



ITEM 8.A

GLENDALE WATER & POWER 2024 Integrated Resource Plan

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Background

IRPs are electricity system **planning documents** that ensure publicly owned utilities (POUs) lay out their **resource needs**, policy **goals**, physical and operational **constraints**, and proposed **resource choices** (including **customer-side** preferred resources).



- ✓ SB 350 – Adopt an IRP every 5 years
- ✓ Submit to CEC to Review for Consistency
- ✓ Address Transportation Electrification

GWP + Ascend Analytics + Strategen

Community Townhalls

Stakeholder Technical Advisory Group
(STAG)



Glendale Water and Power 2024 IRP

Community Engagements

Townhall Meetings: www.GlendaleCA.gov/2024IRP

- Increased from 2 to 4 sessions
 - Jun 29th Pacific Community Center
 - Jul 24th Sparr Heights Community center
 - Aug 12th Brand Studios
 - Nov 16th Sparr Heights Community Center

Stakeholder Technical Advisor Group

- Increased from 4 to 6, plus “office hours”
- 14 STAG Members (Invitations and Open Call)
- Goal: Develop **3** Community Scenarios for Modeling
- www.GlendaleCA.gov/2024IRP/STAG



IRP Process Overview

1. GWP and a Stakeholder Technical Advisory Group (STAG) made up of 13 Glendale community members developed 6 future scenarios to model.
2. Ascend Analytics tested these strategies in their model to see how they compare on **reliability, sustainability, and affordability**.
3. GWP and STAG were presented these results and discussed implications.
4. Based on the results, GWP chose a “preferred portfolio” of resources it recommends developing.
5. GWP Commission was presented with GWP’s selection on November 6th. Two of the four present Commissioners endorsed GWP’s selection.
6. GWP presented the selection to the public at the last Townhall meeting on November 16th.

Community Input in the IRP

- STAG considered community input from Townhalls in all phases of scenario development:
 - Heavy emphasis on customer resources (rooftop solar, energy efficiency, demand response)
 - Preference for local renewables
 - Clean energy timelines that exceed California's 2045 mandate
- In response to community feedback, Ascend and GWP added a third community scenario to the IRP modeling, for a total of 6 scenarios.
- Ascend also conducted social cost of carbon analyses for all scenarios based on community interest.

Modeling Process

- Modeling for the 2024 IRP was conducted in the phases shown below
 - Baseline model with GWP's current and planned resources
 - Provides insight for GWP's portfolio for near term decisions
 - Capacity Expansion Models
 - Outcome provides the timing and quantity of new resource additions to meet the GWP requirements for capacity and renewables
 - Resource selection is based on economics and the ability of resources to satisfy GWP needs
 - Resource Adequacy Models
 - Provide metrics on the ability of GWP's system to serve load all hours of the year over a wide range of system conditions
 - Production Cost Models
 - Outcome shows how GWP's system would operate with the resource selection from the Capacity Expansion model
 - Important outputs include renewable generation serving load, carbon emissions, and portfolio costs

Capacity Expansion Inputs/Assumptions

- The following resources were considered:
 - Geothermal – Provides firm power around the clock via the SWAC transmission path
 - Wind – Could be in the Pacific Northwest via the PDCI path or the Southwest via the SWAC path
 - Solar – Available in Southern California via the SWAC path
 - Green hydrogen – Assumes CT or ICE generators can run on 100% hydrogen by 2035
 - Small Modular Reactors – Smaller nuclear-powered generators using advance nuclear technology
 - Long Duration Storage – Assumes a 100-hour battery available by 2035
 - Li-Ion storage – Model included 4-hr and 8-hr storage options.
 - Customer resources/DERs – Rooftop solar, customer storage, energy efficiency, and demand response were built into the model's demand forecast to varying degrees across scenarios
- Resource selection met the capacity and the RPS/Clean energy requirements
 - 60% RPS by 2030
 - 100% Clean by 2035 or 2045
- Transmission was not directly modeled in the capacity expansion phase, instead limits were placed on resource construction

Long Duration Storage

- Form Energy is developing a 100-hour Iron-air battery
- Currently plan for small pilots with multiple utilities
- ESS is developing a 12-hour Iron flow battery, also in the pilot stage
- Long duration storage provides dispatchable capacity by shifting generation over many hours
- The down-side:
 - Production level technology does not exist currently
 - Low efficiency; roughly 40 - 45% efficient
 - High land requirements (3MW per acre of land); cells cannot be stacked
 - Manufacturing capacity tight for the first decade (Form Energy will produce 500 MW annually at full capacity)



Clean Dispatchable Generation

Hydrogen powered CTs or ICEs

- Currently no green hydrogen powered combustion technology exists
- IPP the first hydrogen facilities in the world when it comes online
- Provides carbon-free, fully dispatchable generation
- Large losses occur when transforming renewable energy to hydrogen and then back to clean power
- Infrastructure is needed to get hydrogen to the power plants



Nuclear Small Modular Reactors (SMRs)

- Currently exists in research and development form
- Small design compared to traditional reactors
- Provides carbon-free, fully dispatchable generation
- Costs will likely be higher than hydrogen



Production Cost Models

Outputs from Capacity Expansion models are fed into production cost models

- Resources are added to one of three locations --. Glendale, Southwest (SWAC line), Pacific Northwest (PDCI line)
- The model simulates GWP's system on an hourly basis, stepping through time to dispatch resources and serve load
- Outputs include
 - Carbon Emissions
 - Energy generation by resource
 - Load
 - Transmission flows
 - Market interactions
- Ascend ran the Production Cost models multiple times to adjust resources around the transmission limits and hit the RPS/Clean energy requirements

Define Clean vs Zero Carbon Emission

Clean Generation per California policy mandates

- Utility serves retail load with carbon free energy
- Retail load is approximately 90% of “gross” load which includes power losses in the transmission and distribution lines.
- GWP’s preferred scenario meets this requirement in 2035, much sooner than required by CA policy

Zero Carbon Emissions is more strict

- A portfolio with zero carbon emissions will have no fossil fuel generation

Scenarios

	Scenario	100% clean energy date	Meets CA mandate	Meets Glendale goal	Key features
1	CA policy	2045	X		<ul style="list-style-type: none"> Serves 91% of load with clean energy by 2035 Keeps existing natural gas resources with reduced use
2	Carbon free 2035	2035	X	X	<ul style="list-style-type: none"> Transitions natural gas to hydrogen in 2035 Increases utility scale renewables early Hydrogen and long-duration storage assumed in 2035
3	CA policy – with offsets	2045	X		<ul style="list-style-type: none"> Relies on REC purchases for 10% of the clean energy mandate
4	Carbon free 2035 - High DER	2035	X	X	<ul style="list-style-type: none"> Integrates City Council goals for clean energy/DER Modeled accelerated electrification and energy efficiency Hydrogen replaces natural gas with long duration storage in 2035
5	Carbon free 2042 - Magnolia retire 2038	2042 (with 90% by 2035)	X		<ul style="list-style-type: none"> Natural gas replace by hydrogen in 2042 Magnolia retires in 2038 Long duration storage in 2042
6	Carbon free 2040	2040 (with 90% by 2035)	X		<ul style="list-style-type: none"> Hydrogen replaces natural gas in 2040 Renewables and storage added to fill resource needs earlier Long-duration storage added in 2040

Key Finding 1

A transition to a clean energy system relies on technological advancement

- Long Duration Storage (multi-day)
 - Able to shift variable generation over several days
 - Not yet commercially available
 - Some pilot projects are being planned with small capacities
 - Installation require large amount of land – (Form Energy states 3MW per acre)
- Medium Duration storage (Eight to ten-hours)
 - Commercially available but not yet widely installed at levels necessary to support utility scale
 - Shifts variable generation from low demand to high demand hours within a day
- Clean Firm Generation (Dispatchable)
 - Most promising technologies are Green Hydrogen, CCUS, Renewable Natural Gas, and Small Modular Reactors
 - Not yet commercially available, but significant funding is available for Hydrogen
 - Of the possible options, Green Hydrogen is considered the most likely and most cost-effective, but requires infrastructure and technical advancement

Key Finding 2

A full transition requires replacement of Grayson 9, ICEs and Magnolia with firm, clean options

- Retirements of in-basin natural gas resources create reliability challenges
- GWP is required to maintain operational reserves based on the N-1-1 contingency planning
 - **416 MW** peak load projection in 2035
 - For N-1-1, GWP can rely on 100 MW from the SWAC line, remaining capacity must be local
 - Remaining resources add up to 376
- GWP must add $416 - 376 = \textbf{40 MW}$ of local capacity to meet load growth
- Natural gas capacity from Magnolia, ICE, and Grayson 9 totals 137 which must be replaced in zero carbon scenarios

N-1-1 Resource Contribution in 2035	
SWAC line (without STS)	113
DR	8
City Solar	10
Magnolia	35
ICE	54
Grayson 9	48
Eland Solar and Storage	25
Energy Storage	75
Scholl’s Canyon	8
Total Resources	376

Key Finding 3

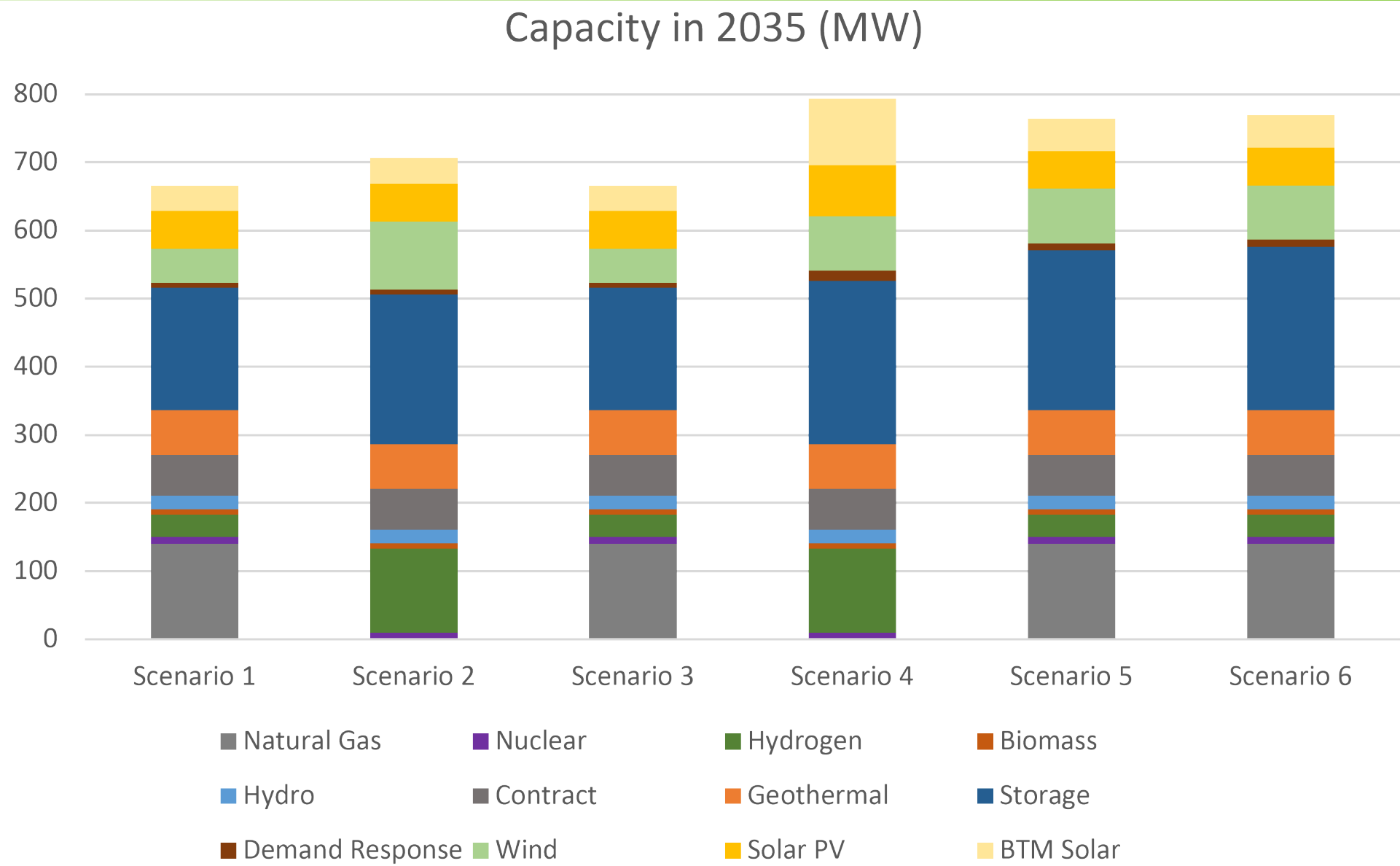
Based on the projected resource costs and market outlook, the capacity expansion model selects geothermal, storage, hydrogen generation, and wind

- Solar is not selected due to the heavy build out of solar in California which has pushed market prices lower during solar hours. Ascend added solar per the scenario requirements by replacing a portion of wind with solar
- Geothermal was selected as soon as possible in all scenarios due to its capacity and high RPS contribution
- Hydrogen was selected for capacity purposes
- Storage, especially long-duration, was selected to boost capacity and manage renewables

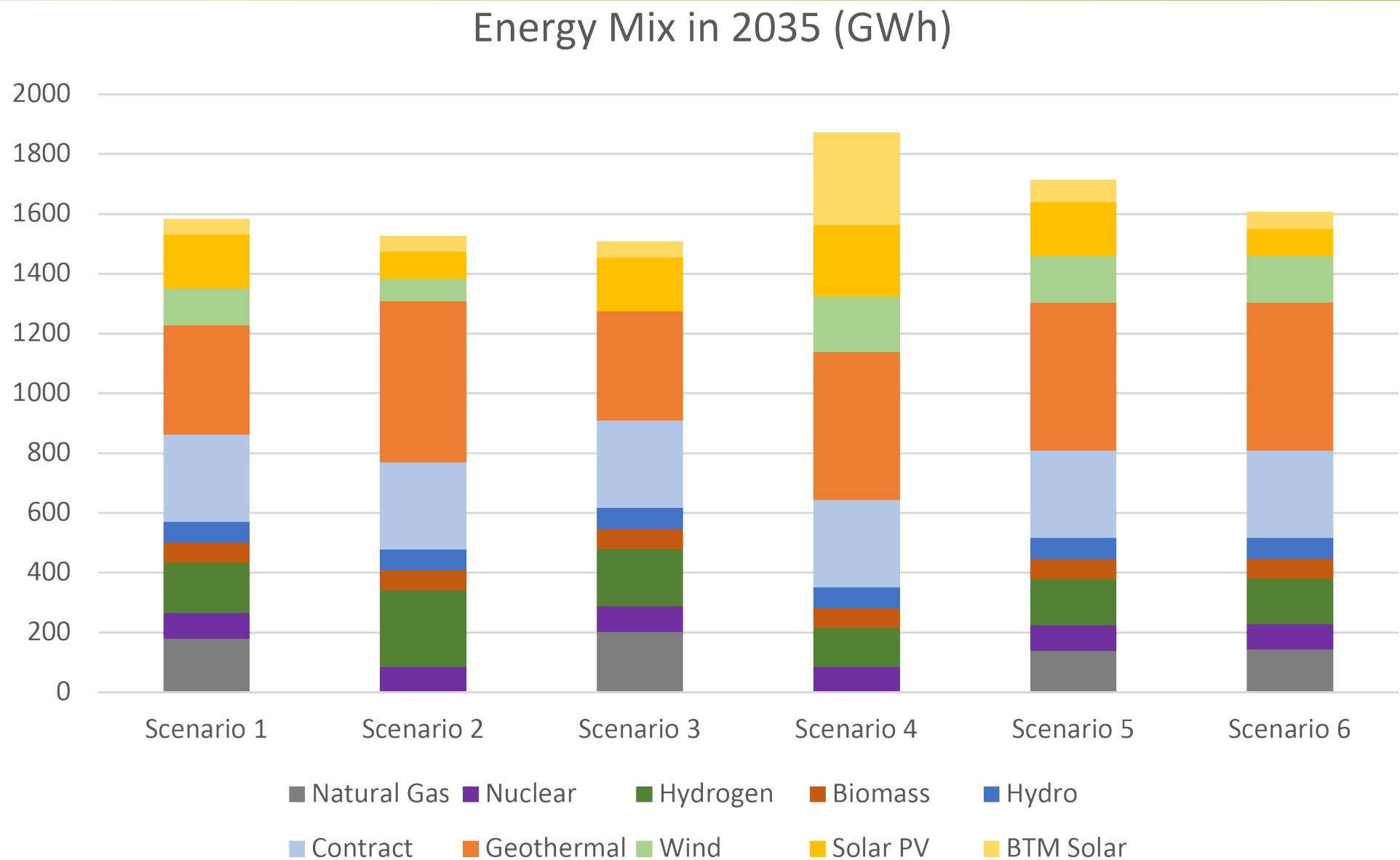
Summary of Results

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Costs in \$M Net Present Value (2024 - 2045)	CA Policy	Carbon Free 2035	CA Policy w/Offsets	Carbon Free 2035 - High DER	Carbon Free 2042 - Magnolia Retire 2038	Carbon Free 2040
New Resource Capital Costs	\$535	\$1,296	\$491	\$1,145	\$897	\$867
Operating Costs	\$1,073	\$970	\$1,098	\$1,086	\$1,131	\$1,142
Total Costs	\$1,608	\$2,267	\$1,589	\$2,231	\$2,027	\$2,009
TOTAL with Social Cost of Carbon Based on EPA's recent estimate (\$200/ton increase 2% per year)	\$1,918	\$2,490	\$1,917	\$2,440	\$2,278	\$2,274
Cost per MWh	\$93.97	\$129.80	\$92.88	\$130.40	\$118.48	\$117.41
Cumulative Carbon Emissions (Tons)	2,597,041	1,642,076	2,765,838	1,434,151	1,816,241	2,035,232
GHG Emission Reductions from Generation in 2035 compared to 2024	67%	100%	63%	100%	72%	71%
% Clean in 2035	91%	109%	84%	129%	103%	95%

2035 Resource Mix

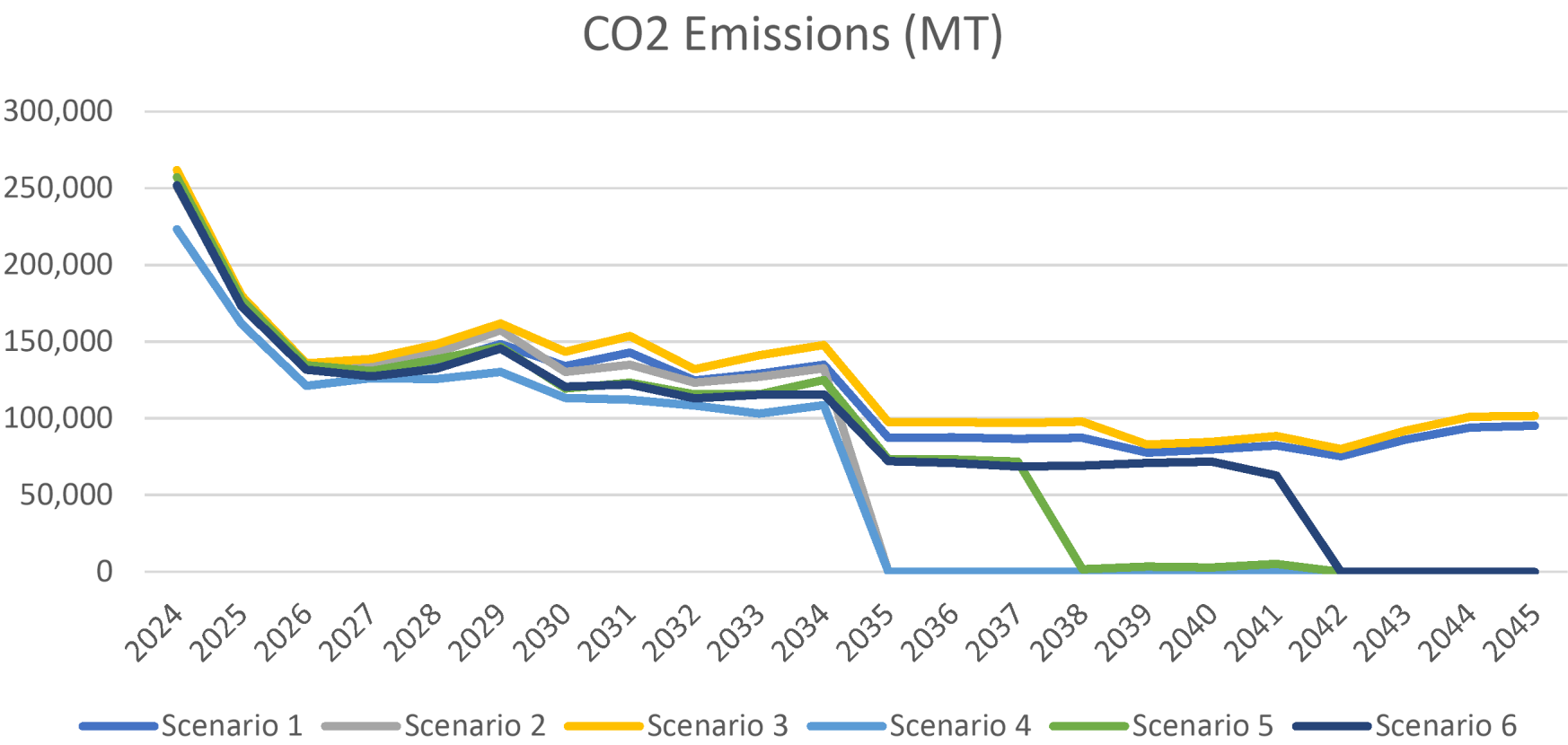


2035 Energy Mix

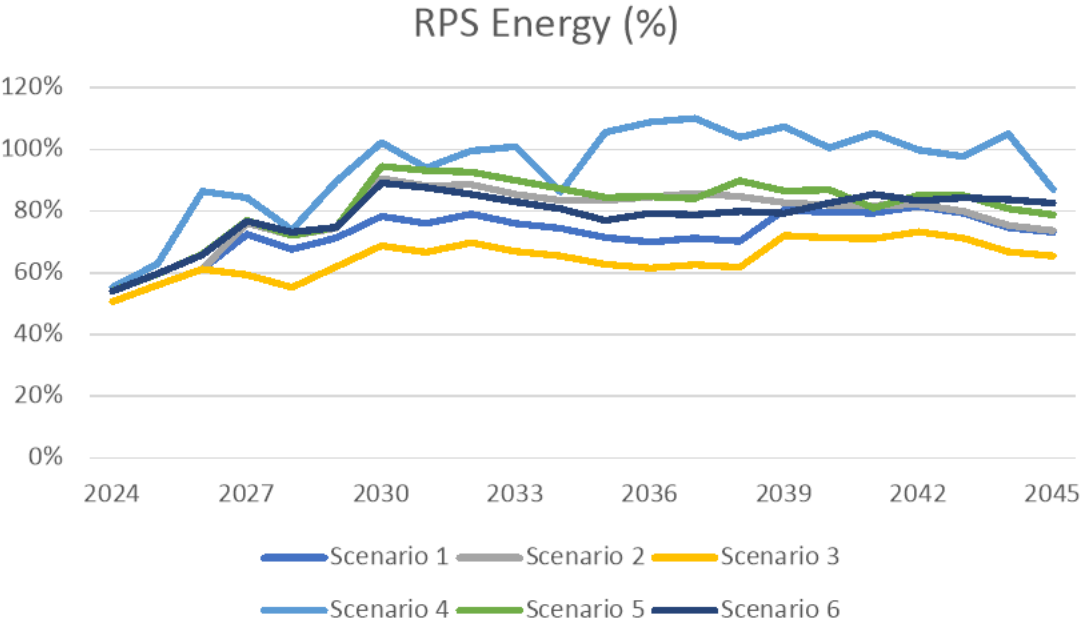


Carbon Emissions

Carbon emissions follow a similar trajectory until 2035 when the GWP 2 and STAG 1 scenarios retire natural gas resources

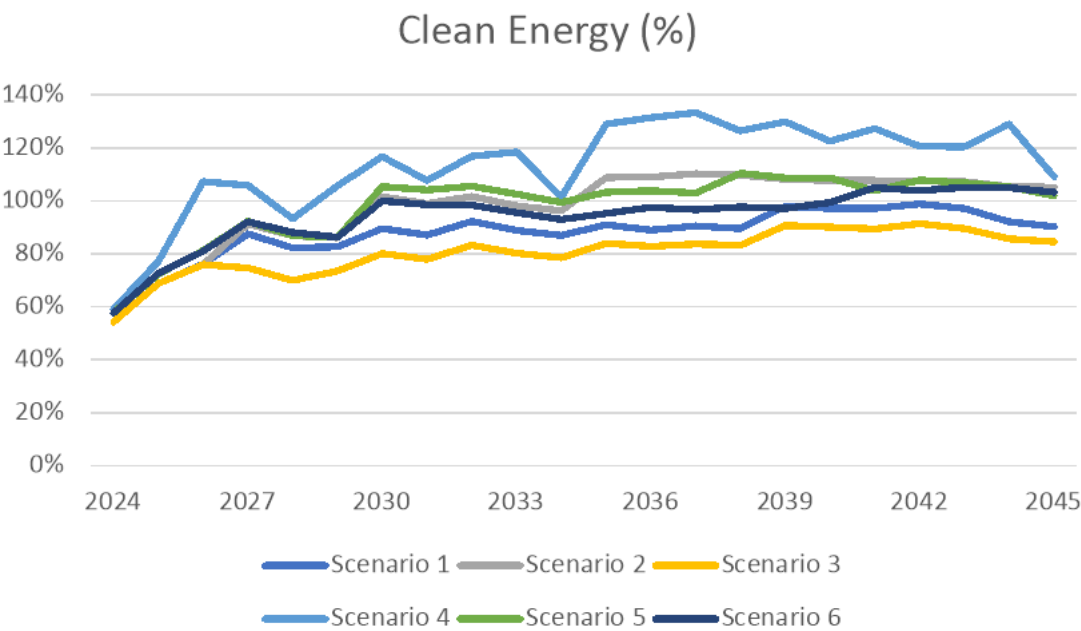


Clean and Renewable Generation



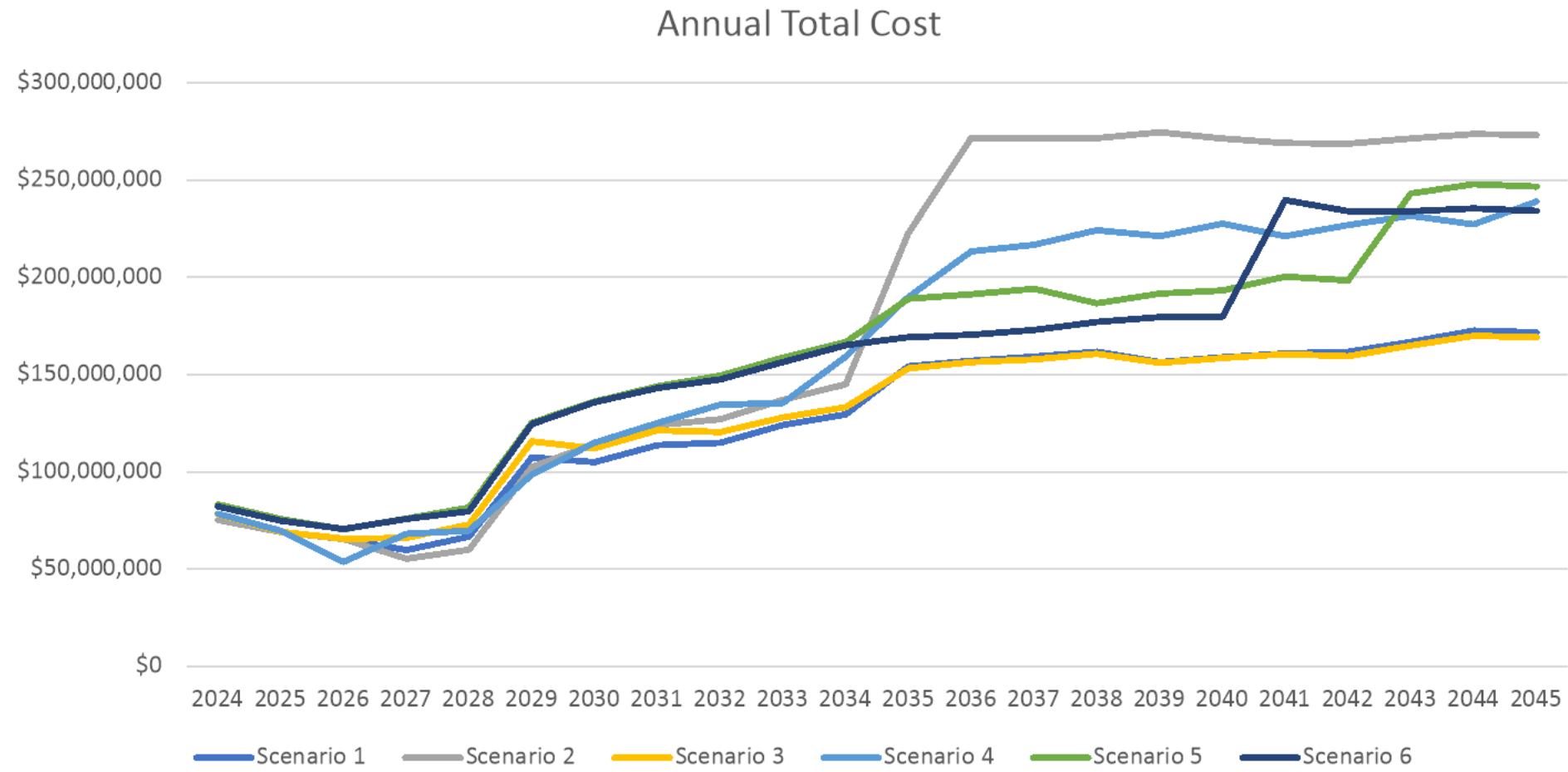
Scenario 4 has the highest levels of clean and renewable energy. All scenarios above 80% clean by 2030

Scenario 1 (preferred scenario) remains above 90% clean after 2035



Costs

Costs are strongly dependent on the timing of the transition from Natural Gas to Hydrogen



STAG Surveys on Modeling Results

- Strategen conducted 2 surveys on STAG's preferred scenario:
 - Survey 1: Before GWP Commission meeting (11/3 – 11/6)
 - Survey 2: After the final townhall (11/28 – 12/4)
- The first survey was conducted before cost results were completed and validated.
 - By the time of the second survey, operating costs were available and an error in hydrogen costs was corrected.
- Survey setup:
 - Choose your top three scenarios (in no particular order).
 - Allocate 100 points among the top three selections to indicate which scenario(s) you prefer, and how strongly. (Members could allocate all 100 points to a single scenario.)
- In both surveys, the **California Policy scenario was STAG's preference**, but there were variances between the two.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	GWP-1	GWP-2	GWP-3	STAG-1	STAG-2	STAG-3
ORIGINAL New Resource Costs (survey 1)	\$535	\$1,887	\$497	\$1,815	\$1,344	\$1,363
UPDATED New Resource Costs (Survey 2)	\$535	\$1,296	\$491	\$1,145	\$897	\$867
Operating Costs (Survey 2)	\$1,073	\$970	\$1,098	\$1,086	\$1,131	\$1,142
Total Costs	\$1,608	\$2,267	\$1,589	\$2,231	\$2,027	\$2,009

STAG Survey Results: Top 3 Scenarios

- Survey 1:
 - Scenario 1 (9 people)
 - **Scenario 5 (9 people)**
 - Scenario 4 (6 people)
 - Scenario 6 (6 people)
- Survey 2:
 - **Scenario 5 (9 people)**
 - Scenario 1 (8 people)
 - Scenario 4 (7 people)
- Scenario 5 was the most popular selection for the group's top 3.

Comparison of top 3 scenario selections between survey 1 and survey 2			
	Survey 1	Survey 2	Difference
Scenario 1: California policy	9	8	-1
Scenario 2: Carbon free 2035	5	5	Same
Scenario 3: CA policy with offsets	4	4	Same
Scenario 4: Carbon free 2035 – High DER	6	7	+1
Scenario 5: Carbon free 2042 – Magnolia retire 2038	9	9	Same
Scenario 6: Carbon free 2040	6	6	Same

STAG Survey Results: Points Allocation

- **Scenario 1** received the most points across both surveys.
- Interest in scenario 4 grew considerably between survey 1 and 2.
 - Separated from scenario 1 by 155 points in survey 1 and 45 points in survey 2.
- Scenario 5 came in third in both surveys, suggesting it is a backup option for many.

Comparison of points allocation results between survey 1 and survey 2			
	Survey 1	Survey 2	Difference
Scenario 1: California policy	<u>530</u>	<u>525</u>	-5
Scenario 2: Carbon free 2035	70	55	-15
Scenario 3: CA policy with offsets	10	30	+20
Scenario 4: Carbon free 2035 – High DER	<u>375</u>	<u>480</u>	+105
Scenario 5: Carbon free 2042 – Magnolia retire 2038	180	170	-10
Scenario 6: Carbon free 2040	135	40	-95

STAG Survey Results: Response Differences

- In survey 2, members concentrated points more heavily around the 2 scenarios that received the most points in the first iteration (scenarios 1 and 4).
- Fewer members allocated points to all of their top 3 selections than had in the initial survey.
 - Support for scenarios 2, 5, and 6 decreased.
 - The number of points members allocated to their top selection increased, and the distance between their first and second choices widened.
- This may reflect new cost information provided to STAG between surveys 1 and 2, or a shift in voting strategy after members saw the results of survey 1.
- While the change in voting behavior is worth noting, ultimately the reasons for these differences are not as important as the results themselves.

STAG Survey Results: Member Perspectives

- Across both surveys, members who preferred scenario 1 highlighted concerns about affordability and technology availability:
 - “GWP 1 (following CA policy) is most cost effective for ratepayers.”
 - “We have real challenges on affordability and it will get worse over [the] next few years. We have to balance cost while trying to make progress toward the transition to clean energy.”
 - “Most of the expensive scenarios rely on high-risk new technologies that might not be built, or will underperform.”
 - “We must remain grounded with technologies that are available today to achieve our goals... We have to face affordability and reliability realities in front of us at this moment.”
- Across both surveys, members who preferred Scenario 4 highlighted the need for a faster clean energy transition and the urgency of climate change:
 - “A net zero target of 2045 is no longer acceptable...”
 - “Future costs are largely fictional at this time, so we need to go for the greatest reduction of carbon by 2030.”
 - “I generally chose the STAG scenarios over the GWP scenarios because they get us to true carbon-free. They’re not *that* much more expensive and they result in significantly lower CO₂ emissions, particularly STAG 1 [Scenario 4].”
 - “Technology improvements will reduce the costs [of the 2035 scenarios]... We need to act now to start moving our city to clean energy!”

Preferred Scenario - GWP 1: CA Policy



ENHANCES ENERGY SECURITY
AND RESILIENCE



OFFERS COST EFFECTIVE
SOLUTION COMPARED TO
OTHER SCENARIOS



ALIGNS WITH STATE
RENEWABLE PORTFOLIO
STANDARDS AND EMISSIONS
MANDATES



LONG TERM VIABILITY AND
ADAPTABLE TO FUTURE
INNOVATIONS AND CHANGING
ENERGY TECHNOLOGIES

The Last 10%...

- 1) NREL Study Identifies the Opportunities and Challenges of Achieving the U.S. Transformational Goal of 100% Clean Electricity by 2035 (August 30, 2022)

<https://www.energy.gov/eere/articles/nrel-study-identifies-opportunities-and-challenges-achieving-us-transformational-goal>

“A growing body of research has demonstrated that cost-effective high-renewable power systems are possible, but costs increase as systems approach 100% carbon-free electricity, also known as the “last 10% challenge.” The increase in costs is driven largely by the seasonal mismatch between variable renewable energy generation and consumption.” – National Renewable Energy Labs



The Last 10%...

2) Getting to 100%: Six strategies for the challenging last 10% (September 21, 2022)

<https://www.sciencedirect.com/science/article/pii/S2542435122004056#abs0010>

In their conclusion from modeling the six potential strategies:

The challenges of achieving a 100% carbon-free grid are disproportionately driven by the difficulty of solving approximately the last 10%. There are significant uncertainties and unknowns with all six strategies reviewed; no option matches the (fictional) ideal one (Table 1), and no single strategy is the clear superior choice under all circumstances.

.... If the last 10% strategies ultimately fail to succeed, then emissions reductions will fall short of 100% but will still be significant. After all, a system still needs to reduce emissions by 90% before the last 10% strategies are truly required.



The Last 10%...

3) SB 100 Joint Agency Report: Charting a path to a 100% Clean Energy Future

<https://www.energy.ca.gov/publications/2021/2021-sb-100-joint-agency-report-achieving-100-percent-clean-electricity>

Key takeaway from the report:

Gas Capacity Is Retained for Reliability Needs, but Cost Reductions and Innovation in Zero-Carbon Firm Resources and Storage May Reduce Gas Capacity Needs

Natural gas capacity is the most economic option to provide capacity for reliability needs with current resource assumptions and demand scenarios. Cost reductions and innovation in zero-carbon firm resources and storage may reduce the amount of gas generation needed. – California Energy Commission



The Last 10%...

- 4) SMUD IRP Section 4 SMUD's 2030 Zero Carbon Roadmap: A Diverse and Flexible Resource Plan (September 14, 2022)

<https://efiling.energy.ca.gov/GetDocument.aspx?tn=246076&DocumentContentId=80241>

Our adopted portfolio sets SMUD on a path to zero emissions by 2030 with a strong foundation of proven clean resources that reduce our emissions by 90% and a broad portfolio of new technology and business strategies requiring additional research before final implementation to address the remaining 10%. Prior to committing to new unproven technologies, we will conduct additional research, industry outreach and community consultation. – Sacramento Municipal Utility District



The Last 10%...

5) LA100 Study Executive Summary

<https://www.nrel.gov/docs/fy21osti/79444-ES.pdf>

Key Distinctions Between Pathways to 100%

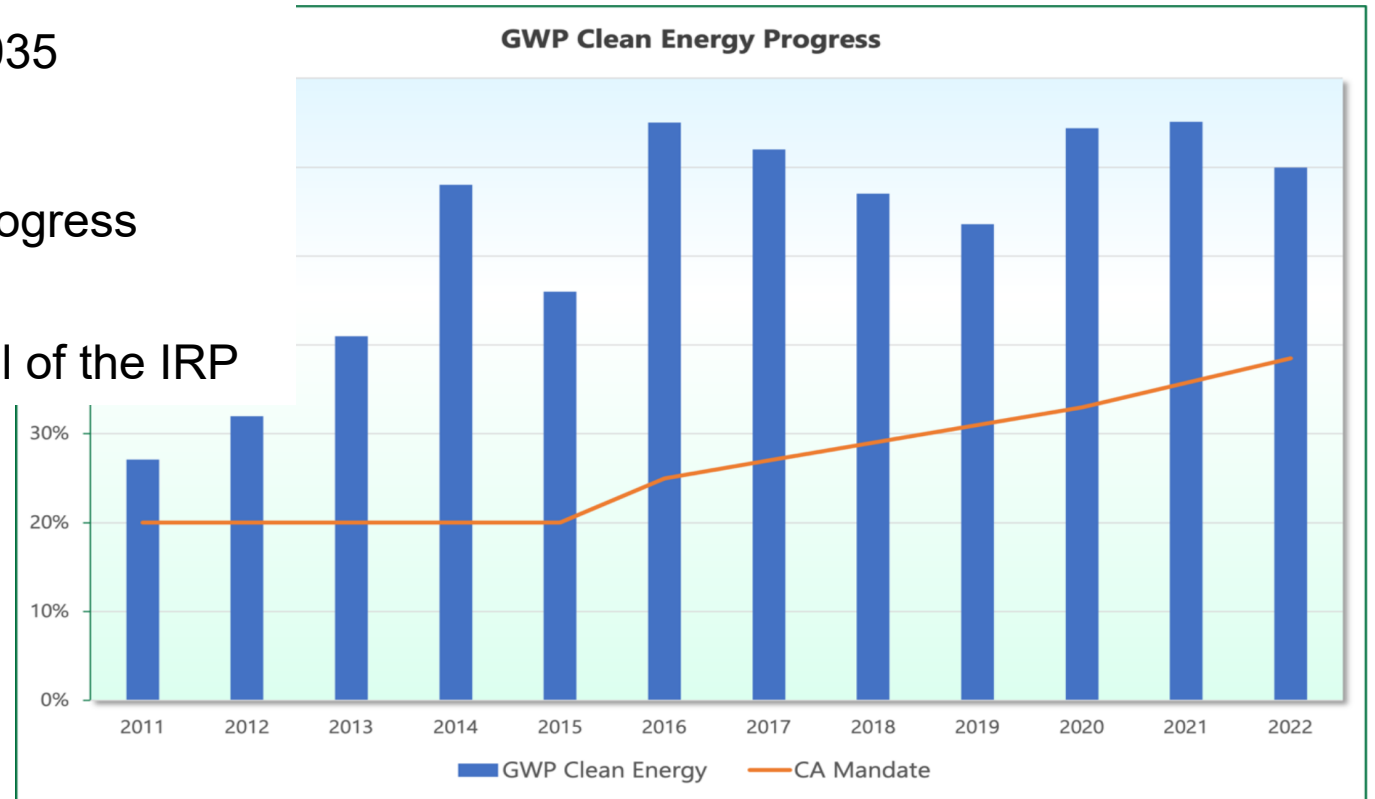
The LA100 scenarios show similar cost increases until approximately 80%–90% renewable energy. The pathways diverge with differences in the technologies deployed to meet the last 10%–20% of energy demand that cannot be easily served by wind, solar, and conventional storage technologies—and to maintain reliability in the face of extreme events.

...The resources used to help meet this last 10% and maintain reliability can produce local air emissions, particularly when based on combustion generation.



Recommendation

- Staff Endorses and Recommends the CA Policy Scenario
 - CA Policy Scenario = **GREEN OPTION**
 - Achieves 91% zero-carbon energy by 2035
 - Received most points by STAG
 - Consistent with GWP's Clean Energy Progress
- Staff Recommends Acceptance and Approval of the IRP



GWP Action Plan Going Forward

- Sustaining efforts to procure clean energy resources (wind, solar, geothermal, storage). Explore and engage in power purchase agreements that align with the IRP goals.
- Actively participating in discussions and decisions focused on reducing emissions from Magnolia Power Plant with co-owners, as well as accelerating the transition of the plant to low-carbon technologies.
- Prioritizing the integration of distributed energy resources, such as rooftop solar, energy storage, and demand response. Look for innovative models to engage GWP customers and businesses in these programs.
- Learning from the Intermountain Power Plant's conversion to hydrogen.
- Continuing to collaborate with LADWP and the City of Burbank on transmission and renewable resource development.
- Continuing to work to meet Council's goal of 100% zero-carbon by 2035





#MyGlendale