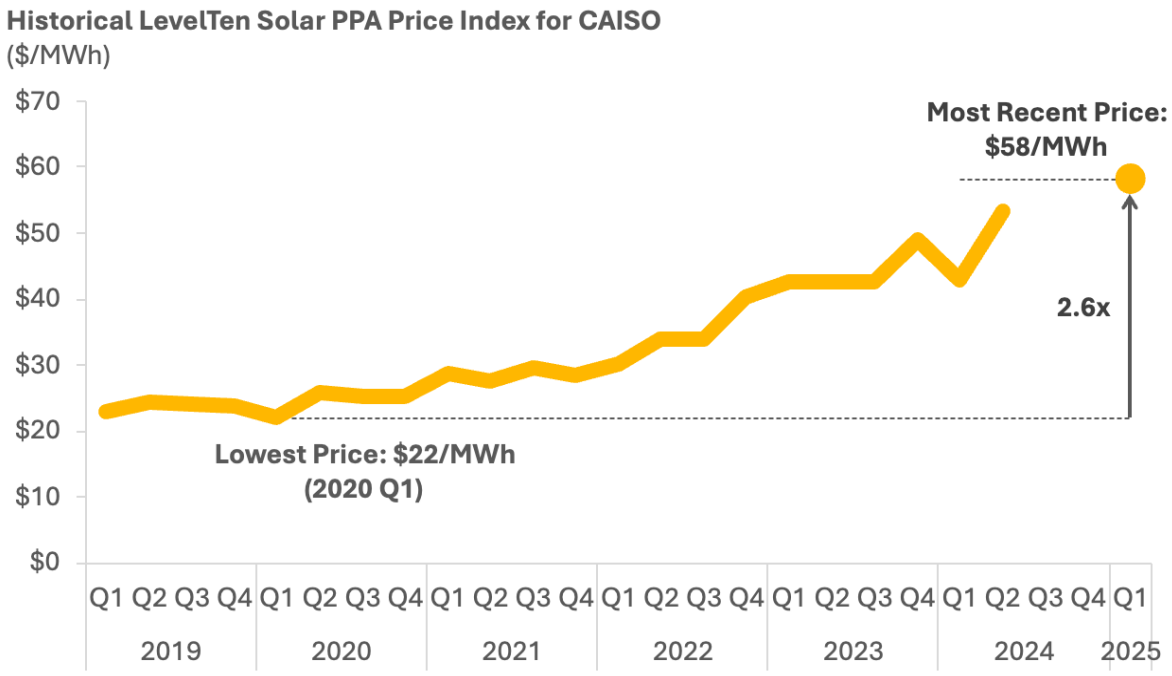
Milestone/Stage	Typical Timeline	Target Date
PWP: Develop & Release All-Source RFP	2-3 months	End of 2025
Developers: Develop & Submit Proposals	2-3 months	Q1 2026
PWP: Evaluate & Select Bids	3-6 months	Q3 2026
PWP & Developers: Negotiate Contract Terms	6-12 months	Mid 2027
PWP: Seek City Council Approval for PPAs	3-6 months	End of 2027
Developers: Construct Project	2-4 years	End of 2030

Uncertainties in Resource Pricing

This rapid timeline for new resource procurement occurs during a period of significant uncertainty and volatility in the cost to develop new generation resources. Inflationary pressure, global supply chain constraints, and federal trade and tax policy have created an environment where buyers of renewable energy are likely to face considerably higher costs for resource development than they would have several years ago.

Contract prices for most new generation resources have increased substantially in the past several years – a trend that predates the current federal administration's major changes to clean energy policy. Changes to LevelTen's PPA price index[17] for California solar resources, one of the most commonly cited benchmarks of the actual cost of commercial transactions between buyers and sellers of renewable energy, provides an instructive example of these changes: since reaching a low watermark in 2020 at $22/MWh, prices for solar PPAs have nearly tripled, most recently reaching the level of $58/MWh. Notably, contracts priced at that level would exceed even the "High PPA Cost" upper bound assumed in the OSP cost impacts analysis ($50/MWh). This trend is not unique to solar PPA prices: inflation, supply chain constraints, geopolitical conflict, tariffs, and large increases in demand have contributed to cost increases for many types of electrical infrastructure. These dynamics mean that cost impacts to ratepayers of procuring the resources in OSP Case Studies under these market conditions could exceed the upper bounds of the ranges quantified in the portfolio analysis.

Figure 26. Historical Level10 Solar PPA Price index for CAISO



[17] LevelTen Energy, PPA Price Index, https://www.leveltenenergy.com/ppa

Ongoing shifts in the federal policy landscape supporting renewable and storage development are expected to increase the cost of developing new clean energy projects even further. The OBBBA – which was signed into law in July 2025, after the completion of the OSP technical analysis – has terminated Section 45Y Clean Electricity Production Credit (production tax credit) and 48E Clean Electricity Investment credit (investment tax credit) for wind and solar projects placed into service after 2027. Additionally, new Foreign Entity of Concern (FEOC) requirements in the OBBBA will likely make claiming tax credits for other clean energy projects, such as storage, more challenging. While still evolving, tariffs could significantly increase the capital costs of clean energy projects as a significant portion of project components are imported. Uncertainty regarding future tariff policy creates a challenging contract execution environment. While the impact of the OBBBA and tariffs are uncertain at the time of this plan development, E3's preliminary analysis indicates that the combined impact of both policies could raise PPA prices for solar by 36 to 124% and storage prices by 18 to 88%, considering current tariffs and Anti-Dumping / Countervailing Duty rates imposed by the U.S. Commerce Department.

Financial Exposure to Wholesale Market Conditions and Implications for Risk Management

The transition to a 100% carbon-free portfolio results in a paradigmatic change the nature of PWP's relationship to the CAISO wholesale energy market. Historically, PWP's portfolio of owned and contracted resources has produced less energy annually than its annual load; to make up the difference needed to serve customers, PWP purchases "unspecified" energy – typically directly through the CAISO wholesale market. In 2023, 83% of PWP's power mix was supplied by owned and contracted resources, while 17% was the result of such unspecified transactions, as shown in the 2023 Power Content Label.[18] In contrast, as shown through the "Hourly" OSP case studies, a portfolio of carbon-free resources capable of serving 100% of hourly needs produces significantly more energy (i.e. 160-170%) than PWP's load over the course of the year, making PWP a significant *seller* of energy into the wholesale market.

This shift changes the nature of PWP's financial exposure to wholesale market conditions and has far-reaching implications for risk management:

- When a utility is "short" (i.e. depends on purchases from the wholesale market), it faces the risk that *high* prices will result in significant additional costs to serve loads;
- When a utility is "long" (i.e. sells large volumes of energy to the market), it faces the risk that *low* prices could limit its ability to offset a portion of its contract costs with revenue from off-system sales.

Given that portfolios that meet 100% of the City's hourly energy needs with carbon-free resources result in a significant "long" position in the market, the potential revenue from off-system sales will be an important consideration in procurement decisions, and a robust understanding of how this will evolve is essential to maintaining affordability through the transition.

[18] See 2023 Power Content Label: https://www.energy.ca.gov/filebrowser/download/7399

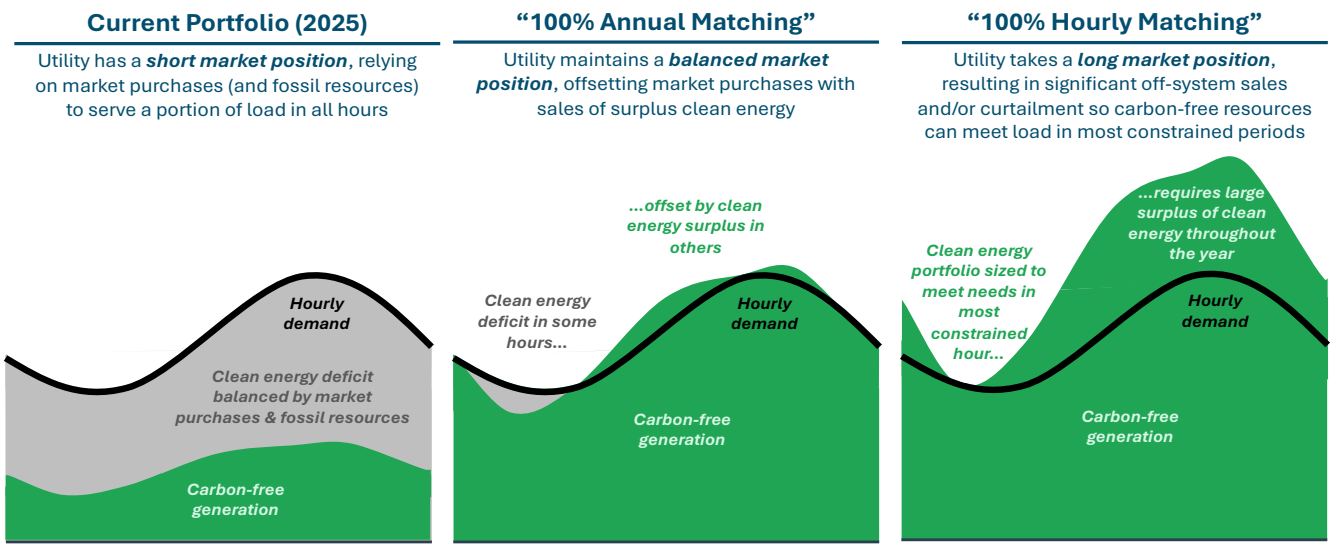


Figure 27. Market position today, achieving 100% annual matching, and achieving 100% hourly matching

The increasing penetration of renewable generation in the CAISO system has reshaped the patterns of wholesale energy prices observed throughout the year. In particular, the significant amount of solar energy available during daylight hours – a combination of output from utility-scale systems and behind-the-meter resources – has led to increasing frequency of oversupply – a condition in which the production of renewable resources on the system is greater than the amount that can be used by loads and stored in batteries. During these periods, wholesale energy prices, which reflect the short-run marginal cost of generation, drop to zero or negative levels – a point at which resource owners must pay, rather than be paid, to provide output to the grid, providing an economic incentive to curtail excess output. In the past several years, the frequency of these oversupply events has grown to over 1,000 hours per year, and the projection of renewable additions is anticipated to lead to further increases.

The dynamics that drive oversupply and negative prices at the system level – for instance, high solar output coupled with moderate loads during spring days – are also likely to result in surplus carbon-free energy in PWP's portfolio in the same periods, making this a correlated risk. To illustrate how coincidence of system oversupply and PWP surplus affects PWP's portfolio as new resources are added, the figure below provides a breakdown of what happens to the energy produced by an addition of a megawatt of solar capacity to PWP's portfolio contracted resources in 2031:

- Twenty percent of the energy produced by the additional solar resource occurs during periods when PWP has a clean energy deficit, while 80% is produced when PWP's carbon-free resources already exceed its loads;
- Of that 80% that occurs when PWP already has sufficient carbon free resources, half (or 40% of the total energy) will occur during periods when the CAISO system is experiencing oversupply, meaning that prices are likely to be zero or negative.

Resource diversity – developing a portfolio with multiple sources of carbon-free electricity including solar, wind, and geothermal – would help mitigate this market risk as PWP's portfolio would contain less of a single resource type - particularly one that has a high degree of saturation in the CAISO market. PWP must carefully consider the impact of procuring a large portfolio of resources that may increase its dependence upon wholesale market transitions to offset costs. If wholesale market prices are lower than modeled in the OSP technical analyses, cost impacts could be higher than presented in the case studies where PWP has a long market position and has a portfolio highly dependent upon one type of resource.

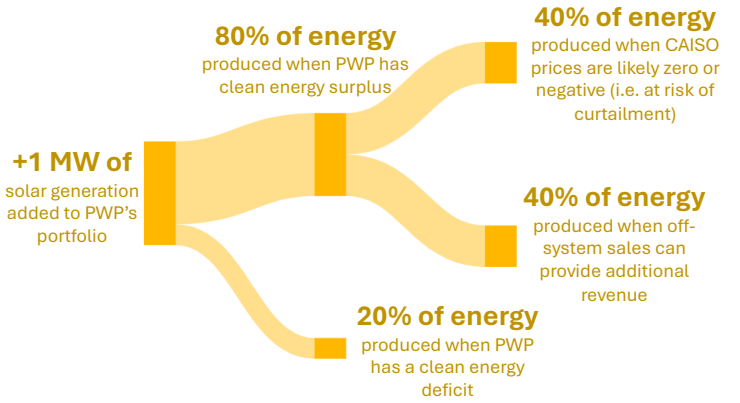


Figure 28. Share of incremental solar generation produced when PWP's portfolio has an excess of carbon-free energy and when prices in the wholesale market are likely <$0/MWh

Seeking City Council Approval of New Contracts

Procurement of over 500 MW of new utility-scale renewables and storage to meet the planning targets established in the OSP will require that PWP bring forward contracts for City Council approval at a rapid pace over the next several years. With typical project sizes ranging from 20-100 MW, meeting the planning targets by the end of 2030 could result in ten or more new PPAs negotiated and signed in this period. The approval of each contract will result in a long-term contractual financial obligation for the City that could, in total, add more than $100 million per year to PWP's Power Supply Cost beyond what is already under contract.

City Council's determinations of whether to approve contracts brought forward will require careful consideration of how each one impacts clean energy and affordability metrics. To promote transparency and provide clear information on the impacts of each decision, PWP will continue to bring forward a standard set of metrics that reflect the incremental impact of each contract. Largely consistent with recent contracts approved by City Council, the most material metrics to consider will be:

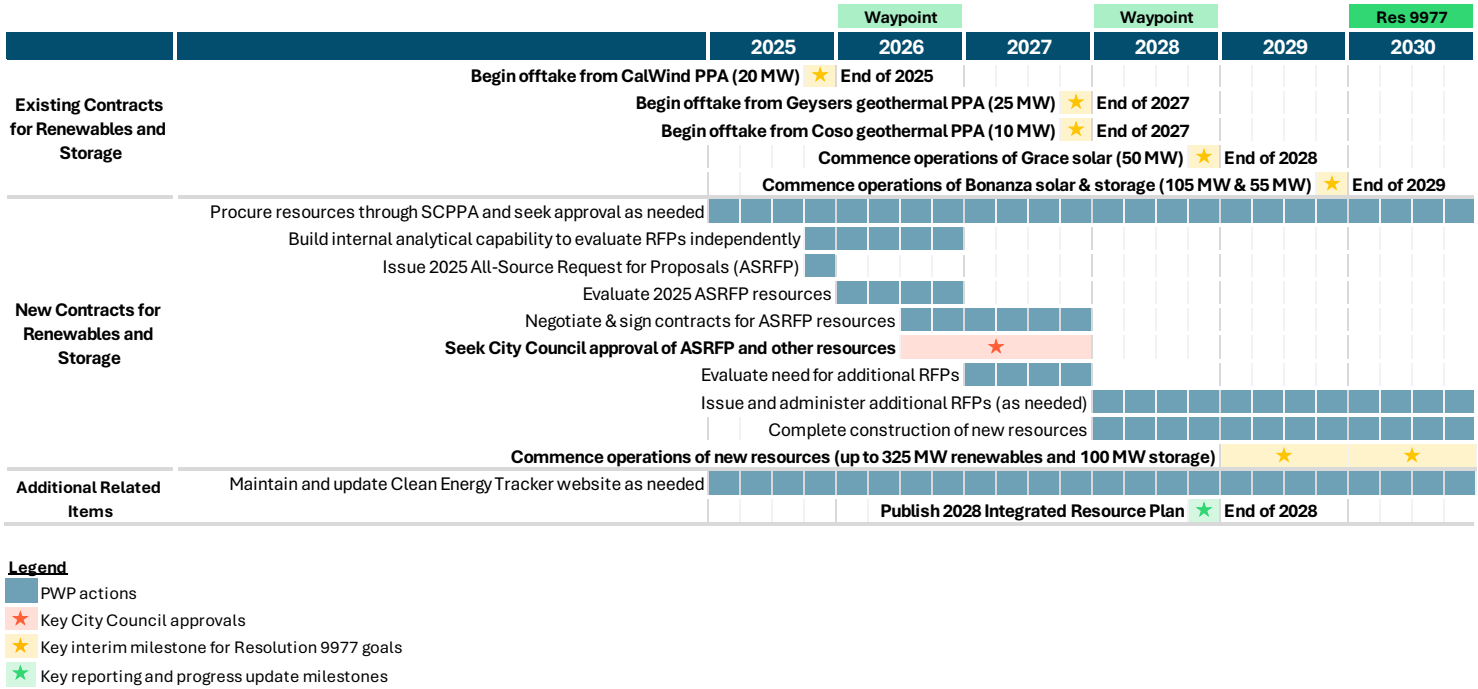
- The expected impact of the project on Pasadena's clean energy metrics;
- The annual and total cost associated with the contract;
- The net impact of the contract on PWP's Power Supply Cost and retail rates.

Closely tracking the evolution of those metrics – which may change quickly as new contracts are brought forward – will enhance City Council's ability to balance the objectives of Resolution 9977.

Action Items

To meet the planning targets for utility-scale renewables and storage while also mitigating key risks associated with current market conditions, PWP plans to take the following actions:

Figure 29. Action plan to meet planning targets for utility-scale renewables and storage



- **Continue to leverage SCPPA membership to facilitate additional procurement opportunities.** Our membership in SCPPA provides an avenue to procure new resources at lower per unit costs and at larger scale. SCPPA reduces procurement costs by taking advantage of existing institutional infrastructure and economies of scale. Centralizing and sharing accounting, legal, and administration resources across multiple projects reduces overhead costs, and leveraging the collective purchasing power of PWP and other SCPPA members when advertising interest in projects generates larger project offers and lower per unit costs. The Grace Solar and Bonanza Solar and Storage projects are two recent contracts that PWP secured through SCPPA. We anticipate that SCPPA will continue to provide important opportunities to contract for new resources. While we do not have direct, unilateral control over SCPPA activities, we will continue to participate actively in these processes and collaborate with neighboring municipal utilities with aligned clean energy goals to capitalize on opportunities for new resource procurement.
- **Issue an all-source RFP by end of 2025 for delivery between 2029 and 2032.** As discussed above, we will issue an all-source RFP by the end of 2025 as one of our core procurement strategies to meet the Resolution 9977 goal by the end of 2030. Because the 2030 timeline would provide developers only two to three years to complete the construction of new projects after contract execution, it is likely that only projects that are already in advanced stages of development today could realistically achieve commercial operations by the end of 2030. Permitting projects with commercial online dates beyond 2030 will expand participation from projects that are not as advanced in project development and from technologies with longer development timeframes (e.g. geothermal), which could contribute to the diversity of our energy portfolio. While we intend to prioritize projects that can achieve operations by the end of 2030, a more expansive set of technology and pricing options will

allow PWP and the City Council to evaluate tradeoffs between cost and timing when considering the long-term commitment of power purchase agreements.

- **Build internal analytical capability to support procurement decision-making.** To support decision-making and procurement, recognizing the unique complexity of our resource needs, we are also making organizational changes to build internal capabilities that will allow our team to evaluate procurement options with less support from SCPPA and external consultants. We are currently in the process of procuring, implementing, and training staff on production cost modeling software which will be used to evaluate proposals received via the all-source RFP as well as other future planning and procurement efforts. This software will be used to evaluate the economic and operational impacts of clean energy integration and support future decision making.
- **Evaluate need for additional RFPs at 2028 Waypoint.** While we continuously consider the need to issue RFPs for resource procurement, the 2028 Waypoint will provide an important opportunity to reassess the need for additional resources to meet the 100% carbon-free objective. Should the 2025 RFP fail to yield sufficient resources to meet PWP's needs – which may occur if responses to the RFP are insufficient, if pricing offered is deemed unfavorable by City Council, or if unforeseen obstacles result in the termination of negotiations for specific projects – PWP will use the 2028 Waypoint to determine what additional procurement needs it should target through competitive solicitations. In addition to evaluating the need and strategy for procuring additional resources, the 2028 Waypoint aligns with PWP's next electric cost of service and rates study where we will evaluate the impact of resources procured by that time and additional future procurement on rates.

5.2 Accelerate Local Solar & Storage Development

Due to constraints on PWP's import capability, continued efforts to support local carbon-free resources will supplement the procurement of external, utility-scale carbon-free resources to meet all system needs and achieve the objectives of Resolution 9977. While both local and external solar and storage can advance the carbon-free objectives of Resolution 9977, there are potential benefits unique to local solar and storage:

- **Reduced utilization of Glenarm:** A unique benefit to local, carbon-free resource development is its ability to reduce output from Glenarm when the plant otherwise would be operated to serve load when customer energy demand exceeds PWP's import capability. Although Glenarm currently operates infrequently, serving load during peak periods is one of the crucial services it provides that can instead be provided by a portfolio of local carbon-free resources.
- **Increased local resilience:** Developing local solar and storage also supports the reliability and resiliency goals of the Resolution. More local resources make the system more resilient during transmission/distribution contingencies that decrease our ability to import power or when Glenarm itself experiences outages or undergoes maintenance. Additionally, microgrids at critical facilities within the City also increase the Pasadena community's resiliency in the event of a natural disaster.

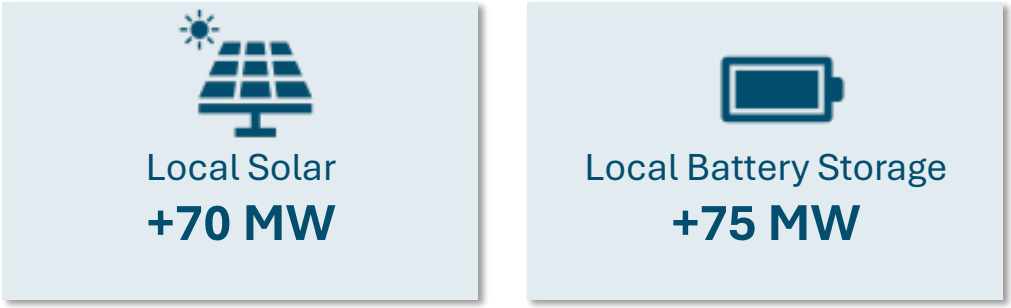
- **Increased community engagement:** Local carbon-free resource development also provides an opportunity for PWP to engage the community. We will seek to broaden participation in the clean energy transition as we accelerate local resource development through programs such as the low income loan program.

PWP will continue to support and increase efforts to accelerate local carbon-free resource development in Pasadena. We currently offer one of the most generous incentive programs in the State to our customers for rooftop solar generation, and we are exploring opportunities to provide additional incentives for customer storage. Additionally, we have procured utility-scale storage to be sited in the City (the 25 MW Glenarm BESS project under development) and are actively looking for additional opportunities to develop carbon-free resources on municipal property including scoping additional storage at the decommissioned Broadway Steam Power Plant site and leveraging the roofs and parking lots on municipal property for solar installations.

More broadly, there are a range of options available to increase local solar and storage, including incentivizing and supporting naturally-occurring customer adoption, direct installation on municipal property, and contracting for development of these resources on private property. Each of these mechanisms has cost and equity implications that we must balance as we pursue all objectives of Resolution 9977.

Based on the cases studies modeled in the OSP, and direction provided by the MSC, PWP has established planning targets for local solar and storage in order to increase our local reliability. These targets are **70 MW of additional solar and 75 MW of additional local storage** relative to resources that exist today or are already under development (e.g. the Glenarm BESS), resulting in total capacities of 100 MW of local solar and 100 MW of local storage by the end of 2030.

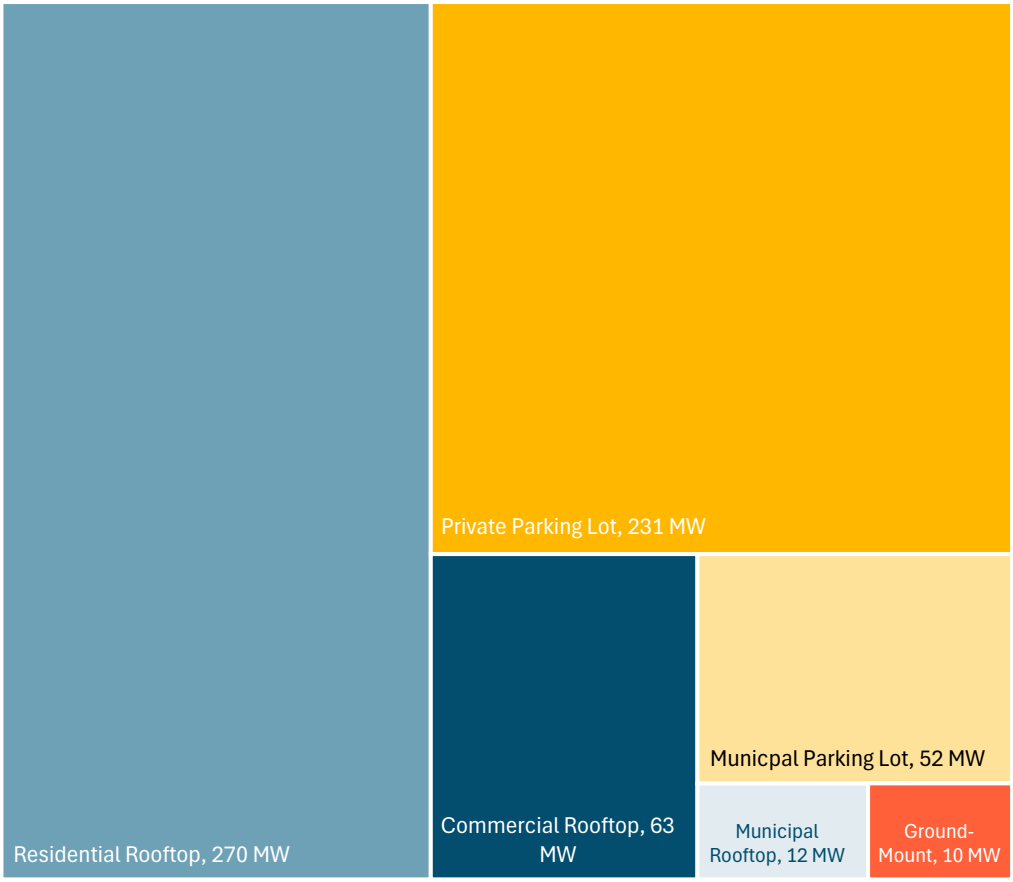
Figure 30 Planning targets for local solar and storage



Technical Potential

In the OSP Local Solar and Storage study, E3 conducted a detailed geospatial analysis to identify the technical potential for ground-mount, rooftop, and parking canopy solar. The technical potential represents the theoretical maximum amount of solar that could be installed based on viable space for development regardless of cost (including roof repairs), grid capacity, and customer or landowner interest. Technical potential does not represent achievable potential or the amount of solar that could be installed based on economics, customer interest, or other market barriers. Technical potential also does not specifically represent the need for solar to achieve the goals of Resolution 9977.

Figure 31 Solar technical potential within Pasadena



The OSP analysis found that there is over 600 MW of technical potential for ground-mount, rooftop, and parking canopy solar in the City. While there is limited land available for developing ground-mount solar (10 MW of potential), there is significant potential for parking canopy (283 MW) and rooftops (345 MW).

About 78% of the rooftop potential in the City is on residential roofs, while 18% and 3% is located on commercial or municipal rooftops, respectively. 60% of the residential rooftop potential is located on renter-occupied buildings. Historically, renter households have encountered a "split incentive" issue, where tenants who benefit from the bill savings provided by solar do not control the rooftop and building owners who make upgrades do not directly benefit from the utility savings, which has made solar development in this sector challenging. Policy interventions or utility programs may be required to overcome the "split incentive" issue.

On City property, there is 12 MW of rooftop and 52 MW of parking canopy potential – representing 10% of the overall developable potential in the City.

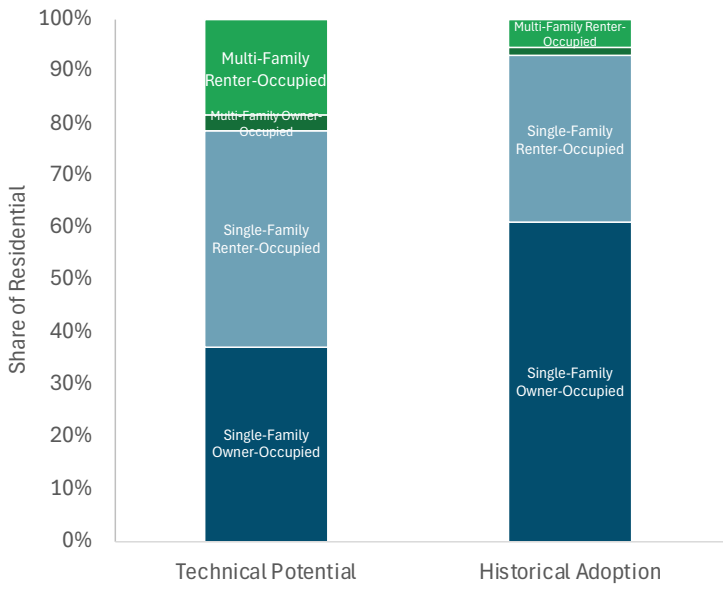


Figure 32 Share of residential solar technical potential and historical adoption by subsector

While there is significant potential for solar in the City, it is dispersed across many small sites, which will make scaling this resource more challenging. The table below summarizes the typical potential at each type of site where solar could be developed, and the distribution of site sizes. There is 8 MW of potential on municipal rooftops spread over 88 sites and 52 MW of potential on municipal parking lots spread over 73 sites. Private and municipal parking lots are the largest sites for solar development, but there are only 22 parking lots in the City that could accommodate a solar canopy installation greater than 2 MW in size. To develop the solar resource on City property and parking lots, PWP will need to develop many small projects, which creates additional process complexity.

Table 17. Distribution of local solar potential

	# of Sites	Median site size (kW)	Total Technical Potential (MW)	Cumulative potential in top 5 largest sites (MW)	Cumulative potential in top 10 largest sites (MW)
Residential Rooftop	18,811	10	270	3	5
Commercial Rooftop	1,237	17	63	5	8
Municipal Rooftop	88	50	12	3	5
Private Parking	702	175	231	25	40
Municipal Parking[1]	73	300	52	26	32

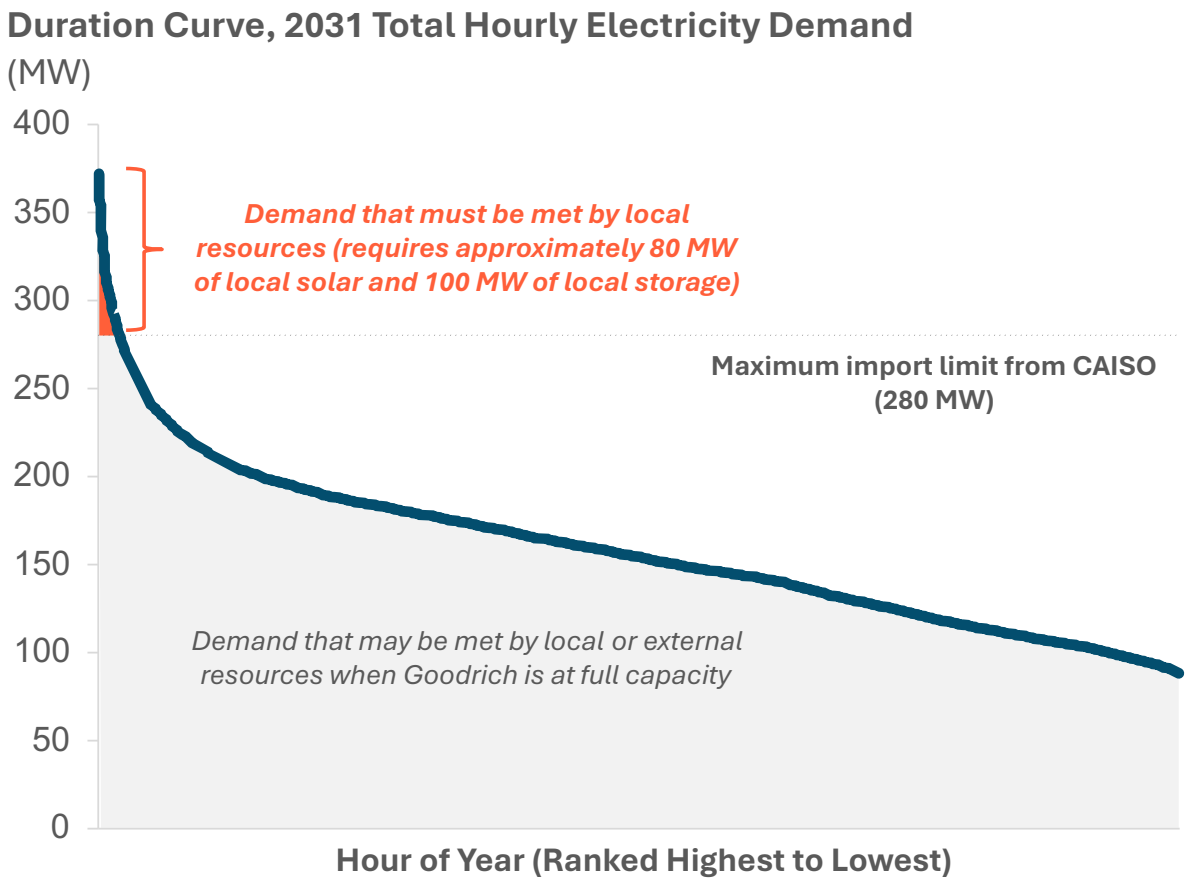
1. 24 MW of municipal parking lot potential is located at the parking lots surrounding and adjacent to the Rose Bowl

Insights from Portfolio Analysis

The OSP analysis considered the role of local and external carbon-free resources to achieve the goals of Resolution 9977. While the options for resource development available to PWP outside Pasadena are generally lower cost and more diverse than those located inside the City, local resources provide distinct benefits due to the current limitations of the transmission system.

The figure below illustrates PWP's forecasted hourly demand in 2031 ranked from highest to lowest demand. The grey area illustrates the demand for electricity up to PWP's 280 MW import limit that could be served by either internal or external carbon-free resources. The red area illustrates hours when system demand exceeds PWP import capability, and local resources inside the City would be needed to meet load. Load above the 280 MW import limit is forecasted to be less than 1% of PWP's annual load in 2031. The OSP technical analysis found that a *total* installed capacity of approximately 80 MW of local solar, 100 MW of local storage, and 30 MW of demand response and flexible loads would be sufficient to serve demand exceeding PWP's import capability in 2031. This analysis served as the basis for the Accelerated Local Resources portfolio and directly informed the proposed planning targets presented in the draft OSP of 50MW of additional (i.e. incremental to existing installed capacity) local solar and 75 MW of additional local storage. Based on direction provided by MSC provided at its November 5, 2025, meeting, the OSP planning target for local solar was revised to 70 MW.

Figure 33. Load duration curve, 2031, compared to PWP's import capacity



Options to Accelerate Local Resource Development

There are several mechanisms PWP can leverage to procure or encourage adoption of local solar and storage resources. Broadly, these mechanisms can be categorized as either:

- "**Naturally occurring" customer adoption** driven by providing a financial incentive(s) to customers through rates (i.e. net energy metering or alternatives) or other programs and enabled by actions that lower non-economic barriers that slow or discourage adoption.
- **Direct installation on municipally-owned property** where the resources are either municipally owned or owned by a third-party who leases the property and sells the generation to PWP through a long-term PPA, or
- **Contracted development on private property** where PWP provides a third-party developer with negotiated long-term compensation in exchange for the generation provided by their resources through a PPA of a feed-in-tariff.

Of all the mechanisms available to PWP to accelerate local resource development, promoting customer adoption of solar and storage via rates and programs provides the least certainty in terms of the amount of resource that will be developed as it is highly dependent upon factors outside of the utility's control, including customer willingness to participate and suitability of property owned by interested customers for development. Direct install on municipally owned properties, however, can provide a greater amount certainty in the scale of development achieved.

The table below summarizes existing procurement mechanisms in place for local solar and storage and additional options we plan to pursue and key distinctions between them including ownership, financing or compensation structure, and typical project size. Our plan to utilize these mechanisms, and the associated cost impacts of each mechanism, is discussed further in the following sections.

Table 18 Local Solar and Storage Procurement Options

	Existing Options		Additional Options Under Consideration		
	Net Energy Metering (NEM)	**Self Generation Incentive Program (SGIP)**	**Municipally Owned**	**Power Purchase Agreement (PPA)**	**Feed-In Tariff (FIT)**
Procurement Mechanism	Naturally occurring customer adoption		Direct installation on municipal property	Direct installation on municipal property OR Contracted development	Contracted development
Size Restrictions	<1 MW	>1 MW	None	None	None
Typical Project Scale	4-10 kW (Res) 20 kW+ (Com)	1 MW+	500 kW+	1 MW+	500 kW+
System Owners	Res & Com Customers	Large Com Customers	City	Third Parties	Large Customers & Third Parties
Metering	Behind-the - Meter	Behind-the-Meter	Front-of-Meter	Front-of-Meter	Front-of-Meter
Financing or Compensation	Bill credits at retail rate *(Full retail rate)*	Bill credits at retail rate *(Energy charge only)*	Financed through Power Fund *(Approved in Capital Improvement Plan)*	Fixed price long-term contract *(Negotiated for each PPA independently)*	Fixed price long-term contract *(Standard price set by PWP)*
Typical Locations	Res & Com Rooftops	Large Com Rooftops, Private Parking Lots	Municipal Rooftops, Municipal Parking Lots	Private or Municipal Properties, Parking Lots	Private Properties, Parking Lots

Cost and Equity Considerations

Equity is core goal of Resolution 9977. Managing the transition to a carbon-free electricity system while maintaining equity means ensuring that the costs to invest in, maintain, and operate power system – including distribution, transmission, and generation infrastructure – are fairly shared across and within customer classes; and taking proactive measures to provide support and assistance to disadvantaged communities and low-income customers to mitigate the effects of increasing electricity system costs on vulnerable populations who rely on access to electricity to meet basic human needs.

Each of the options to incentivize adoption or to procure local solar and storage resources described above result in costs that impact PWP's customers.

- **Projects that are municipally owned** are funded through the City's Capital Improvement Program, which results in allocation of costs to the Power Fund. For small projects, this may be a one-time outlay; larger projects that require issuance of new municipal debt, or otherwise lead to multi-year expenditures, result in the project's costs and any interest associated with municipal debt spread over a longer budgetary horizon.
- **Projects procured through a PPA** (or alternative contract structures, e.g. FIT) result in a long-term financial obligation between the City and a counterparty. The associated payments are treated as an annual expense that is included directly in the Power Fund each fiscal year.
- **Development of behind-the-meter resources that result in bill reductions or bill credits** (as under the current Net Energy Metering program) do not result in a line-item cost in the Power Fund; however, the bill credits, a contra-revenue, are shared among the entire customer class. The credits received by solar customers exceed the avoided cost, which was an intent of the policy implementation, as an incentive to make the upfront private investment. In addition, a substantial portion of the costs in the Power Fund are fixed (not variable, per kWh) costs that cannot be avoided (e.g. personnel and distribution infrastructure), and as PWP collects less revenue from solar customers to defray these costs, it must eventually raise rates for revenue sufficiency.

The figure below provides a comparison between (1) the rates at which residential and commercial customers are compensated through bill credits, (2) cost-based rates for the same residential and commercial systems that would provide competitive returns under a PPA or FIT structure, and (3) a PPA price for utility-scale solar outside the City of Pasadena. Under the current NEM program, PWP pays $50-70/MWh more through bill credits for local solar resources that could be procured at lower cost through a PPA or FIT structure or municipal financing – and at a much more significant premium above the cost of utility-scale solar resources outside the City.

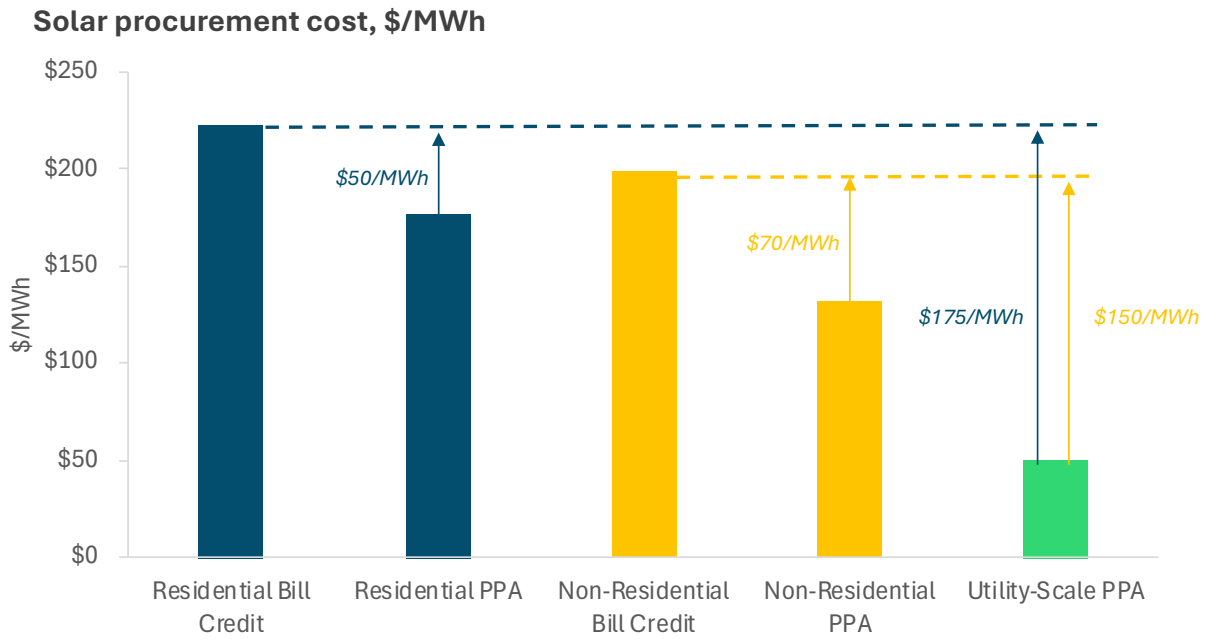


Figure 34. NEM bill credits, PPA cost for local solar, and PPA cost for external, PPA cost utility-scale solar

These differences highlight an important area requiring a balance between the two of the objectives of Resolution 9977: namely, that customer adoption of solar and storage resources enables progress toward the carbon-free goal of Resolution 9977, but it does so at a higher cost to PWP's rate base than if similar local solar and storage resources were directly procured by PWP through municipal or third-party financing. This interplay is especially important in light of the fact that a disproportionately high share of customer adoption of solar and storage occurs among wealthier populations: while 60% of Pasadena's population lives in a low-income or disadvantaged census tract[19] as designated by the State, only 29% of residential solar installations are located in those same census tracts. This mirrors patterns observed broadly across California: that adoption of solar and storage resources is typically skewed towards higher income populations and is lower among disadvantaged communities. As of 2023, only 12% of residential solar adopters in California have a household income less than $50,000.[20]

These cost differences and their impacts upon different socioeconomic strata underscore the importance of carefully considering the optimal balance among customer, municipal, and third-party ownership as segments to meet planning targets established by the OSP as PWP wants to meet the clean energy goals together as a community.

[19] Showcases featuring Low-Income or Disadvantaged Communities Designated by California, California Natural Resources Agency, https://data.cnra.ca.gov/dataset/showcases/low-income-or-disadvantaged-communities-designated-by-california

[20] Lawrence Berkeley National Laboratory, Solar-Adopter Income Trends: 2024 Update, https://emp.lbl.gov/publications/residential-solar-adopter-income-3

In parallel to the OSP, PWP is currently engaged in an Electric Rate Study whose objective is to establish electric rates for the next two fiscal years (2026-2027). Over this period, PWP still intends to compensate customers at the retail rate for energy services charges under its NEM and self-generation policies. This generous financial incentive, coupled with on-going pragmatic permitting reforms and public outreach (discussed further in the following sections), continues to provide customers with a strong financial incentive to invest in local solar resources. As part of the subsequent update to electric rates currently planned for 2028, PWP intends to evaluate rate designs and incentives for all customer-owned distributed energy resources, with a focus on tradeoffs between:

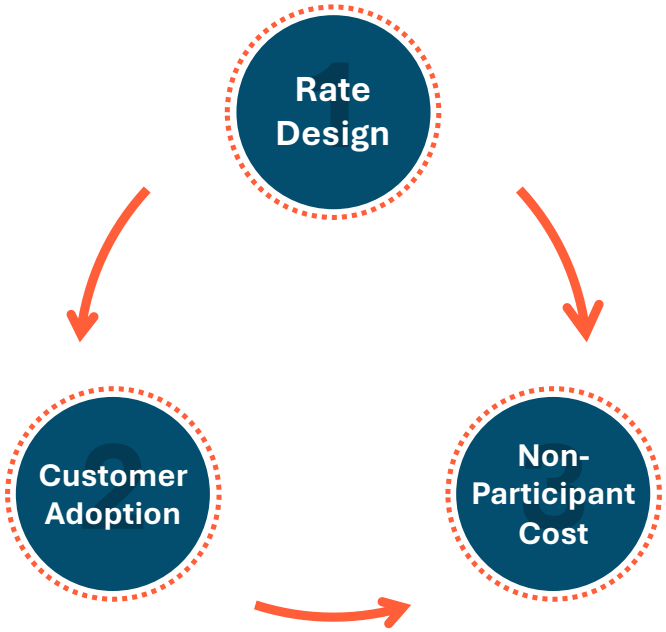


Figure 35. Impact of rate design, adoption, and non-participant costs

- The expected impact upon the customer adoption rate, given the need for local solar and storage to meet the City's goals, progress toward those goals, and future opportunities to develop these resources through other mechanisms enumerated earlier; and
- The expected difference between bill credits received under the current programs and the avoided cost savings from the program, which must be recovered from the entire rate-paying customer base, including both participants and non-participants in the program.

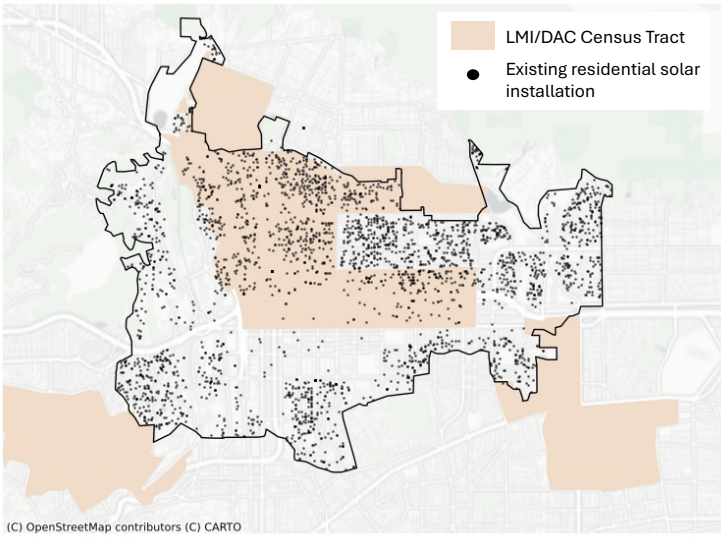


Figure 36 LMI/DAC census tracts and existing residential solar installations in Pasadena

Alternative rate designs that offer compensation for customer solar generation and storage and which are more aligned with the value that generation provides to the grid can mitigate overall rate increases. Consideration of embedding more unavoidable costs in monthly fixed charges or establishing minimum monthly bills can ensure that the utility is able to socialize the costs of maintaining the grid to all customers in an equitable manner. An alternative rate structure such as a net billing tariff – where customers pay a retail rate for the energy they import from the grid and receive credits for generation that they export to the grid at a

rate aligned with the value of that generation to the system - can provide fair compensation to solar customers while mitigating impacts to non-participants.

Loan programs and community-based resource options for accelerating local solar and storage can expand access to solar and storage for PWP's customers by assisting low-income customers with financing and by lowering barriers to access for renters and multifamily housing residents who would otherwise be unable to participate. Currently, only 24% of customer solar installed in Pasadena is located on renter-occupied buildings, while 58% of households in the City are renter-occupied.[21,22] A study conducted by Lawrence Berkeley National Laboratory and the National Renewable Energy Laboratory found that enrollees in community solar programs have been "about 6.1 times more likely to live in multifamily buildings than rooftop solar adopters, 4.4 times more likely to rent, and earn 23% less annual income."[23] Such programs, if made financially self-sustaining, could be coupled with rate reform to support the equity and carbon-free goals of Resolution 9977.

Action Items to Accelerate Local Solar and Storage

To meet the planning targets for local solar and storage development, we plan to pursue multiple mechanisms for resource procurement. We will also develop a series of innovative policy recommendations and new customer programs. These activities will be brought forward to the City Council for approval. As with other aspects of the OSP, PWP plans to maintain flexibility to allow adaption to real world conditions. If the target for local solar or storage adoption is missed by one target group (e.g., customer solar), then PWP plans to maintain the flexibility to adjust the target in another (e.g., municipal owned solar) to compensate.

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[21] City of Pasadena Adopted Operating Budget, Fiscal Year 2023, Fact and Figures https://www.cityofpasadena.net/finance/wp-content/uploads/sites/27/2023-Section-29-Facts-and-Figures.pdf?v=1700265600073#:~:text=Pasadena%20covers%20approximately%2023%20square,of%2010%20residents%20per%20acre.&text=The%202016%2D2020%20American%20Community%20Survey%205%2DYear%20Estimates%20show,homeowners%20and%2058.0%20percent%20renters.

[22] Showcases featuring Low-Income or Disadvantaged Communities Designated by California, California Natural Resources Agency, https://data.cnra.ca.gov/dataset/showcases/low-income-or-disadvantaged-communities-designated-by-california

Table 19 Action plan to accelerate local solar and storage adoption

		2025	Waypoint 2026	2027	Waypoint 2028	2029	Res 9977 2030
Customer Solar & Storage Adoption	Continuously evaluate best use of PBC funds to support clean energy						
	Revise policy on customer solar sizing ★						
	Continuing efforts to streamline permitting process						
	Develop the low interest loan program for low-income customers ★						
	Develop incentive program for customer-owned solar and storage ★						
	Launch public outreach and education campaign						
	Further revise policy on customer solar sizing ★						
	MSC study session on lowering barriers to customer adoption ★						
	Outreach on solar process enhancements and permitting streamlining						
	Outreach on storage incentives						
	Outreach on low interest loan program						
	Continue public outreach and education campaign						
	Develop TOU rates to incentivize customer-owned storage						
	Evaluate tariffs that incentivize customer solar and storage adoption						
	Seek City Council approval for future retail rate structure changes ★ End of 2028						
Large-Scale Energy Storage at City-Owned Properties	Complete construction of Glenarm BESS						
	Commence operations of Glenarm BESS facility (25 MW) ★ Q1 2027						
	Finalize site assessment for Broadway BESS						
	Conduct RFP and negotiate PPA for Broadway BESS with preferred vendor						
	Seek City Council approval for Broadway BESS PPA ★						
	Develop detailed project plans and secure permits for Broadway BESS						
	Complete site demolition and installation of Broadway BESS						
	Commence operations of Broadway BESS facility (75 MW) ★						
	Explore additional opportunities for storage at city-owned properites						
Solar at City-Owned Properties	Identify municipal properties for potential solar development						
	Select municipal sites for initial projects (up to 4)						
	Seek approval to fund initial projects in Capital Improvement Plan (CIP) ★ Q2 2026						
	Conduct RFPs for EPC contractors for initial projects						
	Complete engineering, procurement, and construction for initial projects						
	Select additional municipal sites for projects (up to 10)						
	Seek approval to fund additional projects in CIP ★ Q2 2027 ★ Q2 2028 (if necessary)						
	Conduct RFPs for EPC contractors for initial projects						
	Complete engineering, procurement, and construction for additional projects						
Microgrids at City, Commercial, and Institutional Sites	Establish criteria for selecting municipal sites for microgrids						
	Publish Microgrid Readiness Map of municipal properties ★						
	Develop microgrids at initial selected municipal properties						
	Partner with commercial and institutional sites						
	Publish Microgrid Design and Partnership Template ★ Q4 2027						
	Begin operations of first microgrid projects ★ Q4 2028						
	Evaluate performance of microgrids and publish lessons learned ★						★
	Conduct public outreach on availability of microgrids for emergency services						
	Continue development of microgrids at additional sites						
	Develop proposal for Resilience Rate Class						
Other Opportunities	Partner with Caltech to conduct power flow studies						
	Evaluate opportunity to install solar at Rose Bowl parking facilities						
	Develop feed-in tariff (FIT) program targeting large institutional customers						
	Seek City Council approval for FIT program ★ Q4 2026						
	Partner with large customers and institutions to develop solar and storage under FIT program						
	Negotiate PPAs for local resource development with third parties (as needed)						
	Participate in 710 Stub redevelopment efforts						
Total Annual Resource Additions	Customer-owned solar	+3 MW	+4 MW	+8 MW	+10 MW	+10 MW	+15 MW
	Solar on municipally-owned properties				+4 MW	+4 MW	+12 MW
	Customer-owned storage	Up to 1 MW	Up to 1 MW	Up to 1 MW	+2 MW	+2 MW	+3 MW
	Storage at municipally-owned properties					+75 MW	

Legend

- PWP actions
- ★ Key City Council approvals
- ★ Key interim milestone for Resolution 9977 goals
- ★ Key reporting and progress update milestones

Customer solar and storage adoption

Customer adoption incentivized via rates and incentive programs

Rate design determines the relative cost-effectiveness of behind-the-meter solar and storage, which impacts the rate of customer adoption. PWP currently offers one of the most generous incentives in the State to adopt solar through its net energy metering program. While PWP's program provides a strong financial incentive to adopt solar, it does not incentivize pairing storage with solar due to two elements of its design: (1) the program credits solar at the full retail rate whether it is consumed on-site or exported to the grid and (2) the tariff has no time-dependent charges to incentivize shifting consumption from one time of day to another to reduce system peak load. Alternative rate designs, such as a net billing tariff which includes a time-varying price signal and higher incentives for self-consumption than for exports, could increase the adoption of storage coupled with solar. While a net billing tariff may be beneficial, it is not yet technically feasible until the implementation of AMI.

To align with the City's carbon-free goals, we continuously evaluate the use of PBC funds in order to maximize cost effective conservation and renewable energy for Pasadena customers. PWP regularly reviews our portfolio of conservation, electrification, low-income assistance, and renewable generation programs, shifting funding toward offerings that deliver the greatest verified energy savings, greenhouse gas reductions, and customer benefits.

In 2026, we plan to launch an upfront incentive program to provide additional financial support to our residential and commercial customers looking to install solar and storage. Incentives will be provided on a $/Watt basis for qualified solar installations and a $/kWh basis for qualified storage systems. Given that the existing NEM program provides no incentive for customers to pair storage with solar, this program will be critical to supporting customer storage adoption.

As discussed above, as part of the next electric rate study, we will also evaluate our rates, tariffs, and programs that incentivize the adoption of distributed energy resources by our customers. The analysis will evaluate all customer compensation mechanisms through the lens of Resolution 9977's objectives including decarbonization, affordability, reliability, and equity. PWP will analyze the bill impacts to participants and non-participants of continuing the existing policies and/or instituting alternative programs, along with forecasted adoption and PWP's resulting revenue requirements associated with each program.

Customer adoption enabled by low interest loan programs

Even with a strong financial incentive provided through rates, low-income customers face barriers to adoption of solar due to high upfront costs and/or limited access to financing. To support low-income customers, we will develop a low interest loan program. By providing access to capital, low-income customers also share in the benefits of ownership, such as reduced electricity bills. PWP will release an RFP by the end of 2025 that seeks a financial institution to provide low interest loans, backed by PWP, to our low-income customers seeking to install solar or storage.

Addressing non-economic barriers: streamline interconnection and marketing and outreach

Non-economic barriers to adoption can encompass many obstacles, such lack of awareness or knowledge, regulatory or bureaucratic friction, and social/cultural norms. We are focused on

addressing these barriers through streamlining the interconnection process and conducting aggressive outreach and education.

We are committed to reviewing all solar interconnection applications within five business days to expedite the process and reduce friction to customer adoption. We have partnered with the Permit Center (Planning and Community Development Department) to streamline the entire permitting and interconnection process. In compliance with SB 379, the Permit Center has launched an online Express Permit Portal. This platform provides immediate, automated plan reviews and permitting for standard residential rooftop solar and energy storage systems. This collaborative effort has enabled homeowners and licensed contractors to receive construction permits more quickly, reducing overall project timelines and facilitating faster interconnection. We are committed to continuously finding new opportunities to expedite the permitting and interconnection process for our customers.

We are launching a comprehensive outreach and education campaign to highlight the role of local solar and storage in our OSP and empower our community to take part in achieving the City's 100% carbon-free energy goal by the end of 2030 (See Section 6.1 for more details). We recognize that, for many, the path to installing solar or storage can feel complex. Our outreach will include a mix of strategies including public service announcements, social media campaigns, community events, targeted advertising, and educational materials that demystify the process and highlight the benefits of solar and storage in everyday terms. These materials will include content on how solar and net energy metering works, solar and battery storage payment options, details on PWP rebate programs and how to apply for them, what to consider when evaluating solar and battery storage quotes, and more. Our goal is to build trust by being transparent about what support and programs are available to customers now, while signaling our commitment to expanding support in the near future. By fostering awareness and making clean energy more approachable, we will help residents make informed choices. We are also coordinating with Council District liaisons, the City's Public Information Office, and trusted community-based organizations to ensure our messaging is clear, inclusive, and culturally relevant.

Revise policy limiting the size of behind-the-meter solar installations

At the August 26, 2025, Municipal Services Committee meeting, PWP presented a proposal to lift sizing restrictions on BTM solar and storage installations to allow customers to size their systems to meet up to 150% of their maximum annual historical electricity usage from the past five years. Additionally, customers may size their solar systems to exceed 150% of their historical annual usage when installing an energy storage system of equal or greater capacity or when a customer can demonstrate an immediate need that will increase their energy usage - such as an pending electric vehicle purchase or heat pump installation - as long as the installation does not exceed the 1 MW nor compromise the safety and reliability of the distribution grid. The MSC directed the City Attorney's Office to prepare an ordinance amending the Pasadena Municipal Code Section 13.04.177 to enact this proposal. City Council approved this policy change on September 8th, 2025. This policy change will allow customers interested in solar to increase the size of their systems potentially accelerating the pace of solar adoption in the City. Additional policy changes to allow customers to upsize their BTM solar and storage systems further will be brought forward to City Council for review.

Large-Scale Energy Storage at City-Owned Properties

Currently, we are finalizing plans to install the first large-scale storage resource within the City. The Glenarm Battery Energy Storage System (BESS) project, expected to be operational in 2027, will be a 25 MW four-hour utility-scale battery located on approximately 0.59 acres on the Glenarm Power Plant site. To help offset the battery and installation costs, PWP successfully secured a $9.6 million grant from the California Energy Commission through the Distributed Electricity Backup Assets Program. The 25 MW BESS will increase local reliability and the resiliency of the PWP distribution system.

Figure 37. Site of future Glenarm BESS project

In addition to utilizing the Glenarm site for battery storage projects, we plan to utilize the decommissioned Broadway Steam Plant site for future projects. In 2024, PWP was awarded two grants to support ongoing emerging technology deployment efforts, including investigating opportunities for battery energy storage at the Broadway site. In partnership with the Department of Energy, ENERGYWERX gives in-kind voucher grants to eligible recipients seeking technical assistance to develop clean energy solutions. Pasadena received two in-kind grants, valued between $50,000 to $150,000, with no matching funds from PWP, and was partnered with X Utility, a Fresno, California, based company, and Grand Summit LLC, a Glendale based company, for technical assistance. All in-kind grant awards are anticipated to be completed by December 2027. Through these grants, and in collaboration with our partners, we will develop a project implementation roadmap to evaluate the suitability of LDES deployments at the Broadway site. Study of the Broadway Power Plant site though this grant identified that 100 MW / 800 MWh storage system could be installed at the site. A smaller system may be installed at the site due to the uncertainty of the timeframe of LDES technology maturing in relation to our carbon-free goals or future analysis identifying that commercially available short duration storage would be preferable.

Based on the OSP planning targets, we have established the timeline described in the figure below for the Broadway BESS Project

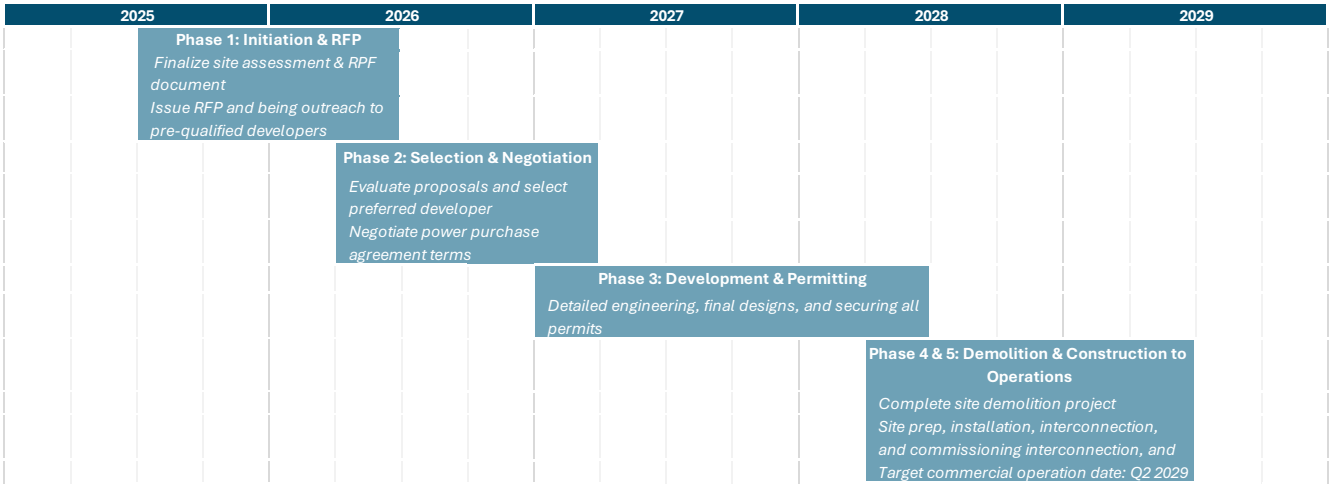


Figure 38. Timeline for Broadway BESS development

Solar at City-Owned Properties

The development of solar on city-owned properties plays a critical role in the OSP and presents opportunity to demonstrate leadership, reduce reliance on Glenarm, and increase the resiliency of our system and community. Learning from other cities, such as Glendale, who have started similar initiatives, City leadership may need to direct all departments to collaborate in order to ensure the success of the initiative and achievement of the planning target for municipal solar. City leadership could pass a resolution or develop a memorandum of understanding to ensure collaboration and continued progress toward the goals, even with expected turnover in staff throughout the years.

Since the completion of the OSP Local Solar and Storage technical study, we have been leveraging the detailed geospatial analysis of technical potential conducted in the study to identify and begin investigating the viability of installing solar on municipally owned properties. We have and will continue to engage other city departments including Public Works, Parks, Fire, and the City Manager's office in this effort, soliciting feedback on candidate sites and identifying sites for further feasibility analysis. Several additional analyses will be conducted to assess site suitability and establish their priority for development. These efforts include:

- **Site-specific solar modeling** to develop detailed specifications and characteristics for potential projects
- **Structural engineering reviews** to determine whether existing infrastructure is capable of supporting new electrical equipment or whether retrofits would be needed;
- **Permitting processes** necessary as a prerequisite to development of new electric infrastructure according to local codes and standards;
- **Hosting capacity analyses** to identify how much solar and storage can be connected to the distribution system in a specific location without adverse impacts to system reliability or power quality.
- **Engagement with local communities** that might be directly impacted by the installation of new electric equipment close to their homes and businesses.

Given the ambitious targets for development of solar on municipal properties, we will employ a phased approach to developing solar and storage, moving forward with projects on sites deemed

ready for solar and storage development while simultaneously continuing to identify additional sites for future development. All installations will be front-of-the-meter to lower costs and ensure the benefits of the projects are shared amongst the entire community.

We plan to release an RFP for a design-build contract for the first phase of projects in early 2026 with a target date of construction in early 2028. A design-build contract is a project delivery method where a single entity is responsible for the engineering, design, and construction of a project under one contract. This turnkey approach is our preferred method for developing municipally owned solar and storage due to its efficiency compared to a traditional design-procure-bid-build project method. We plan to coordinate project construction schedules sequentially, allowing us to control costs, manage risk, and optimize resources and project efficiency. We plan to benchmark, track, and inform the public on our progress on developing local solar and storage on municipal properties. We will share progress with the community through multiple venues including regularly updating the Clean Energy Tracker with information on project status and new projects under consideration.

Project Spotlight: The Sunset Reservoir Complex

The Sunset Reservoir is one of 14 reservoirs that serve a critical role in the City's drinking water system. Approximately 25% of the City's water demand is served by the Sunset Reservoir, which has been operating for over 125-years. The proposed "Sunset Complex Project" improves water system reliability to help ensure all PWP water customers have access to safe drinking water. This project consists of two circular concrete storage tanks designed to current seismic standards to replace existing reservoirs, and a new groundwater treatment plant that will allow PWP to utilize more of the City's groundwater supply.

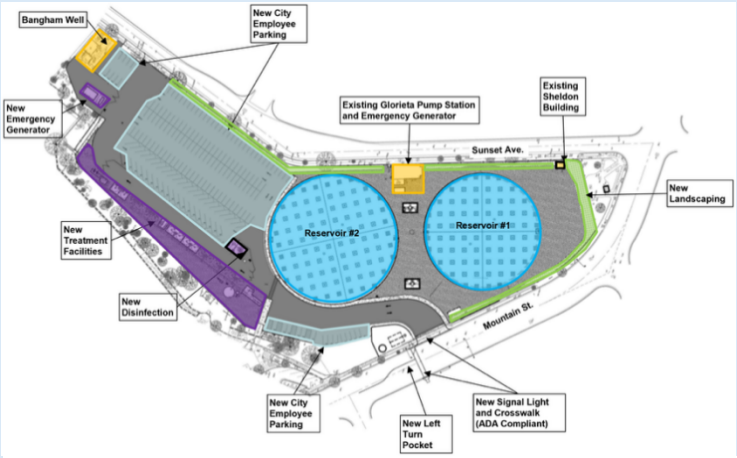


Figure 39 Sunset Reservoir Complex engineering diagram

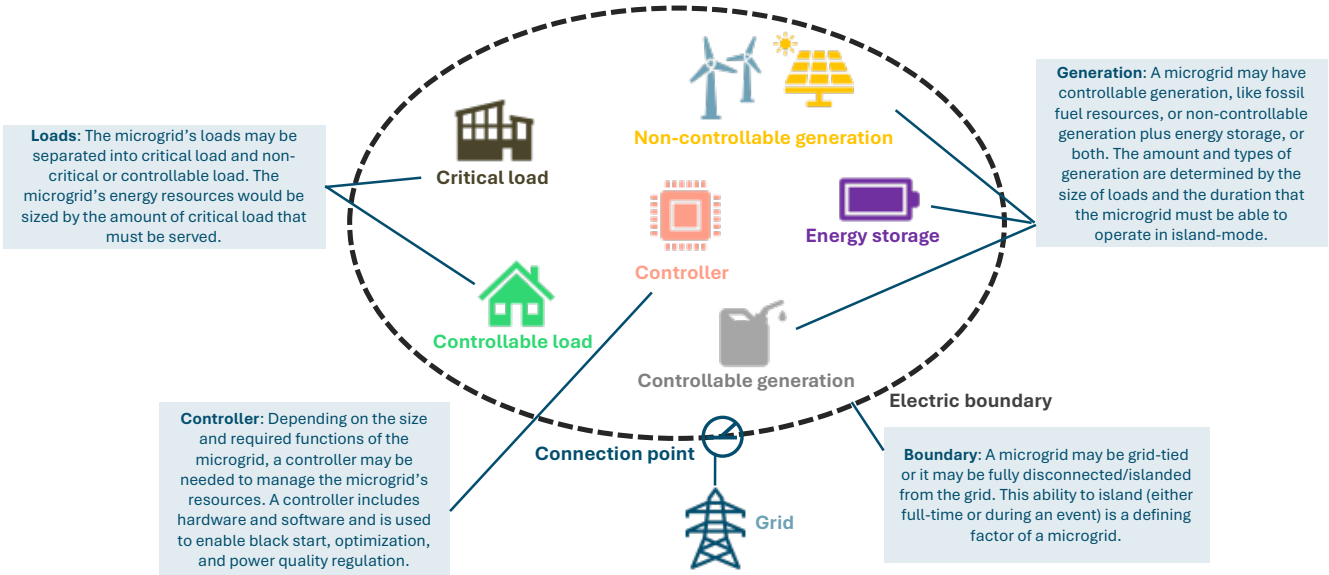
In conjunction with this water project, we are exploring opportunity to install solar at the Reservoir and are completing a feasibility study to assess the potential capacity for solar on this site on the parking lot and atop the two tanks. The OSP analysis found that there is 1 MW of rooftop and parking canopy solar potential at this site.

Microgrids at City, Commercial, and Institutional Sites

Microgrids present another opportunity to deploy solar, storage, and other distributed energy resources (DERs) that can contribute to meeting our planning targets for local resources while also increasing the resiliency of our community to extreme events. A microgrid is differentiated from a collection of DERs or a Virtual Power Plant (discussed further in Section 5.3) by its ability to operate in "island" mode or disconnect from the grid while continuing to power loads within its electrical boundary. While microgrids can operate in "island" mode in case of an emergency, microgrids

applications applicable to Pasadena are connected to the broader grid the majority of the time enabling them to provide grid services and capture economic benefits. Microgrids vary widely in their configurations, but they are generally comprised of critical loads, such as those for emergency services or community centers; flexible or controllable loads such as EV charging; controllable generation like fossil fuel generators and/or non-controllable generation like solar; and energy storage. Compared to a collection of DERs, a microgrid also has additional components including the microgrid controller to coordinate resources, enable black start capabilities, and regulate power quality, which results in higher upfront costs. Due to their higher upfront cost, the primary motivation for installing a microgrid is the resiliency benefits they can provide.

Figure 40 Components of a microgrid



We will advance the deployment of municipally owned microgrids in Pasadena to serve as resiliency hubs during emergencies such as extreme heat, wildfires, or earthquake related outages on our system. We plan to develop a microgrid program that takes a phased approach to scaling microgrids in Pasadena as described in the table below. In parallel to the first phase of work, we will partner with Caltech to develop a microgrid through on-going collaboration under a memorandum of understanding (see Section 6.1 for more details). The technical expertise that Caltech contributes to this collaboration will provide valuable insights and lessons that will help inform subsequent phases of our microgrid program. From this collaboration, we will also gain insight on how best to support our large commercial customers in developing microgrids.

Table 20 Microgrid program development plan

Phase	Activities

Phase 1: Criteria and Site Selection (2025-2026)	• Establish clear criteria for selecting municipal properties suitable for microgrids that reflect technical feasibility and community resilience value. Recommended criteria may include:
	  ○ Critical services role – properties that serve as emergency operations centers (e.g. fire and police stations)
	  ○ Community shelter potential – locations with HVAC capacity and occupancy codes that allow them to act as cooling centers for community gathering hubs
	  ○ Grid integration readiness – ease of interconnecting a microgrids and potential for solar development
	  ○ Geographic coverage – ensuring resilience hubs are dispersed across the community such that no neighborhood is underserved and each City Council district is represented.
	  ○ Equity – prioritize properties located in or adjacent to vulnerable communities
	  ○ Blackstart potential – identify sites that could serve as blackstart assets for Glenarm, allowing local resources to assist in restarting generation and restoring service in event of a system-wide outage
	• Publish a Microgrid Readiness Map of municipal properties evaluated under the selection criteria

Phase 2 (2027-2028): Multi-Site Deployment and Partnership Expansion	• Advance municipally owned microgrids and commercial partnership projects.
	• Develop a Microgrid Design and Partnership Template to standardize specifications for resource sizing, control and islanding protocols, interconnection rules, cybersecurity requirements, and partnership models (e.g. cost-sharing agreements, tariffs, resilience services credits). This Template should enable faster deployments and greater participation from commercial partners.
	• For municipal microgrids, focus deployment on high-visibility, high-value resilience hubs such as:
	  ○ Pasadena Central Library
	  ○ Community Centers (e.g. Robinson Park, Pasadena City College facilities)
	  ○ Public Safety Facilities
	  ○ City Yards and Water Facilities
	• For commercial and institutional sites, early deployments should focus on:
	  ○ Hospitals and Healthcare Facilities
	  ○ Large Commercial Complexes or Campuses
	  ○ Educational Institutions

Phase 3 (2029-2030): Scaling, Evaluation, and Rate Integration	• Evaluate performance of microgrids under simulated grid outage conditions • Develop a Resilience Rate Class recognizing the grid services provided by microgrids. • Conduct outreach to inform the public about the availability of the emergencies services providing by the microgrids. • Explore opportunities to use rate ordinances to require new construction above a defined load threshold to include microgrid-ready infrastructure.

Other Opportunities

Contracted development on private property

There are many mechanisms through which PWP can contract for the generation of local solar and storage resources developed on private property. In all these mechanisms, a private party would own the resources and be responsible for design, construction, and financing the project. PWP would contract for the output of the resources via a PPA or a Feed-in-Tariff. Our focus will be on developing a FIT by mid 2026 alongside ordinance revisions in the Electric Rate study.

A FIT provides potential developers with a fixed, long-term payment rate for each MWh of electricity they generate. The fixed compensation provided by the FIT reduces the financial risk for the customer of investing in solar and storage. The FIT program will be structured to provide customers with higher compensation during peak demand hours to incentivize the deployment of storage and the charging and discharging of storage to maximize the benefits to the grid, the participant, and our ratepayers.

Partnerships with large customers through a FIT can serve as a catalyst for overall community benefits. We are examining opportunities to require or incentivize projects to include workforce development or other community engagement provisions. FIT provide an opportunity to algin our customers' sustainability goals with our clean energy objectives, streamlining the siting, permitting, and funding processes for renewable energy development.

Community-based resources

Community-based resource programs (often referred to as community solar programs) are a tool to expand access to solar and storage to customers without the ability to install rooftop solar such as renters or multifamily housing residents, low -and moderate- income customers, or customers living in homes without suitable roofs. There are three program models for community-based resource programs applicable to a municipally owned utility like PWP: (1) subscriptions, (2) purchased panels, and (3) municipal community solar. As we pursue the carbon-free, equity, and rate stability objectives of Resolution 9977, there are multiple considerations regarding the value proposition of each of these models to the community and our customers.

In the subscription model, customers pay a premium on their monthly energy bills to have their power sourced from local solar projects. An example of this type of program is Austin Energy's Solar Standard Offer Program.[24] In this program, Austin Energy works with host customers to install solar panels or lease space to a third-party developer for installation. Austin Energy compensates the host or developer with the premiums paid by customers subscribing to the program on their bills. Austin Energy offers subscriptions at discounted rates to low-income customer participating in the program.

The value proposition for a participant in a subscription model community solar program is the opportunity to contribute to and accelerate clean energy deployment, which aligns with PWP's

[24] Solar Standard Offer Program, Austing Energy, https://austinenergy.com/green-power/solar-solutions/solar-standard-offer-program

commitment to increase opportunity for our customers to participate in the in the energy transition. However, when PWP achieves 100% carbon-free energy supply, this value proposition may no longer be relevant as all customers will be served with carbon-free electricity regardless of whether they are a participant in this type of community solar program. The longevity and long-term value to our customers of the program model are critical considerations for PWP as we evaluate options for community-based resource programs.

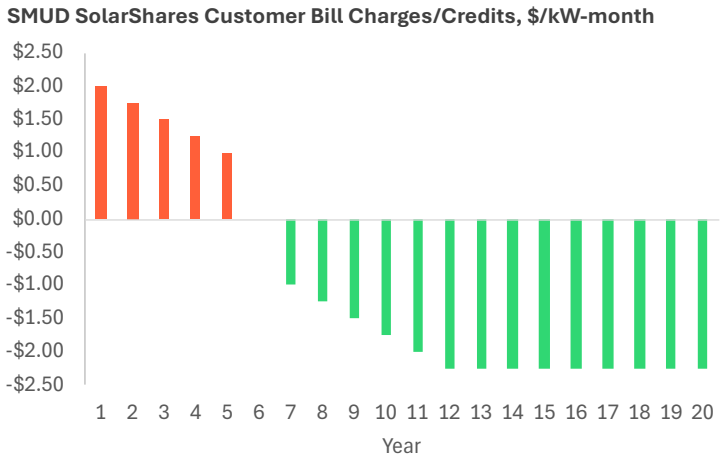


Figure 41 SMUD SolarShares program customer bill charges/credits

In the purchased panels model, participants pay either an upfront or monthly payment to fund the construction of the solar project and then receive bill credits over time. An example of this type of community solar model is SMUD's SolarShares program. [25] Residential customers participating in this program incur additional monthly charges on their customer bill per kW of community solar they support for the first 5 years of the term then they receive monthly credits for the remaining years 15-years as illustrated by the figure to the left.

While this program provides a mechanism for customers without the means to install rooftop solar to realize bill savings like customers under a solar incentive program, there are more direct and effective means of providing bill relief to our customers furthering the equity and affordability goals of Resolution 9977. A purchased panels model has administrative burdens for the utility associated with it and necessarily will be limited in size and participation. Providing this opportunity to reduce electric bills to those customers who signed up for the program first is not an equitable means of providing bill relief to all of our low- and moderate-income customers. Low-income bill assistance programs, potentially utilizing the public benefit charge funds, presents an opportunity to reach all or more of our customers than can be reached through a community solar program. Balancing the affordability and equity objectives of the Resolution is a key guiding principal us as we consider the value of community-resource program offerings.

As a municipally owned utility, resources we procure via direct installation on municipal property or contracted through a third-party developer with a program like a FIT are community owned resources. Procurement through these mechanisms can be considered a municipal community solar program. The costs and benefits of these community-based resources are shared amongst all our customers without singling out a given customer class or group of program participants. Municipal community solar is the most equitable community solar.

[25] Residential SolarShares, Sacramento Municipal Utilities District, https://www.smud.org/Going-Green/Residential-SolarShares

As discussed above, our strategy for accelerating local resource development heavily emphasizes municipal community solar and storage programs given the scalability and equity considerations. However, we will continue to evaluate customer solar program options as we seek to expand opportunity for our renter, multi-family, and/or low-income residents to participate in clean energy transition and lower their energy bills.

710 Freeway Stub

The abandoned 710 Freeway Stub ("710 Stub") is one of the last major open spaces in Pasadena and, as such, provides a unique opportunity to align infrastructure planning with the City's long-term decarbonization goals. The site will be developed for a mix of uses, and the surrounding community has expressed a strong interest in utilizing the site in a manner that balances economic development, livability, and sustainability.

The site encompasses approximately 57 acres, though preliminary assessments suggest that less than 10% of that area will be available for direct PWP activities. Even within this limited footprint, the potential for strategic utility investments is significant. Potential uses for the site for PWP include:

1. **Substation development:** A new dedicated substation will be required to handle new load from residential and/or commercial redevelopment at the site. The construction of a new substation presents an opportunity to enhance the backbone of our power delivery system to support the integration of local solar and storage resources.
2. **Develop battery energy storage systems:** Battery storage could be sited at the 710 Stub, supporting system-wide needs for storage as well as providing resiliency to the localized grid in the redevelopment area.
3. **Local solar development:** While there is likely limited potential for installing ground-mount solar at the 710 Stub, PWP can support the development of rooftop and parking canopy solar on the redevelopment. State building code will require that any new residential and commercial buildings at the site install solar to offset energy consumption and that any new commercial and high-rise multi-family buildings also install storage. We will proactively look for opportunities to support solar development any new parking lots at the site.

As planning for the 710 Stub progresses, we will engage with City planners and developers to secure land allocation for a substation and associated utility infrastructure; evaluate options and optimal sizing of a potential battery storage project that serves system-wide needs and local resiliency objectives; and identify opportunities to develop local solar at on new parking lots.

Participate in power flow study with Caltech

We are engaged with Caltech on a power flow study to evaluate the power quality and reliability impacts of solar, storage, and other DER adoption on 4 (of the 110+) feeders in our distribution system. While the need to perform distribution system upgrades to accommodate DER growth must be made feeder by feeder, we anticipate that the findings of this study will provide valuable information for understanding our system.

5.3 Develop innovative programs and rates to leverage customer-facing solutions

PWP has a long and successful history of working with customers to promote load management solutions through existing conservation and efficiency programs. As described in Section 3.1, we have developed an expansive offering of energy efficiency programs to meet aggressive targets for load reduction approved by City Council, and existing processes are already well-established to update these goals on regular cycles to ensure we can take advantage of all opportunities for cost-effective energy efficiency.

Building on the success of these programs and enabled by technological improvements, advanced metering infrastructure, and novel rate design, the OSP calls for an expansion of our efforts to engage customers in load management by scaling demand response and load flexibility as resources. Alongside existing efficiency programs, demand response and load flexibility will support the objectives of reliability and carbon-free electricity, reducing load during critical periods in a manner that limits reliance on the Glenarm Power Plant. Between load flexibility in buildings and managed EV charging, realizing the potential that is laid out in this study would enable PWP to manage approximately 10% of its peak load in 2030, which would place us among the top 5% of highest performing utilities nationally in load management[26], and the highest performer in the State of California.

Efforts to develop innovative load management solutions as a resource are closely tied to current efforts to deploy AMI throughout the City. Before completion of the AMI rollout (to be completed in 2028), we will engage customers in behavioral demand response – building relationships with key customers and providing community education on opportunities to contribute to the carbon-free energy transition. With AMI in place, we can, with the approval of the City Council, begin implementation of opt-out time-of-use rates to encourage customers to shift energy consumption to off-peak hours. Additionally, we are exploring options for scaling demand response and managed EV charging programs through various mechanisms including direct utility load control programs, third party aggregators, virtual power plants, and/or meter-level firm service limits.

Dependency Upon AMI

PWP is on track to deploy AMI (also referred to as "Smart Meters") by the end of 2028. In addition to providing many other operational benefits[27], AMI is a foundational step to unlock the benefits of load flexibility and managed EV charging, based on several critical features.

First, AMI allows for hourly and sub-hourly measurement and reporting of customer energy consumption to PWP for utility bill calculation. This more temporally granular measurement of

[26] Based on the percentage of enrolled demand response vs annual peak loads, as reported by utilities in the 2023 EIA Form 861: https://www.eia.gov/electricity/data/eia861/ . Smaller utilities with low load (<100MW peak load), or large unitary industrial customers providing DR, were filtered out of the dataset.

[27] Department of Energy, "Advanced Metering Infrastructure and Customer Systems: Results from the Smart Grid Investment Grant Program", 2016,

https://www.energy.gov/sites/prod/files/2016/12/f34/AMI%20Summary%20Report_09-26-16.pdf

energy consumption is necessary to implement time-varying rates, such as time-of-use (TOU) rates. Time-varying rates would give our customers the opportunity to save on their energy bills by aligning their energy consumption patterns with times of day when renewable energy is more abundant and clean energy is less expensive to generate. Time-varying rates also produce a price signal that can be leveraged by smart devices such as battery storage, EV chargers, or smart thermostats to dispatch in patterns that align with grid signals and ultimately reduce energy bills for customers. Since AMI and time-varying rates can be deployed widely across PWP's full customer base, this enables all PWP customers to alter their energy consumption patterns and help achieve Pasadena's Resolution 9977 goals.

Next, for more programmatic, or "actively managed" loads, such as Demand Response or Virtual Power Plants, AMI allows for detailed measurement and verification of baseline loads and load impacts when participating loads are called to respond to electrical system events. This accurate measurement of baseline loads and load impact from events has three key benefits. First, measuring baseline load profiles will help identify customers with the highest consumption during critical hours on the grid, and allow PWP to target those customers for enrollment in programs. Second, the accurate measurement and verification of load impacts allow for the verification and measurement of the extent to which a given customer participated in an event; direct incentive payments to customers, or payments to third-party aggregators, are based on these verified impacts. Third, the verification of event-based load impacts allows utility planners to plan better for future impacts of load flexibility programs, and to gain confidence in the capabilities of load flexibility resources as they scale from pilot to full program to critical resource. Strong data, and confidence in reliable load impacts from load flexibility programs, will ultimately enable utility planners to avoid other costly infrastructure upgrades.

Last, AMI provides a critical communications platform for automated demand response, where devices receive price or dispatch signals from the utility, and programmed devices automatically respond. As is the case for other demand response events, AMI allows for the active monitoring of responses and verification of performance for future incentive payments or bill calculations.

Insights from Technical Studies

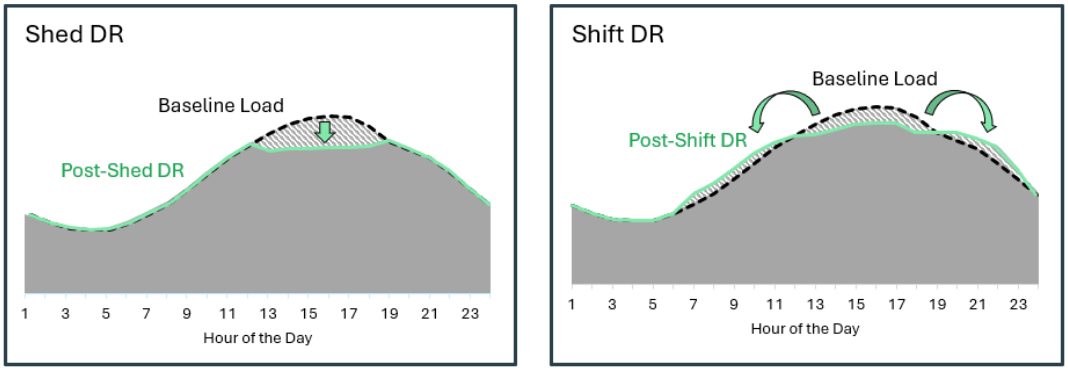
Options for advanced demand response include both "load shedding" and "load shifting" measures.

LBNL's dataset considers two types of demand response, shown in Figure 42. While the mechanisms to enable these two types of demand response may differ, the ultimate goal is to reduce PWP's load during critical hours.

- **Shed:** Loads that can be curtailed to provide capacity reductions. This type of demand response is consistent with more conventional demand response offerings and is typically invoked during a limited number of events per year. Shed DR may rely on temporarily disrupting customer's energy consumption behavior; for example, this could mean setting a thermostat set point on a hot day from 72°F to 78°F for several hours.
- **Shift:** Loads that can be shifted between hours. This type of demand response prioritizes maintaining customer behavior patterns through less noticeable shifts in energy consumption from one time of day to another and is typically performed by scheduled or

automated smart devices, based on time-of-use retail rate signals, and repeated on a daily basis. An example of Shift DR is pre-cooling a building or shifting the schedule on a pool pump to align with lower-cost time-of-use periods.

Figure 42. Illustrative load impacts of "shed" and "shift" demand response



Multiple end uses in buildings provide promising opportunities for load flexibility. Efforts to characterize the potential for advanced DR programs have improved significantly over the past decade, in large part due to the collection and analysis of detailed interval data made available by AMI. While this type of data is not currently available for PWP customers specifically (due to the lack of AMI), studies of neighboring California utilities provide a useful starting point to identify the types of customers and end uses that may provide promising opportunities for future demand response programs.

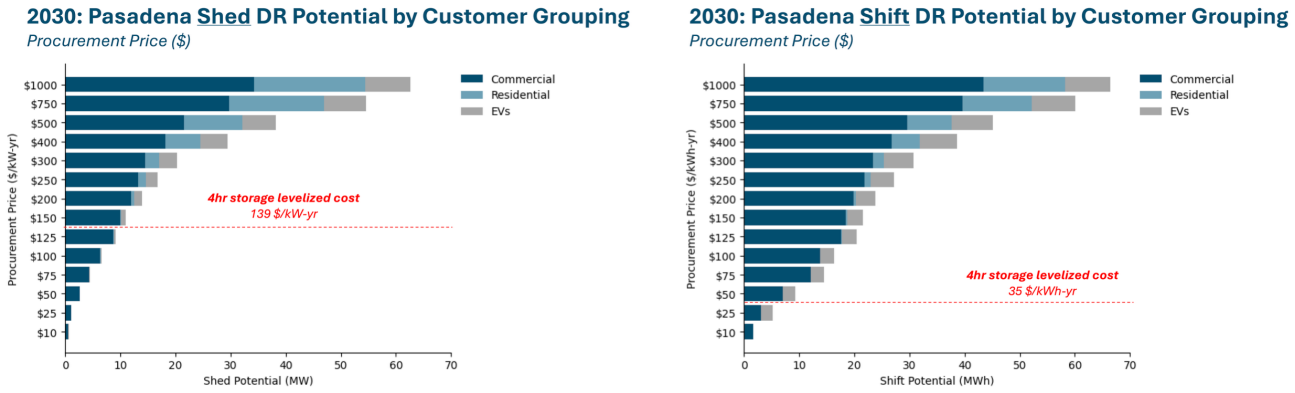
To fill the gap for customer segmentation data and help identify the customer types and end use loads in buildings that are ideal candidates for load flexibility programs, the study team leveraged data from Lawrence Berkeley National Lab's California Advanced Demand Response Potential Study supply curve database.[28] This study, which reflects the most advanced effort to quantify the cost and potential for demand response completed in the industry to date, provides hourly profiles and underlying technology costs for load flexibility by customer sector (e.g., residential, commercial), end use (e.g., space cooling, water heating, etc.), and customer energy consumption decile (e.g., customers in the 90th percentile of annual energy consumption in a given region/sector) for 8 regions across the service territories of the three California investor-owned utilities. To adapt this information for the purposes of the OSP, the study team used per-customer shed and shift potential in hot-dry climates in the Los Angeles Basin region from LBNL's study and scaled values to represent to PWP's

[28] Gerke et al, 2024, "California Demand Response Potential Study, Phase 4: Report on Shed and Shift Resources Through 2050": https://buildings.lbl.gov/potential-studies

service territory based on the number of customers within the energy consumption deciles present in the LBNL database.[29]

The result of this exercise is two supply curves for demand response (shed and shift) in buildings representative of PWP's service territory.[30] These supply curves are shown in Figure 43. By virtue of the fact that shed and shift represent different grid services, the units in which potential are expressed are different: shed DR is expressed in units of MW, representing the potential magnitude of load reduction; shift DR is expressed in units of MWh, representing the amount of energy that could be shifted over a four-hour window.

Figure 43 Supply curves for shed and shift demand response for buildings in PWP service territory



These supply curves provide multiple useful insights to inform PWP's planning efforts:

- The scale of potential cost-effective demand response in buildings (as measured relative to a four-hour battery storage benchmark)[31] represents a potential load impact of roughly 15 MW, or approximately 5% of PWP's peak demand. This scale of impact among residential and commercial customers exceeds the relative size of existing DR programs across almost all utilities in the country today.
- Most potential for demand response in buildings is concentrated in the commercial sector. This is consistent with the fact that a majority of PWP's annual energy (approximately 70%) is consumed by commercial customers; it is therefore more likely that commercial customers have significant load during critical hours.

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[29] LBNL's study is based on AMI data from California's Investor-Owned Utilities, including Southern California Edison (SCE). While LBNL's study was based on SCE customer data, the fundamental data of hourly customer behavior patterns and underlying technology costs (ex. thermostats, communications platforms), are applicable to neighboring utilities such as PWP. PWP should continue refining these estimate of potential as more participation and load impact data from pilot programs for DR becomes available.

[30] Note that LBNL's study also includes DR supply curves for transportation end uses; the potential load impacts of managed charging were considered separately in the OSP and are discussed in greater detail below and so are not included here.

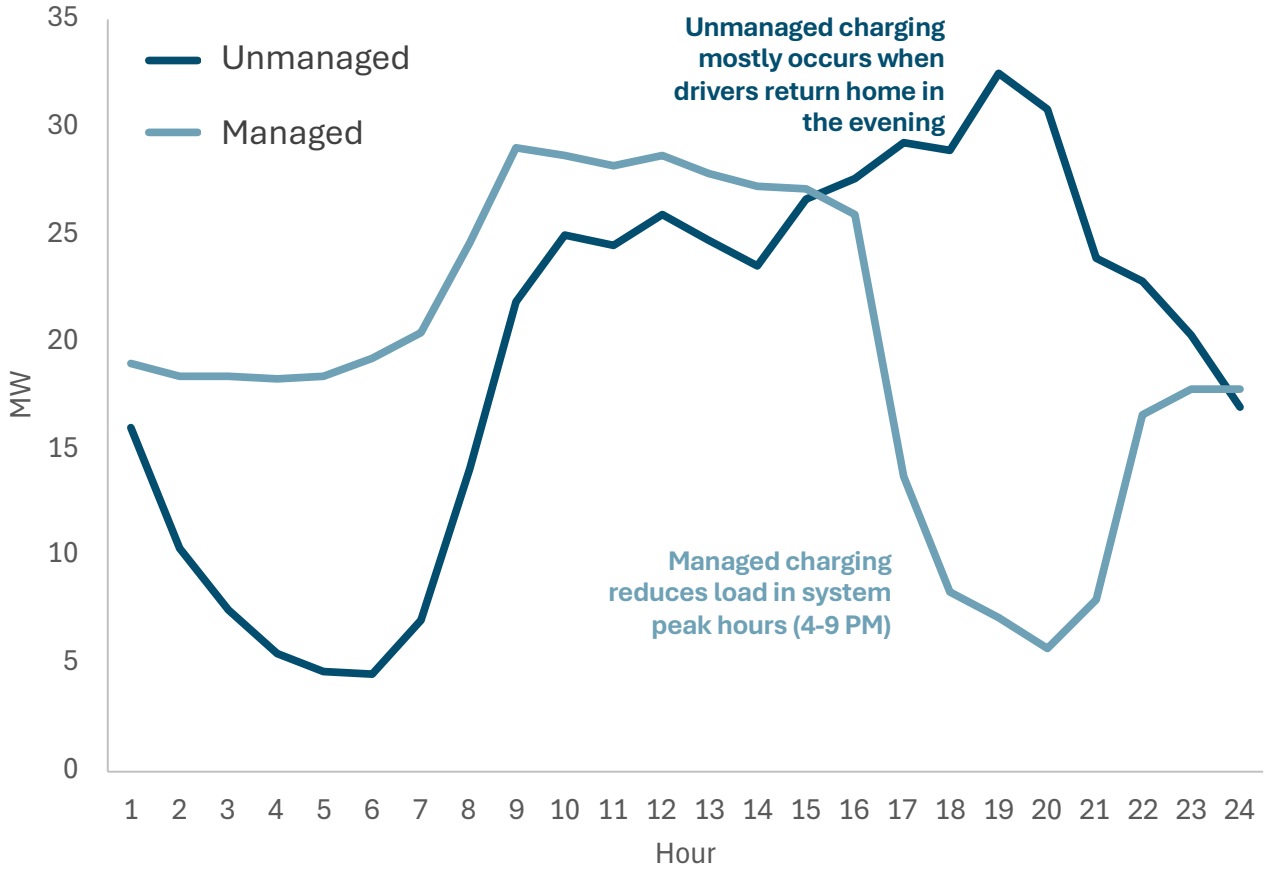
[31] The storage cost benchmark used in this study was developed prior to the imposition of federal tariffs on critical materials that impact the battery supply chain and are likely to result in higher costs in the near term. Higher costs for battery storage could increase the cost-effective potential for demand response in PWP's service territory above the levels included in the OSP.

- Underlying the customer type data presented in the supply curves above is detailed information about specific end uses. These end uses will be targeted in PWP's load flexibility programs, either by tailoring programs specific to these end uses, or by creating programs that are technology-agnostic, and providing educational materials to customers that these end uses are strong candidates for load flexibility. In particular, PWP, in its pilot programs and early large-scale program development, will prioritize large customers and key accounts that may have high levels of load flexibility accessible through single points of contact.[32] The most promising end uses in buildings for DR deployment appear to be:
    - Commercial HVAC (automated)
    - Commercial Refrigeration
    - Commercial HVAC (additional impact manually)
    - Manual control of commercial loads (ex. lighting)
    - Residential smart thermostats
    - Residential water heaters
    - Residential smart panels
    - Residential pool pumps

As electric vehicle loads grow, managing charging behavior will become a critical tool to limit its impacts on peak demand. In addition to loads in buildings, managed EV charging also shows significant promise as a flexible load. EV charging is projected to become a significant source of load growth for PWP in the coming decade and EV charging also has the potential for flexibility and scheduling.

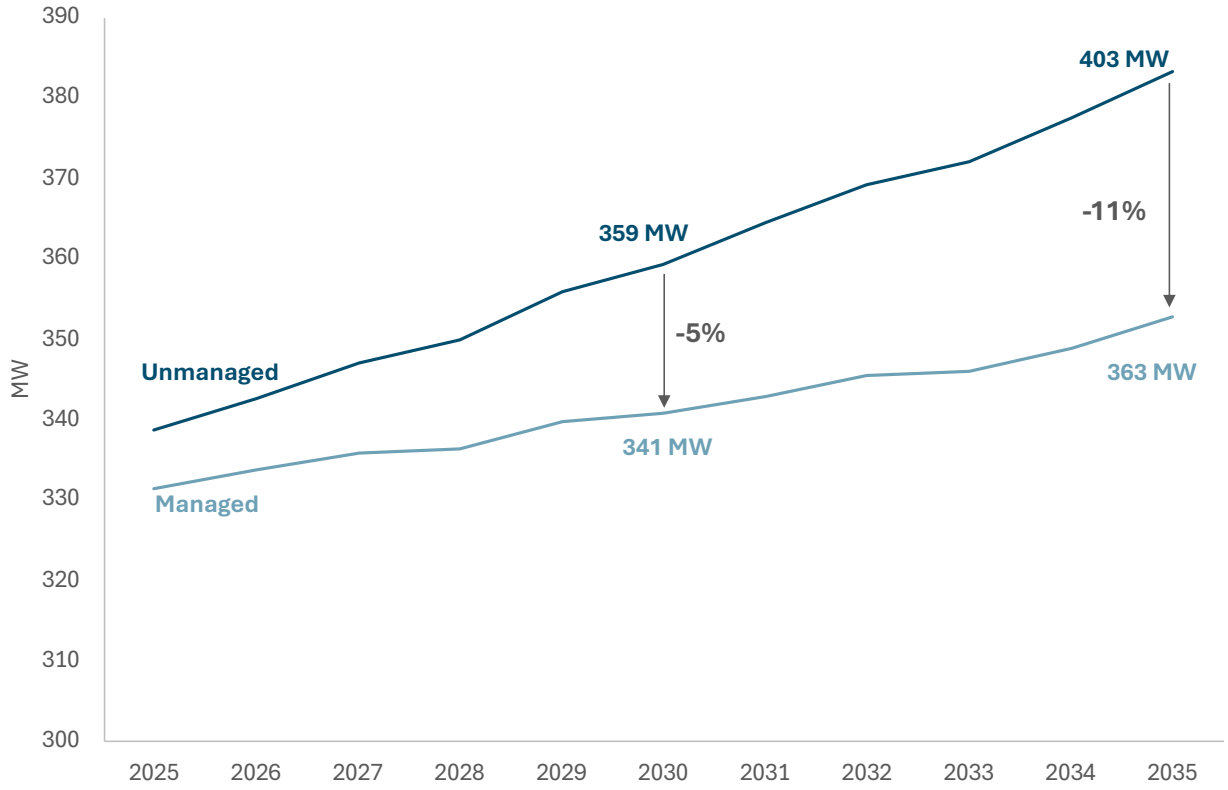
[32] Note that the average of a customer sector is not indicative of all customers within that sector - there is a wide underlying distribution and many customers who do not conform to the sector-average behavior pattern. There are likely to be some residential customers with high load during critical hours (e.g., residential customers with high AC loads at night). Conversely, there are likely some commercial customers that have low loads at night during critical hours (e.g., an office building that closes in early evening and has no loads running overnight), and some commercial customers that have higher loads in evenings/night (e.g., the hotel/hospitality sector). In practice, AMI data can help identify the specific customers that typically have the highest load during critical hours and, therefore, potentially the highest potential to shift or shed loads, if they are targeted for enrollment in load flexibility programs.

Figure 44 Difference in average daily EV charging shapes with unmanaged and managed load



Based on OSP modeling, as observed in Figure 45 below, managed EV charging has the potential to reduce PWP's net peak loads by approximately 20 MW in 2030.

Figure 45. PWP's Forecasted net peak loads with and without managed EV charging



This level of net peak reduction is contingent on achieving highly ambitious levels of nearly universal enrollment in TOU rates and active managed demand response programs and no opt-out of participation. The managed charging scenario shown in the figures above assume 100% participation in active managed programs while the unmanaged scenario assumes 3%. As this new load grows, we plan to enroll these customers in some form of load management strategy. Note that these forecasts of load flexibility potential are based on a forecast of load – actual realized levels of load flexibility will be a function of the actual adoption of electric vehicles and the corresponding load.

The most valuable hours for load management will shift from afternoon peak periods to later in the day as a result of the changing resource mix. Load flexibility and load management should necessarily be aligned with hours of highest grid need, or "critical hours," periods when reliability risk is highest, when the electricity system is most difficult to decarbonize, or both. Critical hours may not align with the peak load of all customers; for load flexibility programs, it is important to target customers or end uses that have load flexibility potential in critical hours. Ideal customers and end uses would have both significant levels of load present during critical hours, and the flexibility to shift or shed load from those hours. Modeling performed in the technical analysis for the OSP identified these critical grid hours; PWP will use these hours as a guide to further identify promising potential candidates for load flexibility programs.

In present-day conditions for PWP, critical hours on the electric grid are concentrated in the summer afternoons, as shown on the left in Figure 46, when high temperatures in Pasadena drive air

conditioning loads and cause system gross peaks. This dynamic is observed throughout California and broadly across the United States and has created an expectation across the industry that peak loads are typically driven by air conditioning in the summer afternoons. Because of this, many existing demand response programs across the State and country target air conditioning through advanced HVAC controls or smart thermostats. Note that this heat map shows the hours of day and the months in which critical hours will take place and does not necessarily indicate that all days in July, August, or September will experience critical load events; in practice, critical hours are when grid reliability is truly threatened and is typically driven by extreme weather events.

The map of critical hours will evolve in a highly decarbonized grid, and load flexibility programs must also evolve in order to continue providing benefits. As seen on the right in Figure 46, OSP modeling shows that, with forecasted load growth and a generation portfolio that meets the carbon-free goal of Resolution 9977, the abundance of solar generation will shift critical hours toward summer nights - particularly on hot days after the sun sets. Functionally, if load flexibility is not pursued, more battery storage will need to be built to move solar energy from the day to the night on these peak days to serve loads and maintain reliability; additional load flexibility achieved at night reduces the level of battery storage that PWP will need to procure.

The evolution from the present-day convention of summer afternoons to summer nights will be rapid, taking place over a couple of years, and will impact which customers and end uses are more relevant to meeting the grid's needs. Beyond 2030, this new dynamic is forecasted to persist; associated programs should focus on building the capability to shed load or shift load out of these nighttime hours on days with extreme weather conditions.

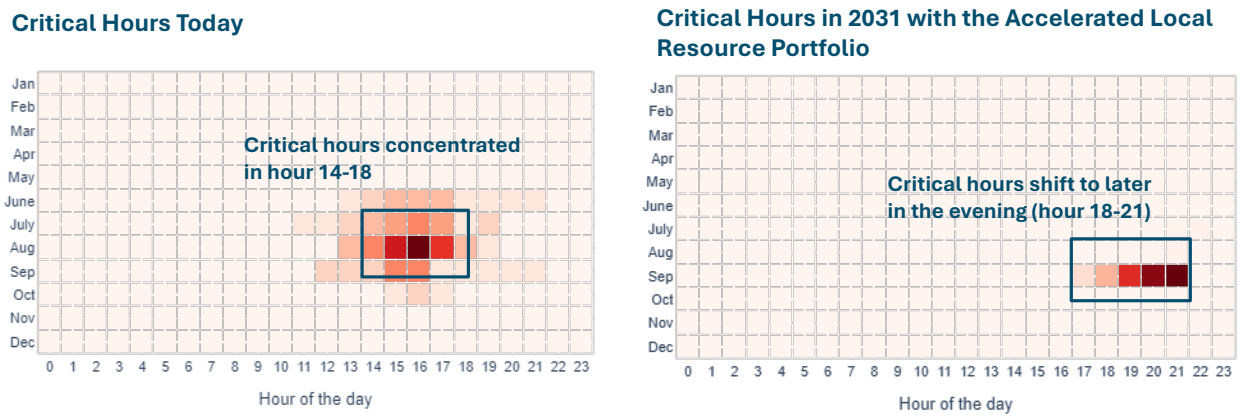


Figure 46. Heat map showing the concentration of critical hours for PWP, by month of the year and hours of the day. Left shows critical hours in PWP's system today and right shows critical hours, based on the loads and generation portfolio present in 2031, consistent with the achievement of Resolution 9977.

While the modeling for the OSP represents the results based on the currently best available input data, estimates, and assumptions, PWP's system needs may continue to evolve based on dynamic conditions impacted by unforeseen factors. As future conditions evolve, to define the critical hours in which load flexibility should be targeted, PWP's resource planners will consider hours in which utility scale batteries are being dispatched at nearly maximum capacity.

Mechanisms to Unlock Load Flexibility

Following the OSP, and in coordination with the rollout of AMI, PWP will develop new customer program offerings to enable load flexibility. While specific procurement mechanisms are not modeled explicitly in the OSP analysis of resource potential or cost, we will explore our options in future work and test what will resonate with the community, what is most impactful, and what is most cost-effective. Potential procurement mechanisms that PWP may explore are summarized in Figure 47 and detailed below.

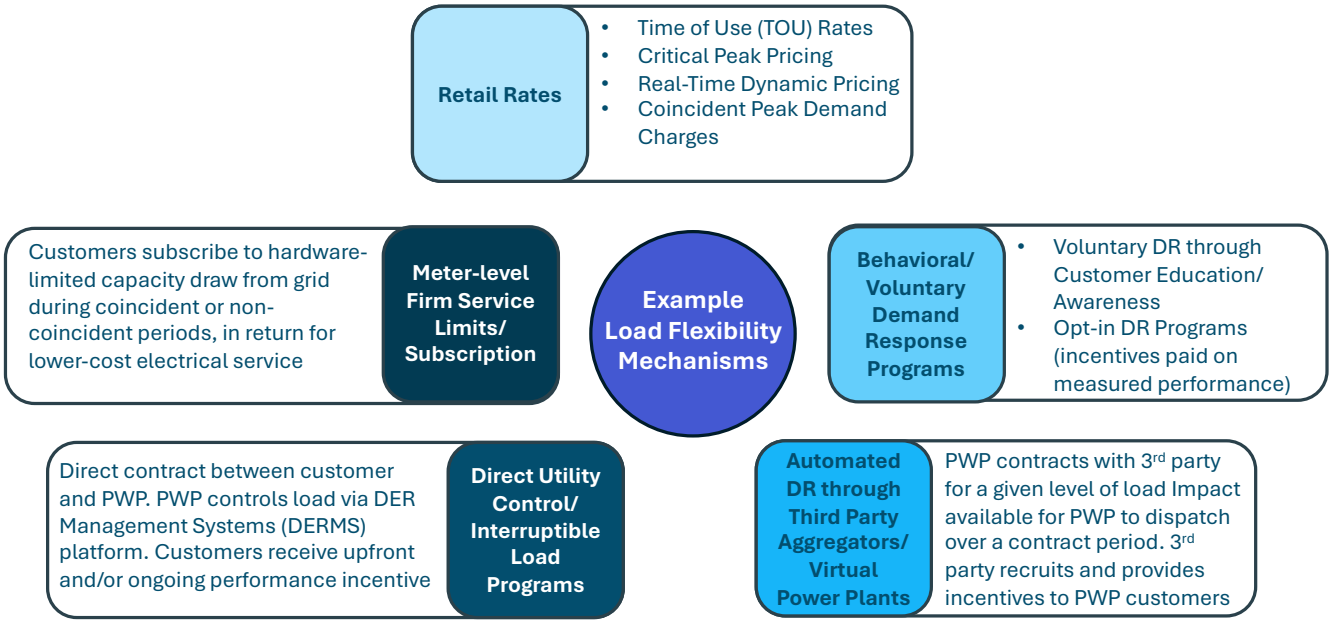


Figure 47 Example mechanisms that PWP can leverage to procure or enable load flexibility

Time-Varying Rates

Time-Varying Rates are a key mechanism to enable load flexibility. Rates are a highly scalable, automatic mechanism that allows customers to achieve bill savings without needing to enroll in programs or install new technologies. Time-varying rates can take several different forms:

Table 21 Rate design options to encourage load flexibility

Rate Design Component	Description and Considerations
Time of Use (TOU rates)	TOU rates typically have 2-4 different price periods in a day, with a pre-determined schedule that repeats daily over the course of a season (e.g., "Off-peak" or "On-peak", on hourly schedule blocks, such as 5-9 PM on summer weekdays). The predictability of TOU periods allows customers to set schedules on devices without advanced controls or build repeatable behavior patterns around these schedules (such as running laundry in off-peak hours). The ratio of off-peak to on-peak pricing can vary to incentivize behavior change to different extents.
Critical Peak Pricing	Critical Peak Pricing programs use short-term weather forecasts to identify days that include critical hours - typically giving participants 1-5 days of

Rate Design Component	Description and Considerations
	advance warning - and set especially high energy prices in those critical hours to incentivize load flexibility. Compared to TOU periods, these rate structures can more effectively capture the high costs of serving loads during scarcity conditions; a relatively limited number of hours over a multi-year period determine the generation capacity and infrastructure needed to provide reliable electricity to customers. Critical Peak Pricing rates may have call limits for a given year (e.g., PWP could only call a Critical Peak Period a maximum of 10 times per year) and, therefore, has some similarities to event-based demand response programs.
Real-Time Dynamic Pricing	Real-Time Dynamic pricing directly exposes customers to hourly or sub-hourly wholesale market prices (e.g., CAISO day-ahead or real-time market prices) and is therefore even more cost-reflective than Critical Peak Pricing rates. These price structures fully align participant costs with the wholesale costs that utilities incur to provide electricity to their customers. Given this alignment, Real-Time Prices are considered to be the most economically efficient rate design. While economically efficient, wholesale markets can be considerably more volatile that typical retail rates, which exposes customers to increased financial risk if they are unable to manage loads around the volatile prices.
Demand Charges	Demand charges are another retail rate mechanism that give customers the opportunity to reduce their bills by reducing their consumption in ways that yield utility cost savings. Demand charges can be "noncoincident" (based on an individual customer's peak load), or "coincident" with their utility's net peak load. Non-coincident peaks are easier for customers to predict and plan around but may yield lower utility benefits due to misalignment of timing. Coincident peak demand charges are more aligned with utility cost drivers but are dependent on a utility's ability to predict and communicate the timing of coincident peaks and on a customer's ability to react to those events in a relatively short amount of time.
Fixed Charges	Fixed charges are a mechanism by which customers are charged a flat fee every month, or billing cycle, regardless of consumption levels, so long as they are an active customer connected to the electric system. Fixed charges play a role in load management by allowing for a lower floor for volumetric rates (per-kWh) – for example, a lower rate in the off-peak TOU period – while still recovering the required costs to operate the utility, and thus providing a stronger signal for customers to shift load into desired hours.

In general, with rate designs, we will continue with planning and community engagement efforts outside the OSP, to determine the right balance for the community between rates that align with its cost drivers and the extent of direct financial risk or volatility imposed on participating customers. Note also that rates are not only a mechanism for incentivizing desired consumption patterns but are also our primary means of recovering the costs of operating the utility. Many priorities must be balanced in setting time-varying rate design.

Utility Demand Response Programs

While time-varying rates are cost-efficient tools for broad-scale participation, programmatic demand response is another key mechanism to enable load flexibility, as it achieves higher levels of certainty in load impacts during critical periods, beyond what rates can provide. We will explore different approaches and programs design options for programmatic demand response, including varying levels of upfront incentives, performance payments, or contractual obligations that can provide a higher level of certainty that load impacts will be realized when they are needed. Demand response programs can be structured in many ways. We will work with the community to test receptiveness to different program structures and determine what will yield the most scalable impact for different customer sectors and different customer types.

A range of potential structures for demand response programs to be explored are summarized in the table below.

Table 22. Demand response program mechanisms

Demand Response Program Mechanism	Description and Considerations
Uncompensated voluntary demand response	This would be structured similar to text message-based "Flex Alerts", in which PWP would provide customers with advance notice that a critical grid event will take place in the near future, and request that customers reduce their consumption during the critical hours. These programs do not rely on financial compensation but instead rely on an informed and responsive pool of customer to respond out of a spirit of duty to the community. Potential testing for the effectiveness of this program structure will include the extent to which customers will respond to these events, the certainty in impact, and the potential degradation of response if multiple events are called over a short timespan. As this is a voluntary response that customers would opt into with little planning, long-term capacity impacts may be difficult to quantify. PWP currently offers an uncompensated voluntary load curtailment program (VLCP) for Key Account commercial customers.
Compensated voluntary/opt-in demand response programs	This type of program is similar to uncompensated voluntary demand response but seeks to improve participation levels and certainty of response by enrolling customers on a seasonal basis, ahead of any events, and providing monetary incentives for participation. Potential compensation mechanisms could include upfront incentives to enroll or to purchase smart devices, an annual incentive for ongoing enrollment, performance payments per event in which a customer participated (direct cash, bill credits, gift cards, etc.), or performance payments per kW of load

Demand Response Program Mechanism	Description and Considerations
	impact during event calls. Upfront incentives could be coupled with penalties for failure to perform, to ensure reliable participation in programs. This program type can be leveraged in any customer sector and typically relies on manual responses by customers (e.g., by physically changing a thermostat set point during an event). PWP currently works with interested commercial customers to enroll in the California Energy Commissions Demand Side Grid Support (DSGS) Program[33], which provides compensation to customers to participate. This program provides an incentive for commercial customers to begin installing demand response controls, and get in the practice of responding to event calls, but this is program is funded by the State, dispatch is controlled based on statewide CAISO market signals; future iterations of this will need to tune dispatch to PWP's unique needs.
Large commercial/industrial interruptible load programs	This type of program functions by enrolling customers on a seasonal basis and providing monetary incentives for participation in programs but targets large commercial and industrial loads that have large single sources of load that can shut down in utility-critical hours (e.g., closing down a manufacturing plant or process for an extreme weather day). These program types are typically coupled with negotiated lower rates on existing service connections or on new utility interconnection requests from large customers (e.g. data centers); the customers would pay less for electricity, or could receive an expedited interconnection to the distribution system but accept a lower quality of service, in that their electricity service would be curtailed during a limited number of critical hours in a year. This style of program is the most conventional form of demand response in California, and pre-dates programs that leverage smart technologies.
Automated Demand Response	This type of demand response program is experiencing rapid growth in the broader utility industry, as it leverages new technology and communications tools that have only recently been made available to the utility industry; automated demand response forms the backbone of many Virtual Power Plant offerings or aggregated demand response programs. Automated demand response is similar to compensated voluntary demand response, in that customers enroll in advance on a seasonal basis, and receive some form of incentive to participate, but with the extra distinction that it would leverage smart devices and communications platforms to automatically dispatch load flexibility without any other manual intervention by customers on the day/time of the event. Customers simply opt in to enrollment for a given smart device at the beginning of their participation, and then the utility or a third-party aggregator dispatches the enrolled devices during critical hour events.

[33] Demand Side Grid Support (DSGS), California Energy Comission, https://dsgs.olivineinc.com/

Demand Response Program Mechanism	Description and Considerations
	Given the automated nature of this style of demand response, it can scale more easily, provide higher levels of certainty, and be easier to forecast in planning. In order to enable this resource, more substantial software-based load management platforms and communications infrastructure would need to be established by PWP. PWP is actively exploring automated demand response for residential smart thermostats, managed EV charging, and battery-based virtual power plants.

In the program design process, we will explore several key program design elements, to create an impactful demand response program. This effort to determine what will be most impactful will require feedback from the community through surveys, workshops, and pilot programs; demand response programs are dependent on community engagement, and customer experience will be at the center of program design elements. Some key considerations include:

Table 23. DR program design considerations

Consideration	Design Choices and Options
Enrollment/Recruitment methods *How PWP establishes initial connections with customers to educate and enroll in programs*	• Partnerships with retailers or tradespeople to offer program enrollment during device sales or device installation. Industry reports have identified point-of-sale enrollment, and device pre-enrollment, as high-impact recruitment strategies[34] • In-person promotional events • Concise information and enrollment opportunities through utility bill mailers • Targeted engagement through key accounts • Partnership with other utility programs, such as energy efficiency or behind-the-meter solar/storage
Incentive types, incentive levels, and associated requirements for receiving incentives: *How PWP compensates customers for participating in programs and what requirements are set for customers as a condition of their compensation to ensure resource performance*	• Incentive type: direct monetary compensation (bill credits, direct cash payments, gift cards, reduced retail rates, etc.), gamified incentives (such as recurring draws for larger rewards among a pool of top program performers, recognizing streaks for continued performance, etc.), accelerated permitting or interconnection, community recognition, or other qualitative rewards that participants feel recognized or appreciated for their contributions • Incentive level: PWP will need to balance the cost and associated rate impacts with some targeted level of cost-effectiveness compared to those of counterfactual utility resources

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Consideration	Design Choices and Options
	• Programmatic requirements: PWP will only be able to avoid procuring other capacity resources to the extent that it can count on load impacts from these programs. To ensure a minimum level of performance, some program designs include performance penalties for lack of performance, particularly if customers receive upfront incentives or discounts on energy rates as a part of enrolling in a program
Customer retention *Once customers enroll, it will be important for PWP to determine the right balance between calling on demand response frequently enough to get the desired grid impacts, and not calling on demand response so frequently that participants begin to opt out.*	• Limits on the number and frequency of event calls in a given year and the tolerance for customers to continue to participate in programs that have a higher number of calls per year • Frequency of customer notification and engagement • Customer flexibility to temporarily opt-out or alter participation level
Procurement/Aggregation model: *Often categorized as Virtual Power Plants (VPPs), there are several aspects of DR procurement and aggregation that PWP can either choose to implement with internal staff and resources, or hire third parties to perform. Some utilities choose to recruit customers, dispatch automated DR through utility-operated software tools, and process performance payments internally. Other utilities opt to hire a third-party vendor as a turnkey virtual power plant solution to recruit customers, provide incentives to the extent necessary, and ensure that impact levels meet contractual performance standards.*	PWP will work to determine which program model (utility-run vs. third party managed) best meets the needs of utility operations and participants from the community for the following program elements: • Customer recruitment and program marketing • Ongoing alerts/communications to participants • Measurement and verification of participant performance during demand response events • Ongoing payments to customers based on performance or participation • Communications/IT for aggregating load and dispatching automated demand response • Ensuring minimum level of performance to meet utility planning targets, and determining which party should take responsibility for performance risk (customers, third-party vendors, or PWP)
Additional program offerings *In addition to these program characteristics, PWP may choose to consider other elements to enable a more streamlined experience*	• Financing options: offering participants subsidized financing options to offset the upfront costs of load flexibility. Loans could be repaid through on-bill financing charges, property tax, or direct payments to partnering financial institutions • Coupling with other customer-facing energy programs: PWP will look for opportunities to pair the installation of load flexibility technologies with other customer-facing programs such as energy efficiency, EV charging infrastructure upgrades, or behind-the-meter solar/storage

Consideration	Design Choices and Options
	• Connections to building permits or new construction or retrofits: PWP can explore the ability to include load flexibility technologies or requirements in local building code and building permit requirements

Tying back to OSP efforts and integration into bulk system planning, in order to avoid the need for additional utility infrastructure (e.g. utility-owned local battery storage), we will analyze ongoing programs to establish high-confidence minimum bounds for performance from load flexibility resources. Improving confidence levels of load impacts can be achieved through contractual obligations from participants, or proven historical performance as programs develop from pilot to fully scaled programs. It is critical to ensure that the impacts of demand response programs are being accounted for appropriately in bulk system planning and utility financial planning, and that bulk system procurement needs are adjusted accordingly.

Virtual Power Plants

Virtual Power Plants are a way to aggregate customer-based load flexibility and is an increasingly popular concept in the industry. VPPs capture the same underlying load flexibility studied in the OSP - behind-the-meter storage, EV charging, and building-based loads - and create a streamlined, dispatchable resource package that can be integrated into utility operations.

As a first step in the process of developing VPPs, PWP will explore what role we, as the utility, should play in recruiting, aggregating, and dispatching demand response. Given the broad use of VPPs as an umbrella term in the industry, if PWP chooses to leverage turnkey VPP providers to procure load management, it is important consider interactions with OSP goals to avoid under-estimating or double-counting the contributions from VPPs by either:

- Setting guideposts for transparency of what customers and end use loads are being leveraged for any given VPP, or
- Merging capacity-based OSP goals to create a diverse blend of behind-the-meter storage, managed EV charging, and building-based load flexibility.

Vehicle Charging Infrastructure

In addition to rates and program offerings, electric vehicle charging infrastructure plays a critical role in achieving the goals Resolution 9977. The location of EV charging infrastructure not only determines *where* on the distribution grid these loads will occur, but also *who* has sufficient access to EV charging, *when* the charging takes place, and *how* flexible that charging can be. Our EV charging infrastructure will be guided by the principles of Resolution 9977:

- **Carbon-free**: Is EV charging available where community members – and their cars – are during hours when carbon-free energy is abundant, particularly during the day when solar generation is highest? How can EV charging infrastructure encourage the widespread adoption of electric vehicles, and more rapidly achieve the associated benefits of reducing vehicle emissions?

- **Affordable**: How can EV charging infrastructure efficiently leverage existing electrical distribution infrastructure and minimize expensive or lesser-utilized distribution grid upgrades? Is EV charging infrastructure available to the community during hours when energy costs are typically lower?
- **Reliable**: Is EV charging infrastructure available where electric vehicles will be parked for longer durations, enabling EV charging to be shifted or managed based on grid needs? Can community members count on EV charging infrastructure to be available to them when they need it?
- **Equitable**: Do all members of the community have convenient access to EV charging, even if they do not have the ability, means, or agency to install EV charging at their residence or place of work?

With these principles in mind, we will develop a comprehensive plan to a) deploy electric vehicle charging infrastructure at municipal and publicly accessible parking lots, and b) partner with private businesses and individuals to incentivize beneficial infrastructure. This plan will inform program structures and guide the number and types of EV chargers (level 2 chargers, direct current (DC) fast chargers, etc.) to deploy at any given electrical location. PWP's strategies to support EV charging infrastructure and associated programs will vary by use case, as shown in Table 24.

Table 24 EV charging applications to be considered in EV Charging Infrastructure Plan

Location/Application	Considerations, Preferred Approach, and Next Steps
Municipal and Other Publicly Accessible Parking Lots	Publicly accessible EV charging infrastructure is a primary means to encourage widespread adoption of electric vehicles and provide equitable access to EV charging for community members who may not otherwise be able to install EV charging infrastructure at their residence or place of work. Public EV charging infrastructure can also have a significant impact on the grid. DC fast chargers generally have charging rates between 50 kW to 350 kW, and charging sites usually have 4-20 chargers at a location, creating localized sites of significant growth in demand. While public EV charging, and in particular high-powered DC fast charging, is generally less flexible than home or workplace charging, we will look for opportunities to mitigate the impacts to the grid. For privately-owned, but publicly available locations, we plan to: • Support third party Electric Vehicle Service Providers (EVSPs) in identifying locations for and interconnecting chargers as quickly as possible. • Pursue flex connect-type programs where DC fast charging stations looking to interconnect may receive interconnection agreements more rapidly if they agree to being curtailed in periods where distribution capacity is limited. For municipal locations, we will: • Work across agencies to identify opportunities for EV chargers in municipal parking lots that are accessible to the public. • Identify the ideal method for installing and managing EV charging stations in municipal parking lots.

Location/Application	Considerations, Preferred Approach, and Next Steps
	• Build upon the analysis of the City's currently deployed charging stations to identify priority sites and ensure a robust and accessible network.
Owner-occupied homes & residencies	EV charging infrastructure at homes and residences plays a critical role in managing EV charging loads, as vehicles are typically parked at homes for relatively long periods of times, during which charging patterns can be optimized to maximize the use of carbon-free generation, and limit grid impacts. This management is largely achieved through rates and programs, but requires some additional infrastructure to support it. Time-differentiated pricing (e.g. TOU rates) provides a useful signal to align charging behavior with grid needs. This results in "passive" managed charging – which encourages charging outside of peak windows but can result in rebound peaks due to lack of coordination across chargers. "Active" managed charging – which allows coordinated charging across customers, dynamic adjustment of schedules, and location-based optimization to mitigate distribution system constraints – requires two-way communications and automated scheduling, typically via third party • Enhance current programs to incentivize residents to purchase EVs and install EV chargers • Develop managed charging programs • For all customer programs that include incentives for charger installation, PWP will require chargers to have two-way communication capability
Tenant-occupied homes and residences	Managed EV charging at tenant-occupied homes provides the same flexibility benefits to the grid as EV charging at owner-occupied homes, but has additional importance through the lens of equity, and equitable access to EV charging. A majority of Pasadena residents are renters; for widespread adoption of electric vehicles, it is important to develop solutions that allow renters to take advantage of the convenience and benefits of at-home charging. • Identify measures to address the specific barriers to installation of charging infrastructure at tenant-occupied homes & residences to ensure equitable access to charging for all Pasadena residents • Work with landlords to support installation and interconnection of EV charging at renter-occupied residences • Enhance the current rebate program to incentivize landlords install EV chargers, and enable renters to participate in managed charging programs
Workplace	Supporting the development of workplace charging in Pasadena would help support the integration of renewables and support transportation electrification in Pasadena and the region. Typical work schedules (i.e. 9 AM to 5 PM) are well aligned with hours in which solar output is high. Encouraging customers to charge during these hours will minimize costs to serve EV charging loads and support the integration of solar resources. Access to workplace charging can also help reduce barriers to EV adoption for Pasadena residents who do not have access to charging at home and can encourage adoption from residents of neighboring cities who commute to Pasadena.

Location/Application	Considerations, Preferred Approach, and Next Steps
	• Continue to work with employers in Pasadena, providing educational materials of the EV charging installation process and exploring opportunities to provide charger installation incentives. • Continue to support businesses in interconnecting EV Charging infrastructure as quickly as possible
Fleet	Fleets of vehicles (ex. delivery trucks owned by a business) make up a significant portion of vehicle-based emissions and present the opportunity of electrifying many vehicles and managing charging loads through a single point of decision-making. Fleet electrification also presents unique challenges, including high upfront vehicle and infrastructure costs, operational uncertainties, and increased electricity demand at specific locations on the distribution system. • Continue to lead by example with an in-depth analysis of the municipal vehicle fleets and the potential to electrify those vehicles. We will collaborate across City agencies to support installation of fleet EV charging infrastructure • Provide technical assistance and streamlined interconnection processes for these particular charger installations. We will work with fleet managers early in the planning process, so that we can ensure that charging infrastructure is properly sized, scalable, and future-proofed. • Explore rate designs and demand response programs that can help reduce infrastructure costs associated with integrating high powered chargers for fleets and help manage charging in a way that benefits the grid and reduces carbon emissions – possibly including vehicle-to-grid (V2G) discharging where feasible

Piloting and Scaling Resources

A key next step will be to gather feedback from the community on potential program structures and to pilot different operational models and program types. While the OSP leveraged best-available industry data on cost and resource potential, customers are at the center of this resource, so it is ultimately up to PWP customers to demonstrate if the OSP planning targets can be met or exceeded. PWP plays a key role in educating customers on the benefits of these programs and will need to see which program characteristics resonate with the community, and what will lead to scalable programs that generate tangible impacts in resource procurement.

We will measure data from pilot programs, to continue informing achievable potential, and the extent to which other capital investments can be avoided. Data to be collected includes normalized load impacts per participant, or normalized load impacts as a percent of a customer's coincident peak load. We will also seek to characterize how customer behavior is impacted by extreme weather (i.e., in extreme weather, loads are higher and, therefore, there is more load to shift, while consumers perceive scarcity, so their behaviors may be to shift less), and find out to what extent customers' responses degrade or persist in each subsequent event.

Interactions with Other Resources

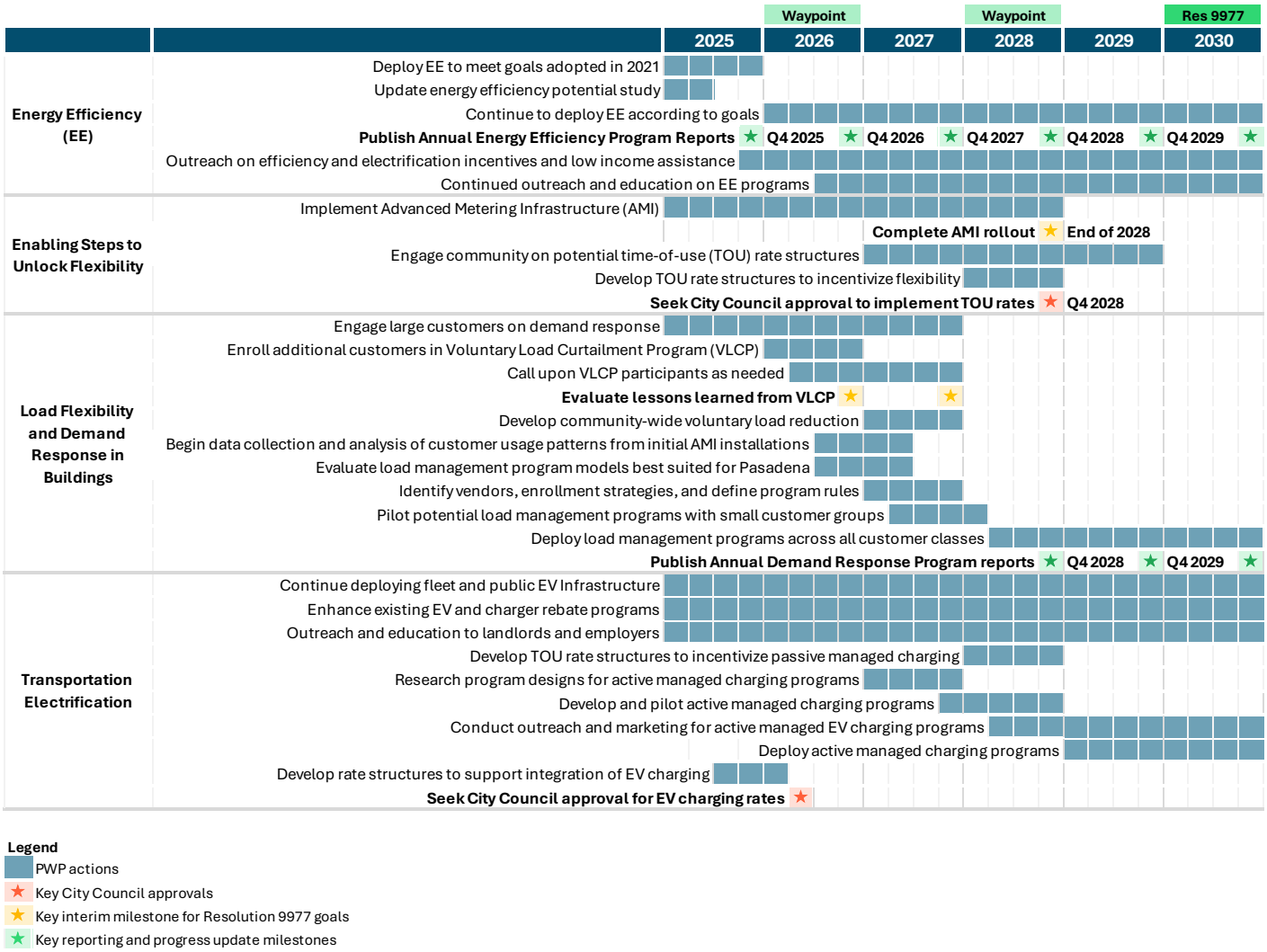
Based on OSP modeling, load flexibility and managed EV charging play a similar function to that of four-hour battery storage in meeting Resolution 9977 goals. This means that, to the extent that the

amount of demand response and load flexibility procured exceeds or falls short of the planning targets, we will adjust our procurement plan for battery storage and other substitute resources as needed. If demand response and managed EV charging gain significant momentum, PWP may avoid procurement of additional utility-scale battery storage. If, however, demand response and managed EV charging fail to materialize, PWP would need to procure more utility-scale battery storage to maintain the same level of system reliability, incorporate higher levels of renewable energy, or run Glenarm less frequently. We will continue monitoring the performance and success of these programs and continually evaluate the need to change our utility scale storage procurement targets.

Action Items

The OSP technical studies provide a clear picture of the potential role of increased load management and advanced demand response programs. While the lack of AMI presently serves as a barrier to harnessing this resource to its fullest potential, PWP has established plans to roll out new load management measures following the completion of city-wide AMI installation. Rapidly scaling these efforts hinges upon successful program design and piloting efforts over the next several years.

Figure 48. Action plan to develop innovative rates and customer programs to enable load flexibility



- **Engage large commercial customers for demand response program enrollment.** We plan to engage our 60 Key Account commercial customers and survey them to determine what DR program structures or retail rate designs would encourage their participation. Details will include incentive levels, extent of utility control or device/communications automation, and other contractual requirements. PWP will evaluate the potential to install enabling communications platforms and metering on larger customers to accelerate the procurement timeline and function as a pilot for larger rollout. PWP will also use this engagement opportunity to communicate the hours of highest grid need for capacity, so that large customers can voluntarily begin shifting their consumption out of these times, where possible.
- **Engage community on timing, benefits, and importance of AMI, before successfully rolling out AMI by 2028**. We will produce public-facing communications to educate customers on the details of the AMI rollout, including the importance of time-varying rates, options for participating in demand response programs, and relevance to achieving the goals set forth by Resolution 9977.
- **Determine implementation plan for demand response, including preferred program structures, communications platforms, and vendor types, before 2028 AMI deployment.** We will engage internal stakeholders, customers, potential vendors, and the public to determine the preferred methods to implement demand response to ensure an operating model that is technically feasible and helps set the foundation for a widely-scalable program. PWP will consider the best models for implementation staffing, customer payments, measurement and verification, and day-to-day-operations. PWP will define responsibilities for recruitment, customer payments, measurement and verification, event operations, and data sharing, and will evaluate standards such as OpenADR and IEEE 2030.5 for telemetry and automation.
- **After AMI is deployed, deploy Demand Response programs for all customer classes**. We plan to recruit and enroll customers into demand response programs, targeted at reducing loads in high-cost and high-carbon hours identified in the OSP. PWP will create annual reports tracking enrollment and program performance that can be tied back into future resource planning. PWP will coordinate with other customer-facing utility programs, such as behind-the-meter solar and storage, EV charging infrastructure, and energy efficiency for a streamlined recruitment process.
- **After AMI is deployed, introduce time varying retail rates that encourage customers to shift energy consumption from higher-cost, higher-carbon hours to lower-cost-lower-carbon hours.** This will be coordinated with the development of new time-of-use rates for solar and storage customers.
- **Perform continued outreach and education for demand response programs.** We will continue to develop and circulate outreach materials to inform customers on the importance of shifting loads from peak to off-peak hours and identifying which hours should be targeted for load reductions. Emphasis will be on the commercial sector while also including residential customers.
- **Provide regular progress reports:** We will provide ongoing communications on our progress using well-established, effective techniques, mediums, and industry recognized

best practices for communications and community engagement. We will regularly communicate new opportunities for customers to earn incentive payments through participation in demand response programs.

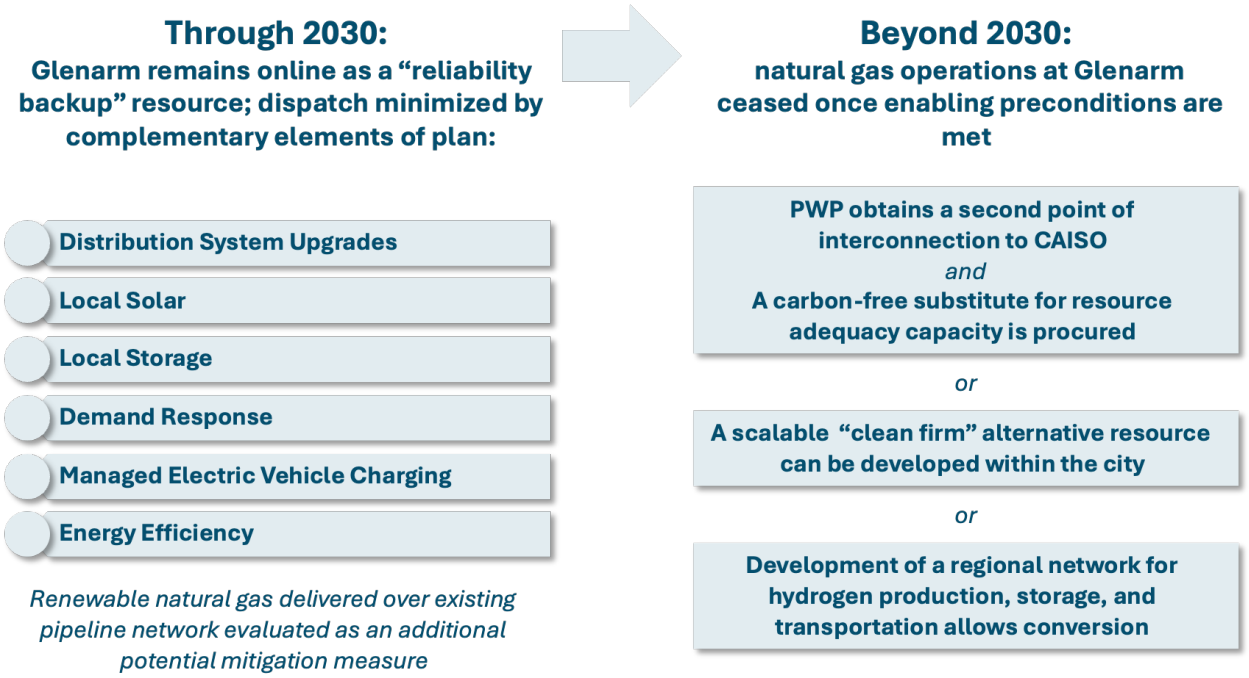
- **Develop comprehensive electric vehicle charging infrastructure plan.** PWP will develop a plan for deploying EV charging infrastructure at municipal and publicly-accessible parking lots, including timing and potential locations. PWP will also enhance its current programs to target EV charging for residential customers, including consideration of incentives for customers to adopt EVs and enroll in managed charging programs, and considerations for renter-occupied housing that will provide equitable access to EV charging. PWP will also engage employers in the community to partner on EV charging infrastructure, and work with fleet vehicle owners to plan for EV charging infrastructure to support their needs.
- **As demand response programs grow in scale, PWP will consider options to locationally target load management programs to relieve distribution system constraints, or perform other distribution-level grid services.** To support this, throughout DR program deployment PWP will record and track the location of participating customers and devices within the distribution network, in order to provide circuit-level resource availability.

5.4 Mitigate Glenarm's Operations Until Another Solution is Available

PWP is committed to eliminating reliance on fossil fuels for energy generation and recognizes that the Glenarm Power Plant can play a vital but limited role in supporting reliability during the transition. The OSP Glenarm Conversion and Replacement Study demonstrated that accelerating deployment of local solar, storage, and demand response programs can reduce the plant's use. Accordingly, we will position Glenarm as a reliability backup, operating only during contingency events or when directed by the CAISO when system-wide demand for electricity is high.

Over the longer term, we will continue to explore pathways for the full retirement or conversion of Glenarm to a carbon-free resource. Achieving this outcome will depend on key technological and infrastructure developments, including the maturation of long-duration energy storage, construction of regional hydrogen supply and delivery infrastructure, and progress on regional transmission enhancements. While these solutions are not likely to be available by the end of 2030, PWP's commitment to a carbon-free electricity supply remains unwavering.

Figure 49 Transition plan for Glenarm Power Plant

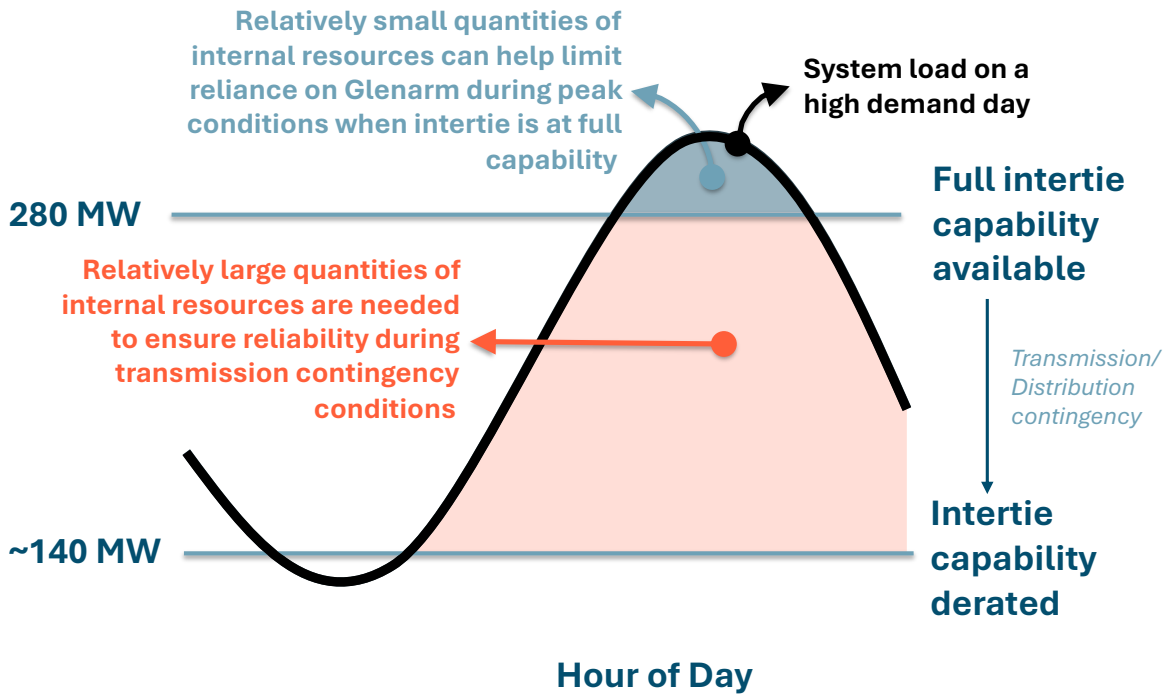


Alternatives Evaluated to Meet Local Reliability Needs

Multiple options to eliminate use of natural gas at Glenarm – while maintaining the same level of reliability provided by the plant today – were considered and evaluated in the study process, including (1) retirement enabled by transmission expansion, (2) replacement with various combinations of local solar and storage resources, (3) replacement with emerging technologies, and (4) conversion of Glenarm to operate using green hydrogen fuel. While some of these options may be potential long-term opportunities, none were identified as viable options to meet the timeline prescribed by Resolution 9977 for a combination of technical and practical reasons.

1. **Transmission expansion:** Transmission expansion – discussed further in Section 6.1 – appears to provide a promising technical solution, but with lead times likely measured in decades, the option cannot be developed by the end of 2030 to meet Resolution 9977 goals.
2. **Solar and storage replacement:** Replacing the 198 MW Glenarm Power Plant with a combination of solar and storage resources would require roughly 500 MW of local solar and 300 MW of local battery storage. The sheer scale of those needs stems from the need to ensure reliability even when our CAISO intertie capability is derated under contingency conditions. The reason that the amount of solar and storage capacity necessary to maintain reliability is so much larger than Glenarm's capacity today is illustrated in the figure below.

Figure 50. Illustrative high load day profile with full intertie capability and derated intertie capability



In the current system, Glenarm can dispatch on demand at full capacity as long as needed, which provides enough generation capacity to meet loads above import capacity during most contingency events, no matter how long they last. Designing a solar and storage portfolio to provide the same level of reliability would require that solar resources be sized to simultaneously (a) meet a large share of daytime load and (b) charge storage resources, so that overnight load could be met by storage discharge. The sizing of solar and storage capacity needs is further magnified by the fact that this system must work even on cloudier days when solar generation is not available at its maximum output.

3. **Emerging technologies:** Several "clean firm" technologies, if developed locally, could provide the same technical capabilities and grid services as the existing Glenarm Power Plant. Examples of such technologies could include hydrogen fuel cells, advanced nuclear reactors, or novel forms of long-duration storage (with durations up to one week) paired with significant quantities of local solar. Technical feasibility notwithstanding, these technologies are not commercially available today and are not expected to reach that point by the end of 2030.
4. **Hydrogen conversion:** The conversion of Glenarm Power Plant to operate using green hydrogen, rather than natural gas, would allow the plant to remain in operation using a carbon-free fuel and provide the same reliability benefits to the system. But while multiple other utilities in the region are exploring retrofits to existing natural gas plants to unlock this capability, none are planning to transition to hydrogen fuel by the end of 2030. Indeed, the upstream infrastructure needs to produce, store, and transport hydrogen to the City of Pasadena would not be ready by 2030. PWP will continue to monitor the emergence of

upstream green hydrogen infrastructure in the region and will evaluate the opportunity for conversion of Glenarm when and if this pathway for decarbonization emerges.

Meeting Future Resource Adequacy Needs

Beyond its importance to ensuring local reliability within the City, Glenarm also plays a critical role in PWP's portfolio as a Resource Adequacy (RA) resource. As a load-serving entity (LSE) in CAISO, we have an obligation to procure a certain amount of RA capacity to demonstrate that our portfolio of resources is sufficient to meet our share of CAISO's total resource needs. Glenarm's capacity currently represents over half of our current RA capacity, and a long-term replacement for that capacity with renewables and storage could require resources incremental to the local solar and storage replacement portfolio described above.

How California municipalities like Pasadena should approach long-term planning to meet RA obligations is a major challenge and uncertainty. Current requirements for Publicly Owned Utilities (POUs) are based on the CAISO Tariff, which were largely established in connection with the CPUC's RA program and focused on ensuring sufficient capacity to meet peak demand periods. However, as penetrations of renewables and storage grow, the greatest risks to system reliability have already shifted to other periods of the day. There is, for instance, now a widespread understanding of the challenge of meeting the "net peak" in California after sundown, and along with it a recognition that reform of RA requirements will be necessary to ensure reliability as renewables and storage continue to scale. However, neither the CAISO (in its Tariff) nor the CEC (in guidelines for IRPs) have provided clear direction to municipal utilities as to how those requirements and conventions may change in the future, and the CPUC is currently contemplating multiple options for short- and long-term reforms to the requirements it imposes on its jurisdictional LSEs.

In the absence of clear direction from regulators at this time, the most reasonable approach to long-term planning is to assume that RA conventions will evolve to align with the changing needs of the grid. In practical terms, this means that the capacity requirements for LSEs and the capacity credits assigned to generators would be determined based on their availability during the periods of highest risk – whenever in the year those may occur. In this framework, the marginal effective load carrying capability (ELCC) methodology is used to assign capacity credits to individual generators, measuring their ability to perform during the most constrained periods of the year. This approach has gained widespread traction among capacity market operators, is used in the CPUC's Integrated Resource Planning proceeding, and is reflected in one of the two proposed frameworks under consideration for CPUC's Renewable and Clean Power Procurement Program.

This type of future change would have dramatic implications for the resources available to PWP to meet RA needs. Fully understanding these implications requires an understanding of how the marginal ELCC of different categories of resources are expected to evolve in the future:

- **"Firm resources,"** defined as resources that can operate at maximum capacity with no limitations on duration, exhibit high marginal ELCCs (on the order of 90%). Examples include natural gas and nuclear generation.
- **"Energy limited resources,"** often exhibit high marginal ELCCs at low penetrations but are subject to saturation effects and can experience declines below 50% at moderate to high penetrations. Examples include battery storage, hydroelectric, and demand response.

- **"Variable resources"** typically exhibit relatively low marginal ELCCs (<50%) and can experience significant saturation effects even at low to moderate penetrations. Examples include solar and wind.

Glenarm is a "firm" resource – meaning it can be dispatched on demand for as long as needed – so its accredited capacity under a marginal accounting framework is high and expected to remain relatively stable. In contrast, the marginal ELCC values of renewables and storage decline as penetrations increase – meaning that the accredited capacity for a fixed portfolio of renewables and storage resources will likely decline over time. How quickly those declines will occur is another uncertainty that depends on the rate at which other utilities within CAISO develop solar and storage resources, but analysis from the CPUC indicates that the marginal ELCC of four-hour storage – a resource accredited at 100% capacity under today's accounting rules – could drop below 40% by 2030 and continue to decline thereafter. What this means is that even the scale of solar and storage resources needed to meet local reliability needs as described above may prove insufficient as a long-term replacement for the RA capacity provided by Glenarm.

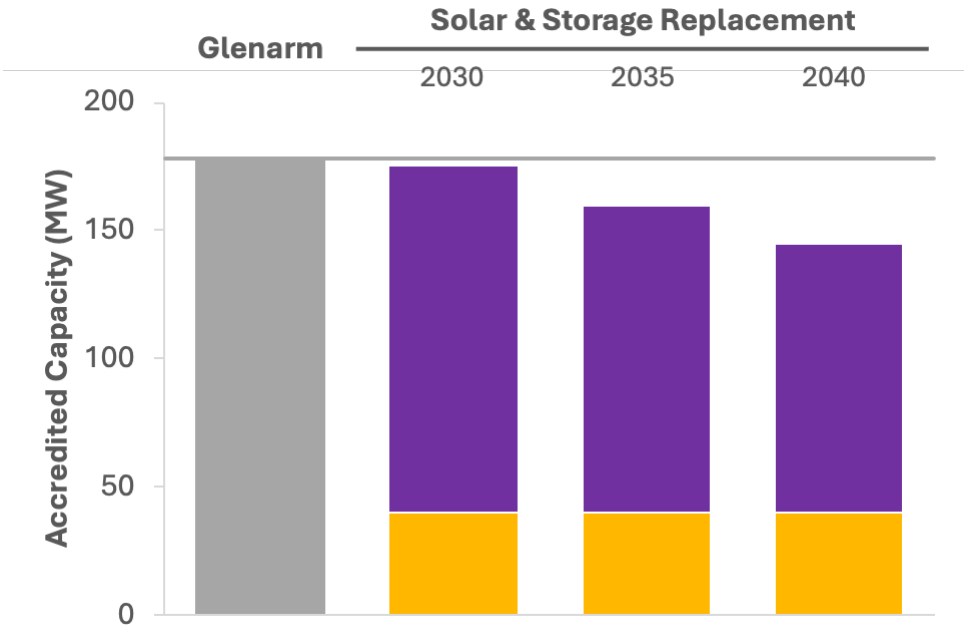


Figure 51. Capacity accreditation for solar and storage Glenarm replacement portfolio

Facing institutional uncertainty surrounding future RA accounting rules and technical uncertainty as to how quickly solar and storage resources will be developed across the CAISO system, the decision to preserve Glenarm as an RA resource in the near term is a key risk mitigation tool.

Anticipated Conditions for Future Operations

Balancing these considerations with the ambitious goals of Resolution 9977, PWP has recommended a path forward in which Glenarm is preserved as a reliability backstop, expected to operate even less frequently than today. We will plan our system and resource portfolio so that the circumstances that would require the plant to operate are limited to (1) situations where Glenarm is needed to maintain local reliability, and (2) instances where CAISO calls upon Glenarm to dispatch.

The first set of conditions under which Glenarm will operate are when it is needed for local reliability – or, in other words, when *not* operating Glenarm would require PWP to institute load shedding among our customers. Multiple complementary elements of the OSP are expected to minimize the frequency with which the plant is needed for local reliability:

- Additional demand-side measures and programs, including demand response, energy efficiency, and managed electric vehicle charging, mitigate the frequency with which electric demand in the City exceeds the intertie capability at TM Goodrich (280 MW);
- The planning targets for local solar and storage resources, as described in Section 5.3, are sized to provide the City with resources to meet internal demand above 280 MW with carbon-free resources instead of Glenarm; and
- The replacements and improvements of underground distribution lines, once complete, are anticipated to reduce the frequency of internal contingency events (e.g., line outages) that have historically required Glenarm to operate.

Anticipated improvements notwithstanding, PWP still expects there will continue to be circumstances where Glenarm remains necessary to ensure local reliability. These may include:

- **Severe transmission and sub-transmission contingency conditions,** including issues on PWP's internal sub-transmission system, a problem at TM Goodrich, or issues upstream on SCE's transmission system (for instance, potential future Public Safety Power Shutoff events)
- **Periods of system maintenance**, including maintenance work on PWP's internal system or at TM Goodrich (including the eventual replacement of transformers in the 2030s)
- **Unforeseen extreme weather events,** as growing climatic uncertainty introduces the possibility that conditions beyond those used to inform the development of the plan may cause unanticipated equipment failures and/or extreme peak demand

The second set of conditions under which Glenarm will operate is when called upon for dispatch by CAISO. Like all resources that provide resource adequacy capacity in CAISO, Glenarm has a "must offer obligation" requiring that its capacity be offered into the wholesale market. Based on prevailing conditions in the wholesale market, CAISO may provide dispatch instructions that require Glenarm to operate.

Despite the fact that Glenarm produces direct greenhouse gas emissions when instructed to dispatch by CAISO, it is important to recognize that its operation under these circumstances provides economic and environmental benefits. CAISO dispatches resources in its system in "merit order" – that is, in order of increasing short-run marginal costs – meaning that a peaking plant like Glenarm is only called upon to dispatch once lower cost resources have been exhausted. During these periods, wholesale energy prices are typically high, as prices are set by the cost of the marginal generator. When the wholesale price exceeds Glenarm's operating cost, higher-cost, lower-efficiency, higher-emitting natural gas resources are operating elsewhere on the grid – and that *not* operating Glenarm during this period would lead to even higher cost, less efficient units operating. Thus, there are three distinct benefits to Glenarm's operations during this period:

1) An **economic benefit to PWP ratepayers**, for whom incremental net revenue earned by Glenarm's operation reduces PWP's revenue requirement;

2) An **economic benefit to California ratepayers** at large, who otherwise would have had to purchase electricity on the wholesale market at an even higher price; and
3) A **global environmental benefit**, as the direct emissions from Glenarm's operations is lower than the counterfactual case if an additional unit higher in the "merit order" had been dispatched.

Therefore, the circumstances under which Glenarm would operate in the 2030 timeframe would include (1) situations where *not* operating the plant would lead to load-shedding events for the City of Pasadena, or (2) situations where *not* operating the plant would lead to higher costs and potentially more greenhouse gas emissions.

Additional Mitigation Options

During the period that Glenarm remains in service to meet resource adequacy requirements and local reliability needs, PWP intends to explore whether additional measures can help to mitigate the environmental impact of natural gas combustion at the plant. One option that PWP may consider is the possibility of supplying the plant with "renewable natural gas" (RNG) as an alternative to fossil natural gas. RNG refers to methane fuel produced from biogenic origins that has been purified to a state where it is "pipeline quality" – meaning that it can be transported via the existing natural gas pipeline system and does not require any investment in new infrastructure. Short-term fuel supply agreements with RNG suppliers may therefore provide an opportunity for a bridge to a long-term solution for Glenarm to reduce the impact of the plant's operations on climate change. **However, PWP does not intend to utilize RNG to extend the life of Glenarm past the point when a carbon-free replacement is feasible.**

The two key questions that will inform our recommendations regarding the potential use of RNG include (1) the price premium above natural gas, and (2) the net impact on greenhouse gas emissions:

1) **Greenhouse gas impact:** most sources of RNG result in a reduction in greenhouse gas emissions relative to fossil natural gas; the specific greenhouse gas impact of RNG does vary depending upon how it is produced. For instance, RNG produced from landfill gas has a carbon intensity that is roughly 80% of that for fossil natural gas, but RNG produced from dairy manure has a net negative carbon intensity. In considering any specific opportunity to procure RNG, PWP would evaluate and present the resulting greenhouse gas benefits to City Council.
2) **Price premium:** RNG is typically a higher-priced fuel than natural gas, due to (a) higher costs to produce the fuel, (b) a less liquid market for the product, and (c) opportunity costs associated with California's Low Carbon Fuel Standard program. Pricing for RNG supplies can range between $25 and $35 per MMBtu (versus approximately $5 per MMBtu for natural gas). At these prices, supplying the Glenarm plant with RNG fuel could result in incremental costs to PWP customers of $10 to $15 million per year.

We intend to gather further market intelligence on specific potential opportunities for RNG supplies. By evaluating the effective cost of carbon abatement and comparing it with other measures the City

is pursuing, we will make informed recommendations to City Council on the potential to source RNG to mitigate Glenarm's physical climate impact.

Enabling Conditions to End Natural Gas Combustion

Under the goals of Resolution 9977, maintaining Glenarm as a reliability resource is an interim solution, not the final endpoint for the City's transition. The OSP technical studies point to three potential pathways for a longer-term plan to end combustion of natural gas at Glenarm entirely:

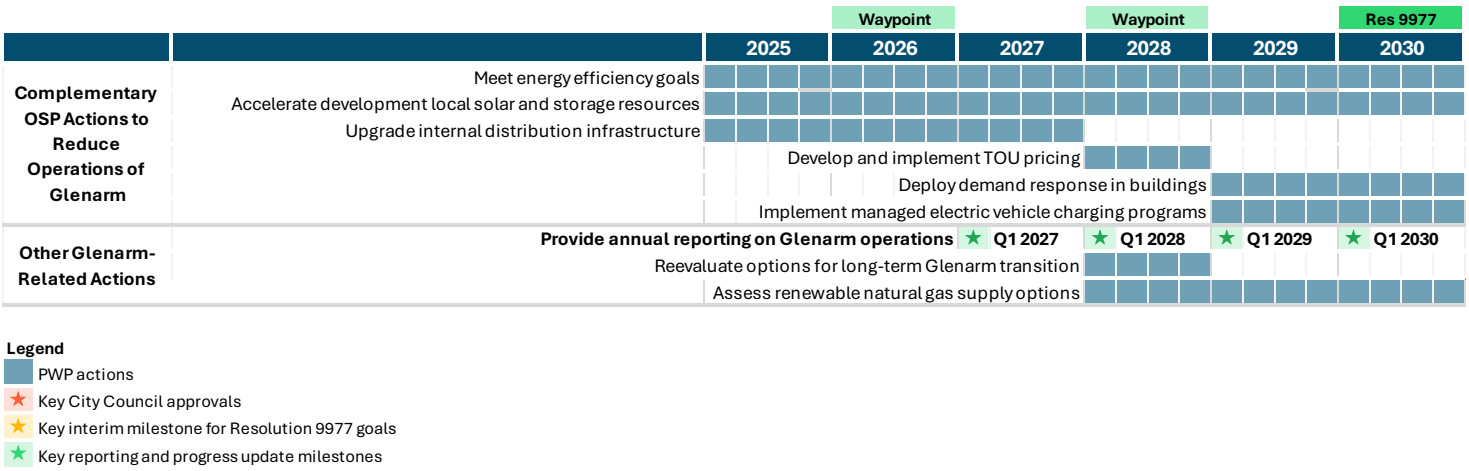
1) **Transmission Expansion:** Secure a second point of interconnection to CAISO and a replacement for the resource adequacy capacity provided by Glenarm today; or
2) **Local Emerging Technology:** Develop a "clean firm" resource within the City of Pasadena as a local replacement for Glenarm; or
3) **Hydrogen Conversion:** Convert Glenarm to green hydrogen should a broader regional network to produce, store, and transport the fuel become available

Importantly, the timing and feasibility of each of these options depends on factors that PWP does not control. The timelines for emerging technologies to reach commercialization, for the necessary transmission planning and permitting processes, and for development of upstream and midstream infrastructure for a hydrogen supply chain are difficult to predict – but likely require a decade or longer. Nonetheless, we recognize the importance of a longer-term transition plan for Glenarm and intends to take proactive steps to preserve each of these potential opportunities – so that if and when one becomes available, we are in a position to capitalize upon it.

Action Items and Signposts

The preservation of Glenarm, coupled with the acceleration of local solar and storage resources and improvements to the distribution system, will provide Pasadena residents with an electricity system that is more resilient to disruption than it is today. In many respects, the plan to transition Glenarm to reliability backup is an effect of the other complementary measures of the OSP — increasing local carbon-free resources, scaling demand-side programs, and making system improvements — rather than a distinct element of the plan itself. After all, natural gas peaking plants are only called upon to dispatch once all other lower-cost options available have been exhausted. The actions that PWP plans to take to limit reliance on Glenarm and continue to explore a longer-term pathway to eliminate natural gas use entirely, are summarized in the figure below.

Figure 52 Action plan and signposts for Glenarm mitigation and transition



Additionally, PWP commits to the following important steps in support of our efforts to reduce reliance on the Glenarm Power Plant:

- **Provide annual reporting on Glenarm operations.** We will provide reports to the Municipal Services Committee and City Council on plant operations, including capacity factors and reasons for dispatch. While the measures described above are designed to enable reductions in Glenarm's operations by the end of 2030, we currently anticipate that the plant will likely operate at higher capacity factors over the next several years as replacement of internal distribution infrastructure will limit PWP's ability to serve internal loads with CAISO imports.
- **Reevaluate long-term transition options at the 2028 Waypoint.** We will evaluate whether additional information regarding the three long-term transition pathways would allow us to establish a more concrete timeline and plan to end natural gas consumption.

5.5 Upgrade Power Delivery Infrastructure

The constraint on our ability to import electricity from CAISO is a key driver of the need for local generation for reliability and may limit our ability to access incremental carbon-free resources in the future. We will pursue opportunities to expand our existing interconnection with the CAISO at TM Goodrich and to develop a second point of interconnection. Expanding import capability will allow PWP to access a more diverse set of carbon-free resources and potentially reduce reliance on internal generation (i.e. Glenarm).

TM Goodrich Expansion

The 2022 PDMP identified the replacement of transformers at TM Goodrich, supported by additional internal improvements, as a priority for the system over the course of the next decade. Because PWP's current contract with SCE allows for up to 336 MW of imports at TM Goodrich (greater than the current physical ratings of the transformers, which only allow for 280 MW), the PDMP identified 336 MW as a tentative target for expansion of import capability at TM Goodrich.

Generally, a larger increase of import capacity at TM Goodrich would relieve local import constraints, allow for greater imports of carbon-free generation, and reduce the need for local generation. At the

same time, the difference in scope and complexity of an upgrade to the current contractual limit (336 MW) versus an upgrade above that limit is potentially significant, as the latter would require renegotiation of PWP's current interconnection agreement with SCE and may trigger the need for physical upgrades on the SCE transmission system. For this reason, whereas an upgrade to 336 MW may be feasible in the mid-2030s, an upgrade beyond 336 MW may not be possible until later in the decade. The table below compares the steps necessary for these two upgrade options.

Table 25 Roadmap for expansion of TMG receiving station

Stage	Estimated Timeframe	Necessary for Upgrade to 336 MW (Option 1)	Necessary for Upgrade above 336 MW (Option 2)
Upgrades to Internal Subtransmission System Identified in PDMP *Replace and upgrade existing 35 kV subtransmission lines to enable greater cross -town power flow and improve reliability*	3-4 years	**Yes** *(in progress)*	**Yes** *(in progress)*
Right-Sizing Study for TM Goodrich *Determine ideal sizing of interconnection considering long -term load growth and plans for internal generation*	1 year	No	**Yes**
Technical & Engineering Studies (TM Goodrich Station) *Develop detailed project plans for selected expansion option*	1-2 years	**Yes**	**Yes**
Technical & Engineering Studies (Internal System) *Evaluate whether additional internal improvements are necessary at higher import levels*	1-2 years	No	**Yes**
Renegotiation of Interconnection Agreement with SCE* *Renegotiate agreement to allow maximum interchange above 336 MW*	Uncertain	No	**Yes**
Competitive Procurement Processes *Conduct request for proposals, evaluate responses, select vendor, negotiate contracts*	1-2 years	**Yes**	**Yes**
Equipment Procurement Lead Time *Place orders transformers and other necessary specialized equipment*	3-5 years	**Yes**	**Yes**
Additional Upgrades to Internal Subtransmission System *Reconfigure PWP subtransmission system to higher voltage level consistent with higher TMG rating*	Uncertain	No	**Maybe** *(depending on rating)*
Upgrades to CAISO/SCE Transmission System* *Study and complete upgrades to SCE system*	Uncertain	No	**Maybe** *(depending on rating)*
Project Construction *Complete construction outside of summer peak seasons and Rose Bowl event moratorium*	2-4 years	**Yes**	**Yes**

Stages are organized roughly chronologically, but not all stages must occur sequentially; stages marked with asterisks (*) represent stages involving or led by other parties (SCE & CAISO)

Right-sizing the TM Goodrich transformers to meet PWP's future energy needs, in the context of an overall import capacity upgrade, will be a critical decision for PWP over the next several years. The current transformers at TM Goodrich were installed in the 1970s and will likely remain in service into the 2030s; replacement transformers are expected to have similarly long lifetimes. Therefore, the sizing of replacement transformers will not only impact short-term opportunities to continue our efforts to pursue a carbon-free energy supply in the next decade but will also be a decision with lasting impacts on the dynamics of the power system over much of the next century.

Key questions that should inform the right-sizing of the intertie include:

1. What level of long-term load growth PWP plans for over the next several decades;
2. What degree of confidence PWP has in potential plans to secure a second point of interconnection to CAISO; and
3. Whether the long-term vision for the PWP system includes some form of local firm generation capacity (either clean firm or natural gas as backup).

Second CAISO Interconnection

We will also explore opportunities to develop a second point of interconnection with CAISO. In comparison to the expansion of TM Goodrich, a second point of interconnection would provide additional reliability benefits by reducing risks associated with a single interconnection.

While a second interconnection would be a considerably more complex and longer undertaking, it would also provide several key benefits compared to the upgrade of TM Goodrich transformers. Most importantly:

1. The addition of a second point of interconnection would increase the resilience of the local system to transmission-related contingencies either at TM Goodrich or on the SCE transmission system. In light of the vulnerability of the transmission system exposed by the prospect that future SCE PSPS events could impact our ability to import generation at TM Goodrich, this benefit is particularly important.
2. The additional import capacity, if sufficiently sized, could provide an opportunity to further minimize or replace the Glenarm Power Plant.

The table below summarizes how the expansion of the TM Goodrich Receiving Station would compare to a second interconnection to CAISO in terms of potential project benefits and project complexity.

Table 26. Comparison of the value proposition of TMG expansion vs a second point of interconnection

Option	Goodrich Expansion	Goodrich Expansion	Second CAISO Intertie
Study History	Previously studied by PWP	**Yes**	**Yes**
Value Proposition	Increases access to CAISO market and external carbon-free resources	**Yes**	**Yes**
	Increases local reliability & reduces reliance upon internal generation	**Yes**	**Yes**
	Increases system redundancy/resilience & reduces contingency risks	**No**	**Yes**
Land Use & Infrastructure Considerations	Leverages existing city-owned properties	**Yes**	**No**
	Avoids need for construction of new high-voltage receiving station	**Yes**	**No**
Interconnection Agreements	Requires negotiation of new interconnection agreement with SCE	**Maybe** *(if rating exceeds 336 MW)*	**Yes**
Permitting & Study Processes	Requires CAISO/SCE studies of external transmission infrastructure	**Maybe** *(if rating exceeds 336 MW)*	**Yes**
	Requires approval through CAISO Transmission Plan	**Maybe** *(if upgrades to SCE tx needed)*	**Yes**
	Requires Certificate of Public Convenience & Necessity from CPUC	**Maybe** *(if upgrades to SCE tx needed)*	**Yes**

Benefit **Uncertainty** **Challenge**

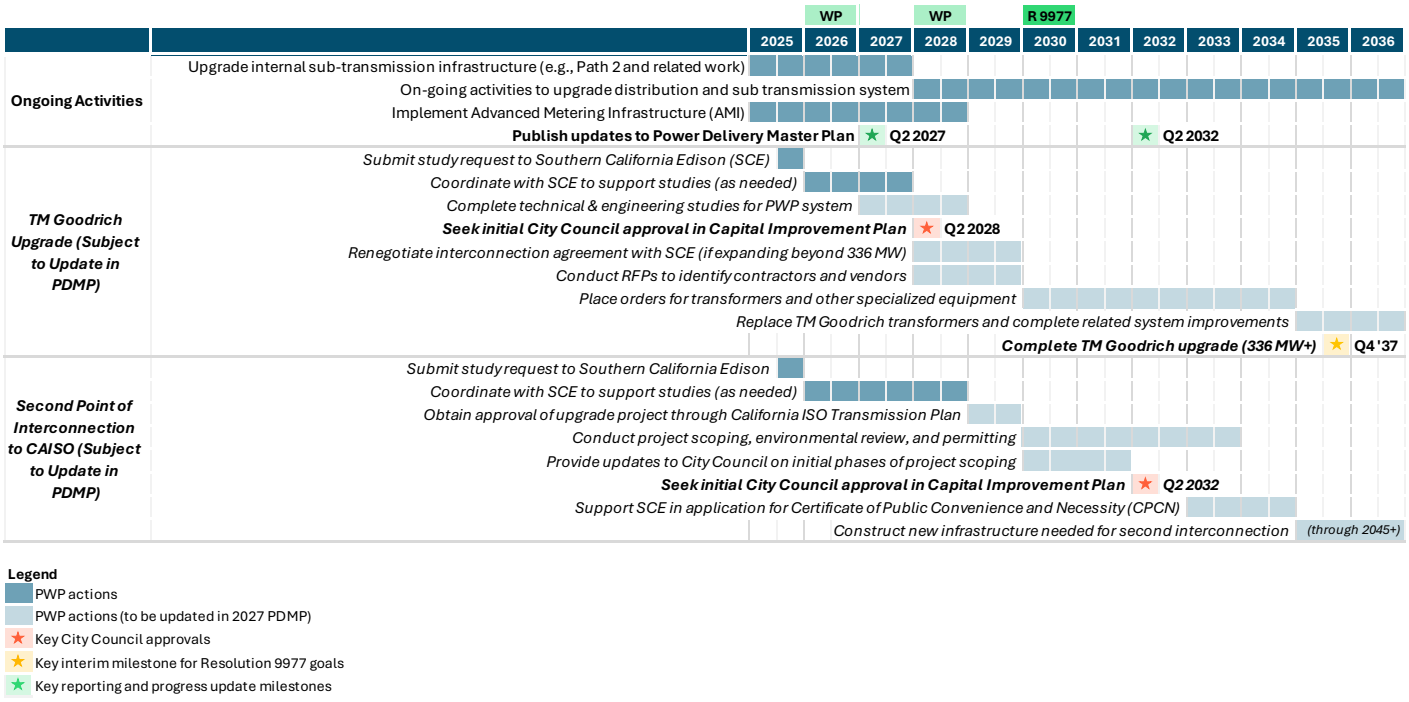
Action Items and Next Steps

Recognizing the long lead times for transmission-based solutions, we have already taken the important step of submitting feasibility study requests to SCE for the TM Goodrich Expansion and

for a second point of interconnection located on the west side of Pasadena. PWP has requested that SCE study the impacts of expanding the TM Goodrich substation to allow for a maximum import of 420 MW and has requested that SCE evaluate options for a second point of interconnection with equal transfer capacity.

Identifying a recommendation for the right-sizing of the TM Goodrich expansion project that aligns with the priorities of Resolution 9977 and that considers the long-term implications of investments in assets whose lifetimes may last the remainder of this century, will be a key study item within the scope of the next update to the PDMP.

Table 27 Action plan to upgrade power delivery infrastructure



5.6 Monitor Emerging Technologies

Pursue Pilot Projects for Emerging Long-duration Energy Storage Technologies

We will proactively identify opportunities to support and develop pilot long-duration storage projects. Thus far, we have received two grants for feasibility studies for siting LDES projects within the City and has issued an RFI/RFP for project development. Several utilities across the country and in California are pursuing LDES pilots. For example, SMUD received a grant from the State to install a 3.6 MW 8-hour battery, and Burbank Water and Power commissioned a 75 kW/500 kWh iron flow battery.

At the State level, there is also strong support for the development of long-duration storage technologies. In 2024, the CPUC issued a decision implementing AB 1373, which directs the California Department of Water Resources to procure long-lead time resources, including up to 1 GW of >12-hour storage and 1 GW of multi-day storage, to be online between 2031 to 2037, to support the State's long-term decarbonization goals. Additionally, the CPUC's mid-term reliability

order requires 15.5 GW (net qualifying capacity) to be procured from 2023-2028, and at least 1 GW of that capacity must be from long-duration (>8 hour) storage.

Options for Long-Duration Energy Storage Technologies

The landscape for energy storage today includes a diverse range of technologies that reflect differences in technical characteristics (e.g. duration, round-trip efficiency), cost, commercial and market readiness, and land and siting requirements. Long-duration storage technologies are generally categorized as either electrochemical, mechanical, or thermal with various subtypes.

Table 28 Long duration storage technologies

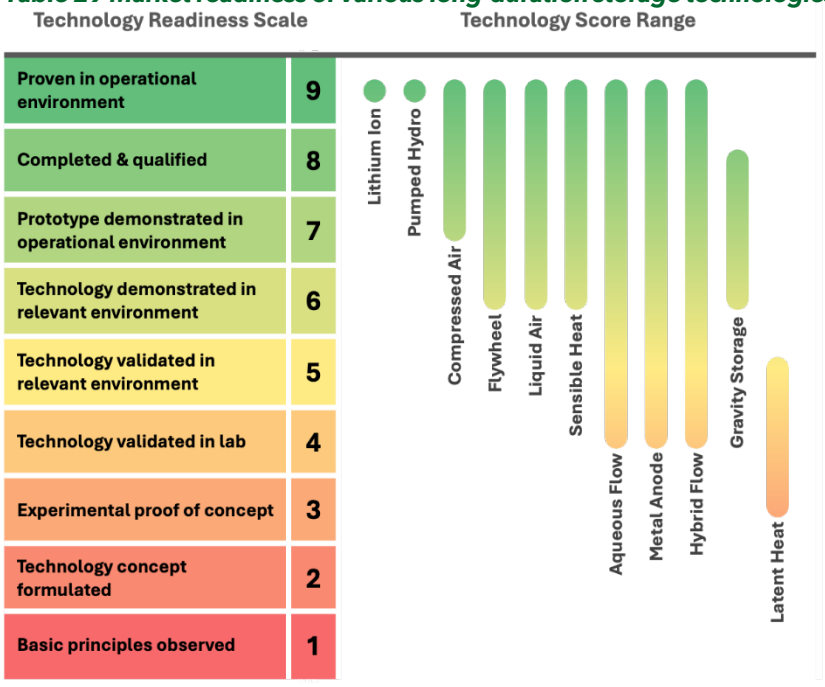
Category	Type	Typical Duration (hours)
Electrochemical	Lithium Ion	<8
	Aqueous Flow	4-12
	Metal Anode	50-200
	Hybrid Flow	8-50
Mechanical	Pumped Hydro	<15
	Flywheel	<1
	Gravity Storage	<15
	Compressed Air	6-24
	Liquid Air	10-25
Thermal	Sensible Heat	10-200
	Latent Heat	25-100
	Thermochemical Heat	Too nascent to characterize

Land use and siting needs are important consideration as we look to site storage within Pasadena. Pumped storage, a mature long-duration storage technology, and gravity storage have highly specific siting needs and require a large footprint and, therefore, are not candidates for local resource development. Chemical long duration storage resources are very modular in design and can be deployed with a smaller footprint, making them a more suitable resources for potential development in Pasadena.

Market Readiness

Pumped storage and lithium-ion batteries are the only storage technologies currently considered mature. Many LDES technologies are in development at the scale of small pilot projects, which typically occur at technology readiness level 5 to 8, as described in the table right. [35] Many indicators suggest LDES will not reach technological maturity until the mid-2030s. The U.S. Department of Energy's (DOE's) Pathways to Commercial Liftoff reports describe an optimistic roadmap

Table 29 Market readiness of various long-duration storage technologies



[35] Department of Energy, Pathways commercial liftoff reports, https://www.energy.gov/technologycommercialization/pathways-commercial-liftoff-reports

to commercialize LDES technology by 2030.[36]

Monitor Landscape of Other Emerging Technologies

We will continue to monitor the landscape for other emerging technologies that could contribute to the City's carbon-free energy goals and provide a clean firm resource that could enable the retirement of Glenarm. The resources we are monitoring closely include:

- **Hydrogen conversion** was a key focus of one of the OSP case studies. Many neighboring utilities, including LADWP and GWP, have identified green hydrogen as a key strategy for decarbonization in their long-term planning. LADWP is currently pursuing a modernization project of their Scattergood Generating Station, replacing existing generation units with a combined-cycle generation system capable of operating on a mixture of natural gas and hydrogen. Fully converting Glenarm to hydrogen requires the development of dedicated hydrogen pipelines to deliver fuel to the plant. SoCalGas's Angeles Link project is in the feasibility study phases, exploring options to transport green hydrogen from production sites to various users in central and southern California. PWP is actively engaging in discussions with SoCalGas on this project through SCPPA.
- While no **offshore wind** resources have been developed along the Pacific coast, developers, utilities, regulators, and policymakers have taken important steps to support the industry's development. In 2024, the CPUC issued an order directing the California Department of Water Resources to procure up to 7.6 GW of floating offshore wind by 2037 based on its authority granted by Assembly Bill (AB) 1373.
- **Advanced nuclear** technologies, including small modular reactors (SMRs), represent a next-generation approach to nuclear energy that emphasizes enhanced safety, scalability, and economic flexibility. Unlike traditional large-scale reactors, SMRs are compact, factory-fabricated units designed for modular deployment, making them faster and potentially more cost-effective to build. While California does not have an outright ban on nuclear power, the Nuclear Safeguards Act of 1976 established a moratorium on the construction of new nuclear power plants until the federal government has identified and approved a demonstrated technology for construction and operation of nuclear fuel rod reprocessing plants and permanent disposal of high-level nuclear waste.
- **Enhanced geothermal** technologies have significant potential to expand geothermal resource availability beyond what can be developed with traditional geothermal technologies. While traditional geothermal energy relies upon hot rock, water, and permeable fracture found in very specific geological settings, enhanced geothermal engineers better conditions for energy generation using hydraulic fracturing and horizontal drilling techniques. Enhanced geothermal developers have signed contracts for projects to be online as early as 2026-2028, but the technology is yet to be demonstrated at commercial scale. SCE, Google, and Meta have all announced PPAs for enhanced geothermal projects. The CPUC's AB1373 decision also directs procurement of 1 GW of enhanced geothermal

[36] Department of Energy, Pathways commercial liftoff reports, https://www.energy.gov/technologycommercialization/pathways-commercial-liftoff-reports

6 Additional Foundations Supporting the Plan

In addition to the five pillars of the OSP, there are additional principal foundations supporting the achievement of the Resolution 9977 objectives. As a municipally owned utility, we are committed to fostering community engagement and partnerships, working across City agencies and collaborating with commercial customers. We are also committed to maintaining affordability and providing competitive electricity rates, which means deploying all feasible financial strategies to reduce costs to ratepayers and pursuing external funding opportunities to support the achievement of this plan.

6.1 Community Engagement and Partnerships with Key Local Stakeholders and Industry Groups

Outreach, Marketing, and Community Engagement

We are implementing a comprehensive communications and outreach strategy that combines research, creative design, and community engagement. This work is designed to inform, inspire, and involve our stakeholders to contribute to meeting the goals of Resolution 9977.

Our efforts will begin with foundational research and collection of stakeholder feedback to identify communication gaps and opportunities to improve how we connect with our community. These insights will guide the development of a refreshed brand identity and a compelling outreach strategy that supports the implementation of the OSP.

Key activities and timeline for our near-term communications plan include relevant program and activities noted in the chart below. The outreach, marketing and community engagement activities identified are intended to remain flexible and will be revisited and refined on a rolling basis as new opportunities, insights, and community-driven ideas emerge.

Table 30. Near-term community engagement activities

Timeline	Actions	Relevant Programs and Activities
Fall 2025	We will launch the first wave of outreach with a focus on awareness-building. This includes a media buy for digital and print ads, toolkits for community-based organizations, newsletter articles, Key Account customer outreach and partnerships, collaboration with Council District Liaisons, and integration into community events.	EngagePWP.org – Community Engagement Platform OSP Public Comment Period Rooftop Solar Process Enhancements & Permit Streamlining Energy Efficiency Incentives: (Rebates & Direct Installations for Residential & Commercial) Low-Income Assistance Electrification (Building & Transportation for Residential & Commercial) Key Account Demand Response: PWP Voluntary Load Curtailment Program (VLCP) & CEC Demand Side Grid Support Program (DSGS)

Timeline	Actions	Relevant Programs and Activities
		National Public Power Week (Oct) Energy Awareness Month (Oct) News Media Relations and Social Media
Winter 2025-2026	We will deepen engagement through storytelling and education. This includes publishing op-eds and feature articles, launching a social media campaign, and workshops, as needed. We will also begin targeted outreach to hard-to-reach communities, working with local partners and community-based organizations.	Energy Storage Customer Rebate In-Classroom Education (PUSD partnership) Rooftop Solar Process and Awareness Video Series -Public Service Announcements (Pasadena Media partnership) Outreach to Business Improvement Districts, Chamber, Neighborhood Associations and Community Centers, Senior Center, Libraries EngagePWP.org – Community Engagement Platform Energy Efficiency Incentives: (Rebates & Direct Installations for Residential & Commercial) Low-Income Assistance Electrification (Building & Transportation for Residential & Commercial) Educational scholarships with Clean Energy Focus. Targeting graduating high school seniors planning to attend a 2- or 4-year college, or trade school) News Media Relations and Social Media

Timeline	Actions	Relevant Programs and Activities
Spring 2026	We will focus on mobilization and participation. This includes a second round of ad buys, new video content, and a refreshed social media push. We will also coordinate with local schools, businesses, and institutions to amplify our messaging and encourage community involvement.	Collaboration with Key Account Customers on Sustainability Plans/Activities Large Commercial Customer Annual Meeting – Featuring Inaugural Green Business Champion award and recognition. Water/Energy Nexus messaging during Water Awareness Month (May) Key Account Demand Response: PWP Voluntary Load Curtailment Program (VLCP) & CEC Demand Side Grid Support Program (DSGS) Residential Demand Response Energy Storage Customer Rebate Rooftop Solar Process and Awareness EngagePWP.org – Community Engagement Platform In-Classroom Education (PUSD partnership) Energy Efficiency Incentives: (Rebates & Direct Installations for Residential & Commercial) Community event participation (in-person and virtual) Low-Income Solar Loans
Summer 2026	We will evaluate progress and prepare for the next phase. This includes analyzing campaign performance, gathering additional community feedback, and updating materials as needed, as well as activities related to summer heat readinessWe will also host a mid-year community event to share updates and celebrate milestones.	Low-Income Solar Loans PWP 2nd Annual Open House Key Account Demand Response: PWP Voluntary Load Curtailment Program (VLCP) & CEC Demand Side Grid Support Program (DSGS) Residential Demand Response with high heat and safety messaging EngagePWP.org – Community Engagement Platform Program Participation Surveys Outreach to Business Improvement Districts, Chamber of Commerce, Neighborhood Associations and Community Centers, Senior Center, Libraries Rooftop Solar Process and Awareness Energy Storage Customer Rebate

Timeline	Actions	Relevant Programs and Activities
Continuous	We will maintain a steady drumbeat of communication. This includes developing and distributing press releases, managing media relations, and preparing department leadership for interviews. We will also produce original content in English and Spanish to ensure accessibility and inclusivity. We anticipate ongoing refinement of these activities as we gather additional insights and identify new ways to strengthen community engagement.	

Our content strategy spans digital platforms, traditional media, and in-person engagement. We are creating a story schedule and content templates for use across social media, newsletters, blogs, and email campaigns. Messaging will be tailored for platforms like Facebook, Instagram, and X (formerly Twitter), and shared with local partners to extend our reach.

Ultimately, this work is about building trust, fostering collaboration, and inspiring action. By combining strategic planning with creative execution and community-centered outreach, we are laying the groundwork for a carbon-free Pasadena that reflects the values and aspirations of the people we serve.

Partnerships with Key Stakeholders

Achieving Resolution 9977 goals will require us to develop strong partnerships with industry groups and our large commercial customers. Many of our large commercial customers have their own sustainability commitments, technical expertise, and the resources that can be utilized collaboratively to mutually pursue a clean energy transition at a faster pace than PWP can achieve alone. By working together, we can pilot innovative solutions, leverage shared investments, and create replicable models that benefit smaller customers and the entire community. These collaborations demonstrate leadership, helping to align our mission of delivering reliable, affordable, and clean energy with the collective vision of a healthier, more resilient, low-carbon future for all.

We will launch multi-faceted educational and outreach campaigns targeting large commercial customers, or Key Accounts. The goal of this campaign is to foster open communication, transparency, and collaboration with stakeholders through:

- **Relationship Building**: Community relationship building is a long-term commitment to trust, collaboration, and shared responsibility. By engaging openly with our commercial businesses, and local organizations, we aim to strengthen connections that go beyond providing services. Through dialogue, transparency, and partnership, we work to understand community priorities and co-create solutions that ensure reliable, affordable, and sustainable utility services for all. As discussed in Section 5.3, strong customer relationships will be a key component to the success of the demand response programs we will pursue to support the achievement of Resolution 9977 goals.
- **On-Going Communication**: We are committed to maintaining strong, ongoing communication with our commercial customers. Through dedicated account management, regular business reviews, and tailored updates, we will ensure that our largest customers have

the information and support they need to manage their operations effectively. By offering online tools, workshops, and feedback channels, we will create two-way dialogue that fosters trust and collaboration. In addition, we provide timely communication during emergencies and partner with businesses on energy efficiency, water conservation, and sustainability initiatives. This ongoing engagement allows us to better serve our commercial customers while aligning services with their operational and long-term goals.

The following describes some of the partnerships we plan to nurture and grow as we pursue the goals of Resolution 9977.

Pasadena Unified School District

Pasadena Unified School District (PUSD) currently operates 23 schools and programs, enrolling more than 15,350 students in Transitional Kindergarten to 12th grade in a 76-square mile area that includes Altadena, Pasadena, Sierra Madre and unincorporated areas of Los Angeles County. In December 2022, the PUSD School Board approved a resolution urging the electric utilities supplying the District, including PWP, to source 100% carbon-free energy by 2030. PUSD received California Clean Energy Jobs Act (Proposition 39)[37] K-12 Program funds to plan and install energy efficiency upgrades and clean energy, as well as funding from Measure TT Bond Obligations ($350M to repair and upgrade PUSD's aging and deteriorating campuses). Utilizing this funding, PUSD has installed 7 solar carports and shade structures district wide.

We continue to engage with PUSD regarding infrastructure upgrades, school beautification, and energy efficiency projects, including investigating opportunities to install distributed energy resources such as solar and battery storage at PUSD facilities located in PWP service territory. We will continue to collaborate on efforts to secure a long-term compensation rate for solar generation and storage for the District. PUSD offers large rooftops, open land, and predictable usage patterns that make an ideal partner developing local solar and storage.

Pasadena City College

Pasadena City College (PCC) is a community college with approximately 26,000 students and 1,600 administrators and professors. PCC has received Proposition 39 funds that have been utilized to make several campus-wide upgrades. As part of their master plan, PCC is considering campus modernization improvements and building a satellite campus. Included in these plans is the installation of solar, as they are currently the only community college in California without a solar energy system. PCC plans be Net Zero Energy by 2030 for all major renovations and new construction on their campus.

We continue to engage with PCC leadership to determine opportunities to assist PCC to reach their sustainability goals. We have begun working with PCC to assess site potential, energy usage, and further opportunities to deploy distributed energy resources. The self-generation rate coupled with

[37] California Clean Energy Jobs Act K-12 Program – Pro 39, California Energy Commission, https://www.energy.ca.gov/programs-and-topics/programs/california-clean-energy-jobs-act-proposition-39-k-12-program

a power purchase agreement or public financing could assist PCC to reduce the cost of installing solar and battery energy storage on their campus.

California Institute of Technology (Caltech)

The City of Pasadena and Caltech formalized a partnership aimed at decarbonizing and modernizing the City's electricity infrastructure through a Memorandum of Understanding (MOU) that outlines plans for collaboration on sustainable, carbon-free energy initiatives. The MOU formalizes the shared goals of decarbonizing and modernizing the City's electricity supply and distribution system and recognizes the potentially significant benefits from the increased collaboration and the synergy of working together to develop a clean, resilient and modern power system.

PWP and Caltech have been engaging in MOU Implementation meetings to facilitate coordination and to identify specific actions to address common development goals including, carbon-free energy procurement, microgrids, and resiliency initiatives. As part of these meetings, PWP and Caltech are exploring opportunities to implement microgrid systems that can operate independently of the local utility grid. These discussions include evaluating the existing distribution system to identify opportunities for performance and reliability improvements, identifying constraints within the current system that result in reduced reliability of the overall system, assessing the feasibility of integrating further solar and adding storage on the Caltech campus, and enhancing the campus grid's resilience to withstand emergency disruptions. As PWP and Caltech explore and implement these opportunities, shared learnings on microgrid deployment can be leveraged to support the development of microgrids at other locations and with other critical loads across the City.

Rose Bowl Operating Company

The Rose Bowl Operating Company (RBOC) is responsible for the governance and stewardship of the Rose Bowl Stadium and Brookside Golf Courses. The Rose Bowl is maintained to preserve the dignity and historical significance of the stadium in a majestic park environment and will continue to be recognized as one of the nation's premiere sport and entertainment venues.

The Rose Bowl represents a high-visibility, high-impact opportunity to accelerate local solar and storage by transforming the extensive parking lots into solar canopies and a resiliency hub for the surrounding community. Through the installation of large-scale parking canopy solar systems, the facility could generate significant carbon-free energy close to load centers, while providing shaded parking, which can enhance the visitor experience during events. The potential solar and storage system could be sized to power the stadium, serve EV charging stations at the facilities, and shave the facility's peak load to reduce strain on the local gird infrastructure as well as lower energy costs at for RBOC.

A solar and storage project at the Rose Bowl could serve as a highly visible demonstration of the City's carbon-free goal and commitment to climate leadership. The project could have a significant impact the community and attitudes toward supporting the clen energy transition.

Pasadena Center Operating Company

The Pasadena Center Operating Company (PCOC) is a non-profit organization, formed by the City of Pasadena to manage the Convention Center, Civic Auditorium, Convention and Visitors Bureau,

and Ice Skating Center. PCOC is funded by earned revenue from its facilities, proceeds from a tourism business improvement district that is funded by a hotel/motel assessment, and a portion of the hotel/motel transient occupancy tax. We maintain a close relationship with PCOC and have encouraged them to install high-efficiency lighting and equipment, automated building control systems, an operational recycling program, water-conserving restroom fixtures, drought-resistant landscaping, and a new energy-efficient central plant.

As part of ongoing discussions, PCOC has expressed interest in installing solar at their facility but has yet to find a cost-effective solution. An initial investment would allow PCOC to install solar and storage to lower its energy costs, gain a predictable revenue stream, and demonstrate climate leadership, while PWP would gain access to local clean energy capacity without owning the assets directly.

Los Angeles Cleantech Incubator

We are a member of the Los Angeles Cleantech Incubator (LACI), a public-private partnership focused on accelerating the transition to a resilient, innovative, and equitable zero-carbon grid with a focus on working with startups to accelerate the commercialization of clean energy technologies. Through our membership with LACI, we gain access to opportunities to pursue pilot projects and grant funding with joint applications amongst members. We plan to pursue future opportunities with LACI including piloting new and emerging technologies, as well as the deployment of renewable energy microgrid solutions to integrate distributed energy resources, energy storage systems, and EV charging infrastructure. In addition, we plan to continue to pursue grant funding opportunities for demand response pilot programs, deployment of battery storage systems to enhance grid resilience, and renewable workforce development through internship offerings.

6.2 Identify Financial Strategies and External Funding to Mitigate Rate Impacts

Maintaining affordable energy bills for our customers is a core objective of Resolution 9977. We will continue to build upon the strategies we have deployed to keep PWP's rates some of the lowest in the State. These strategies include:

- **Reduce operational costs:** We continually seek opportunities to reduce the costs to operate our system; with long-term financial planning, we will operate the system with an eye toward the best return on investment and lowest total operating costs for clean energy solutions
- **Municipal borrowing:** As a municipal utility, we can leverage municipal borrowing to spread the cost of infrastructure investments over a longer duration and take advantage of our lower cost of capital as a tax-exempt borrower. This also creates intergenerational equity amongst our customers who will reap the benefits of historic investments now for an ideal future state.
- **Innovative new financing strategies:** We pursue innovative new financing strategies, such as prepay deals, to realize any savings on existing or future resources. We will also continually keep our eye out for state-of-the-art solutions as they emerge.
- **Alternative sources of revenue:** We also aggressively pursue opportunities for alternative sources revenue from grant programs operated by the State, federal government, and non-profits aligned with our mission.

Prepay deals

One of the innovative financing tools we are exploring is prepay renewable energy bonds, a mechanism that allows PWP to leverage its tax-exempt status to reduce the cost of long-term renewable energy contracts. Under this mechanism, PWP can issue tax-exempt municipal bonds - permitted by the Internal Revenue Service - to prepay for energy under existing PPAs. In return, PWP receives the energy at a discounted rate over the life of the contracts. These savings are made possible by the lower cost of capital associated with tax-exempt bonds, which benefits the utility and, ultimately, our customers.

We plan to work with SCPPA to issue a prepay bond by the end of 2025. While the structure of the bond issuance is still under development and the exact savings are not yet determined, PWP intends to include five existing PPAs (Antelope Big Sky Ranch Solar, Big Sky Summer Solar, Columbia 2 Solar, Kingbird Solar, Wind Resource II in the prepay structure due to their relatively high costs and long remaining contract terms. As other renewable PPAs reach commercial operation, PWP will consider additional prepay transactions to capture further savings when market conditions are favorable.

In the prepay structure, PWP will assign the rights to receive energy from these renewable projects to SCPPA and will agree to repurchase the energy through a Clean Energy Purchase Contract. SCPPA will use the bond proceeds to make a prepayment covering most of the purchase price, enabling it to sell the energy back to PWP at a discounted price per MWh compared to the original PPA terms. The long-term nature of the agreement provides budget certainty, which is essential for long-range planning and rate stability.

If an adverse event, such as a counterparty bankruptcy or significant interest rate volatility, impacts the tax-exempt financing structure, the original PPAs and all their terms would revert back to PWP. Additionally, if the discount rate falls below a certain threshold, PWP has the option to cancel the limited assignment agreement and resume direct control of the PPAs.

Grants

We will seek partnerships for grants and co-funding with entities such as the State of California, the federal government, and non-profits to supply the funding needed to finance the City's carbon-free future. To date, we have actively pursued and secured several competitive grant opportunities that directly support our transition to a carbon-free future, included:

- A $9.66 million grant from the California Energy Commission's (CEC) Distributed Electricity Backup Assets (DEBA) Program for our Glenarm Battery Energy Storage System;
- A $60,000 grant from American Public Power Association (APPA) – Demonstration of Energy and Efficiency Development (DEED) Program for a distributed energy resource rooftop wind microturbine pilot project;
- Two technical assistance vouchers with a combined values of up to $275,000 from the DOE in partnership with ENERGYWERX for long-duration energy storage planning and implementation (see section 5.2);
- $500,000 from the California Electric Vehicle Infrastructure Project (CALeVIP) for EV charging infrastructure; and,

- $193,600 from DOE's Energy Efficiency and Conservation Block Grant (EECBG) Program for energy efficiency initiatives.

Additionally, we have pursued the following grants unsuccessfully:

- $48,994,187 for the Glenarm BESS Project from the DOE's Grid Resilience and Innovation Partnerships (GRIP) Program;
- $5,097,415 for a long-duration energy storage pilot project from the DOE's Energy Storage Pilot Demonstrations and Pilot Grant Program;
- $100,000 for the Optimized Strategic Plan from CEC's California Clean Energy Planning Program

We are currently pursuing grant funding from the CEC's Round 2 Community Energy Reliability and Resilience Investment (CERRI) Program which provides funding for grid-hardening and grid resilience projects that strengthen and modernize the grid against wildfires, extreme weather, and other natural disasters. We are also pursuing this grant opportunity to support the AMI project. We will continue to pursue new funding opportunities that align with our strategic priorities with state and federal agencies as well as non-profits that support our goals.

7 Conclusion

7.1 Resolution 9977 Objectives

With the adoption of Resolution 9977, the Pasadena City Council recognized the severity and urgency of the climate emergency and set the City on a course to be a leader on the clean energy transition. Resolution 9977 set several objectives including:

- **Carbon-Free:** The Resolution's goal to achieve 100% carbon-free energy by the end of 2030 sets Pasadena on a path to achieve the State's 100% clean energy standard by 2045, 15 years in advance. Additionally, the decarbonization goal of Resolution 9977 is more ambitious than many of the voluntary goals set by other utilities and corporations and makes Pasadena a leader amongst California municipalities with clean energy goals.
- **Reliable:** As a utility, providing safe and reliable electricity service has always been core to our mission. A reliable electric grid is essential to the function of modern society. Resolution 9977 recommits us to providing reliable service during a period when doing so is increasing in complexity as the grid shifts to depending more upon variable and energy-limited resources; climate change creates difficult to predict extreme events; and usage patterns change with electrification, new loads, and evolving customer behavior.
- **Affordable:** Access to affordable electricity directly impacts quality of life, health, and economic opportunity. Low and stable electricity rates are also critical to attracting business to our community as well as supporting economy-wide decarbonization efforts through transportation and building electrification. PWP currently has some of the lowest rates in the region, and we are committed to keeping electricity bills affordable to support our diverse community.
- **Equity:** As low-income customers spend a disproportionate share of their income on utility bills, providing affordable service is directly connected to achieving the equity objectives of the Resolution. Pursing equity also entails expanding access to and creating opportunities for all our customers to participate and benefit from the clean energy transition. Promoting equity involves designing customer programs and rates that do not benefit one subset of our customers at the expense of others.

Our OSP was designed to optimize for all of these objectives, and we will continuously try to balance them as we chart our path forward.

7.2 Adaptive Planning and the Waypoint Framework

We developed this OSP to be flexible and adaptive in response to many of the transformational changes and significant uncertainties facing the electric industry today and to preserve optionality for the future in a rapidly changing technology landscape. Key drivers of change and uncertainty include escalating costs for new generation resources, evolving federal trade and energy policy, emerging technologies, shifting customer preferences and demand-side innovation, sources of load growth, and the impacts of climate change. In this environment, adaptability and flexibility are crucial

for mitigating risk and responding quickly to changes in market conditions, customer preferences, and unforeseen events.

We established the Waypoint framework in the 2023 IRP process in recognition of the need to adapt to the shifting landscape of this industry and the known challenges of achieving an ambitious carbon-free energy goal. The Waypoints in 2026 and 2028 provide an opportunity to take stock of our progress and reevaluate our strategies and policies to achieve all objectives of Resolution 9977.

7.3 Action Plan

Recognizing the need for adaptability and flexibility, the OSP presents a comprehensive set of actions we plan to take to achieve the goals of Resolution 9977. Each action is aligned with one or more of the pillars of the OSP:

1. Rapidly scale proven technologies, including renewables and energy storage, within Pasadena and across the broader region;
2. Develop innovative programs and rates to leverage customer-facing solutions;
3. Mitigate Glenarm Power Plant (Glenarm) operations, using it as a "reliability backstop" until another solution is available;
4. Upgrade our power delivery infrastructure to improve reliability, relieve import constraints, and enhance demand side innovation; and
5. Monitor and encourage emerging technologies to expand options to decarbonize.

Many actions in our plan are already underway or have been completed including replacing our aging sub-transmission infrastructure, deploying AMI to enable demand response programs at scale, revising the policy limiting the size of customer solar installations, streamlining the permitting and interconnection process for customer solar and storage, and developing outreach and education campaigns to encourage our community to participate in the clean energy transition. Our Action Plan also continues our commitments to transparency with progress reports on several of the measures that will be taken and continuing to update our Clean Energy Tracker.

Our Action Plan includes an aggressive suite of measures we plan to pursue with urgency before the 2028 Waypoint. These include issuing an RFP for utility-scale carbon-free resources, developing solar on municipal properties, creating a feed-in-tariff, and engaging large commercial customers in demand response and developing implementation plans to scale this resource.

We plan to use the 2028 Waypoint to evaluate our progress and several significant policies related to the Resolution 9977 goals. At the Waypoint, we will have deployed AMI across the City, enabling us to institute time-of-use rates and potentially evaluate rate designs and incentives for all customer-owned distributed energy resources. We will evaluate, and present to City Council, the impact of all programs and potential alternatives on meeting our local solar and storage planning targets and on participating and non-participating customer bills.

At the Waypoint, we will also be able to assess whether we need to issue additional RFPs for utility-scale resources based on what we have procured to date, from the RFP we will issue in 2025 and through continued participation in SCPPA RFPs, and the impact of those contracts on rates. Additionally, the 2028 Waypoint will present an opportunity for us to reevaluate long-term transition

options for Glenarm given how the technology landscape has evolved and the timeline for transmission expansion.

While the 2028 Waypoint may identify the need for new additional actions or a reprioritization of actions included in this OSP, we currently plan to focus our efforts between the Waypoint and the end of 2030 on deploying and scaling demand response programs, bringing online the Broadway BESS project, continuing the development of solar on municipal property, and pursuing pilots for emerging technologies.

Recognizing that we must plan for the future of our system beyond 2030, and that ceasing fossil fuel combustion at Glenarm remains a long-term objective for achieving decarbonization, our Action Plan includes several measures that will be completed after 2030. These include increasing import capacity at TM Goodrich and pursuing a second point of interconnection with CAISO.

Our action plan is summarized in the table below.

Table 31. OSP Action Plan

Action Plan Item (Organized by OSP Pillars)	Applicable OSP Pillars	Timeline
0 General reporting and progress updates		
Provide quarterly progress updates to Municipal Services Committee	1 2 3 4 5	2025-2030
Maintain Clean Energy Tracker website	1 2 3 4	2025-2030
Publish 2028 Integrated Resource Plan	1 2 3 5	2028
1 Rapidly scale proven technologies (utility-scale renewables & storage)		
Integrate new contracted resources into portfolio (210 MW renewables & 55 MW storage)	1	2025-2029
Continue to procure resources through SCPPA and seek approval (as needed)	1	2025-2030
Conduct all-source RFP for new utility-scale renewables and storage	1	2025-2027
Reassess cost impacts to continue procurement above 100% annual matching	1	2026-2028
Evaluate need to issue additional RFPs for renewables and storage	1	2028
Issue and administer additional RFPs (as needed)	1	2029-2030
Integrate additional contracted resources into portfolio (up to 325 MW renewables and 100 MW storage)	1	2029-2030
1 Rapidly scale proven technologies (local solar & storage)		
Revise policy on customer solar sizing	1 3	2025
Reevaluate best use of Public Benefit Charge funds	1 2 3	2025-2030
Launch public outreach and education campaign	1 3	2025-2026
Identify municipal sites for solar development	1 3	2025-2026
Conduct studies to identify potential microgrid sites	1 3	2025-2026
Develop Glenarm BESS project (25 MW, online 2027)	1 3	2025-2027
Bring proposal to further revise policy on customer solar upsizing to City Council	1 3	2026
MSC study session on lowering barriers to customer adoption	1 3	2026
Develop feed-in tariff (FIT) program for solar & storage targeting large institutional customers	1 3	2026
Streamline permitting and interconnection processes	1 3	2026
Develop the low interest loan program for low-income customers	1 3	2026
Develop incentive program for customer-owned solar and storage	1 3	2026
Develop municipal solar installations at initial high priority sites	1 3	2026-2028
Explore other opportunities for solar and storage development (e.g. Rose Bowl, 710 Stub)	1 3 5	2026-2030
Develop Broadway BESS project (75 MW, online 2030)	1 3 5	2026-2030
Develop microgrids at initial selected municipal properties	1 3	2027-2028
Partner with commercial and institutional sites for microgrid development	1 3	2027-2028
Continue public outreach and education campaign	1 3	2027-2030
Develop municipal solar installations at additional sites	1 3	2027-2030
Partner with large customers and institutions to develop solar and storage under FIT program	1 3	2027-2030
Evaluate tariffs that incentivize customer solar and storage adoption	1 3	2028
Continue development of microgrids at additional sites	1 3	2029-2030
2 Develop Innovative Programs and Rates to Leverage Customer-Facing Solutions		
Continue to deploy energy efficiency resources to meet energy efficiency goals	2 3	2025-2030
Enroll large customers in Voluntary Load Curtailment Program (VLCP)	2 3	2026
Evaluate building load management program models best suited for Pasadena	2 3	2026-2027
Evaluate program design for active managed charging of electric vehicles	2 3	2026-2027
Pilot building load management programs with small customer groups	2 3	2027-2028
Develop and pilot active managed charging programs	2 3	2027-2028
Develop TOU rates to incentivize load management, flexibility, and energy storage	1 2 3	2028
Deploy building load management programs acorss all customer classes	2 3	2028-2030
Deploy and scale active managed charging programs	2 3	2029-2030
3 Additional Actions Related to Mitigating Glenarm Operations		
Provide annual reporting on Glenarm operations	3	2026-2030
Reevaluate options for long-term Glenarm transition	3	2028
Assess renewable natural gas supply options	3	2028-2030
4 Upgrade Power Delivery Infrastructure		
Upgrade internal distribution infrastructure	3 4	2025-2027
Implement Advanced Metering Infrastrcuture (AMI) throughout the City	3 4	2025-2028
Publish 2027 Power Delivery Master Plan	3 4	2027
Increase import capability at TM Goodrich Receiving Station	3 4	2025-2035
Develop second point of interconnection with CAISO	3 4	2025-2040
5 Leverage Emerging Technologies		
Montitor emerging technology status	3 5	2025-2027
Coordinate with neighboring utilities to planning for hydrogen conversions	3 5	2025-2030

Notes

Items are categorized according to the most directly relevant area, but secondary linkages to other pillars are shown in "Applicable OSP Pillars"
Additional detail on schedule and milestones for action items are provided in detailed action plan schedules