



Pasadena Water and Power

2023 Power Integrated Resource Plan (IRP)

City Council Meeting

12/11/2023

Item #26



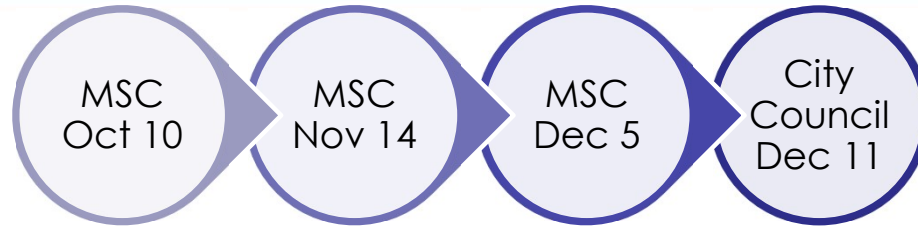


Introduction

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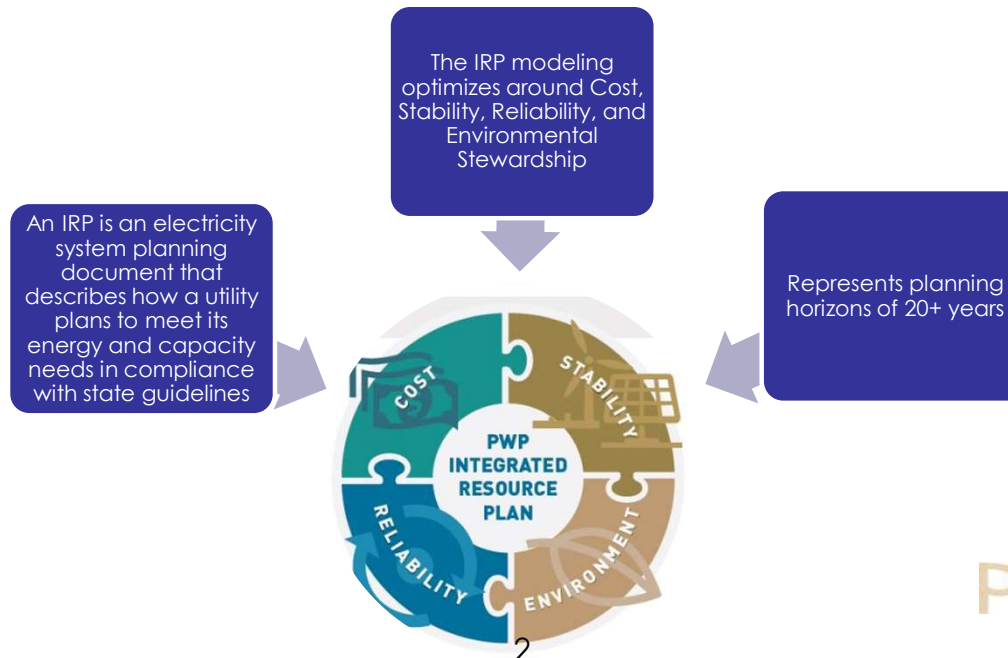
Agenda

- Introduction
- 2023 IRP Development
- Summary of MSC meetings and action items
- Scenarios and Modeling Process
- Implementation Plan and Waypoints
- Energy and Environmental Economics (E3) Independent Review Presentation



Key Takeaways

- Satisfies Resolution 9977 objectives
- Shows multiple pathways to Carbon-Free by 2030
- Meets all CEC requirements and guidelines for IRPs
- IRP uses good utility practices and follows industry standards
- Exceeds state mandates
- Has concrete, specific details for each year in the Implementation Plan
- Submittal to the CEC is required 5 years after the previous IRP was approved (2018 IRP approved December 10, 2018)

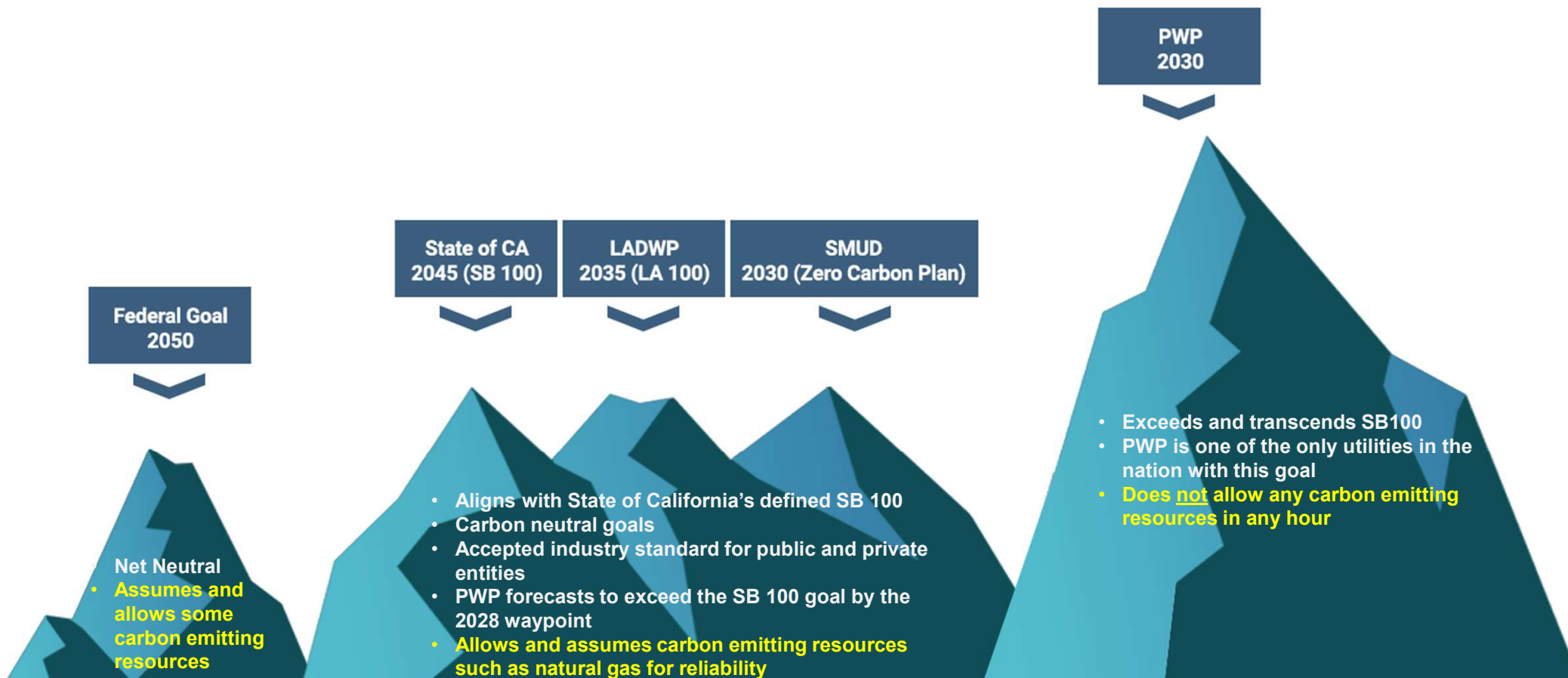


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Comparison of Goals

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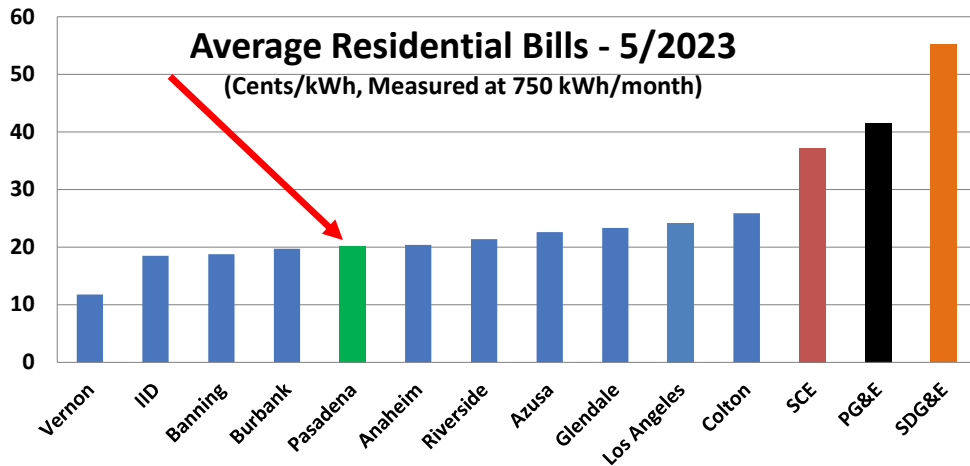




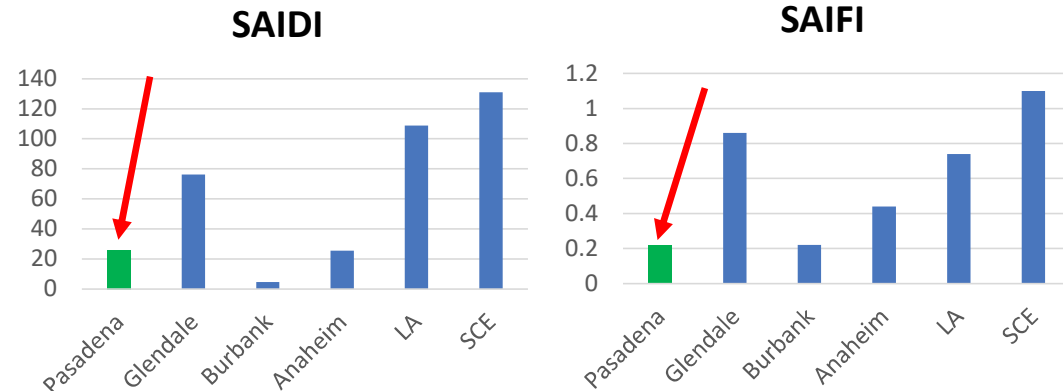
PWP Key Metrics

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- Offers one of the lowest residential electric rates compared to neighboring utilities
- Provides programs for energy efficiency, low-income, and disadvantaged communities
- Consistently exceeds State Renewable Portfolio Standard (RPS) requirements
 - > 2022 Requirement: 38.5%; Reported 40%



- Among the best reliability metrics compared to those of neighboring utilities in 2022
 - > SAIDI (System Average Interruption Duration Index)
 - Average minutes per outage (~26 minutes)
 - > SAIFI (System Average Interruption Frequency Index)
 - Average frequency of outages (~1 outage every 4 years)
- APPA RP3 Utility “Platinum”





2023 IRP Development

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An Integrated Resource Plan (IRP) is an electricity system planning document that describes how a utility plans to meet its energy and capacity needs in compliance with state guidelines

- This document is required every five years by the California Energy Commission (CEC)

2023
IRP



Pasadena Water and Power (PWP) has accomplished all objectives and requirements and are recommending approval and adoption

- Meets all requirements for a Compliance Filing to the CEC
- Plans multiple approaches to source 100% Carbon Free electricity by the end of 2030 (Resolution 9977)



Contracted with Alliance for Cooperative Energy Services (ACES) for modeling

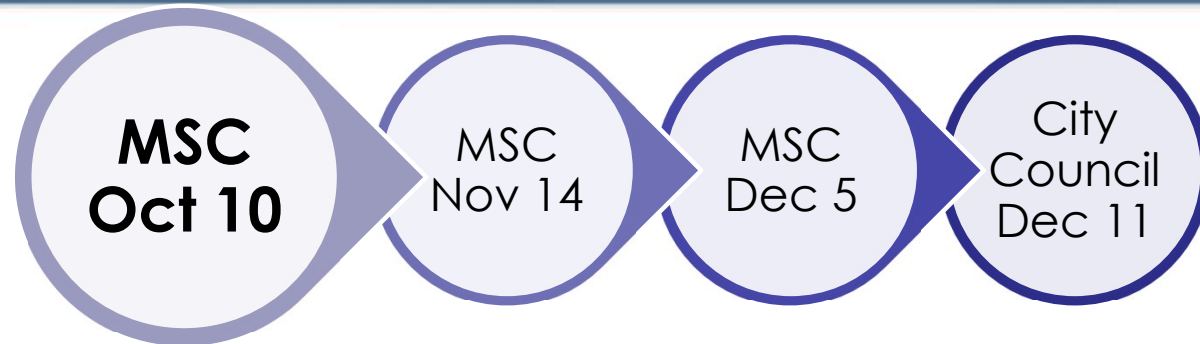


Energy and Environmental Economics, Inc. (E3) performed an independent review



MSC – October 10, 2023

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- **October 10, 2023**

- > Staff provided a detailed presentation on the 2023 IRP plan for adoption and approval
- > Staff presented a flexible plan that includes multiple pathways leveraging the implementation plans from all carbon-free scenarios to achieve the goals of Resolution 9977
- > Staff also presented forecasted costs and their estimated impact on customer rates

- **MSC Directives**

- > Provide incremental Implementation Plan details
- > Provide enhanced information on the Waypoint framework



MSC – November 14, 2023

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- **November 14, 2023**

- > Provided responses on the October 10, 2023 meeting follow-up items
- > Outlined the 2028 Waypoint framework, aligned with Carbon Free Scenario 2, to include a detailed Implementation Plan mirroring the scenario's resource types and resource timing, as derived from the computerized modeling optimizations
 - > The Waypoint framework provides for the potential integration/review of new and emerging technologies while dovetailing into the next regulatorily required 2028 IRP filing

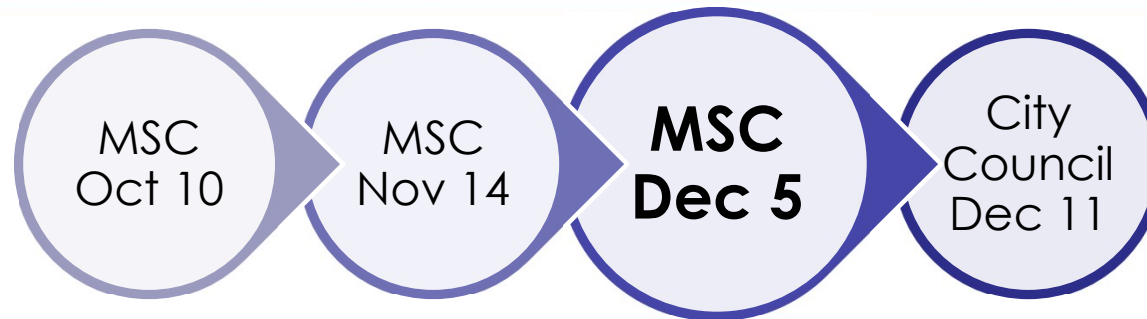
- **MSC Directives**

1. Create an incremental 2026 Waypoint, allowing for future evaluation and technical analysis of Goodrich Receiving Station ("Goodrich") upgrades and the required key system modifications described in the Power Delivery Master Plan (PDMP)
2. Provide an incremental timeline and detail associated with the planned 2024 Electric Cost of Service and Rate Design Study (COS)
3. Provide incremental Distributed Energy Resource (DER) and Demand Response (DR) information and concepts. The Implementation Plan patterned after Carbon Free Scenario 2 modeling results identifies DER and DR resource types
4. Provide commentary of dashboard concepts that could be used to assist in future monitoring and communication



MSC – December 5, 2023

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- **December 5, 2023**

- > Provided responses on the November 14, 2023 meeting follow-up items

- **MSC Motion and Direction**

- > Recommended approval of the IRP to City Council and directed Staff to include additional items as part of that approval:

1. Create a future dashboard to track the City's progress towards meeting its carbon-free goals
2. Conduct a two-year review of the IRP and present to the MSC
3. Develop an integrated strategic plan that synergizes waypoint evaluations, Power Delivery Master Plan, Cost of Service Studies, Rate Studies and evaluation of new and emerging technologies along with the 2028 IRP CEC required submittal

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Metrics Dashboard – Dec. 5 Directive #1

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- Develop a web-based dashboard to include:
 - > Quarterly progress updates on timeline, resource procurement, and other activities
 - > Summaries of relevant studies that have been completed
 - > CAISO metrics related to key transmission corridors and programs
 - > Status of renewable projects under development where PWP may have a commercial interest
 - > Rates, cost impacts and other considerations as they may occur dynamically
 - > Regulatory compliance considerations or changes that may have material impact upon the project, Renewable Portfolio Standards, or CAISO Resource Adequacy program enhancements
 - > Updates on other sponsored initiatives such as energy efficiency and electric vehicle charging
 - > Answers to Frequently Asked Questions
 - > Regular content updates

Net Zero Dashboard Example Dashboard



Source: Hawaii Office of Sustainability

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Integrated Strategic Plan – Dec. 5 Directive #2

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- Develop an integrated strategic plan that outline a path to carbon-free energy through 2030
 - > Integrated Strategic Plan (“ISP”)
- The ISP will integrate PDMP, Cost-of-Service and Rate Studies, Waypoint Framework, various planned topic studies, and others
 - > MSC recommended that the ISP be prepared in consultation with E3 and/or other consultants
- The ISP would be analogous in format to other strategic plans like SMUD’s Zero Carbon Plan and LADWP’s LA100 plan
 - > SMUD’s and LADWP’s strategic plans were informed by their IRPs



Perform a review of the 2023 IRP – Dec. 5 Directive #3

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Conduct a review of the 2023 IRP and present it to the MSC

- > PWP will provide the MSC with periodic informational updates supplemental to the required CEC 5-year filings



Scenarios

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- A scenario is a mix of resources created given some assumptions
- Provide valuable information towards shaping pathways to meet carbon-free goals

Scenario 1: 100% Carbon Free by 2030 with No Limit on Internal Resources

- Internal Resources are those located within PWP's service territory or City limits

Scenario 2: 100% Carbon Free by 2030 with a Limit on Internal Resources

- Limit estimated by size of resources and land available for use

Scenario 3: 100% Carbon Free by 2030 with a Limit on Internal Resources and Doubled Distributed Resources

- Distributed Energy Resources (DERs) include Residential Solar/Batteries and Commercial Solar/Batteries

Scenario 4: Reference Case

Scenario 5: Reference Case + Social Cost of Carbon

- Same assumptions as Scenario 4 but adds the Social Cost of Carbon as determined by the Environmental Protection Agency (EPA) to any resource that emits carbon

Scenario 6: Emerging Technologies Study Scenario

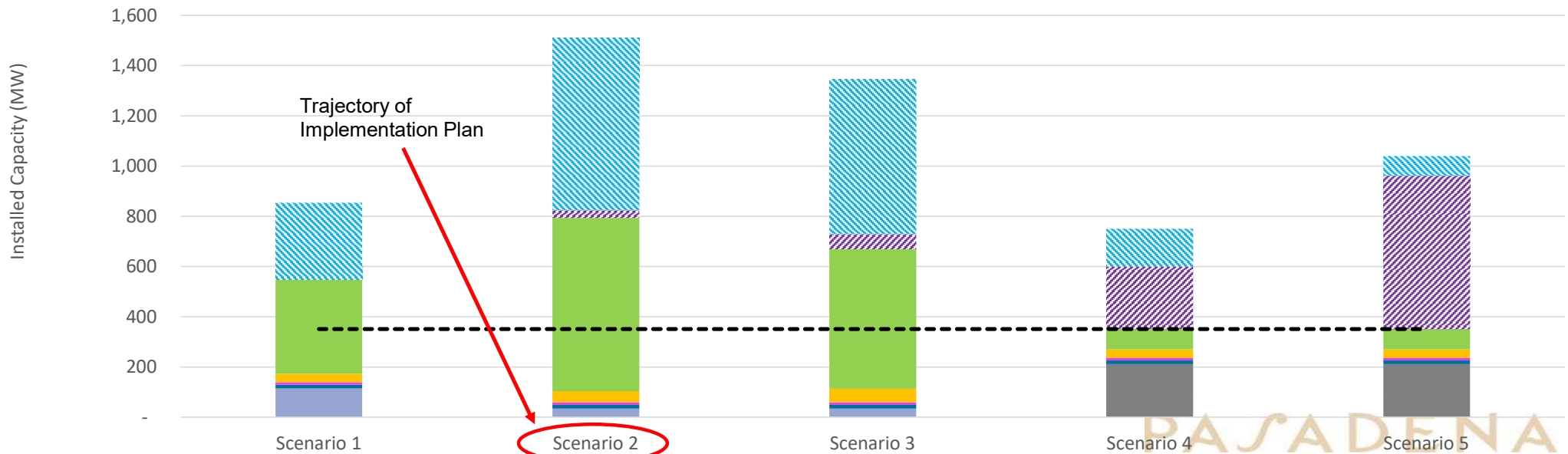
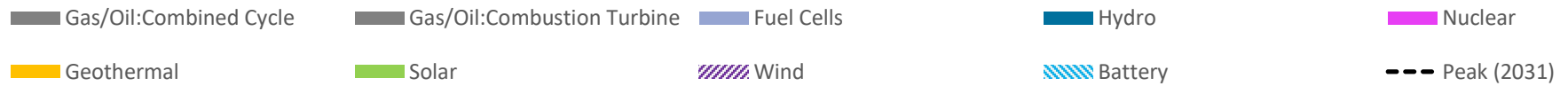
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Resource Additions

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Installed Capacity By 2031



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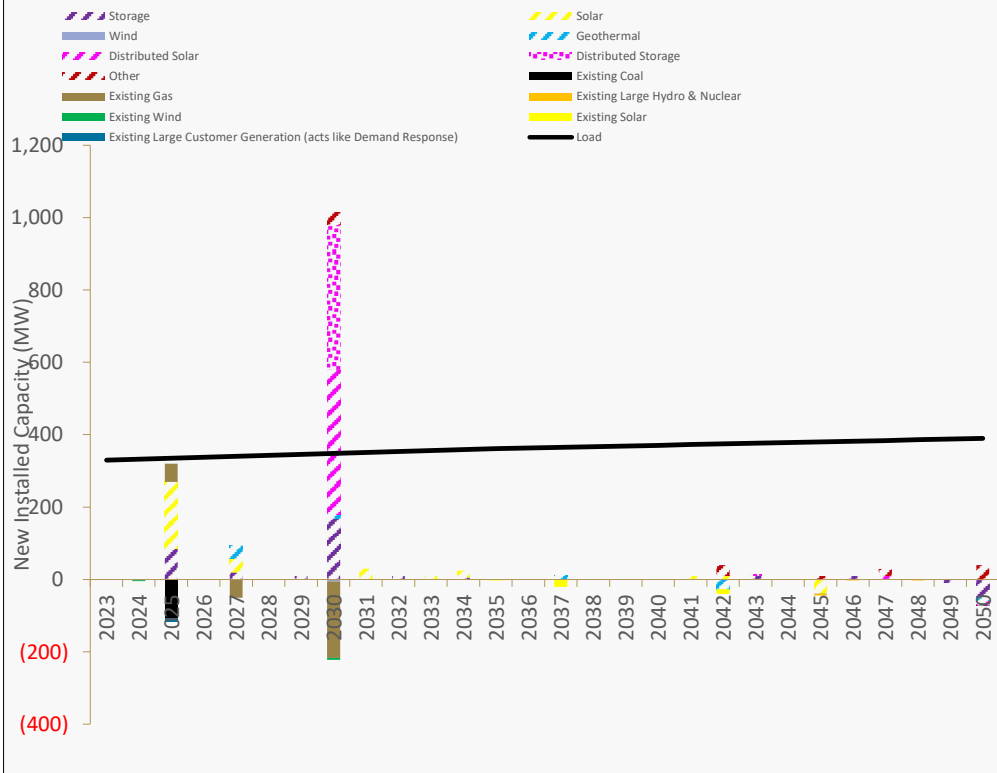
IRP: Figure 152



Scenario 2 Procurement Schedule

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Scenario 2: Island: Incremental Capacity Additions



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Scenario 2

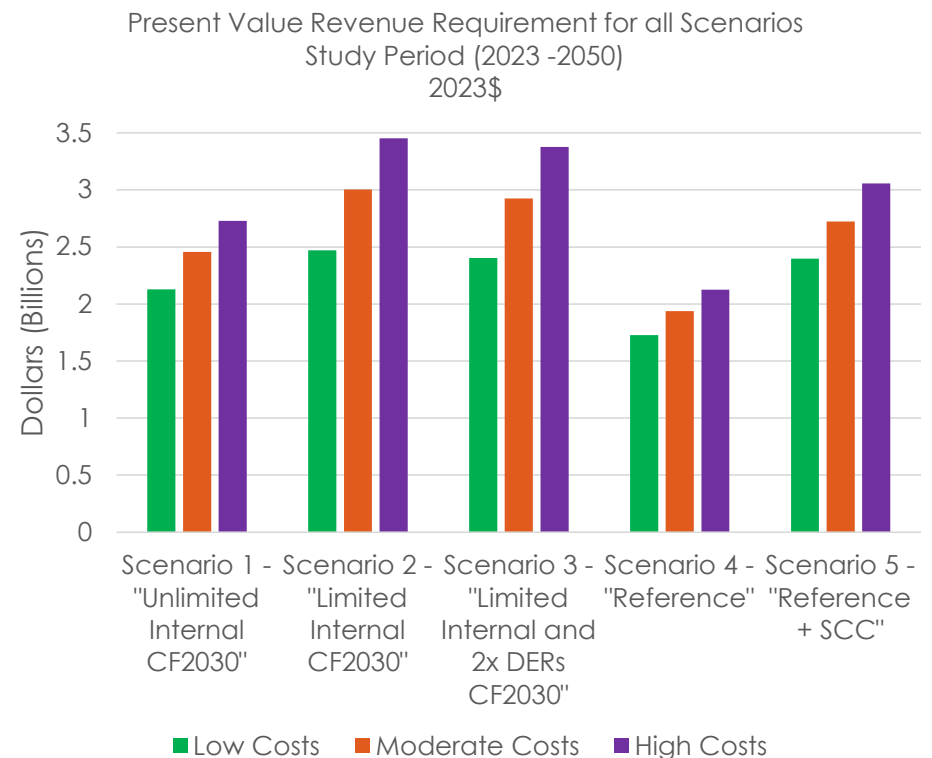
Timeline	Impacts
2025	<p>Retirements</p> <ul style="list-style-type: none"> 108 MW IPP Coal 10 MW Large Customer Generation <p>Additions</p> <ul style="list-style-type: none"> 54 MW Natural Gas (IPP Renewal) 185 MW Solar 30 MW Wind 85 MW Storage
2027	<p>Retirements</p> <ul style="list-style-type: none"> 54 MW Natural Gas (IPP Renewal) <p>Additions</p> <ul style="list-style-type: none"> 39 MW Solar (EDF Sapphire through 2046) 35 MW Geothermal (Coso Geothermal through 2041 and Calpine Geysers through 2041) 20 MW Storage (EDF Sapphire through 2046)
2030	<p>Retirements</p> <ul style="list-style-type: none"> 212 MW Natural Gas (Glenarm + Magnolia) 5 MW of Wind (Milford 1) <p>Additions</p> <ul style="list-style-type: none"> 170 MW Storage 35 MW Fuel Cells 10 MW Geothermal 400 MW of Distributed Solar 400 MW of Distributed Storage
Overall Impact	Scenario 2 focuses on Distributed Energy Resources; specifically, solar and storage to meet needs.



Present Value Cost of Scenarios

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- Scenarios range in cost from \$1.7 Billion to \$3.5 Billion
- Cost Representation
 - > In 2023 dollars
 - > Present Value Revenue Requirements (PVRR) for each scenario for each cost case (Low, Moderate, or High)
- Costs affect only the energy charge portion of a customer bill
 - > Do not include transmission and distribution, overhead, or maintenance costs



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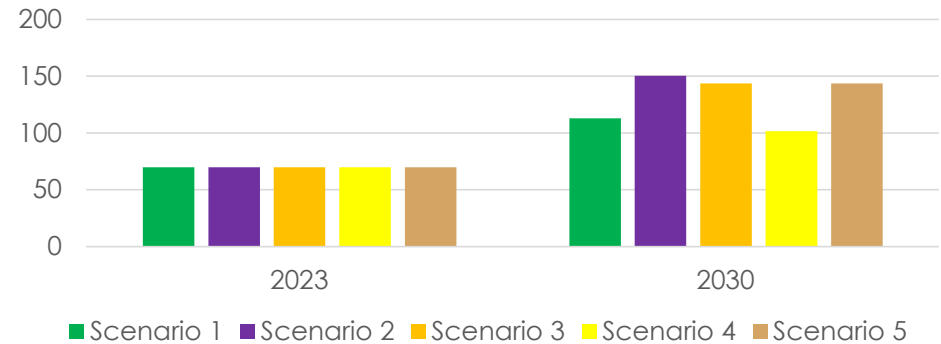


Bill Impacts

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- For single-family residential customers, assuming 500kWh per month usage, and only the Energy Charge portion of the bill
- Cost-of-Service study is needed to give more certainty on the exact rate impacts
- Impacts do not reflect:
 - > Stranded investment costs
 - > PDMP estimate of \$821 million in investments needed through 2042
 - > Other components such as finance, administration, information technology and customer service
 - > CAISO's estimates that approx. \$7.3 billion must be invested in new/upgraded transmission infrastructure
 - New/upgraded transmission lines are required to support new renewable resource development in California
 - As a CAISO market participant, PWP will bear a portion of these costs.

Monthly Impacts on Energy Charge Portion of Customer Bill (\$/single family residential customer, 500 kWh)
High Costs Case



Scenario	Energy Charge Portion of Customer Bill in 2030 (\$/single-family residential customer, 500 kWh, monthly, High Costs Case)	% Change in Energy Charge Portion of Customer Bill from 2023 to 2030
1	\$112.88	50%
2	\$150.50	91%
3	\$143.53	83%
4	\$101.73	38%
5	\$143.53	90%

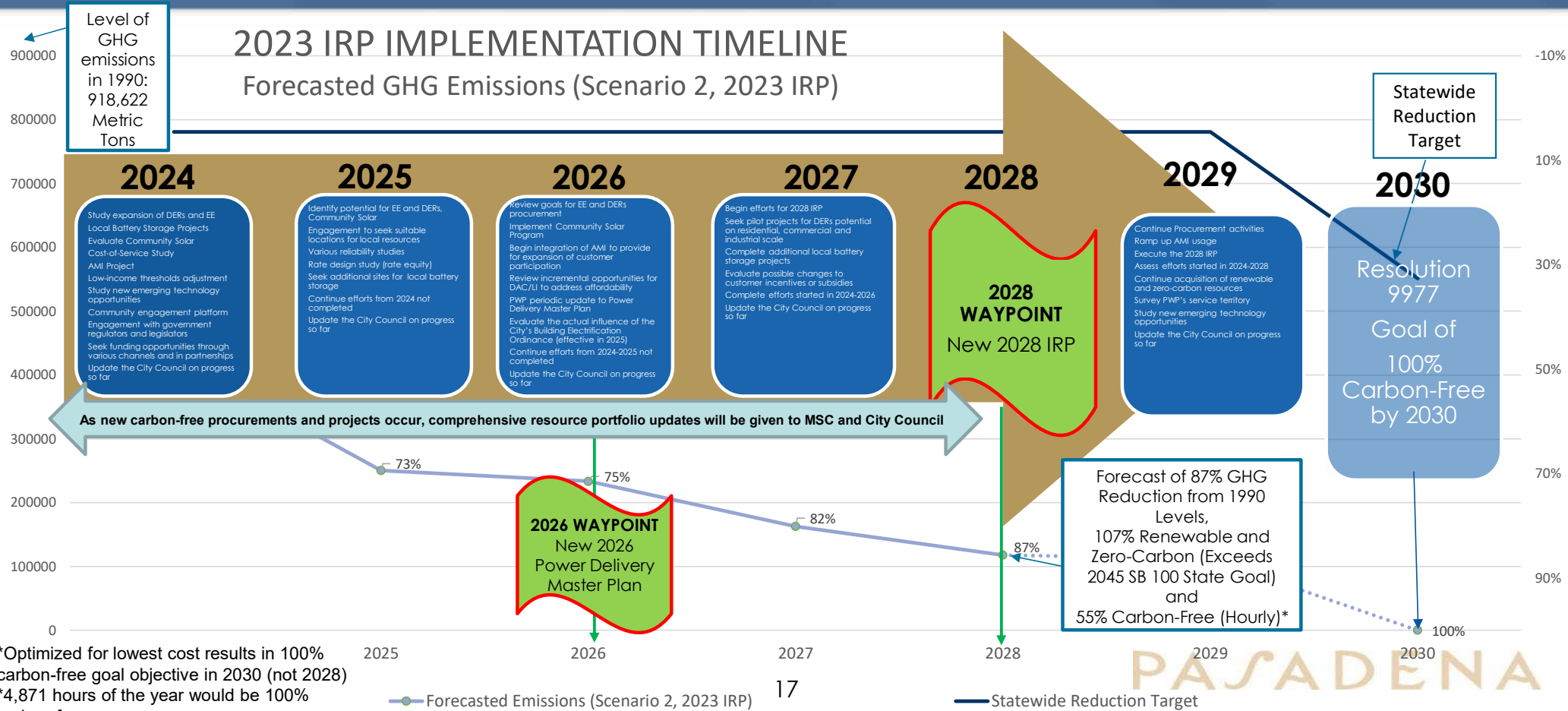


100% Carbon-Free Trajectory to 2030

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2023 IRP IMPLEMENTATION TIMELINE

Forecasted GHG Emissions (Scenario 2, 2023 IRP)



*Optimized for lowest cost results in 100% carbon-free goal objective in 2030 (not 2028)
 *4,871 hours of the year would be 100% carbon-free

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Challenges and Solutions

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Challenge	Solution	What is Needed to Achieve the Solution?	What are we doing to address it?	Where has PWP discussed this previously?
Market Conditions	Market Expansion, R&D, Self-Development	Maximize PWP's exposure to relevant opportunities	<ol style="list-style-type: none"> Monitoring the market Issuing PWP-specific RFP to find more offerings 	10/10 MSC
Limited Transmission	Dependent on CAISO	CAISO will announce changes in their Scoping Plan	Lobbying relevant state officials to improve the transmission system	10/10 MSC
Goodrich	Upgrade Goodrich	Execute 56 MW capacity expansion upgrade	<ol style="list-style-type: none"> Upgrade plan is underway (PDMP) Studying options for reducing the timeline and shifting to internal resources 	11/14 and 12/5 MSC
Glenarm	Convert to an alternative fuel source	Zero Carbon Fuel	Studying the possibility of hydrogen gas usage at Glenarm, including the sourcing of green hydrogen	10/10 MSC
Distributed Energy Resources	Rooftop solar Distributed storage	Support customer installations	Hosting Plan and Resource Study	11/14 and 12/5 MSC
Demand Response	Install Advanced Metering Infrastructure (AMI)	Advanced Metering Infrastructure allowing two-way communication	<ol style="list-style-type: none"> Planning incentives to encourage customer participation in Demand Response Setting up Demand Response programs utilizing AMI 	12/5 MSC
Reliability	Strict, uncompromising adherence to regulatory standards	Make changes to PWP's resource portfolio only as reliability/availability performance permits	<ol style="list-style-type: none"> Striving for resource diversity (by technology, internal/external, geographic location, etc.) Retiring resources only after determining that the rest of the portfolio will perform well enough without them 	IRP (Resource chapter 17)
Land Available	Efficiency and optionality	Opportunities to work with Customers and City Officials	Pursuing more energy-dense technologies as appropriate for installation inside Pasadena	10/10 MSC



Independent Review

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- Energy and Environmental Economics, Inc. (E3)
 - > Recognized leader in clean energy policy implementation
 - > Worked with clients including CEC, CPUC, CARB, and many other utilities such as SMUD and LADWP
- PWP contracted with E3 to review the IRP analysis



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E3 Independent Review of 2023 IRP Results

Presented by:
Nick Schlag (E3)



Who is E3? - Energy and Environmental Economics Inc.

Thought Leadership, Fact Based, Trusted.



100+ full-time consultants | 30 years of deep expertise | Engineering, Economics, Mathematics, Public Policy...



San Francisco



New York



Boston



Calgary

E3 Clients

300+ projects per year across our diverse client base



Buy-side diligence support on several successful investments in **electric utilities** (~\$10B in total)

Acquisition support for investment in a **residential demand response company** (~\$100M)

Supporting investment in several **stand-alone storage** platforms and individual assets across North America (10+ GW | ~\$1B)

Acquisition support for several portfolios and individual **gas-fired and renewable generation assets** (20+ GW | ~\$2B)

Recent Examples of E3 Projects

United Nations Deep Decarbonization Pathways Project

California: 100% clean energy planning and carbon market design for California agencies

Net Zero New England study with Energy Futures Initiative

New York: NYSERDA 100% clean energy planning

Pacific Northwest: 100% renewables and resource adequacy studies for multiple utilities

Integrated Resource Plan (IRP) Review Purpose

- + E3 served as a technical reviewer of Pasadena Water and Power's (PWP's) IRP analysis.
- + The scope included an evaluation of the methodology for consistency with industry standards, review of inputs and assumptions, and validation of results and key findings, among others:



Process & Methodology

- CEC Alignment
- IRP framework
- Modeling Methods
- Scenario Design



Inputs & Assumptions

- Load Forecast
- Resources
- Market Prices
- Policies



Results & Key Findings

- Resource Mix
- System Costs
- Benchmarking
- Carbon Abatement Costs

Pasadena set an ambitious goal of delivering hourly carbon free electricity ... PWP's IRP explores strategies to accomplish that goal by 2030

Given the importance and impact for Pasadena, this review provides confirmations, critiques, and insights to support PWP in this challenge

Key Findings: Review of PWP's 2023 IRP

- + IRP framework and inputs and assumptions generally follow industry standards and best practices
- + IRP results align with common trends seen in other jurisdictions seeking to decarbonize

Process & Methodology

IRP complies with California Energy Commission (CEC) submission guidelines

—

Framework is transparent, engages stakeholders, and sets clear objectives

—

Modeling relies on industry standard standard capacity expansion and system operation modeling methods

E3 recommends additional reliability analysis in scenarios that include fossil retirement and hourly carbon-free goals

Inputs & Assumptions

Key inputs (load forecast, market and commodity prices, resource costs, etc.) are from reliable sources or analytical processes

Key sources: CEC Integrated Energy Policy Report, NREL Annual Technologies Baseline

—

Today's market environment is rapidly shifting, and results should be interpreted within this context

Recent upward pressure on resource PPA pricing will warrant continue market monitoring for future IRP updates

Results & Key Findings

Technical results are generally consistent with studies of low-carbon and carbon-free portfolios conducted by utilities and research institutions:

Significant additions of renewables and energy storage across all scenarios

Scenarios that meet PWP's carbon-free goal are more ambitious than most of its peers' current goals, requiring additional resources and resulting in higher costs

Reliance on fuel cells is a unique aspect of PWP's carbon-free portfolios; most other plans retain or repurpose natural gas until a commercial alternative is viable

Deep Decarbonization Planning Studies: Common Trends

+ E3's work with utilities and regulators to develop long-term electric system resource plans that achieve ambitious clean energy targets support four common findings:

1. Technologies available today can enable significant progress towards ambitious state and utility clean energy objectives
2. A technology-neutral approach to planning and procurement will enable utilities to meet reliability and clean energy goals most affordably
3. Decarbonization of the "last 10%" poses the greatest challenge, and may lead to significant increases in costs
4. Some form of firm capacity is needed for reliability even under a deeply decarbonized grid

+ These findings are supported by a growing body of literature, including recent studies by the National Renewable Energy Laboratory (NREL), Princeton University, the Electric Power Research Institute (EPRI), and the Massachusetts Institute of Technology (MIT)

Blueprint for a Low Carbon Grid



Scalable Low-Cost Clean Energy Resources

Today: wind, solar, efficiency

Future: nuclear small modular reactors (SMR), carbon capture & sequestration (CCS)



Balancing Resources

Today: batteries, pumped storage, hydro, demand response

Future: advanced flexible loads, other storage technologies



Firm Resources

Today: nuclear, natural gas, geothermal, biogas

Future: hydrogen, long-duration storage, nuclear SMR, CCS

Key Takeaways: PWP IRP Results Benchmarking

+ PWP's resource portfolios are consistent with common the blueprint for a low carbon grid

- All resulting portfolios include a mix of firm capacity, scalable clean energy generation, and balancing resources

+ Carbon-free portfolios (scen. 1-3) require higher quantities of clean energy and storage capacity, resulting in considerably higher costs

- PWP's carbon-free portfolios result in high "implied carbon abatement" costs (~\$600-1,200 per ton in 2030) compared to the social cost of carbon assumed in Scenario 5 (\$400 per ton)

+ Among California utilities' plans, PWP's consideration of hydrogen fuel cells for firm capacity is unique

- No other California utilities have committed to plans that include retirement of all existing natural gas plants that play critical roles in maintaining reliability
- Sacramento Municipal Utility District's current plan anticipates relying on existing gas resources for firm capacity through 2030, planning a transition to renewable fuels or CCS to support further decarbonization

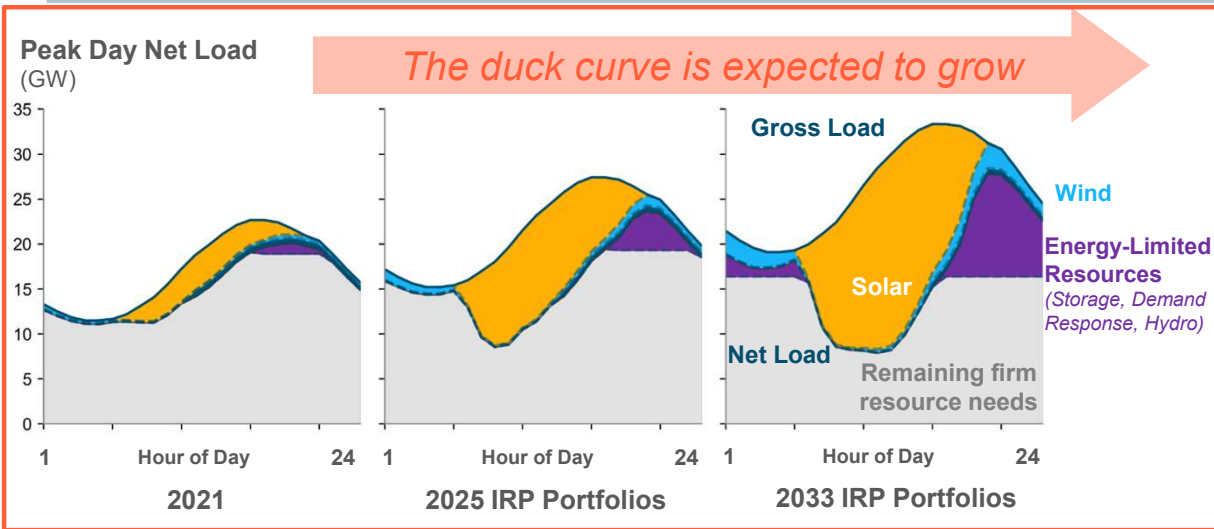
IRP Benchmarking Framework

Despite differences among utilities and their modeling methods and assumptions, common findings observed across a broad range of decarbonization studies should be broadly applicable and consistent across them

*PWP IRP results were compared against three California planning activities to identify key differences and validate model results:

1. California Public Utilities Commission IRP *Preferred System Plan* (CPUC Resource Plan): A 73% Renewable Portfolio Standard, with 86% GHG free resources by 2032
2. Sacramento Municipal Utility District *Case A* (SMUD 2030 Carbon Neutrality): No allowance of combustion generation beyond currently contracted biogas; no unspecified market purchases in 2030
3. NREL LA 100% Renewable *Scenario SB100* (LA 100% Renewable Plan): 100% renewable energy by 2045

Current Trends: A Large Share of California's Long-term Needs Will Be Met With Solar, Storage, and Other "Non-firm" Resources

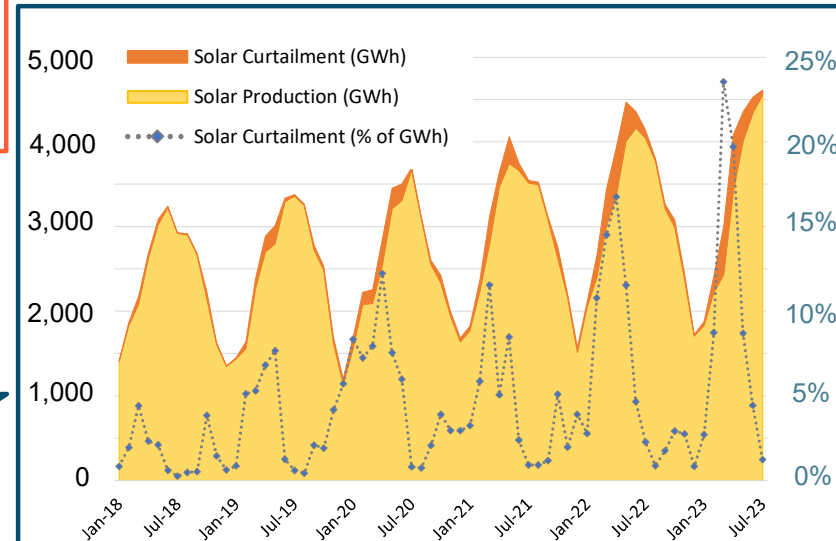


As more solar is integrated, the duck curve will deepen

Additional storage will help shift energy to hours of greater need

Already, annual curtailment is growing in California and with additional solar set to be deployed, the trend will only continue.

Curtailment happens the most during spring months when solar production is high and demand levels are lower



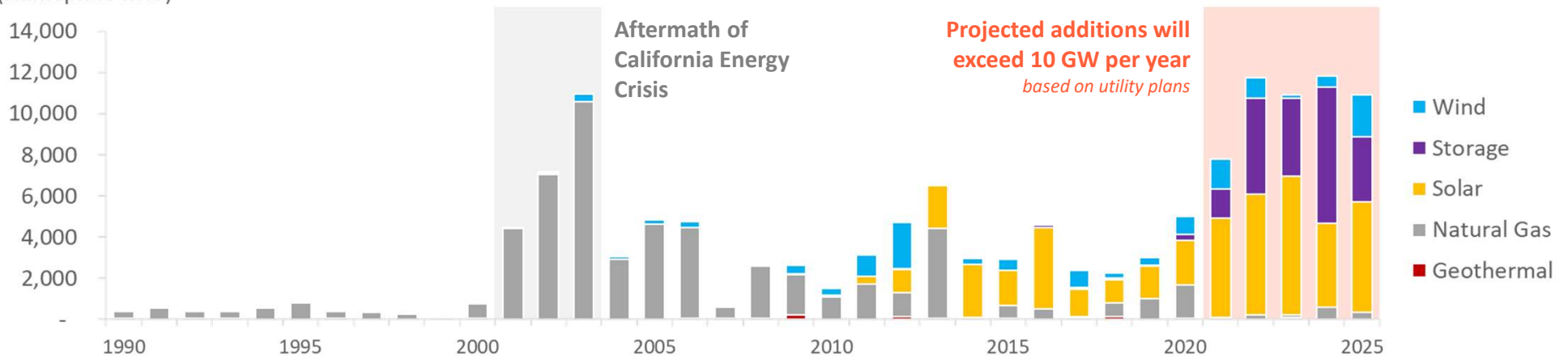
Current Trends: Development Of New Resources Is Expected to Occur at an Unprecedented Rate

- + To maintain reliability and meet clean energy objectives, utilities in California and the Southwest will add significant quantities of renewables and storage resources in the next decade
- + Coupled with supply chain constraints and interconnection queue issues, there is uncertainty in both cost and project execution timelines



New Installed Capacity Added by Year (AZ, CA, NM, NV)

(Nameplate MW)





Recommendations

Pasadena Water and Power

- Adopt and Approve the 2023 Power Integrated Resource Plan (“IRP”) for filing with the California Energy Commission (“CEC”) for the Water and Power Department (“PWP”); and
 - > Approval contingent on the addition of MSC’s Dec. 5 directives
 - Create a dashboard to track progress towards meeting the carbon-free goals of Resolution 9977
 - Conduct an internal review of the IRP in two years and present to the MSC
 - Develop an integrated strategic plan that outlines a path to carbon-free energy through 2030 while synergizing key inputs including the Power Delivery Master Plan (“PDMP”), Waypoint Framework, Cost of Service and Rate Studies (“COS”), and others.
- Support PWP’s continuing decarbonization trajectory while exceeding State regulatory requirements, and simultaneously working towards achieving the policy goal of 100% Carbon-Free electricity by 2030, through the utilization of the 2028 Waypoint Framework supported by the 2023 IRP Scenario 2 modeling results