EXHIBIT 1

Ascend Analytics

Better models. Better decisions.

REPORT

100% Clean Energy By 2030

Feasibility Study

Prepared for:

City of Glendale Water & Power

Your Trusted Community Utility

March 01, 2021

Contents

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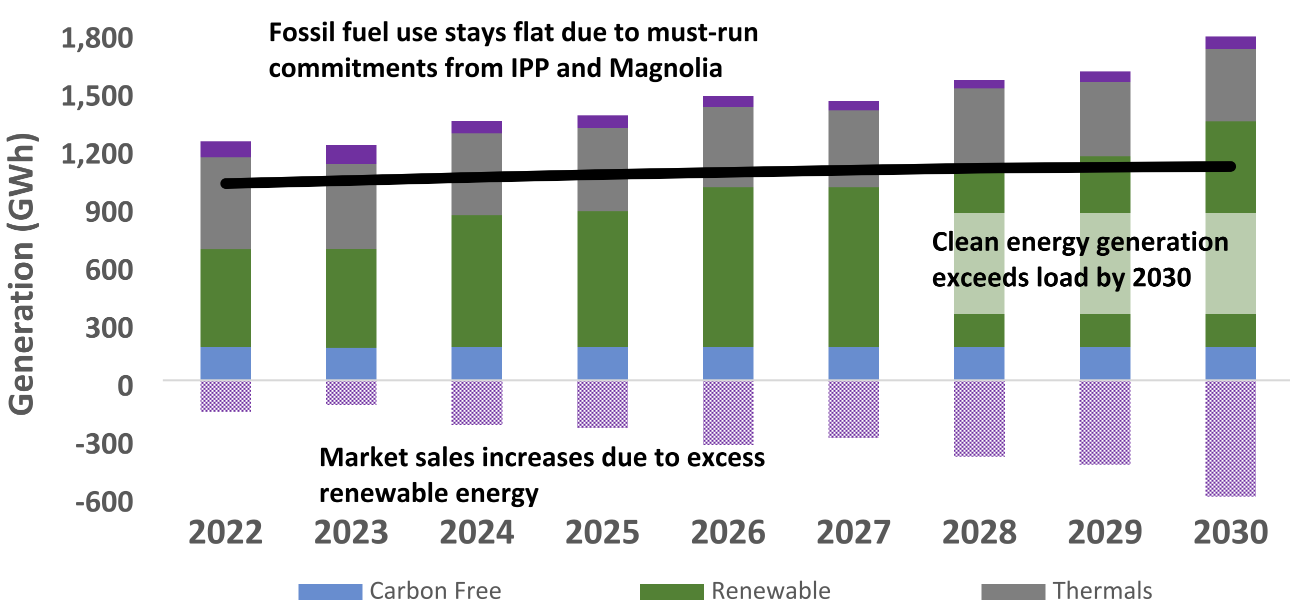
1. Executive Summary

Glendale Water and Power (GWP) asked Ascend Analytics (Ascend) to build upon the work performed for the 2019 Integrated Resource Plan (IRP) to assess the feasibility of developing a power supply portfolio that can reliably serve 100% of GWP's retail load with clean energy by 2030. Clean energy is defined as energy generated by technologies that do not emit greenhouse gas (GHG) emissions, including renewables like wind and solar as well as existing large hydro and nuclear energy, plus non-emitting integrating technologies like energy storage. From the outset, the project team designed the plan to be realistic in the assumptions and relevant inputs, meaning no reliance on technologies that do not exist or are not expected to be commercially viable and/or procurable within the next decade.

This report is the output of modeling to determine feasibility without consideration of cost-effectiveness. As such, this is not meant to be a strategic plan. However, it is hoped that this report can provide some assistance to the City Council as they consider paths forward for GWP's energy future.

Ascend built a portfolio that maximizes clean energy generation over the next eight years. Figure 1 shows that the assembled portfolio in this study generates clean energy more than load by 2030. However, due to various barriers discussed in this report, not all the clean energy can serve load. Figure 1 differentiates between carbon free energy (large hydro and nuclear) and renewable energy (wind, solar and geothermal). Both categories will be referred to as "clean energy" in this report since they include all non-emitting resources.

Figure 1: Annual Energy Generation and Load



In Figure 2, the percent of load served by clean energy is shown to reach 89% in 2030. When clean energy sales and curtailments are added to the clean energy serving load, the total clean energy potential is 144% of retail load. While there is more than adequate clean energy generation in the model, a significant portion of the clean energy is curtailed or sold.

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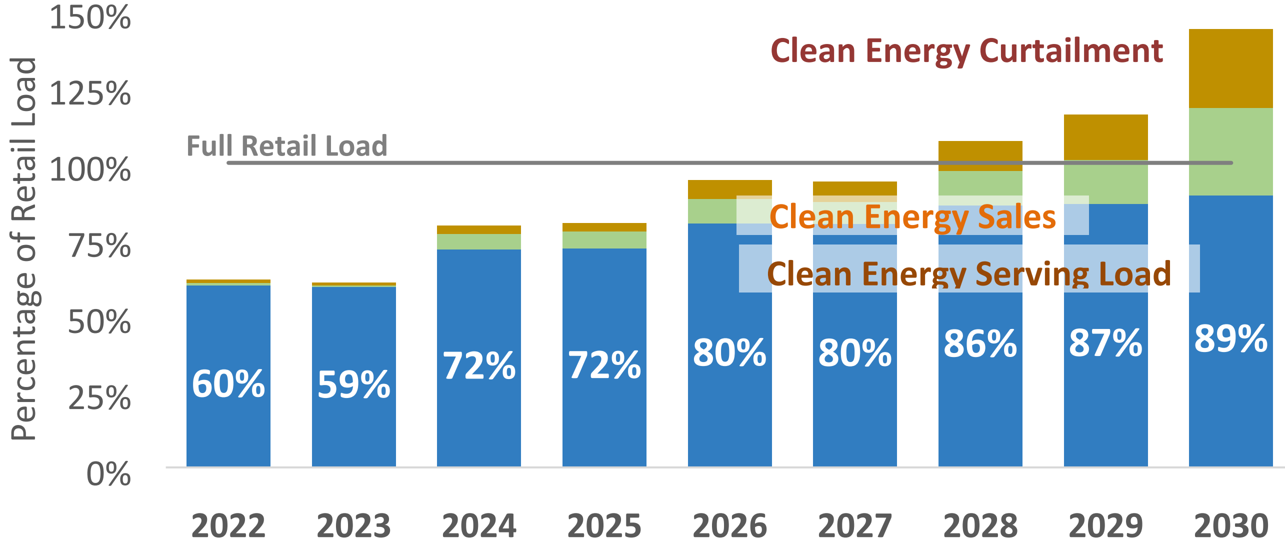
Figure 2: Portion of clean energy curtailed, sold, and serving load as a percentage of retail load



As described in the report, the focus of this study was to maximize clean energy around the clock. Achieving clean energy "24-7" or all hours of the day, is a high bar to meet. As figure 2 shows, the model used in this analysis shows that GWP can generate adequate clean energy to be "net clean" on an annual basis. However, the hours when GWP's clean resources are generating electricity do not always line up with the hours when GWP customers consume electricity.

The capacity buildout of the modeled portfolio is shown in Figure 3. Aside from the planned additions and retirements over the next 8 years, the plan includes additional wind, geothermal, solar and batteries. This mix of clean energy generation was optimized to maximize deliveries of clean energy day and night.

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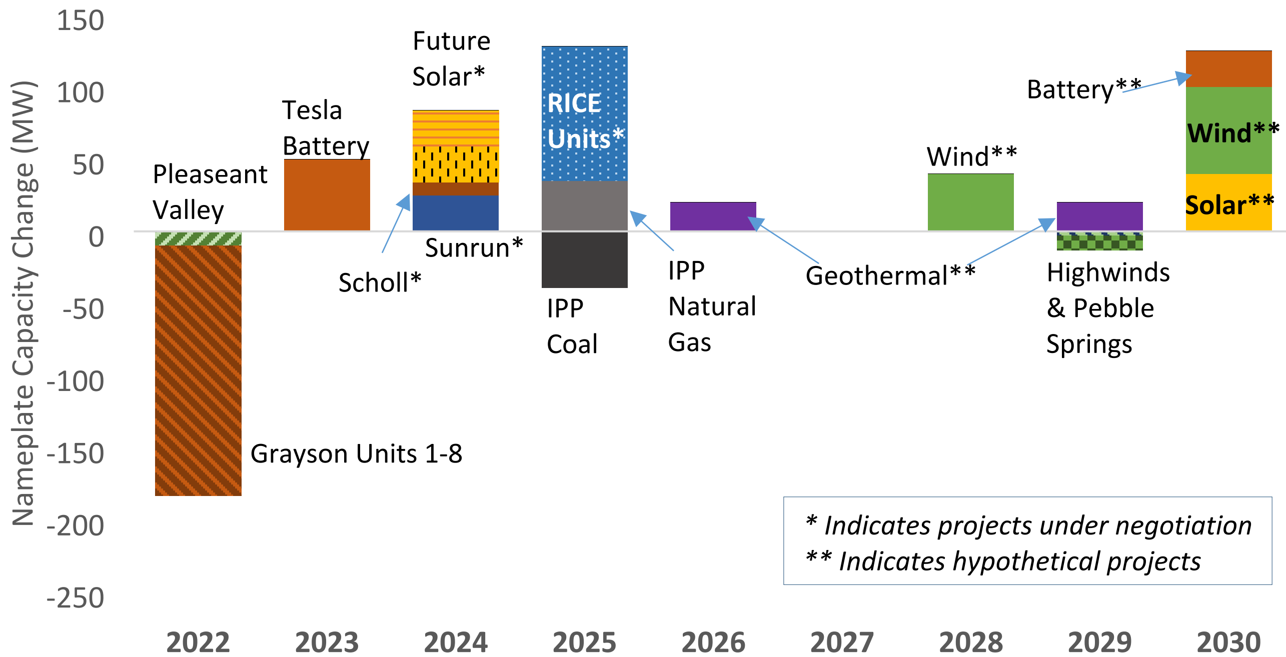
Figure 3: Annual capacity additions and retirements for GWP in the modeled plan



This study is premised on certain assumptions about GWP's power supply. First, this study assumes that in 2022, the Grayson power plant Units 1-8 will be retired after a remarkable 45 to 81 years of service. This study further assumes that by 2023, GWP will install the 50 MW of 4-hour duration Tesla battery as shown in the 2019 IRP. This study also assumes that in 2024, GWP adds both new wind and solar and storage to the portfolio from projects that have not yet been identified. Additionally, this study contemplates that by 2025, 93 MW of reciprocating internal combustion engines (RICE) will be added into service while also completely exiting from coal at the Intermountain Power Project (IPP). To drive up the clean energy content of the portfolio, the study found that GWP would need to acquire additional geothermal, wind, solar and battery storage through 2030 to the extent possible given the available transmission capacity.

Pollution from GWP would drop considerably. Carbon emissions fall nearly 50% between 2022 and 2030 and are squarely in the allowable range per SB350 2030 GHG Planning Targets[1]. As shown in Figure 4, nearly all carbon emissions are due to Magnolia and IPP which both run at their respective minimum generation levels most hours after 2026.

[1] Glendale's SB350 GHG planning range is from 119,000 tons to 210,000 tons of carbon emissions as adopted in July 2018. See https://ww2.arb.ca.gov/sites/default/files/2020-08/sb350-staff-report-2018.pdf. GHG targets will be updated this year.

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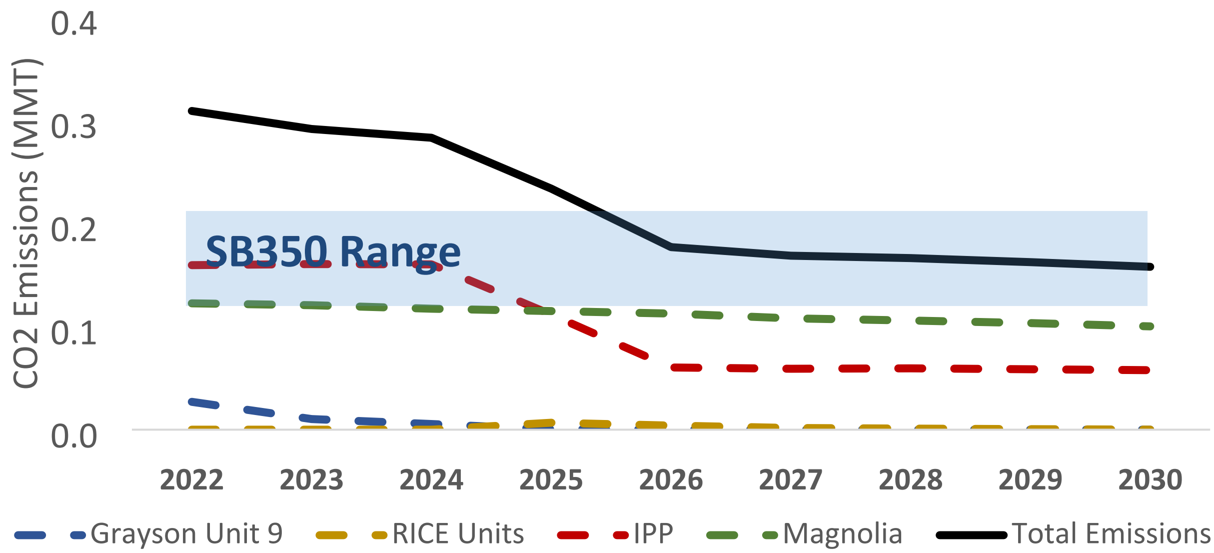
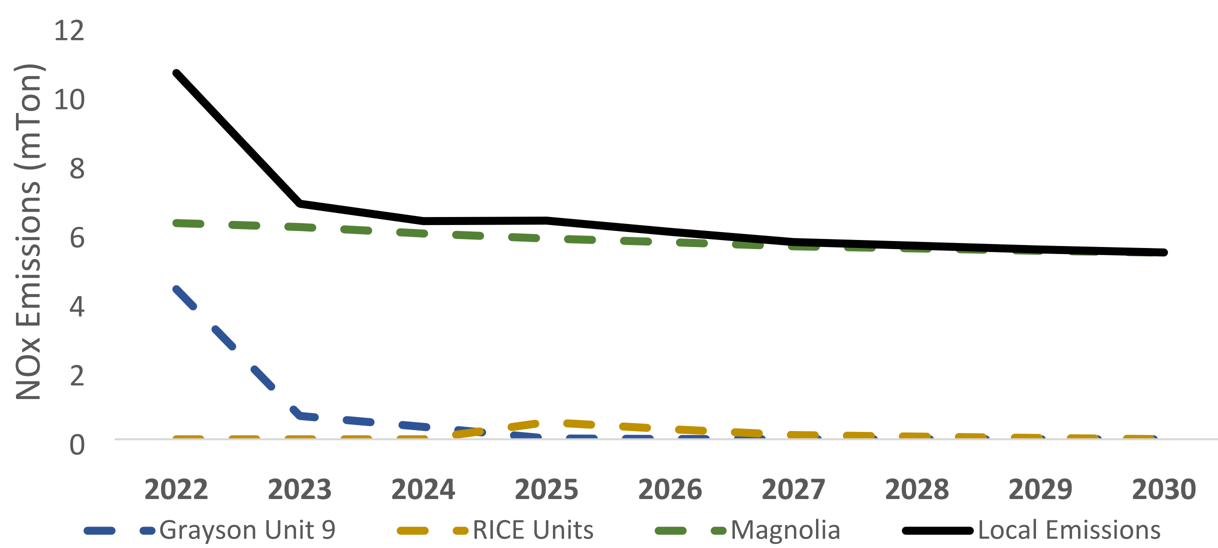
Figure 4: Carbon emissions in GWP from 2022 to 2030



Importantly for disadvantaged communities near the Grayson plant site, local criteria pollutants like NOx would also decline 50%, even after the replacement of Grayson Units 1-8 with 93 MW of RICE units.

Figure 5. Local NOx Emissions in GWP from 2022 to 2030



The portfolio meets the standard industry planning reliability targets of having enough resources to limit energy shortages to less than "1 day in 10 years." Expressed in another way, the annual average shortfall is 2.4 hours by 2030. The shortages are much higher in the near term due to the retirement of Grayson Units 1-8 in 2022. By 2027, the RICE units and additional transmission add enough capacity to return the portfolio to meeting this reliability standard.

In addition to resource adequacy for planning purposes, GWP implements an operating reserve policy of "N-1-1" which requires adequate resources such that GWP could endure outages from the two largest resources and still

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serve load. The two largest potential contingencies in GWP's system are transmission outages totaling a loss of 162 MW after 2027. Therefore, GWP must keep local reserves available to cover this potential loss of resources. Once again, the RICE units and local battery storage provide valuable back-up and allow GWP to maintain a high level of operational reliability.

The cost of this plan is estimated to increase GWP ratepayer bills by 28% in 2030 compared to today. This includes rate effects from the local Clean Energy Projects and equates to a bill increase of $285 per year for the average residential customer. GWP customer bill impacts may vary between customers and customer classes. Individual impacts would depend on the rate design and energy consumption profiles. Actual expected bill impacts by customer class would have to be further studied in a Cost-of-Service Analysis and estimated by GWP.

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2. Introduction

This report provides an analysis of a proposed path to bring GWP as close as physically possible to 100% clean energy by 2030. GWP retained Ascend Analytics to build upon the 2019 Integrated Resources Plan, which envisioned achieving the State's SB100 goals of 60% renewable energy by 2030, on track towards 100% emissions-free retail sales by 2045. This analysis demonstrates that even without technological advancements in clean fuels or additional transmission capacity above current expectations, GWP can make significant progress towards the 100% clean energy goal. However, considering their land and transmission constraints, GWP is unlikely to realize this goal by 2030.

2.1 Key Findings from 2019 IRP

The 2019 IRP primarily focused on what GWP should do to replace the Grayson Power Plant. GWP completed a "Clean Energy RFP" process, which invited bidders to propose local clean energy projects that could provide reliable capacity and energy to reduce or replace the amount of gas-fired capacity in Glendale. The bidding process resulted in a proposed portfolio that would include contracts for increased energy efficiency and demand response, residential rooftop solar and storage, battery storage and natural gas-fired RICE units for critical back-up power applications. These contracts alone would establish GWP as a nationwide leader in clean energy on a path to achieving 77% renewables by 2030 on a net energy basis.

2.2 Moving Towards 100% Clean Energy

The Glendale City Council requested GWP to undertake an effort to analyze the potential to provide the city with 100% clean energy by 2030, fifteen years ahead of the State targets. GWP agreed to conduct the analysis and provide a written report for the Council's review. This report is meant to satisfy those requirements.

In order to move beyond the IRP, Ascend worked with GWP to identify potential sources of clean energy additions to GWP's portfolio. This analysis focuses on providing clean energy around-the-clock which is a much more challenging task than what nearly every other electric provider in California is planning for. There are roughly 170 cities and communities with pledges to reach 100% renewables by 2030.[2] These pledges will surely push utilities to increase the amount of renewable energy across the US and reduce emissions. However, the cities making these admirable pledges are "Net Zero Clean Energy" pledges, which net

UNDERSTANDING KEY TERMS

Net Zero Clean Energy: At an annual level, a community generates at least as much clean electricity as the load but not coincident with hourly demand.

Around-the-Clock Clean Energy: Electricity generated by clean resources is delivered coincident with hourly load at all times. A much harder portfolio to build with renewables and storage.

[2] Ready For 100 | Sierra Club

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out energy use at an annual level (see box at right). This masks the fact that the cities will inevitably consume electricity produced by fossil fuels during hours when renewables are offline, especially overnight. Glendale, on the other hand, is striving to provide completely clean energy all hours of the year. To achieve such a task, GWP will need to add a diverse mix of wind, solar, geothermal, and storage, a mix that can provide clean energy during morning, evening, and nighttime hours.

2.3 GWP is a National Leader in Carbon Reduction

In 2019, GWP submitted an IRP that proposed meeting 77 % of its energy needs on a net basis with GHG free resources by 2030, putting GWP well ahead of the SB100 requirement to reach 100% clean by 2045. This would reduce greenhouse gas emissions from GWP by 60% by 2030 (using 1990 as the baseline). If the current proposed plan were to be adopted, GWP would reduce emissions by 75% by 2030. With the Council's request, GWP is now researching options to meet 100% of its load with clean energy by 2030. Ascend Analytics works with numerous utilities across the US and is not aware of any other such ambitious goals. For example, Xcel Energy has a plan to be carbon free by 2050[3], and Duke Energy is planning to achieve net-zero carbon emissions by 2050[4]. Community Choice Aggregators (CCAs) are known for their progressive action towards decarbonizing the grid, and among them is Silicon Valley Clean Energy whose decarbonization plan proposes a 50% cut in carbon by 2030.[5] If GWP were to implement the plan outlined in this study, it would lead all other utilities in clean energy use.

3. Glendale Water & Power Background

Glendale Water and Power serves the residents and businesses in the City of Glendale. Table 1 shows a summary of the GWP electric system. The City of Glendale was incorporated on February 16, 1906 and spans approximately 31 square miles with a current population of approximately 205,331 (US Census). Located minutes away from downtown Los Angeles, Pasadena, Burbank, Hollywood, and Universal City, Glendale is the fourth largest city in Los Angeles County and is surrounded by Southern California's leading commercial districts.

Table 1: GWP Electric Service at-a-glance as of 2020

NUMBER OF DISTRIBUTION MILES	503
NUMBER OF SUBTRANSMISSION MILES	58
NUMBER OF POLES	14,768
NUMBER OF SUBSTATIONS	14
NUMBER OF METERS	90,030
ANNUAL POWER SALES (MWH)	1,462,539
ANNUAL PEAK LOAD	336 MW on 8/18/2020

GWP's portfolio consists of local thermal generation (Magnolia and Grayson power plants), remote thermal generation (the Inter-mountain Power Project in Delta, Utah), remote hydro (Hoover Dam and Tieton

[3] Xcel Energy press release; Xcel Energy - Xcel Energy aims for zero-carbon electricity by 2050
[4] Duke Energy aims to achieve net-zero carbon emissions by 2050 | Duke Energy | News Center (duke-energy.com)
[5] Decarbonization - SVCE (svcleanenergy.org)

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hydro), remote nuclear (Palo Verde power plant in Arizona), geothermal in Southern California, and wind projects in Northern California, Oregon, and Wyoming. Together these assets constitute 417 MW of capacity.

Table 2: GWP's Resource Portfolio

	Resource Type	Capacity (MW)	Expiration Date
Grayson Units 1-8	Gas	173	2022
Grayson Unit 9	Gas	48	-
IPP	Until 2025: Coal After 2025: Gas	39 35	
Magnolia	Gas	48	-
Palo Verde	Nuclear	10	2030
Hoover	Hydro	12	2067
Skylar Contract	Contract	50 (75% clean)	2040
Highwinds	Wind	3	2029
Ormat	Geothermal	3	2031
Open Mountain	Geothermal	15	2045
Pleasant Valley	Wind	10	2022
Pebble Springs	Wind	10	2029
Tieton	Small Hydro	6.8	-

GWP has contracted capacity along several transmission lines, shown in Figure 6, to bring in power from non-local contracted resources including wind and hydro assets, nuclear power, the Skylar renewable energy contract, and the IPP. GWP's primary resource challenge stems from the lack of available transmission capacity. Additional resources must be located outside of Glendale's territory due to land constraints, meaning that transmission capacity is incredibly important for resource adequacy. Two inbound transmission lines provide a total of 200 MW of capacity into Glendale which are used to transport energy from remote resources.

The Southwest AC (SWAC)[6] line can bring 100 MW[7] of generation to Glendale from Nevada and central California. The Pacific Direct Current Inter-tie (PDCI) line can also bring up to 100 MW of energy from Oregon to Sylmar and into Glendale. Glendale's rights on the SWAC line are expected to increase from 100 MW to 167 MW[8] in 2027 as part of the renewal IPP contract which includes a portion of a large wind project in development in Wyoming. Aside from the transmission increase associated with IPP, there are no realistic options to further add transmission capacity. Ascend did not consider any sensitivities that included transmission beyond 100 MW on the PDCI and 167 MW on the SWAC line.

[6] Refers to the three (3) firm transmission service contracts with LADWP providing GWP with the ability to transmit the power from Victorville/Adelanto to the Air Way Receiving Station in Glendale.
[7] The Southwest AC line has a maximum capacity of 112 MW with capacity derates to 100 MW occurring frequently to prevent line failures. For this modeling work, Ascend assumes a maximum capacity of 100 MW on the Southwest AC line.
[8] The maximum transmission capacity will be raised to 175 MW but as discussed above, GWP expects a portion of this capacity will be reduced during peak load events to 167 MW. All modeling and discussion in this report references the 167 MW reliable capacity of this line.

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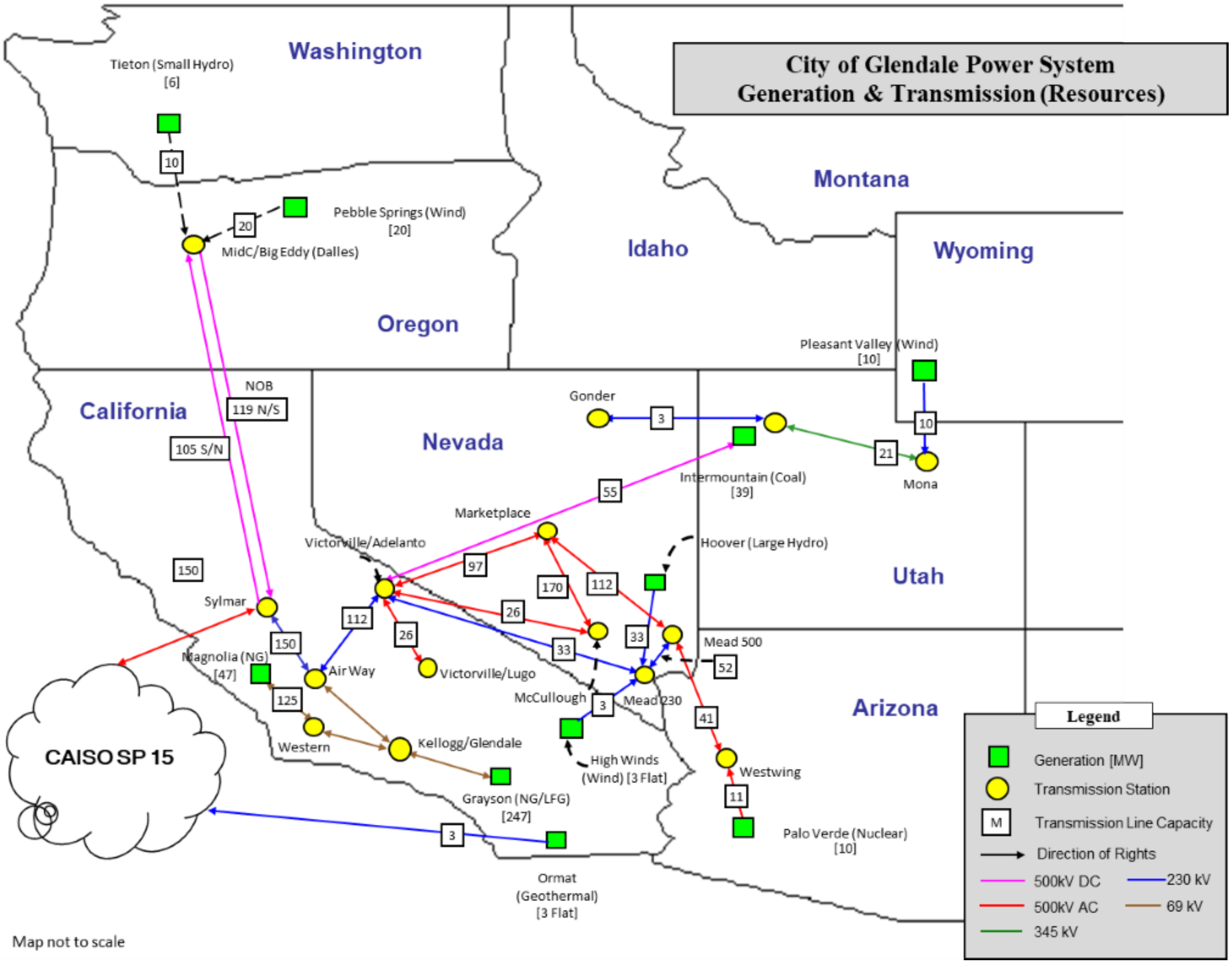
Figure 6: Glendale Transmission Map



GWP has contracts with resources and transmission across a wide geographic area. However, all transmission is bottlenecked down to the Pacific DC intertie (listed as the blue arrow connected to Air Way with 150 MW capacity in the figure above) and the Southwest AC intertie (listed as the blue arrow connected to Air Way with 112 MW capacity above). All non-local resource – renewable, thermal, and market purchases – must be received through this limited transmission capacity. Furthermore, the Pacific DC intertie has 50 MW contractually dedicated to the Sylmar hub, reducing the actual usable capacity to 100 MW. The Southwest AC intertie is constructed from a technology that is sensitive to temperature and is generally de-rated to 100 MW during the hottest days of the year.

4. 100% Clean Energy Study Design and Results

GWP and Ascend worked together to develop a “best case” pathway to maximize the amount of clean energy delivered that also maintains the high-level of reliability GWP customers expect. The team sought to be ambitious, while adhering to reality-based limits on technology, resource, and transmission availability. For this target to be achieved within 9 years, all technologies needed to exist and be commercially available today. This means energy would be provided by proven solar, wind, and geothermal technologies and capacity provided by lithium-ion batteries. The portfolio is filled with additional renewable capacity based on generic but achievable procurement. Examples include new geothermal from the California-Nevada border, solar and storage from southern California and Arizona and wind from Northern California and Oregon. Resource additions that are not realistically procurable or even desirable were not considered, such as large-scale hydro or nuclear power.

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Reliability in this context was determined via loss-of-load expectation analysis which is a statistical model showing how often the resource portfolio could be short of supply to fully serve customer demand. GWP also maintains system reliability during operations through operational reserves determined based on the "N-1-1" criteria. Ascend investigated the reliability of the system from both loss-of-load resource adequacy and N-1-1 perspectives. The reliability analysis showed that while clean energy is necessary to meet the primary objective, GWP needs dispatchable, firm capacity to keep the lights on when the system is stressed.

Adding to the challenge of getting 100% of clean energy by 2030, GWP is in an urban region with considerable limitations on where resources can be constructed to provide clean energy. Ascend assumes that Sunrun's proposal of adding 34 MW of residential rooftop solar is the maximum amount that can be obtained from GWP residential customers. Also, Ascend's modeling suggests that beyond 75 MW, the value of local battery storage drops significantly. While GWP is continuing to pursue opportunities to install clean energy resources, such as solar and storage on City facilities, the option to develop large scale clean resources in the city limits of Glendale is not available due to space limitations. Rooftop solar is limited by available unobstructed rooftop space as well as cost given rooftop solar is approximately three times as expensive per unit of energy as utility-scale solar. Glendale's most viable option to reach 100% clean energy is increasing remote resources via the two major transmission lines connected to GWP: The Southwest AC line (SWAC) and the Pacific Direct Current Inter-tie line (PDCI).

4.1 Maintaining Reliability

The primary role of GWP is to reliably serve customers. Ascend investigated the reliability of the proposed portfolio described in this report with a loss of load analysis on the portfolio which provides a probabilistic assessment of the system to determine how likely it will experience a capacity shortage. The model used for the loss of load analysis included transmission limits and a wide range of possible renewable generation, customer load, and generation availability.

Additionally, the portfolio must meet the operational reliability requirement of meeting "N-1-1" contingencies. This criterion which stems from the National Electric Reliability Council (NERC), requires GWP to maintain sufficient reserve capacity to back up the single largest contingency, which is the 100 MW Pacific DC transmission line. During an extended N-1 event, the next largest contingency, a 50% loss of the STS line, must also be backed up. After 2027, the STS line capacity is assumed to be 124 MW, meaning the contingency of an STS line outage is a loss of 62 MW of transmission capacity. Reliability details are described in Chapter 6.

4.2 Portfolio Construction

GWP and Ascend designed a portfolio targeting 100% clean energy deliveries by 2030 while following a realistically achievable procurement plan and meeting reliability requirements. Cost was not considered a limiting factor in how to select the resources for the portfolio, but all resources had to be technically feasible today.

Obstacles such as lack of locally available clean resources, and transmission constraint prevented the portfolio from achieving fully 100% clean deliveries in 2030. The portfolio presented here achieves 144% clean generation and 100% clean deliveries by 2030. The clean generation that was not part of the clean deliveries was assumed

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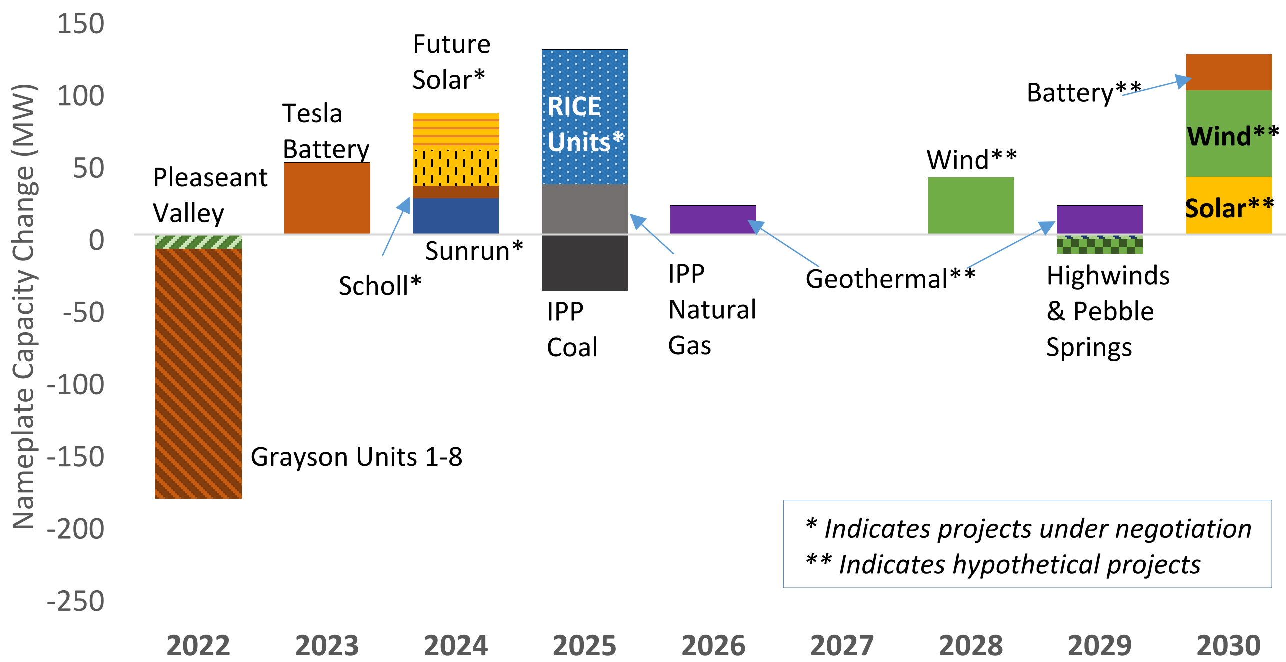
to be sold to markets within and outside of California because it could not be delivered to load due to transmission congestion. GWP remains committed to achieving 100% clean energy deliveries and will continue to pursue clean procurement before and after 2030 as technology improves and these obstacles are overcome.

The annual buildout of the proposed Clean Energy Portfolio is shown in Figure 7. Generic wind, solar and geothermal resources in the figure represent hypothetical portfolio additions as opposed to projects that are identified at this time.

Figure 7: Annual capacity additions and retirements



Most capacity additions and retirements shown in Figure 7 were included in the 2019 Integrate Resource Plan. The primary portfolio changes modeled in this study include the proposed Grayson retirement (2022), the proposed Tesla BESS (2023), proposed SCCPA solar and storage projects (2024), and IPP repower (2025). In addition to these proposed resource changes, Ascend selected new geothermal additions in 2026 and 2029, new solar in 2030, and new wind in 2028 and 2030 for inclusion in the model. The resources planned beyond 2025 were selected to maximize clean energy serving load around-the-clock. New resources are remote resources that rely on one of the two major transmission lines coming into Glendale.

The total annual capacity is shown in Figure 8. The renewable resources have been adjusted to show their accredited capacity, the level of capacity that can provide reliable contributions towards serving load. The bulk of the capacity comes from natural gas, specifically the proposed reciprocating internal combustion engines that GWP is evaluating through the Limited Notice to Proceed Phase of the proposed Grayson alternative repowering effort.

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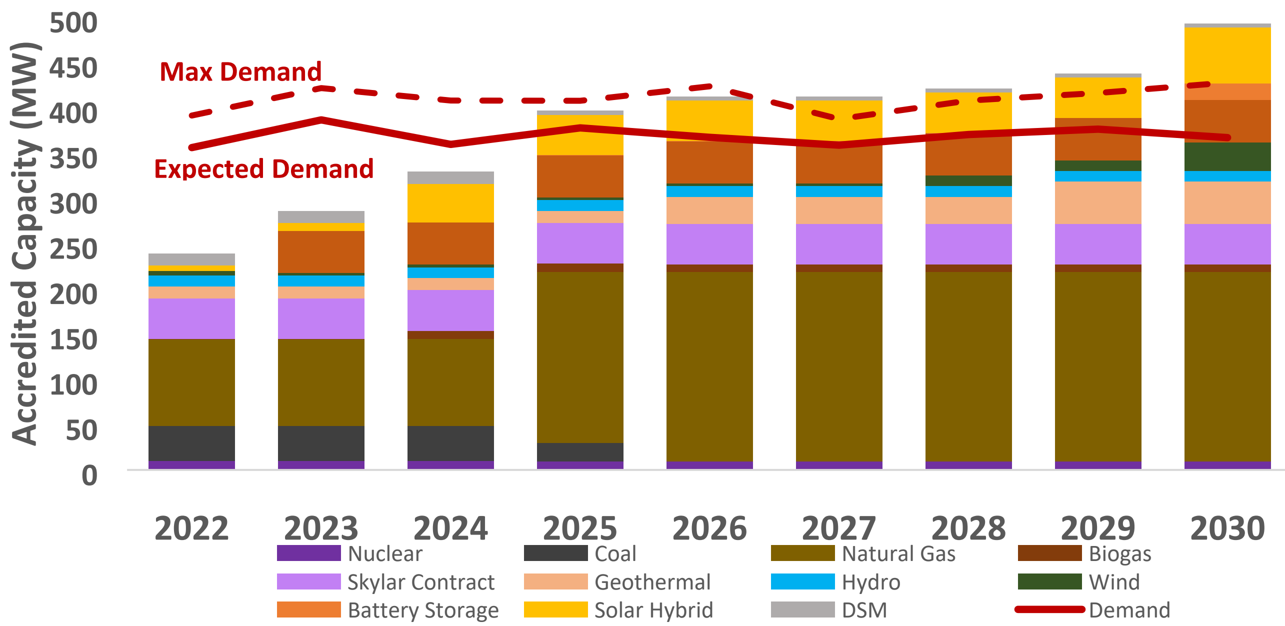
Figure 8: Annual capacity of resources used for this study by fuel type (includes hypothetical and proposed projects)



The capacity values in the figure above show that GWP has a capacity shortfall in the near term due to the retirement of Grayson Units 1-8. Beginning in 2026, GWP's expected capacity is greater than its expected peak load. In 2027, GWP's capacity position is high enough to satisfy the full range of modeled loads (the dotted line shows the 95th percentile of the simulated loads).

In 2025, the IPP coal plant is retired and replaced with a combined cycle power plant, capable of burning a blend of natural gas and hydrogen. The hydrogen fuel would be created through the chemical process of electrolysis, whereby hydrogen atoms are separated from oxygen atoms in water using electricity generated by renewable energy. This "green hydrogen" concept has the potential to be a critical component of a 100% clean energy system, serving as a type of seasonal energy storage from periods of renewable overgeneration to periods of high electricity demand. The IPP hydrogen capability is one of the first of its kind, with inherent risks in being able to realize the goal by mid-decade. While the current plan is to power the IPP replacement with a 30% volumetric hydrogen fuel mix, uncertainty regarding the viability of achieving this goal by 2025 led Ascend to not include its emissions reduction benefits in the model. This means that any actual green hydrogen burned at IPP would increase the clean energy content beyond what is presented in this report.

4.3 Future Procurement

Potential future resource additions to the GWP portfolio include solar, wind, batteries, geothermal, and internal combustion engines. The choice of resource mix was driven by cost and the need to serve load with clean at all hours of the day. Utility-scale solar energy paired with batteries is an affordable, clean energy resource, but the four-hour batteries cannot stretch the solar generation through the night. GWP will need to invest in non-solar renewables to get clean energy generation during evening and night hours. Wind tends to generate more energy at night but is more intermittent and volatile. Geothermal provides firm energy all hours of the day, albeit at

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about double or triple the cost of utility-scale solar. Ascend combined wind and geothermal resources to develop an energy mix that can provide adequate clean energy around the clock at a reasonable cost. Reciprocating internal combustion engines (RICEs) were recommended in the Clean Energy RFP process and the 2019 IRP and are undergoing engineering and environmental reviews as part of the Limited Notice to Proceed Phase of the proposed Grayson repowering project alternative. This study assumes that the RICEs will come online in 2025. While RICEs do not provide clean energy (unless converted to a clean fuel), they provide critical reliability services that can serve load when GWPs system is stressed from extreme temperatures, transmission outages, or other contingencies. Given the high amount of renewables in GWP's portfolio, the RICE units will start infrequently, mainly to cover extreme load peaks and fill in during contingencies.

An additional advantage of battery energy storage is the flexibility it brings to the system. Flexible resources can start and ramp up and down quickly in response to system needs or price signals. This added flexibility is especially valuable in a system with high renewables to act as a counter to the volatile generation of solar and wind.

Flexible resources can also extract value in real-time markets. Batteries react quickly to real-time price spikes that often last for only a few minutes but can be hundreds of dollars per MWh. Real-time markets also produce negative prices when there is an abundance of energy flowing into the system which provides opportunity for batteries to charge excess energy as low or negative cost. The transition from traditional generation to a high renewables grid will require flexible resources like batteries and create the market signals to incentivize battery additions.

Solar paired with batteries, also known a solar hybrid projects, is becoming increasingly common. Solar generation is predictable, providing power during the middle of day and ramping down in the evening hours. The battery charges during the day when solar generates more energy than needed and discharges excess energy to evening hours when it can be used to serve load. The interconnection queue in CAISO is dominated with solar and storage with some wind also in the queue.

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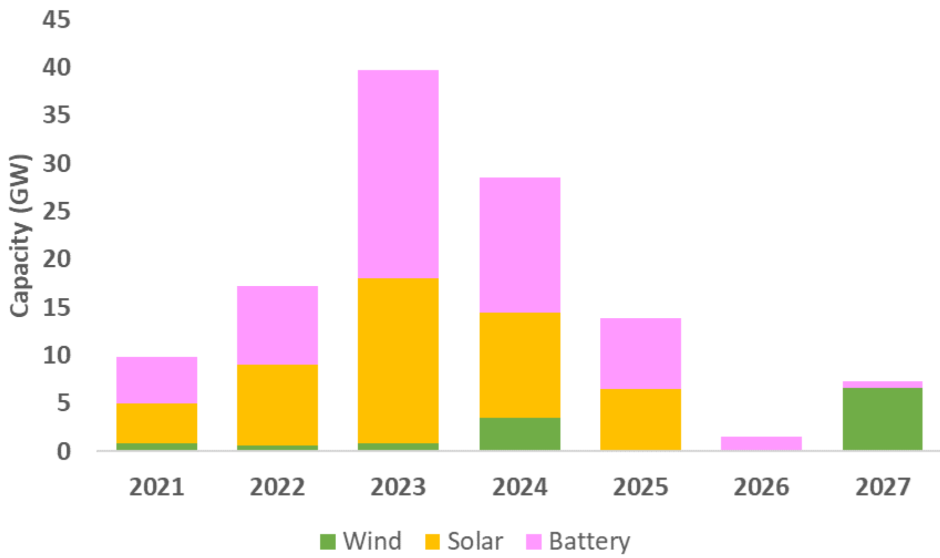
Figure 9: CAISO interconnection queue to 2027



GWP's 2019 IRP portfolio includes three solar hybrid projects (the proposed Sunrun project, the approved Eland project, and the proposed SCCPA solar project). There are currently three wind projects in the portfolio, Pleasant Valley, Highwinds, and Pebble Springs which are set to retire by 2029. The assembled portfolio for this study includes two new wind projects (generic resources; to be identified in the future) for a total of 100 MW, a hypothetical commercial building roof-top solar build-out (20 MW), a generic solar and storage project (30 MW) and generic geothermal energy added in two installments (40 MW). Table 3 shows a summary of the proposed new solar, wind and geothermal projects in the portfolio in 2030. Note that solar paired with batteries cannot dispatch beyond the capacity of the solar nameplate.

Table 3: New Solar, Wind and Geothermal Projects in the Clean Energy portfolio

Project	Nameplate (MW)	Battery Capacity (MW)	Battery Storage (hr)
Sunrun (DER solar)	34	25.25	2
Proposed SCCPA Solar projects	25	12.5	4
Eland Solar	25	18.75	4
New Comm Solar	20	10	2
New Solar	30	26	4
New Wind	100		
New Geothermal	40		

In addition to the proposed solar resources with batteries, this model assumes that GWP will install 75 MW of proposed stand-alone batteries located in Glendale from the Clean Energy RFP by 2030. The amount of local battery capacity that can effectively shift energy is limited by the amount of local generation and transmission capacity. In the case of Glendale, Ascend's models showed that 75 MW of four-hour storage can cycle fully and provide value to GWP. Beyond 75 MW, the batteries will be under-used.

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Resource additions must be technically and economically feasible today to be considered for this analysis. That eliminated storage with durations longer than 8 hours[9], hydrogen power, and small modular nuclear. While these technologies show promise in the long term, they are not likely to play a significant role in the next nine years that GWP is considering for a full switch to clean energy.

Other resources that are technically feasible were not considered, such as large hydro. Large hydro is an extremely scarce resource, which is entirely locked up by other load serving entities in California to meet the state's GHG goals as well as utilities in the Pacific Northwest with similar carbon reduction goals. Additional nuclear was also not considered as it is not a realistic choice in southern California at this time.

Finally, in assembling the portfolio, it was assumed that solar would be available on the SWAC line only while a limited amount of wind could be added to the PDCI or SWAC lines. The amounts added to adjusted to reduce curtailments and maintain a realistic level of these resources given the transmission constraints.

5. Clean by 2030 Portfolio Operation

5.1 Generation and Dispatch

The proposed Clean Energy portfolio modeled for this study relies primarily on battery storage in Glendale (Tesla 50 MW and future 25 MW four-hour batteries) paired with remote renewable resources (geothermal, wind, and solar) to maximize around-the-clock renewable energy and make optimal use of limited transmission line capacity. Figure 10 shows annual portfolio generation and market purchases and sales. Clean generation exceeds load by the year 2030, but unfortunately, a significant portion of the clean generation is sold or curtailed as shown in Figure 12.

[9] Ascend tested 8-hour duration batteries, but found they were severely underutilized while also extremely expensive. Therefore only 4-hour duration batteries were considered for the final portfolio.

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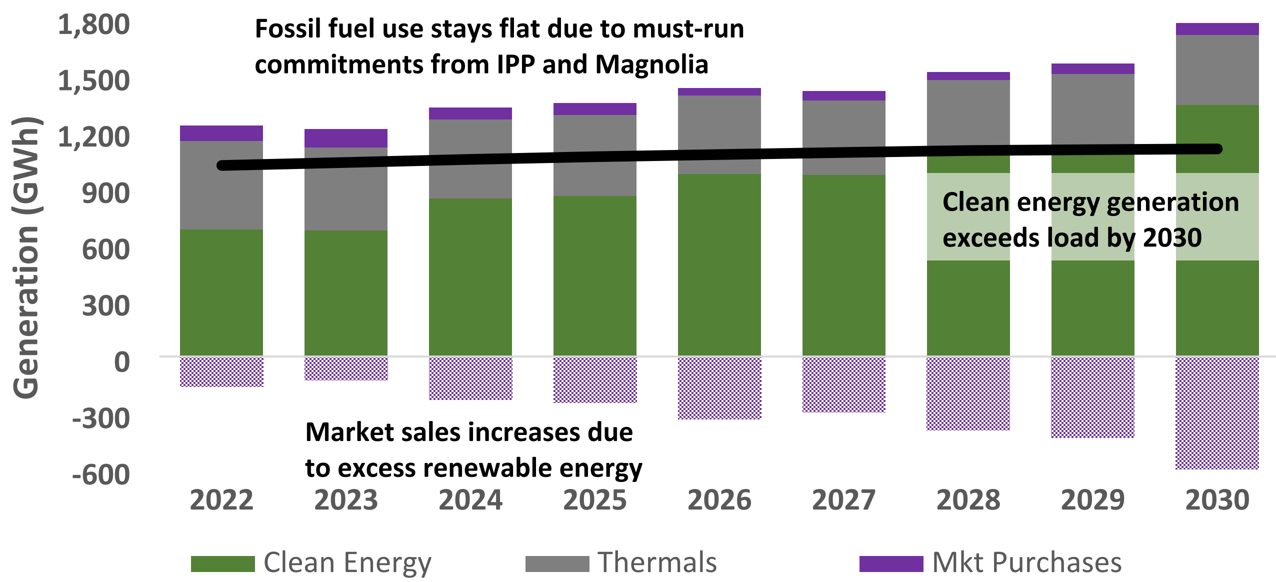
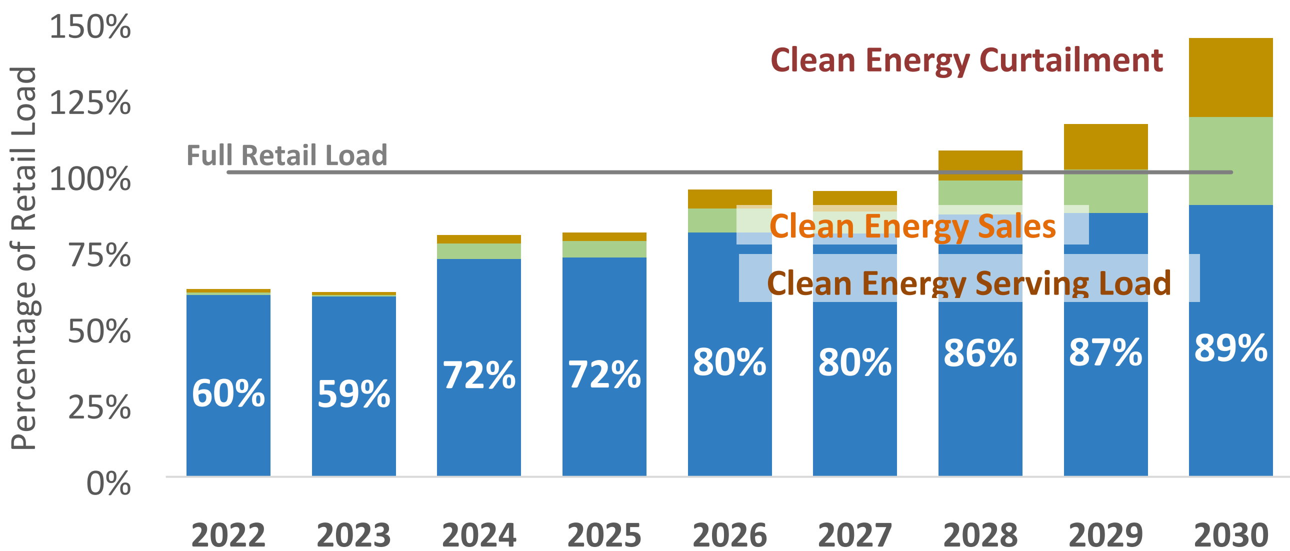
Figure 10: Annual Energy Generation and Load



The key result shown in the graphs is that in 2030, GWP will generate enough clean energy to cover 144% of customer load, but due to timing between electric demand and clean generation along with transmission limits, only 89% of customer load is served by clean energy. Given the high level of renewables in this portfolio, there are many hours where clean energy vastly exceeds customer load and must be sold or curtailed. Other times, the clean resources are not able to satisfy customer load so fossil fuel generation must be used.

Figure 11: Clean Energy Generation and Delivered as a Percentage of Retail Load



Clean generation increases year by year with additional clean resources coming online. This plan assumes solar and storage will be developed in the near term (the approved Eland project, as well as the Sunrun and proposed SCCPA Solar projects under negotiation) along with proposed 50 MW standalone storage (Tesla) which is under

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evaluation through the Limited Notice to Proceed Phase of the proposed Grayson repowering alternative, as well as an additional proposed 25 MW of standalone storage in 2030. Assuming these projects come to fruition, total solar capacity expected from planned and existing projects would reach 128 MW (nameplate), including residential and commercial rooftop solar. Solar generation would provide energy during the day when loads are high, but GWP will need additional clean resources for evening and night hours.

Table 4 lists all resources included in the GWP model for the year 2030. New resources are given generic names to indicate type and year they come online ("Geo 2026" or "Wind 2030").

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Table 4. 2030 Portfolio Snapshot

Resource		Nameplate Capacity (MW)
Geothermal		
	Starpeak	13
	Whitegrass	3
	Ormat	3
	Geo 2026	20
	Geo 2029	20
Hydro		
	Hoover	12
	Tieton	5
Hybrid Solar		
	Eland	25
	SCCPA Proposed solar*	25
	Hybrid Solar 2030**	30
	Sunrun Rooftop Solar*	28
	Commercial Rooftop Solar**	20
Wind		
	Highwinds	3
	Pebble Springs	10
	Wind 2028**	40
	Wind 2030**	60
DER		
	Sunrun*	34
	Lime/Franklin	8
Power Contracts		
	Skylar (75% clean)	50
Storage		
	Tesla 2023*	50
	BESS 2030*	25
Thermal		
	RICE units*	93
	Grayson	48
	Magnolia	48
	Scholl*	8
	IPP	39
Transmission		
	SWAC	167
	PDCI	100

* Contracts under negotiation/ not yet approved and/or subject to environmental reviews
** Hypothetical projects used for this study to maximize clean energy generation

Increased clean energy in the proposed GWP portfolio coupled with declining market prices causes Grayson Unit 9 and the RICE Units to run infrequently over time. While Grayson Unit 9 and the RICE Units do not provide a lot of energy, they provide valuable capacity for resource adequacy and peak load support. Magnolia and IPP have contractual minimum run levels that require capacity factors at least 50% and 40% respectively. IPP has a must-

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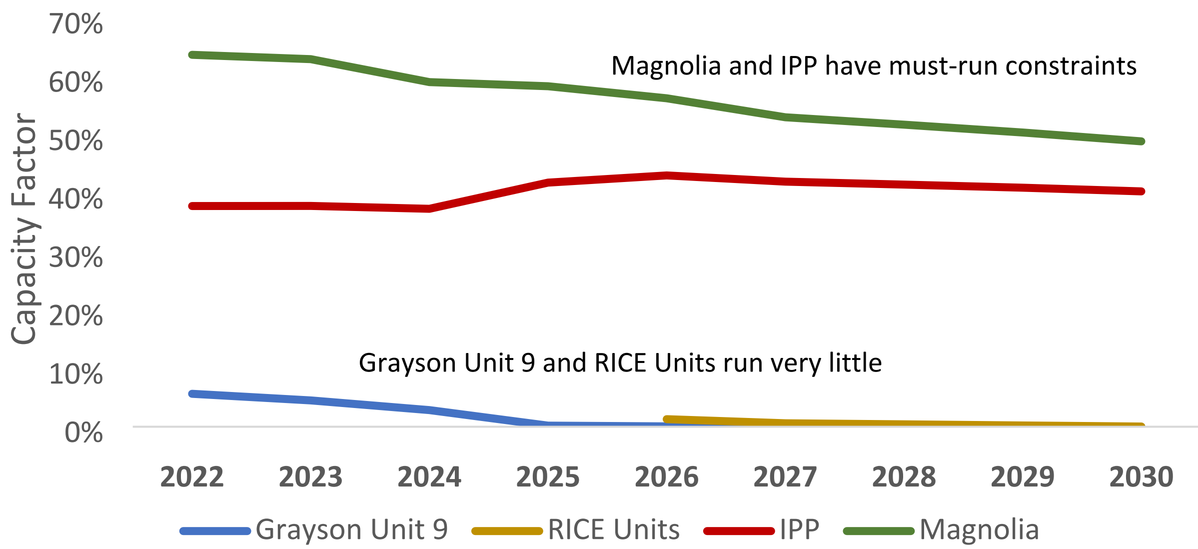
run requirement because it contributes to transmission grid stability. Magnolia is owned by a consortium of utilities that must have unanimous agreement if the plant should stop running for a period. Figure 12 shows annual thermal capacity factors for GWP resources.

Figure 12. Thermal Resource Capacity Factors



The contracts associated with Magnolia and IPP provide reliability benefits to GWP. Magnolia is located next to Glendale in neighboring Burbank so it does not rely on transmission access to bring power to Glendale. The contract with IPP is necessary to gain critical transmission capacity on the SWAC line. In the long term, IPP is expected to convert to green Hydrogen which is generated from renewable energy. Starting in 2025, the IPP replacement is expected to burn a fuel mixture of 70% natural gas and 30% hydrogen by volume; on energy basis, that would equate to approx. 90% natural gas and 10% hydrogen. This ratio is expected to evolve to 100% hydrogen on an energy basis over time. As hydrogen and renewable fuels mature, there is the possibility that Magnolia will also run on a renewable fuel in the future. This is discussed further in Chapter 8.

5.2 Transmission

Reducing GWP's dependence on gas-fired generation requires optimal use of the limited transmission capacity available. A true 100% clean energy portfolio would need to bring in high amounts of clean energy over the transmission lines. However, clean resources are not available equally everywhere. GWP has 100 MW of transmission on the PDCI line which brings power from the Northwest. Ascend assumed that wind is the most likely resource along the PDCI line so 100 MW of wind is modeled on this line. For the SWAC line Ascend added geothermal (40 MW) and solar (30 MW) to maximize the clean energy deliveries around-the-clock to Glendale. Wyoming wind will also come through the SWAC line from IPP. Ascend did not specifically model this resource since it is not clear if all of the wind will be used to create hydrogen for the replacement plant at IPP. To increase clean energy, GWP would need addition transmission capacity.

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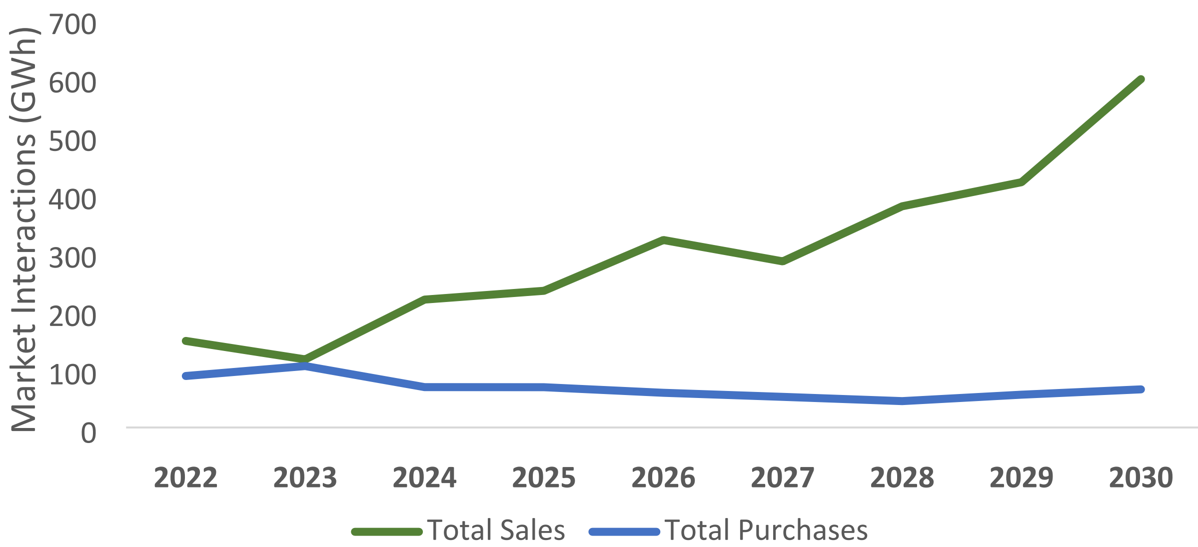
5.3 Market Interactions

The large quantity of renewables in this proposed portfolio pushes GWP into a long energy position. As more resources are added to the portfolio, the market sales increase considerably (Figure 13). As the chart indicates, the increased market sales are attributed to increased renewables.

Figure 13. Market Interaction Quantities



5.4 Curtailment

Maximizing clean energy deliverables inherently results in increased curtailment of renewable energy. Renewable curtailments occur due to physical constraints, when the energy cannot be used or sold because of transmission congestion. Systems with high levels of renewables are more susceptible to curtailments, and the proposed portfolio for GWP is no exception. It should be reiterated that curtailed energy was not included in any calculations of the share of load served by clean energy.

Figure 14 shows how curtailments evolve over time with the deployment of the Clean Energy portfolio modeled in this study. During periods of high generation, there is no ability to use all the energy to serve GWP load, and transmission constraints impede the ability to sell the excess energy.

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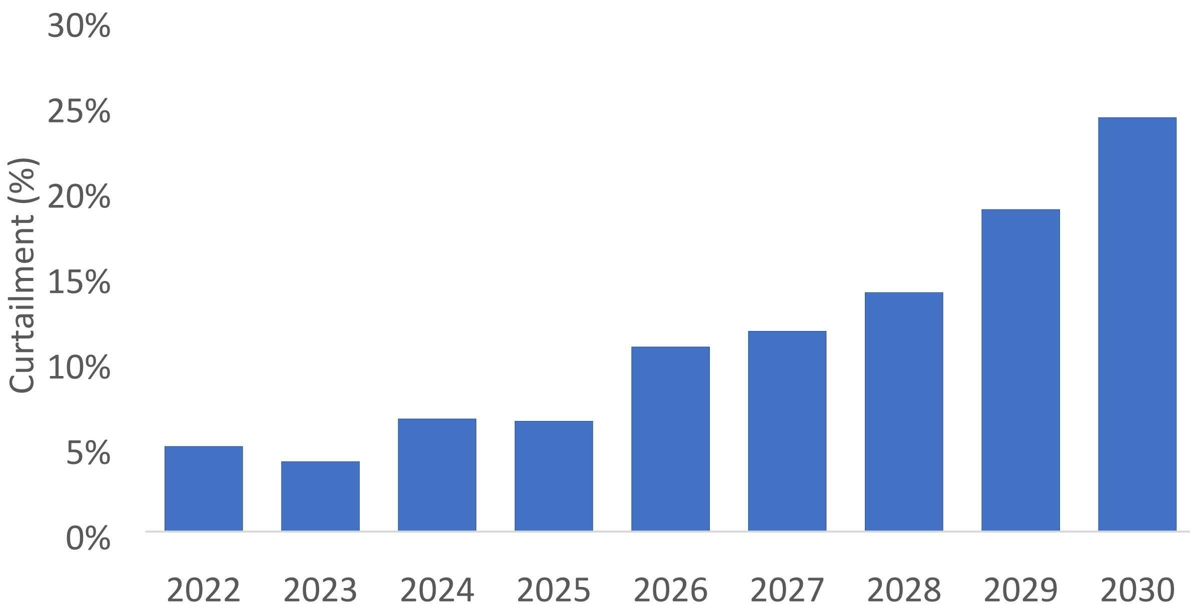
Figure 14. Annual Renewable Curtailments



Energy storage can reduce renewable curtailments by charging when the renewables would be curtailed. In the case of GWP, solar generation curtailments occur most often in the middle of the day when solar output is high. Battery charging during can absorb a portion of the energy that otherwise would have been curtailed. Excess solar generation generally occurs when market prices are low; thus, charging the batteries with excess solar generation makes sense. Ascend performed sensitivity analysis on the amount of local energy storage and found that beyond the 75 MW of standalone battery in the model in 2030, the benefit of added storage is minimal.

Energy storage located on the remote side of the SWAC line could potentially reduce curtailments by charging when the SWAC is at full capacity and discharging when transmission space is available. However, Ascend's analysis found that the marginal benefit of adding remote energy storage to the model was low compared to the cost of the batteries. This result is driven primarily by the fact that the batteries discharge during off-peak periods when GWP's load is lower and can be served by other clean resources. Thus, the benefit of remote storage was not found to justify the cost.

5.5 Emissions

GWP's transition towards a 100% carbon-free portfolio reduces carbon emissions by 50% over the next decade. Nearly all carbon emissions come from Magnolia and IPP because of their must-run contracts. All other thermal generation is expected to run very few hours and provide only a small level of carbon emissions. Overall, total emissions from GWP will fall in the middle of the SB 350 target range for carbon emissions. Figure 15 shows the drop in carbon from 2022 to 2030.

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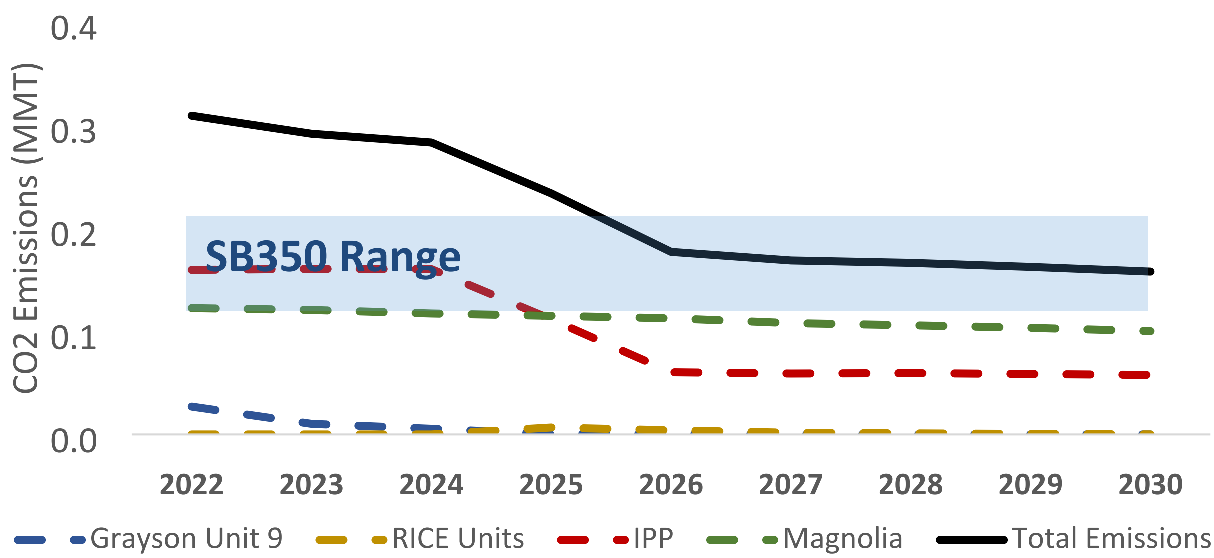
Figure 15. Carbon emissions in GWP from 2022 to 2030



The total CO2 emissions in 2030 is 157,000 metric tons, a decline of 151,000 metric tons over 8 years which is the equivalent of removing 32,000 passenger cars from the streets of Glendale[10]. As described in Section 8, the carbon emissions from IPP are expected to decline when the replacement unit begins running partially on hydrogen. The figure above did not include the potential emissions reduction, but it is likely to be in place well before 2030.

Aside from a reduction in carbon emissions, criteria pollutants drop to near zero over the same time frame. The retirement of Grayson Units 1-8 drives most of the decline in NOx pollution, see Figure 16. Magnolia accounts for nearly all local NOx pollution. The remaining thermal resources run much less over time, resulting in less pollution, due to the strong growth in renewables and declining market prices.

[10] https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#:~:text=typical%20passenger%20vehicle%3F-,A%20typical%20passenger%20vehicle%20emits%20about%204.6%20metric%20tons%20of,8%2C887%20grams%20of%20CO2.

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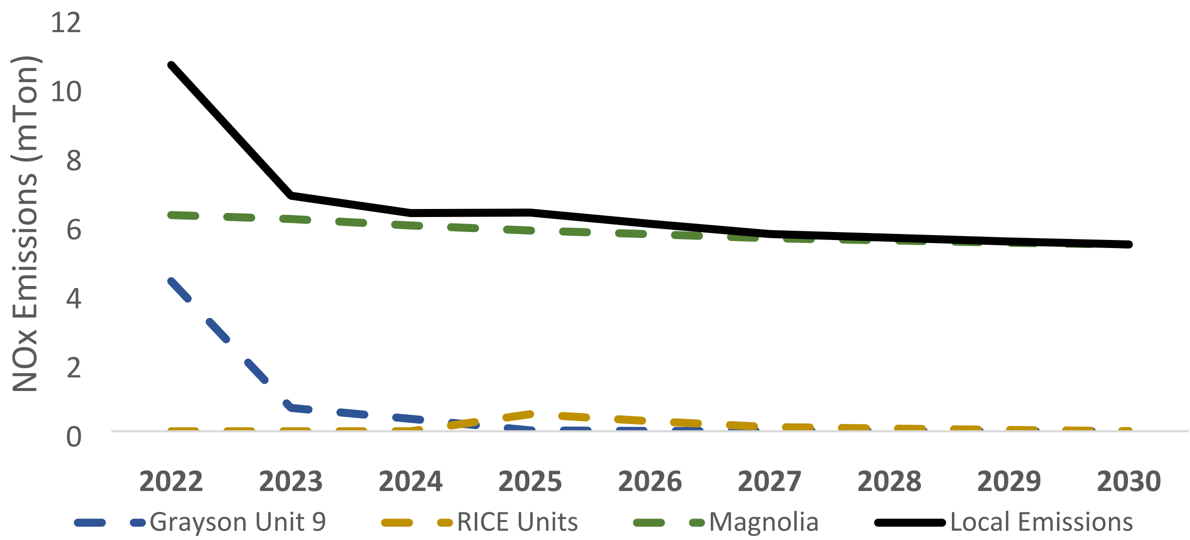
Figure 16. Local NOx emissions in GWP from 2022 to 2030



6. Reliability

6.1 Peak Load

Ensuring portfolio reliability is intrinsically related to an accurate understanding of customer peak demand and its variability. Peak demand happens at different dates, different hours, and different magnitudes each year. To maintain reliability, GWP must be prepared to meet peak demand at any time, even if generation or transmission resources happen to be experiencing an outage.

For this clean energy modeling exercise, Glendale's load was simulated as driven by weather 50 times to determine the expected range of peak demand in each year. While GWP could plan only to meet the average forecasted peak load in a year, this would result in a 50% chance that actual peak demand would be higher than estimated and Glendale residents would be subjected to blackouts precisely when they need power most. By using Ascend's PowerSimm model to simulate Glendale's load many times, GWP can estimate that how much peak demand might vary in a year and plan accordingly.

GWP has observed that yearly peak demand typically matches the 1-in-10 peak demand forecast from the CEC, so this portfolio was structured around meeting the 80th percentile of simulated peak load values in each year as shown in Figure 17. Ascend built the proposed portfolio to be able to serve the 80th percentile load even in an N-1-1 contingency situation, ensuring reliable power to all Glendale residents. With the retirement of Grayson Units 1-8, GWP will not be able to meet an N-1-1 contingency until 2027. In fact, GWP will rely heavily on markets to supply load until it is fully adequate in 2027.

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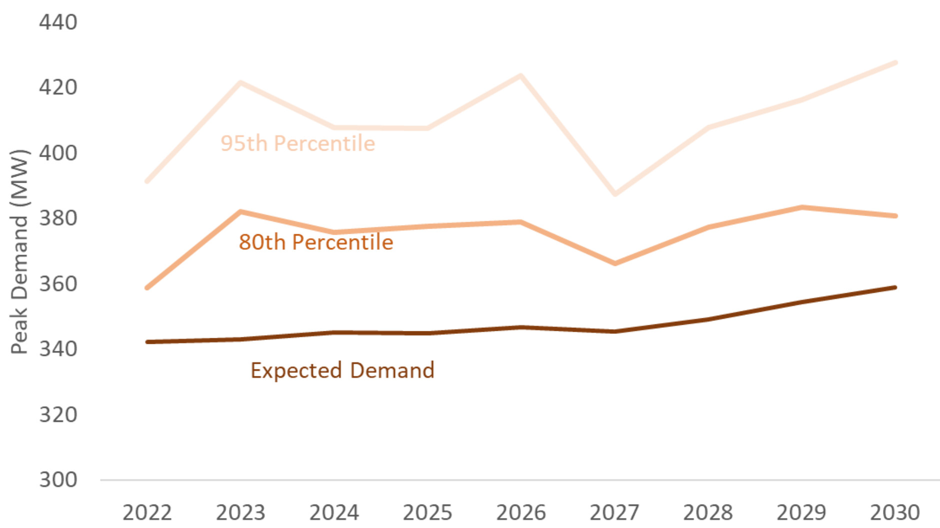
Figure 17: Annual demand forecast with higher demand levels included in model



Peak demand is expected to increase over time as Glendale becomes increasingly electrified. Increasing deployment of electric cars, electrification of building systems (HVAC, stoves, water heating), and increase in average demand over time all contribute to rising peak demand. While these factors cannot be predicted exactly, they are each considered in modeling load. Aggressive adoption of electrification or EVs may drive more rapid increase in peak load, which would necessitate a revision of GWP's resource plan.

6.2 Resource Adequacy

Maintaining a reliable system is a critical part of GWP's mission. In order to quantify the system reliability, Ascend ran loss of load studies on the GWP system. A loss of load study calculates the probability that a system does not have the resources to fully serve custom load on an hourly basis. The hourly results can be summed over a year to determine the mean number of hours that a system does not have adequate resources to serve load. The calculations are based on 250 grid simulations meant to capture a wide range of uncertainty in customer load, renewable generation, and forced outages.

The industry standard for resources adequacy is for electric systems to have adequate resources such that shortfalls will occur on average less than 1 day in 10 years. Ascend translates this target to mean the system should not exceed a shortfall more than 2.4 hours per year.

GWP proposes to retire Grayson Units 1-8 in 2022, a loss of 173 MW. As shown in chapter 4, this proposed retirement pushes GWP into a capacity short position. GWP will not be able to meet the NERC reliability guideline of 2.4 loss of load hours (LOLH) per year until the capacity lost from Grayson is replaced. Annual results from the loss of load analysis are shown in Figure 18. In 2022, GWP's system is adequate with annual loss of load hours less than 2.4. Upon the retirement of Grayson Units 1-8, the system is no longer adequate with a mean number of hours of shortfall of 400. The next year, the LOLH drops closer to 230 due to the proposed installation of the 50 MW Tesla Battery (assuming approval of that project). In 2025, the LOLH drops to a much better value of 8 with the proposed 93 MW RICE units coming online (assuming project approval).

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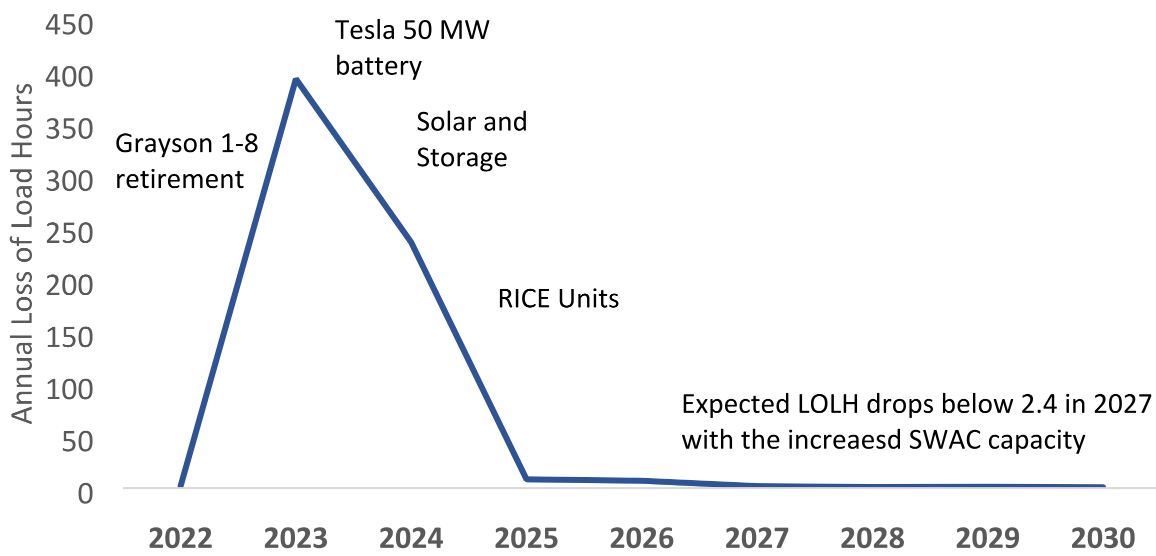
Figure 18: Annual loss of load hours for GWP. Years 2023 and 2024 have high values due to the loss of Grayson Units 1-8.



Overall, the loss of load analysis indicates that GWP will meet reliability standards after 2027. However, in the interim, GWP is taking on more resource adequacy risk, and would experience a high number of hours where GWP cannot serve load, particularly during the transition between the proposed retirement of Grayson Units 1-8 and the proposed Tesla battery and RICE units coming online. By 2030 the portfolio is reliable while serving customers with nearly 90% clean energy.

6.3 Markets

The loss of load analysis presented in the previous section excludes market purchases and relies solely on GWP resources to determine when GWP will not have adequate resources to serve load. When GWP is short capacity from its own portfolio, it will rely on markets to supply energy to serve a portion of its retail load. Reliance on markets carries risk that GWP will face high power prices during periods of extreme temperatures when prices in CAISO can spike as high as $2,000 per MWh. There is also the risk that markets will not deliver energy during the most stressful times such as what was experienced in CAISO in August 2020 when demand was so high that no market energy is available. Figure 18 shows that during the years 2023 to 2025, GWP will not have sufficient resources to act as a physical hedge against market risk.

6.4 Transmission Outages

Resource adequacy as described above analyzes whether a utility can reliably supply power to meet custom load over the next several years. To be able to withstand a N-1-1 event, GWP must maintain 150 MW (162 MW after 2027) of contingency reserve capacity in addition to the capacity required to maintain resource adequacy during peak load hours, as shown in Table 5. The reserve requirement is calculated as the loss of the PDCI line and 50% loss of the STS line.

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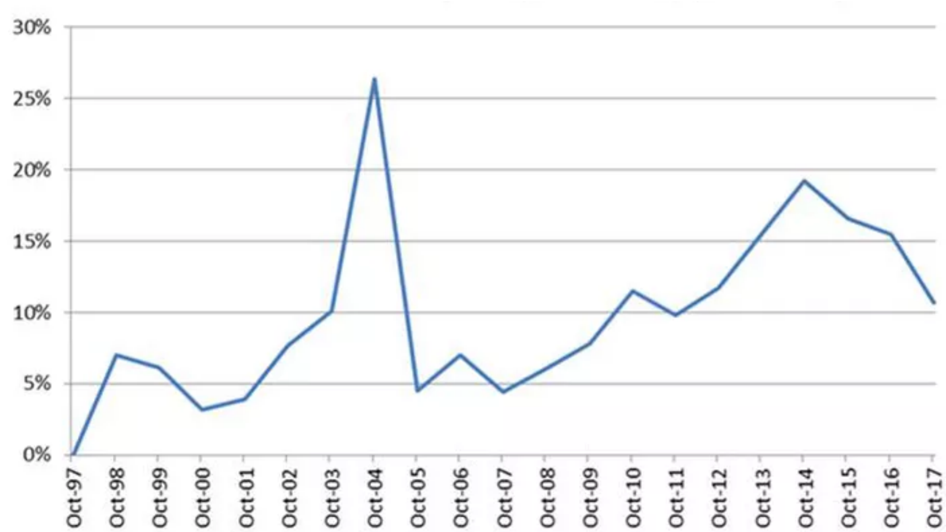
Table 5: Peak Procurement Requirement Based on N-1-1

(MW)	2022	2025	2030
Expected Demand	342	345	347
N-1-1 Reserve Requirement	150	150	162
Total Capacity Requirement (at peak)	492	495	509

While most utilities can maintain reserve capacity using a mix of local, remote, and market resources, the stringent bottleneck of transmission capacity in Glendale forces GWP to rely primarily on local resources to provide reserves. The threat of wildfire damage to transmission lines adds to the need for local resources to ensure reliable operations. The 2019 IRP proposed considerable local resources, including behind-the-meter, storage, DSM, renewables, and thermal resources.

Ascend modeled the system with transmission outages on the PDCI and STS lines. Both transmission lines are often de-rated due to repairs and high summer temperatures. De-ratings reduce the amount of transmission capacity that GWP has available and often last for more than 60 minutes and can last for several hours, days, weeks, or even months. Figure 19 shows the percentage of time such de-rates or outages have occurred over the past 10 years during the highest load months of May through October, demonstrating the need to evaluate GWP's system with this stress test.

Figure 19: Pacific DC Intertie N-S TCC Outage May-October Yearly (1997-2017)[11]



The Pacific DC Intertie experiences frequent de-ratings or outages that often last for more than 60 minutes and can last several hours, days, weeks, or even months. This figure shows the percentage of time these outages have occurred during the highest load months of May through October. Note that during October 2017 the Pacific DC Intertie was de-rated (or out of service) for just over 10% of the month.

Contingencies like an outage on the STS or PDCI lines are examples of the times when GWP will need firm local generation which is why the reciprocating internal combustion engines are an important element in the

[11] https://www.glendalerumorpage.com/grayson-public-comment

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transition to a 100% clean grid. Figure 21 illustrates GWP's dispatch in the model when one of the transmission lines is out and when both lines are down.

Table 6: Generation from GWP local thermal generation resources during one week of normal operations, N-1 operations, and N-2 operations in September of 2030.

Resource	Normal Operations Generation (MWh)	N-1 Operations (loss of PDCI line) Generation (MWh)	N-2 Operations (loss of PDCI and 50% of STS) Generation (MWh)
Grayson 9	-	8	161
RICEs	14	273	1,388
Magnolia	15,910	16,270	17,301

During the first and second contingency events shown, local resources are called upon to continue serving customer load with less energy available through the transmission network. Without the proposed RICE units, GWP would have insufficient capacity and would be forced into an emergency load shedding event. As shown in the previous section, the RICE units and Grayson 9 have low-capacity factors, but this section shows their value as a capacity resource to enhance reliability.

7. Cost

GWP is undertaking the Limited Notice to Proceed Phase, including environmental reviews, permitting, and engineering, as part of a proposal to upgrade its system by replacing Grayson Units 1-8 and adding more flexible resources like batteries and fast ramping gas. If Glendale moves forward with the proposal, the result would be a cleaner and more reliable system for the residents of Glendale.

Total estimated portfolio costs for the plan analyzed in this study are shown in Figure 20. The cost rises from $90 million in 2022 to $150 million in 2030, an increase of $60 million. Dividing this amount by the reduction in carbon emissions achieved (151,000 tons) leads to a cost of $397 per ton of carbon avoided. There is considerable uncertainty in this calculation from the stochastics used in the model. A ninety percent confidence interval around the 2030 supply cost is $143 million to $155 million.

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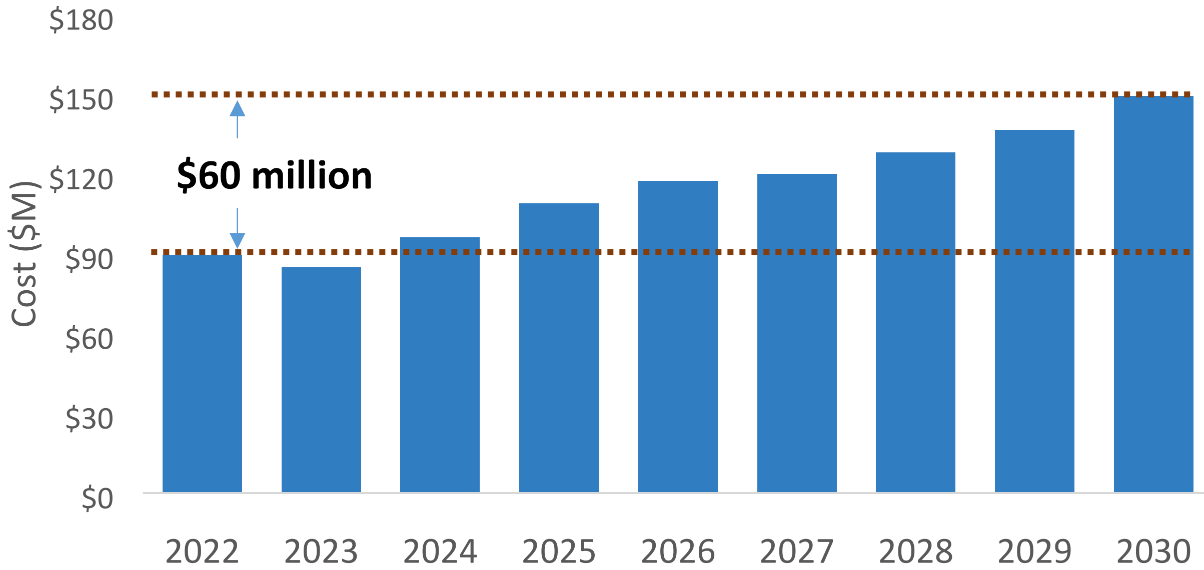
Figure 20: Economic breakdown of supply costs by year



GWP's annual load is projected to rise to 1,451 million kWh in 2030. Therefore, the projected cost increase results in an additional revenue requirement of 4.1 cents per kWh. Customers in GWP would see a monthly electric bill increase of roughly $24 per month ($285 per year)[12]. Another way to look at the cost increase is to consider the overall system cost. The 2019 IRP included a cost-of-service study showing an annual revenue requirement of $214,767,143.[13] Adding $60 million to this figure would amount to an overall average increase of 28% to customer bills. Considering the full range of uncertainty in the cost, we can estimate that customer bills would increase somewhere between 25% and 31%.

It should be stressed that this high-level estimate is not based on a detailed cost-of-service study and used broad assumptions for future costs of hypothetical resources. If GWP elected to adopt this path forward, they would conduct a detailed analysis of all system costs to determine the full effect on rates.

8. The Path to 100% Clean

Glendale has demonstrated a strong commitment to taking bold local action to combat climate change. In doing so, it has pushed GWP to reduce carbon emissions to the greatest extent possible by 2030. In our estimate, given the challenges laid out in this report, GWP can realistically achieve a portfolio that provides enough clean energy to serve 89% of retail load by 2030. This number could increase if GWP would be able to increase transmission capacity and build additional renewable energy locally. Unfortunately, at this point, this outcome does not seem feasible.

Due to severe land constraints and a lack of transmission availability, GWP is limited on the amount of clean energy to its portfolio. As a result of the Clean Energy RFP, Sunrun is expected to install 34 MW of local residential rooftop solar which is likely the maximum amount of cost-effective rooftop solar available. Ascend

[12] The calculation assumes an average California household uses 6900 kWh annually (575 kWh monthly) (Household Energy Use CA (eia.gov))

[13] See page 83 in Chapter 11 of the GWP 2019 Integrated Resource Plan

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estimated that battery capacity greater than 75 MW (with the 167 SWAC capacity) would be wasted in GWP because it would not have adequate energy to charge. Maximizing the local capacity of solar and battery resources brings GWP further along the path to 100% clean energy, but it will need to rely on remote resources as well.

Therefore, Ascend added solar hybrid and wind plants on the remote side of the SWAC and PDCI lines. The amounts added were limited by the available transmission capacity procured by GWP. If GWP were able to obtain additional transmission capacity, they could add more renewables on these lines. As it is now, GWP does not have enough import capacity to deliver clean energy around the clock. Chapter 5 showed curtailments on the order of 25% for renewables. Transmission constraints are the bottleneck when it comes to delivering clean energy to Glendale, or even transporting clean energy to trading hubs, over the SWAC or PDCI lines.

The cost of carbon abatement grows exponentially higher as GWP moves up the carbon curve, getting closer to 100% clean energy. Under this model, Glendale would serve 89% of their customer load with clean energy by the end of the decade. Achieving 100% requires increased access to transmission and/or the ability to run local generation (Grayson RICE units, Magnolia) on renewable fuels such as green hydrogen or renewable natural gas. Between now and 2045, technical change will likely make the road to 100% Clean more feasible. However, it is unlikely, albeit not impossible, that technological advances would occur prior to 2030 that would allow GWP to move to 100% Clean without additional transmission. We recommend revisiting this analysis later to assess the state of technological development and the impact it has on new clean energy technology options.

Currently, the state of renewable fuel for power generation is still in development and has not reached full commercialization. The same is true for hydrogen use as a fuel in power plants. However, there is considerable work towards the commercial development of both alternatives so that future natural gas plant such as RICE units and combined cycle units (like Magnolia). As mentioned earlier in this report, the IPP replacement is expected to be a combined-cycle natural gas power plant that will use a mixture of natural gas and green hydrogen. Green hydrogen is made via an electrolysis process powered directly from wind or solar energy. Initially, the plan is to use a ratio of 30% hydrogen and 70% natural by volume. This equates to roughly a 10% hydrogen and 90% natural gas ration by energy supplied to the plant. Over time, the ration is expected to change to a higher percentage of hydrogen, reaching 100% by 2045.

9. Conclusions and Recommendations

GWP partnered with Ascend Analytics to evaluate the possibility of serving 100% of customer load with clean energy by 2030. As described in this study, Ascend found that achieving 100% clean energy around-the-clock by 2030 is unlikely. The primary reason for this finding is the fact that GWP has very limited options to add resources. Locally, there is not adequate land for constructing sufficient new resources, and any resources built outside of Glendale will face transmission bottlenecks.

GWP can realistically serve 89% of their customer load with clean energy by 2030. In doing so they would generate enough clean energy to match nearly all customer load. However, due to transmission constraints, GWP cannot deliver all the clean energy needed to serve customers in the proposed portfolio.

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GWP’s 2019 IRP laid out a far-reaching plan that shows it is serious about decarbonization efforts. If GWP were to follow the plan laid out in this report, and assuming the best-case-scenario assumptions modeled in this report are accurate, they would be a leader among utilities nationally. California has an aggressive mandate to serve retail load with 100% clean energy by 2045. GWP is undertaking efforts to meet this target ahead of schedule, going to 89% by 2030 would be extremely progressive, even for California. To reach 100% clean energy, technological advancements will be necessary.

When GWP reaches a point where they can serve customer load fully with clean energy, firm capacity will be more important than ever. That is why GWP will need to procure the proposed 93 MW of reciprocating internal combustion engines identified in the most recent integrated resource plan. These assets will provide reserve capacity in the rare event that GWP needs it to keep the lights on during a contingency. Conversion from natural gas to a clean fuel, such as renewable gas or green hydrogen, is a potential future upgrade that would allow GWP to run the RICE units as an energy resource instead of relying on them purely for the capacity value. Local generation that is clean and dispatchable will be a valuable resource for GWP to achieve 100% clean energy.

Aside from the significant carbon savings, GWP will also benefit from lower emissions of criteria pollutants, providing a significant benefit for disadvantaged communities. Given that most of the clean energy resources are proposed to replace Grayson Units 1-8, most of the benefit will be in Glendale. After the IPP coal retirement, there will be a significant drop in emission at the IPP site in Utah as well. The future IPP replacement will determine the extent of the emissions drop. Current plans for the IPP replacement involve a natural gas combined-cycle plant capable of running partially on hydrogen fuel with a plan to transition fully to hydrogen fuel later.

By acting aggressively now, GWP will be well positioned to adapt to the energy transition with adequate resources to serve customers in an environmentally responsible manner. As technology changes, GWP will likely be able to take advantage of additional clean resources through fuel conversions in their thermal assets which will put GWP in a position to meet all energy needs with clean sources.