2023 Power Supply Roadmap

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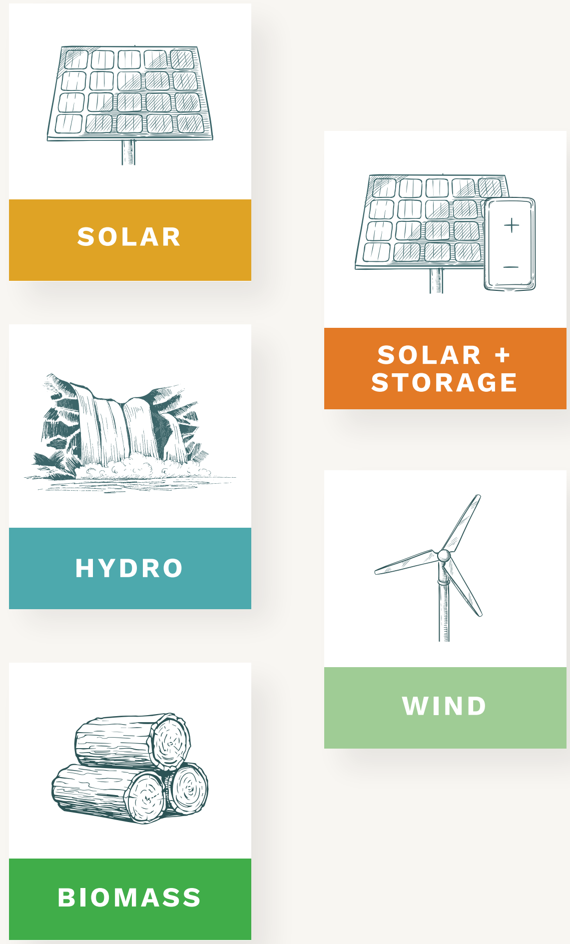
Executive Summary

Founded in 1939, Holy Cross Energy (HCE) is a not-for-profit rural electric co-op providing safe, reliable, affordable, and sustainable energy and services that improve the quality of life for HCE members in western Colorado. HCE serves over 45,000 members and maintains over 62,000 meters. Peak demand on the HCE system is approximately 260 megawatts (MW).



HCE’s 100×30 Goal is to provide members with 100% clean energy by 2030, and to achieve net-zero greenhouse gas emissions by 2035. To meet the clean energy goal by 2030, HCE must partner with members and communities to incorporate new, clean, dispatchable resources into HCE’s power supply mix.

In 2022, HCE had 53 MW of on-system renewable generation in its portfolio, which contributed to 50% renewable energy annually for HCE. By the end of 2024, HCE expects to have 77 MW of on-system and 180 MW of off-system renewable generation in its portfolio, which, combined with other wholesale renewable energy purchases will contribute to approximately 90% renewable energy on an annual basis. HCE is in the midst of an energy supply transition towards clean and low-cost renewable energy.

Load and Generation Modeling and Forecasting

This resource plan utilized stochastic weather modelling to produce correlated weather, load, and resource generation across one thousand individual simulations. This produced a weather normalized load growth base case of approximately 1% annual load growth.

HCE expects to begin experiencing oversupply conditions during certain months and days in 2024, when HCE will have more renewable generation in a given hour than load to serve. Renewable oversupply is most likely to occur during spring and fall months and during solar production hours. This is a necessary occurrence and byproduct of working towards HCE’s 100x30 Goal. Starting in 2024, the remaining space for additional renewable content is largely during non-solar hours and in the winter.

Importantly, there is greater uncertainty of percent renewable content amounts in future years because future load is more uncertain and annual renewable production is inherently variable. Higher than expected load growth between 2025 and 2030 would mean lower percent renewable amounts. As a result, there is a tradeoff between gaining greater amounts of percent renewable content and incurring larger oversupply costs.

Resource Plan

This document serves as HCE's resource plan for the development and management of new and existing resources. The analysis in this resource plan suggests that new generation needs to be flexible to mitigate oversupply. In addition, there is a preference for new resources to be on-system, which bring both energy and capacity benefits to HCE. The modeling in this resource plan and analysis of HCE's contractual landscape leads to the following needs from the next procurement cycle.

HCE's forecasted net load is highest during the winter months, particularly December and January. This resource plan recommends exploring seasonal contracts for up to 60,000 MWh of any renewable resource type between the November and February winter months to increase renewable content seasonally during this time.

Utility-scale solar is the best fit generation type for new on-system resources. Utility-scale wind is infeasible given on-system locational constraints, new hydro development opportunities are limited, and hydrogen resources are currently cost prohibitive. The preferred utility-scale solar volume to seek in the next Request for Proposals (RFP) is 10-15 MW of solar nameplate capacity, likely spread between multiple project locations. Amounts beyond this level incur too much renewable oversupply to be economic given current forecasts of load and generation.

New on-system solar generation should be paired with battery storage. The best fit storage duration is likely 3-4 hours of capacity. The cost of additional capacity beyond this duration generally outweighs the benefits, because: 1) shorter duration storage already captures the vast majority of the economic value to HCE based on peak capacity costs, 2) contracts are already in place for HCE's resource adequacy needs, 3) the value of oversupply mitigation beyond 4 hours is relatively low. Thus, the addition of longer duration storage technologies, for example, iron air batteries, is currently cost prohibitive given HCE's current landscape. HCE will continue to reevaluate this over time.

This resource plan recommends adding battery storage to the existing Pitkin Solar array. Adding storge at this location will help mitigate oversupply and provide capacity. This plan also recommends adding 3-6 MW of firm renewable energy and capacity to backfill a gap in HCE's WAPA allocation. Finally, using programs and rate design to create more flexible load will help with renewable integration, mitigation of oversupply, and manage capacity costs.

HCE will continue to monitor market and wholesale developments that could eventually improve the economics of longer duration storage, given HCE's contractual landscape. Nevertheless, for the time horizon of this road map to 2030, this analysis suggests the above recommendations to be the most economic and effective in HCE's journey toward 100x30.

Conclusion

With the currently contracted resources, HCE expects to have an approximately 90% renewable power supply by the end of 2024 on an annual basis. To work toward reaching the 100x30 Goal of 100% renewables on an annual basis, HCE will continue to selectively add new flexible renewable resources that help fill in the final gaps during non-solar hours and winter months of high load. Throughout this process HCE continues to first prioritize system reliability and overall costs to members.

Introduction and Background

Holy Cross Energy Background

Founded in 1939, Holy Cross Energy is a not-for-profit rural electric co-op providing safe, reliable, affordable, and sustainable energy and services that improve the quality of life for HCE members in western Colorado. HCE was built by a group of farmers in effort to bring electric services to rural areas. HCE belongs to the diverse communities and member-owners that HCE serves.

Vision—
Holy Cross Energy is leading the responsible transition to a clean energy future.

Mission—
Holy Cross Energy provides safe, reliable, affordable, and sustainable energy and services that improve the quality of life for our members and their communities.

Previous Seventy70Thirty Plan

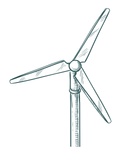
In 2018, HCE announced the adoption of its Seventy70Thirty plan, to use clean and renewable resources to supply at least 70% of the power provided to HCE members, and to reduce the greenhouse gas emissions associated with HCE's power supply by 70% from 2014 levels. In the following years as HCE worked to meet these goals, the Board of Directors decided to adopt a more ambitious goal of 100% clean energy by 2030, outlined below.

Current 100x30 Goal

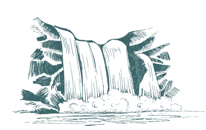
HCE's 100×30 Goal is to provide members with 100% clean energy by 2030, and to achieve net-zero greenhouse gas emissions by 2035. To meet the clean energy goal by 2030, HCE must partner with members and communities to incorporate new, clean, dispatchable resources into HCE's power supply mix.

There are several key focus areas to meet the 100x30 Goal:

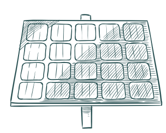
Energy Efficiency
Obtain an additional 0.25% per year of energy efficiency improvements.



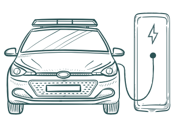
Cleaner Wholesale Power
Incorporate new, clean, dispatchable resources into HCE's power supply mix.



Local Clean Energy Resources
Continue HCE's existing agreements for energy from local biomass, hydro, solar, and wind.



Distributed Energy Resources
5 MW of distributed energy resources, including rooftop solar, distributed local solar arrays, & energy storage.



Smart Electrification
Encourage the expanded use of electricity for transportation, building heating and cooling, and industrial processes.

Regulatory and Planning Landscape

Clean Energy Plan Guidance and Emissions Verification

Pursuant to the requirements established by Senate Bill 19-236 and House Bill 21-1266, Holy Cross Energy filed a Clean Energy Plan in 2022. Under the guidelines approved by the Colorado Air Quality Control Commission (AQCC), the plan established a path to achieve 99% percent reduction in 2030 green gas emissions associated with retail sales from 2005 levels, above and beyond the 80% threshold for an acceptable plan. The plan was approved by the HCE board of directors, sent to the AQCC for verification, and approved by the Colorado Public Utilities Commission.

The framework that was used to develop the HCE Clean Energy Plan and the subsequent verification process is currently being used as HCE pursues its 100x30 Goal, including the handling of Renewable Energy Certificates (RECs) and greenhouse gas emissions reduction calculations.

HCE Contractual Landscape

In 1990, HCE entered into a Transmission Investment and Equalization Agreement (TIE) with Public Service Company of Colorado (PSCO) that established an Integrated Transmission System, which pre-dates federal grid open access standards by several years. As a result, HCE and PSCO jointly pay for transmission investments across both the HCE and PSCO systems according to each utility's load ratio share. HCE receives access to the PSCO transmission system at no additional wheeling cost, and thus new resources sited on either the HCE or PSCO transmission systems are preferred.

In 1992, HCE entered into a Power Supply Agreement (PSA) with PSCO for both resource adequacy and energy supply. The PSA differs from typical all-requirements power supply agreements in that HCE obtained the option to secure energy from the wholesale marketplace with no percent limitations. In addition, HCE obtained a waiver from PSCO capacity purchase obligations under certain cases, including purchases from the Western Area Power Administration (WAPA) and from Qualifying Facilities (QFs) as defined under the Public Utilities Regulatory Policy Act of 1978 (PURPA).

Within the PSA, HCE has the option to make purchases of Economy Energy from off system resources. Importantly, for any resource located off the HCE system, HCE currently only receives energy value, not capacity value. HCE receives both energy and capacity value from on-system Qualifying Facilities, so long as the resource produces during peak hours each month.

In 2012, HCE took an 8% ownership stake in PSCO's newly built 750 MW Comanche 3 supercritical coal-fired power plant. Comanche 3 is currently scheduled to begin reducing operations and output in 2025, and again in 2027, before being retired at the end of 2030.

Additionally, HCE has entered into multiple wholesale electric purchase and sale agreements with Guzman Energy. These agreements were developed as a part of the HCE Board strategic goals. The wholesale contracts with Guzman provide for:

1. The sale of Comanche 3 energy, creating room in HCE's portfolio for additional replacement renewable resources.
2. The purchase of wholesale renewable energy, providing low-cost and price-stable energy.
3. The sale of excess renewable energy on a seasonally shaped basis, allowing HCE to integrate additional renewable resources when HCE needs them the most.

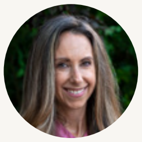
Finally, HCE has entered into multiple Power Purchase Agreements (PPA) for the direct purchase of renewable energy, as outlined further in this document.

HCE's Planning Requirements

HCE is governed by a member-elected Board of Directors consisting of seven active HCE members from specific geographical districts serving staggered three-year terms. HCE is not subject to the ratemaking or resource planning jurisdiction of the Colorado Public Utilities Commission because its members have elected to exempt HCE from such jurisdiction. As a result, HCE is not required to prepare an Integrated Resource Plan and is voluntarily publishing this report to share with members and stakeholders, and to provide transparency.

2023-2024 Board of Directors

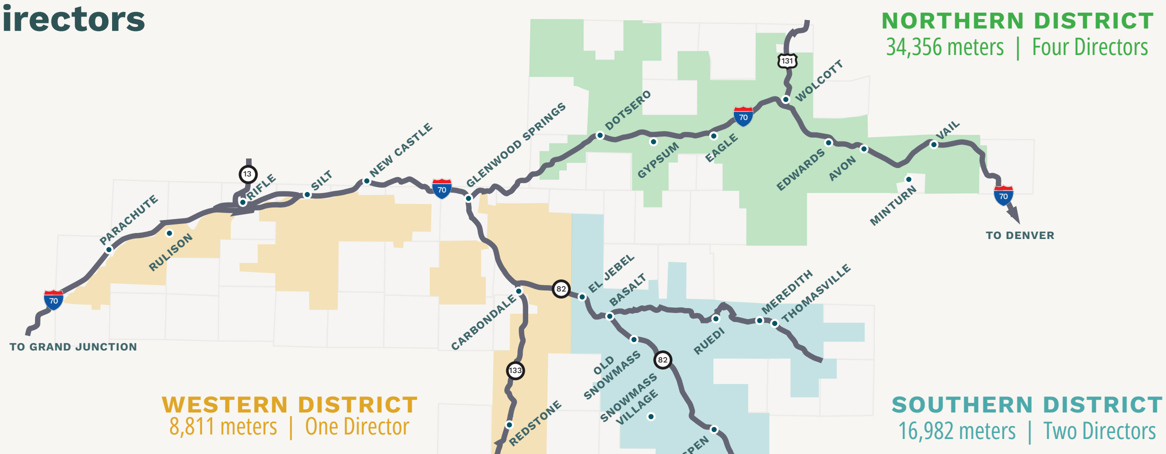
Keith Klesner, Director
Hometown: Eagle
Current Term: 2021-2024



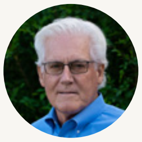
Kristen Bertuglia, Vice Chair
Hometown: Edwards
Current Term: 2021-2025

Adam Quinton, Treasurer
Hometown: Edwards
Current Term: 2022-2026

Linn Brooks, Director
Hometown: Avon
Current Term: 2023-2027



Alex Degolia, Secretary
Hometown: Carbondale
Current Term: 2023-2027



Robert H. Gardner, Director
Hometown: Basalt
Current Term: 2021-2025

Dave Munk, Chair
Hometown: Carbondale
Current Term: 2022-2026

Current Resource Portfolio

Existing and Contracted Resources

HCE's current and contracted portfolio includes a diverse mix of renewable and zero-carbon emission resources, as well as battery storage, outlined in Table 1.

Table 1. HCE Current and Contracted Resources

Name	Resource Type	Size	Location	COD	Status
Net Metered Solar	**Solar**	23 MW	*Multiple*	*Multiple*	Online
Generation Tariff Hydro	**Hydro**	0.3 MW	*Multiple*	*Multiple*	Online
Generation Tariff Solar	**Solar**	1.6 MW	*Multiple*	*Multiple*	Online
Community Solar Arrays	**Solar**	8.5 MW	*Multiple*	*Multiple*	Online
Eagle Springs Solar	**Solar**	1 MW	Silt	2012	Online
Eagle Valley Clean Energy	**Biomass**	12 MW	Gypsum	2013	Online
Pitkin County Solar	**Solar**	5 MW	Aspen	2021	Online
Grand Valley Hydro	**Hydro**	4.9 MW	Palisade	2023	Online
CMC Solar	**Solar+BESS**	4.5 MW PV 5 MW/15 MWh BESS	Glenwood Springs	2023	Online
Bronco Plains II Wind	**Wind**	150 MW winter 100 MW summer	Kit Carson County	2023	In Development
Hunter Solar	**Solar**	30 MW	Arapahoe County	2023	In Development
High Mesa Solar	**Solar+BESS**	10 MW PV 10 MW/20 MWh BESS	Parachute	2023	In Development
Mamm Creek Solar	**Solar+BESS**	10 MW PV 10 MW/20 MWh BESS	Rifle	2024	In Development

Existing Programs

HCE's programs support local generation, electrification, and demand flexibility. These programs represent a valuable tool in HCE's portfolio to encourage load growth in strategic hours of the day, reduce peak costs, and add operational flexibility. Existing programs are outlined in Table 2 below.

Table 2. Existing HCE Programs

Program	Enrolled Energy/ Capacity in 2022	Overview	Status
Peak Time Payback	2 MW	Voluntary demand response	Full Implementation
Power+	2.73 MW	Behind-the-meter battery dispatch	Full Implementation
Net Meter Renewable Generation	23 MW	Rebates for local renewable development	Full Implementation
IQ Sustainable Solar	354 MWh	Income-qualified members eligible to receive share of production	Full Implementation
Generation Tariff	2,305 MWh	Solar or hydro generation exceeding net-meter limit	Full Implementation
Beneficial Electrification	3,071 MWh	Rebates for electrification	Full Implementation
Energy Efficiency	686 MWh	Rebates for energy efficiency	Full Implementation

POWER+ MEMBER – REDSTONE, COLORADO

Current Renewable Content and GHG

As a result of the most recent RFP, HCE is actively bringing online new renewable resources. In 2022, HCE provided members with 50% renewable energy. By the end of 2023 HCE will benefit from an additional 150 MW of seasonal wind and 44.5 MW of solar, with an additional 10 MW of solar reaching commercial operation between 2024-2025. By the end of 2024, the power supply mix is forecasted to exceed 90% renewable. See Figures 1 and 2 for changes in resource mix from 2022 to 2025.

Figure 1

2022 Energy by Fuel

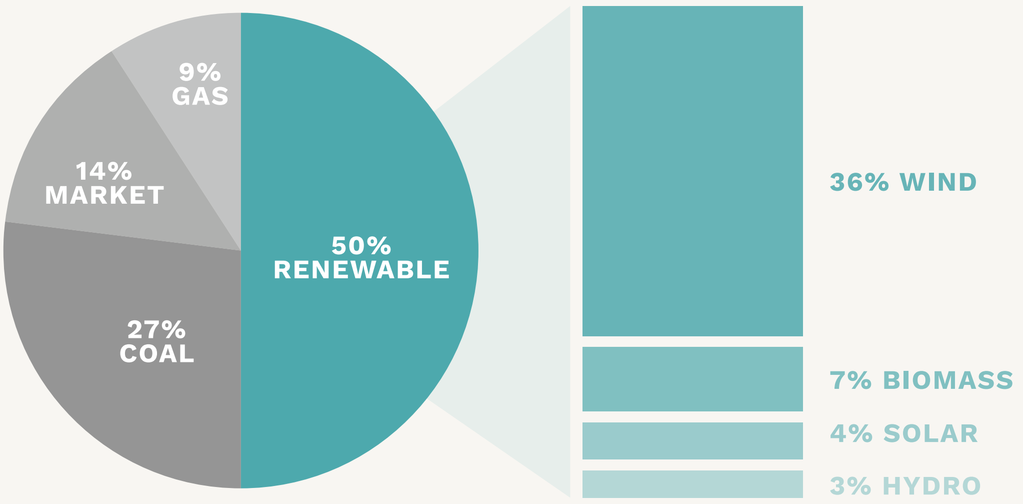
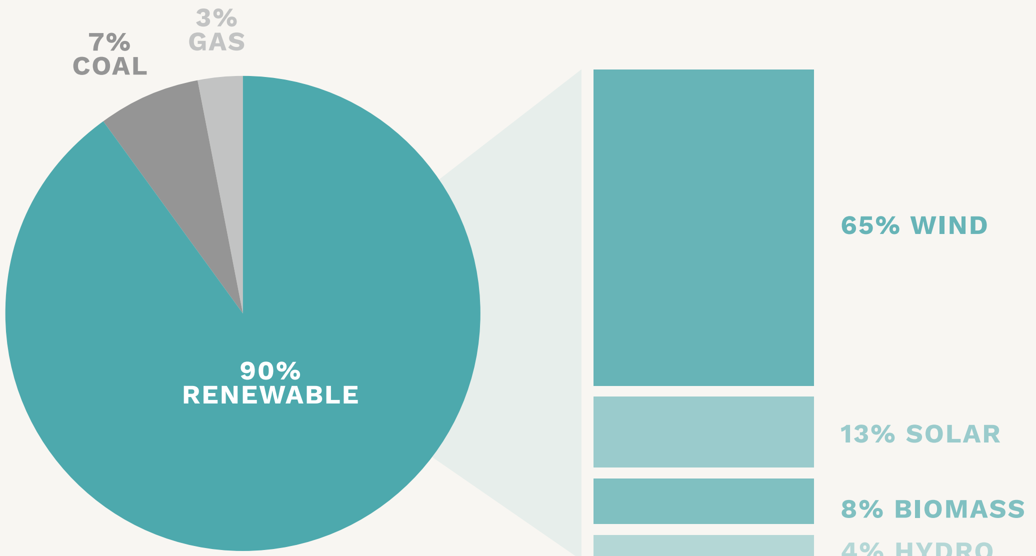


Figure 2

FORECASTED

2025 Energy by Fuel



The remaining non-renewable energy in the HCE power supply mix in 2025 is related to wholesale purchases from Public Service Company of Colorado (Xcel Energy). With HCE's currently contracted resources and because of Xcel's Clean Energy Plan (80% renewable in 2030), HCE expects to reach between 95% and 100% renewable energy in the year 2030.

Long-Term Load Modeling

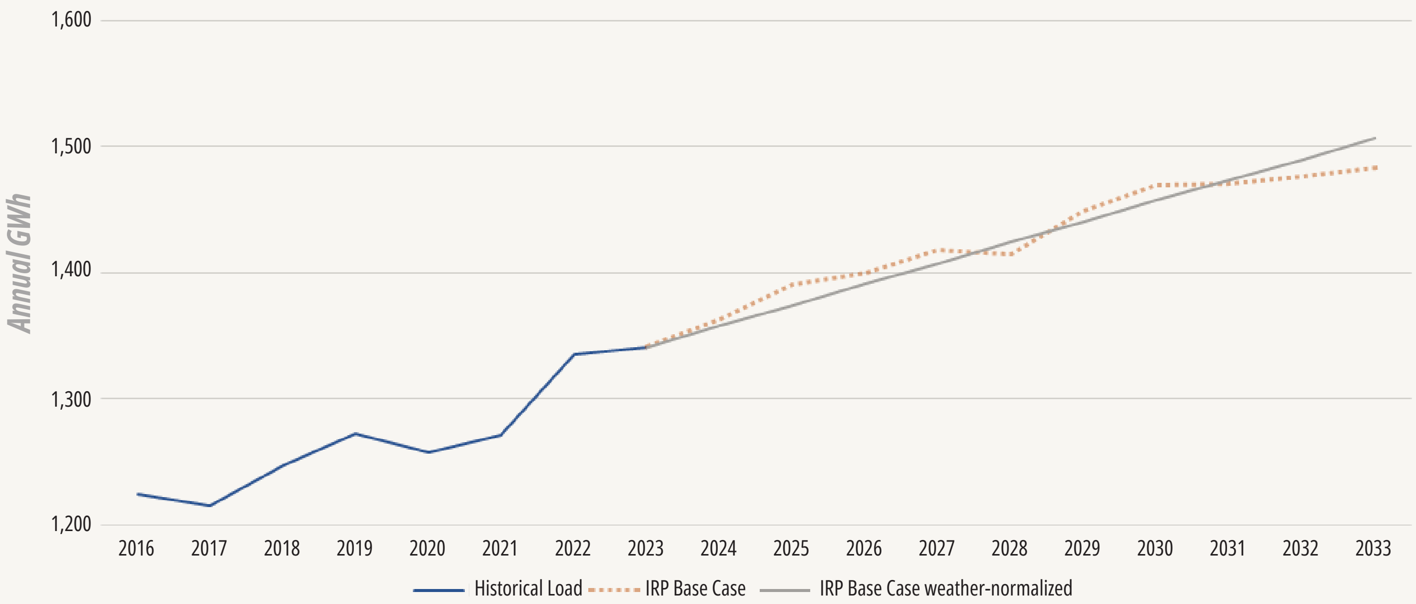
Planning Horizon and Load Modeling

The planning horizon of this resource plan is 10 years, from 2024 to 2033. Importantly, HCE's full requirements contract with PSCO provides for resource adequacy needs through 2042. As a result, HCE's resource planning focuses on the addition of new renewable resources to lower power supply costs and reach the 100x30 Goal, with a focus on load growth, resource output, and resulting hourly net demand and oversupply positions.

To improve HCE's forecasting of load and net demand, stochastic weather modelling was used to produce correlated weather, load, and resource generation across 1,000 individual simulations. Location specific historical load data across the HCE service territory was incorporated into the model, isolating large loads and applying machine learning to hourly load shapes. This produced more statistically relevant hourly outputs for variations in future weather as load continues to change. This hourly modelling is of particular value for resource planning as it allows for a more accurate representation of the fluctuations in electricity supply and demand throughout the day and can incorporate separate growth rates across different hours.

Additional factors such as electric vehicles (EVs), net metered generation, and energy efficiency (EE) were considered separately from the gross load model to allow for isolating those variables and allow precise assumptions. HCE weather normalized loads have experienced approximately 1% annual growth over the past decade and the hourly growth profile was scaled to this level, as seen in Figure 3 showing base case load.

Figure 3 - HCE Load Growth - Total System



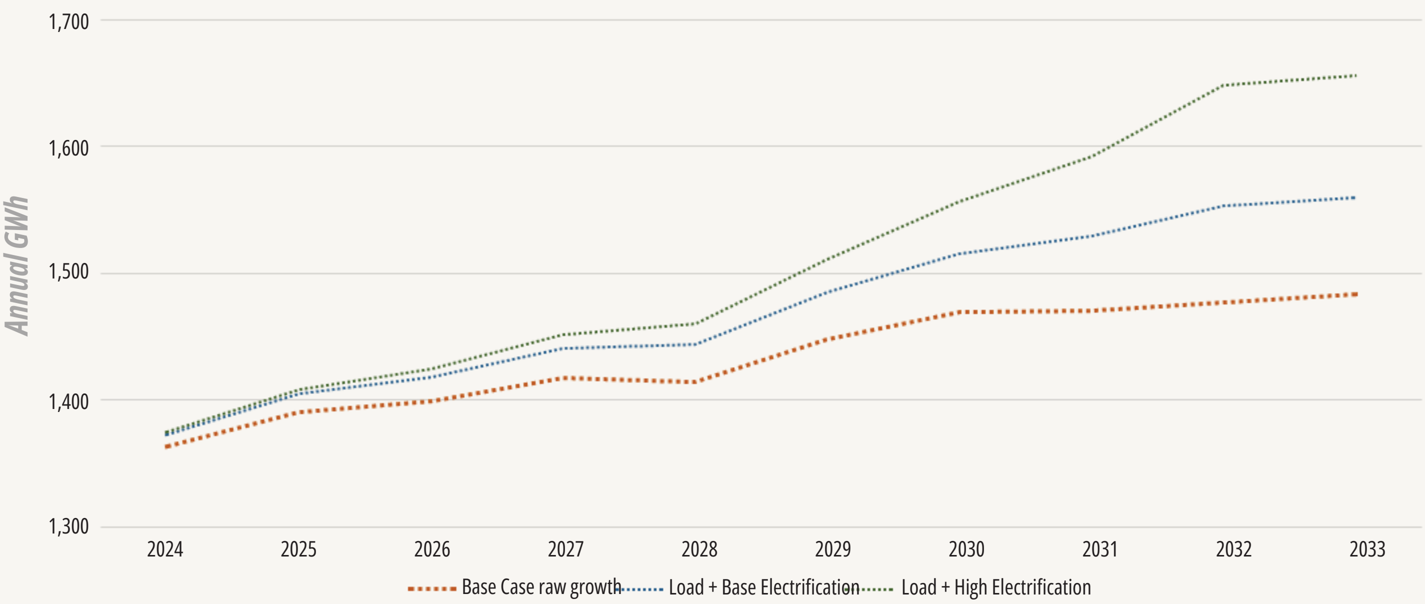
The variability between years in this base case model results from the correlation to weather differences across years in the simulation runs. While it is unknown if 2028 will be a lower load year for example, this variability provides HCE with a realistic baseline for diurnal, daily, seasonal, and annual variability - a crucial but sometimes overlooked factor in planning decisions. Moreover, this interaction reflects the everyday, real-life challenge HCE faces in managing supply and demand on behalf of its members.

Additional Load Modeling Considerations

Energy efficiency for the HCE system is forecasted at 0.25% of sales per year, in alignment with HCE's EE goals that are accomplished through direct incentives paid to residential and commercial members. HCE has an expectation of adding distributed solar PV system deployments at a rate of 2 MW/year. Modelling for this Roadmap assumes continued increases in installed capacity at that rate. A forecast of behind the meter energy storage based on a historical dispatch of existing HCE controlled generation was also incorporated, impacting the final hourly load and monthly capacity forecast. There is currently 3 MW of distributed storage on the HCE system participating in the Power+ program, with a projected total 10 MW of available capacity by 2030.

HCE utilized Colorado Energy Office (CEO) EV studies and reports to identify most likely adoption scenarios and scaled existing EV charging loads in the HCE service territory accordingly. Total electrification scenarios evaluated by HCE are shown in Figure 4, with raw load growth in the base case, a high electrification scenario, and the chosen base electrification. Evaluation of electrification trends will continue in the years to come and inform future renewable energy procurement and programs. Final load outputs were also compared to work from RMI on electrification in the HCE service territory, and final load figures were found to be similar for the planning period through 2033.

Figure 4 - Electrification Scenarios



Load Risk and Uncertainty Analysis

Gross load variability has historically been driven by predictable behavioral patterns, for example people cooking dinner in the evening, as well as weather-driven patterns like AC drawing more load on hotter days. HCE's winter load is particularly sensitive to weather, as resort snowmaking requires specific cold weather conditions, and resort visitation fluctuates based on snow conditions. There are emerging dynamics that are critical to incorporate into load modeling. Rapid behind-the-meter generation adoption is shifting hourly load patterns, as well as reducing mid-day load while increasing variability. HCE has over 35 MW of distributed solar on system and heavy clouding can lead to a significant jump in midday load.

The increased likelihood of extreme weather events adds to the uncertainty around load growth and load variability. Additionally, the changing climate impacts member consumption patterns, from electrification of vehicles to households purchasing AC or heat pumps for the first time. The gross load simulations summarized in Figure 5 capture weather and climate driven uncertainty, not just based on historical weather averages, but possible extreme future weather events such as significantly warmer summers or sustained cold weather events like winter storm Uri. This underscores that HCE's renewable percentage will fluctuate between years based on the impact of weather variability on load. HCE would need to procure tens of thousands more renewable MWh to be 100% renewable across all weather scenarios, rather than 100% renewable on average.

Figure 5 - Distribution of simulated annual gross load, mean and percentile – 2025-2030.

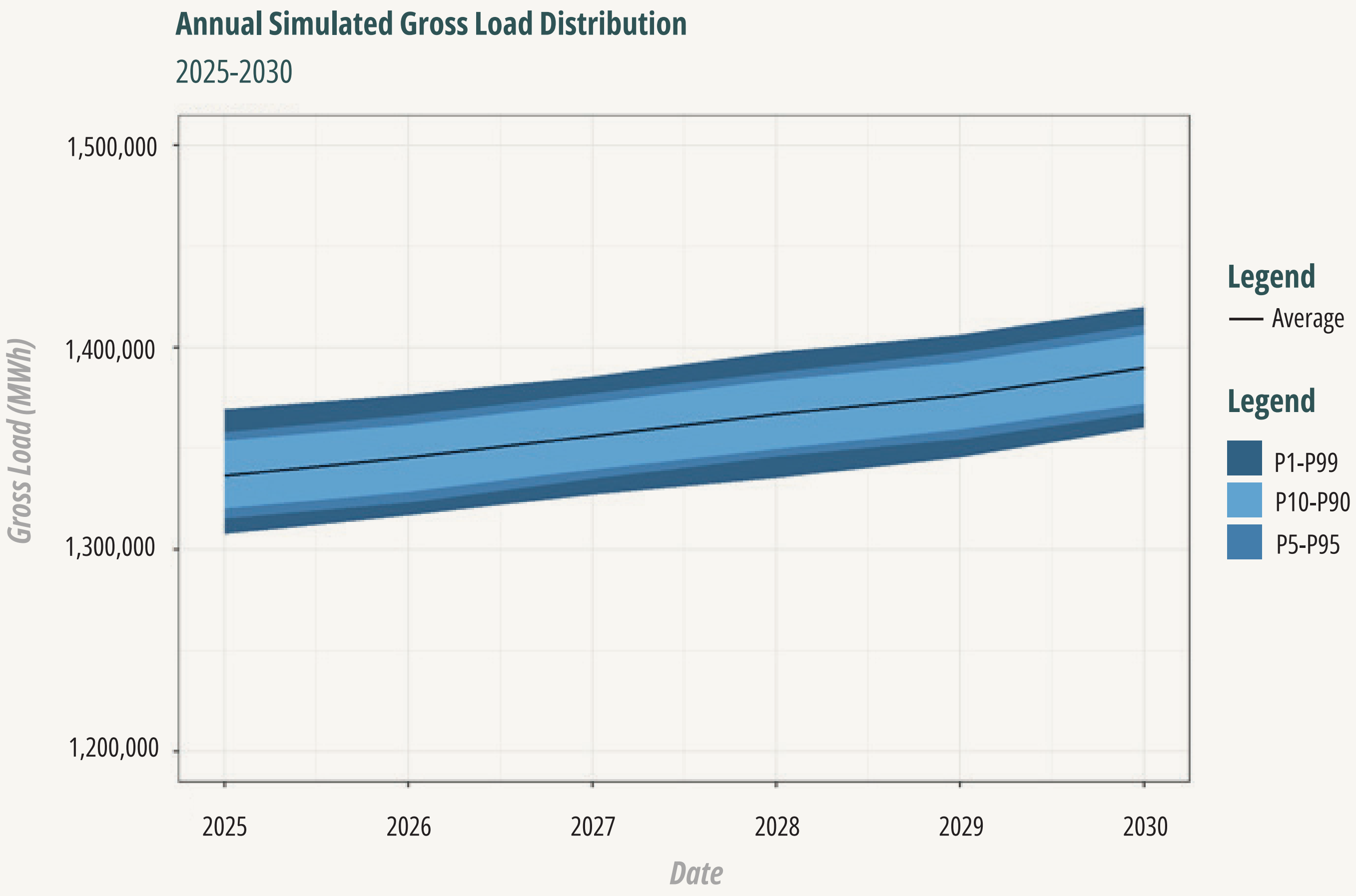
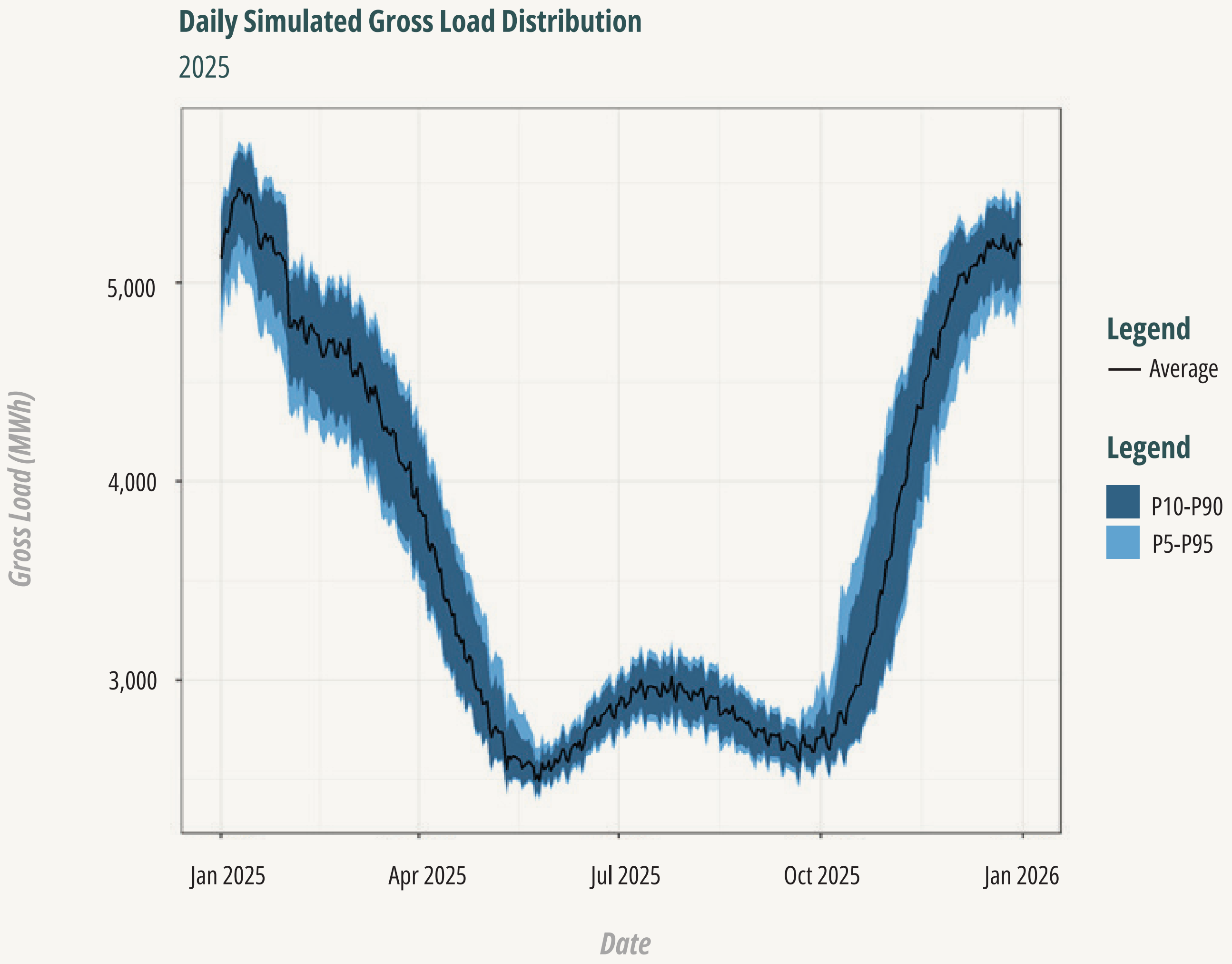


Figure 6 of daily gross load for a single year illustrates the level of uncertainty there is in load during specific seasons. For example, in addition to the rapid decrease in load during the spring, the timing of the decrease exhibits significant uncertainty – if resort snowpack stays good well into the spring, it can keep loads elevated, and vice versa.

Furthermore, because cold weather and weather-dependent resort activities are a critical determinant of winter load, gross load is particularly uncertain during the winter. This requires careful planning to identify additions to HCE's renewable portfolio that match seasonal uncertainties in load without contributing too much to oversupply. The plot highlights the importance of procurement strategies that can be robust across a range of different seasonal weather patterns, for example asset flexibility.

Figure 6 - Distribution of simulated daily gross load, mean and percentile – 2025



Generation and Net Load Analysis

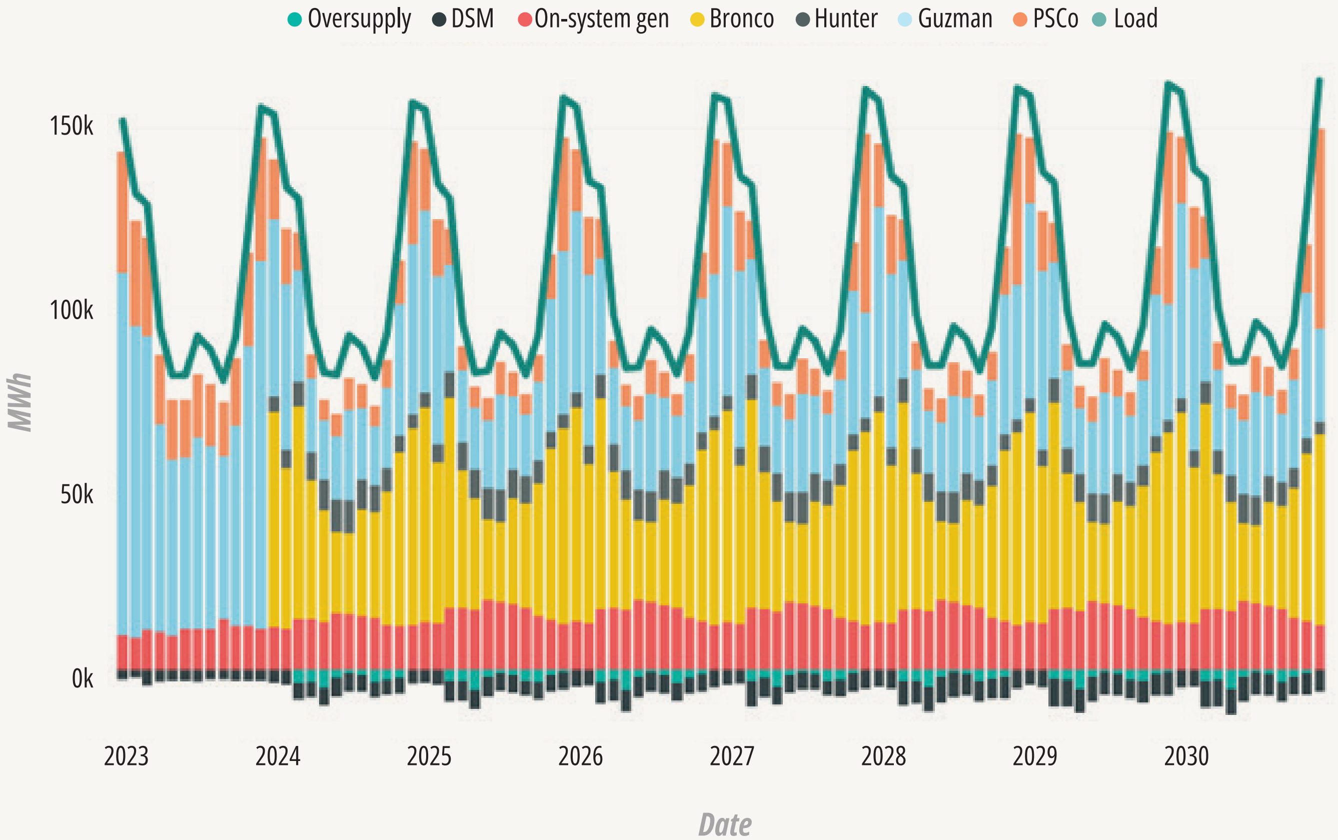
Generation Modeling and Uncertainty

To establish a base case for generation modelling, outputs for each utility scale resource that corresponded with the weather simulations in the base case load model were incorporated. By maintaining alignment in weather conditions between simulated hourly weather, this allows for analysis of expected performance of generation assets in tandem with load in like conditions.

For example, it maintains high solar output and high wind output on days in May that will be sunny, breezy, and mild, thereby also producing lower HCE load. On the opposite end of the spectrum, for periods in the winter with heavy clouds, cold temperatures, and little wind, the model will concurrently maintain low wind and solar output alongside increased HCE load.

All resource adequacy needs are handled by PSCO, and any remaining hourly net load that is not served by direct renewable energy purchases will be covered by a combination of purchases from Guzman Energy and PSCO. So, while the lights will stay on for HCE members regardless of whether the wind blows or sun shines, aiming for maximum alignment with renewable resource generation and HCE load will produce the best outcomes for power supply costs and renewable portfolio optimization.

Figure 7 - Base Case Resource Model - Monthly Outputs

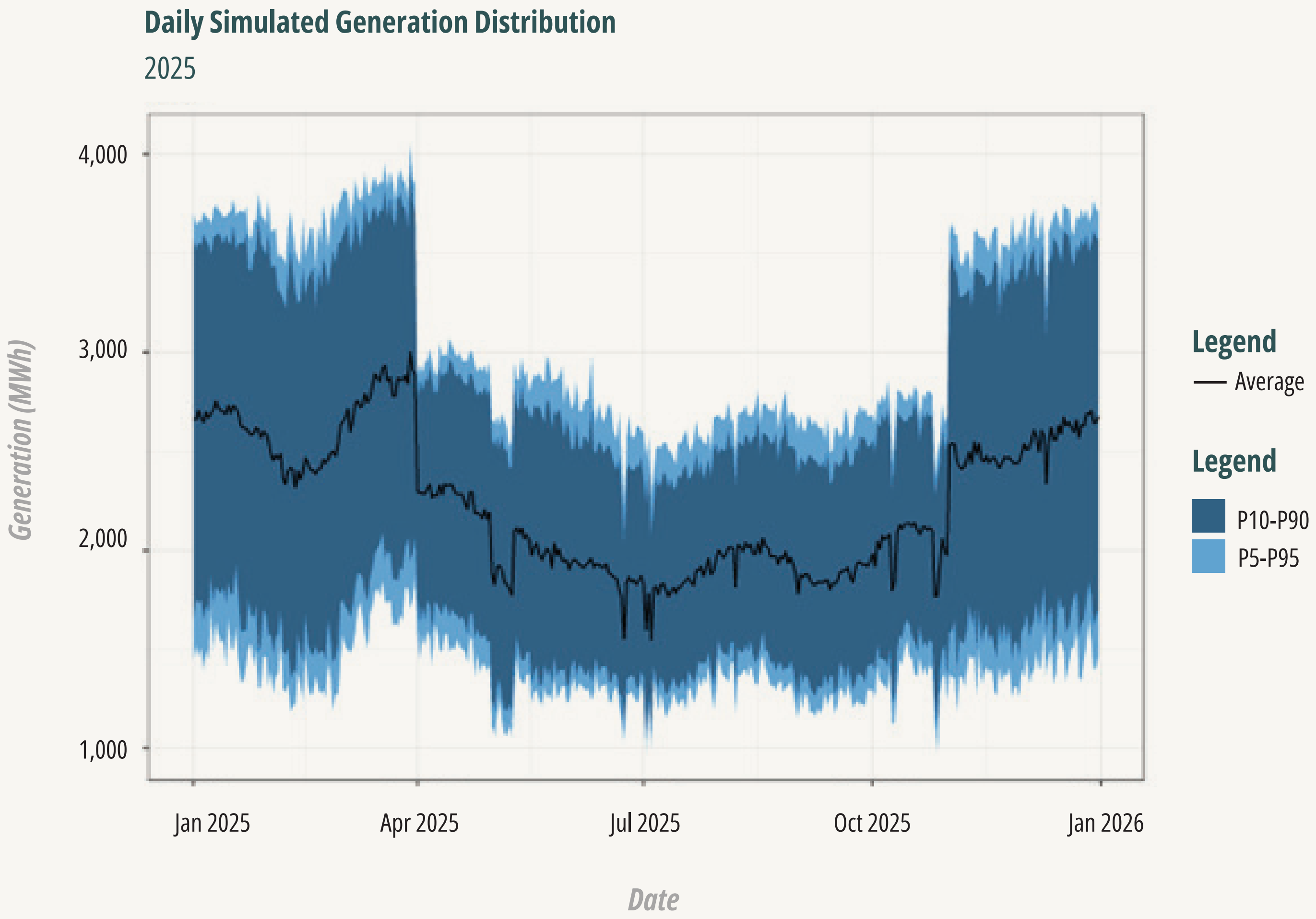


On a full portfolio basis, there is significant uncertainty in daily generation. Figure 8 of daily portfolio generation shows a notable decline at the beginning of April and a significant increase at the beginning of November as the volume of HCE's proportional purchase from the Bronco Plains II Wind project changes seasonally from 150 MW in winter to 100 MW in summer.

This seasonal shift is an essential tool to match renewable generation with HCE's winter peak. As HCE adds to its portfolio, other mechanisms that match HCE's strong seasonality in load will be critical for managing oversupply.

Furthermore, strategies to manage the significant variability in daily generation, such as firm renewable resources, longer duration storage, and resource diversity, will help manage this uncertainty.

Figure 8 - Simulated daily total portfolio generation distribution, 2025 – summary statistics



Net Load Profile

As the HCE resource mix approaches 90% renewable energy, the need to balance adding new renewable generation with the challenge of renewable oversupply becomes more significant. Oversupply in this context means more renewable generation in a given hour than customer load to serve. HCE expects to begin experiencing renewable oversupply in 2024 during certain hours. Accordingly, HCE is increasingly focused on managing both peak demand and net demand, i.e demand minus renewables.

Stochastic modelling of load and generation produced a base case resource model, the outputs of which yielded the following insights:

- Positive net load increases over time as load grows and existing generation resources degrade.
- Despite purchasing an additional 50MW of wind in winter months, HCE has the most room for additional renewable generation in the winter.
    - HCE's net load is projected to be greater than 80,000 MWh in Jan. and Dec., and over 60,000 MWh in Feb. and Nov.
- Net load space is moderately uniform across all hours in a given year (see Figure 9)
    - Net load is lowest during solar midday solar hours and overnight low load/high wind hours
    - Evening and morning hours have the most opportunity to absorb more renewable generation

Figure 9 - Anual Net Load by Hour

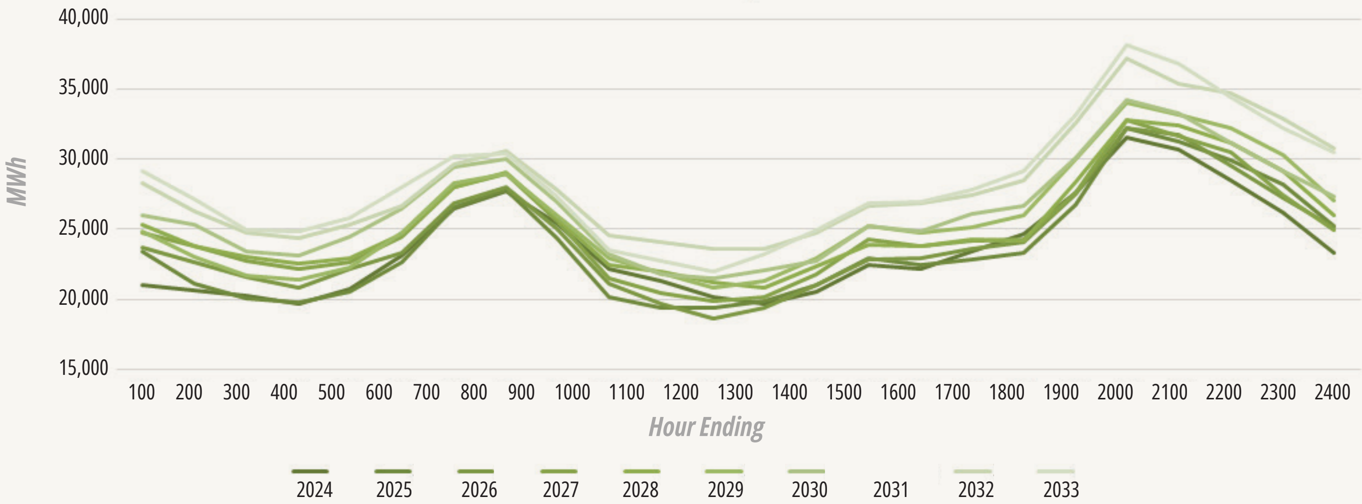
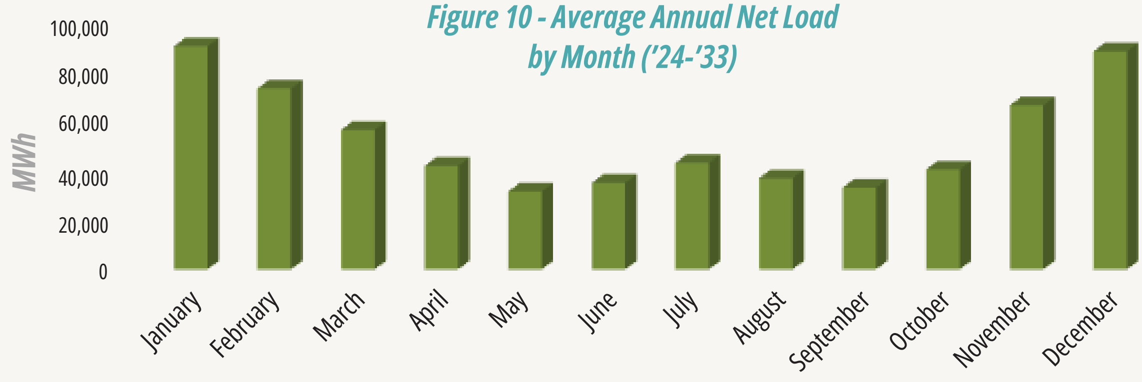


Figure 10 - Average Annual Net Load by Month ('24-'33)



Renewable Oversupply

During hours when HCE has more renewable generation than load to serve, producing renewable oversupply, HCE must either curtail or sell that energy at a loss. As a result, HCE is working hard to align generation profiles with load as much as possible to minimize the volume of oversupply and keep power supply costs low and predictable.

The outputs from the base case resource model provide the following insights:
- May produces the most oversupply of any month due to low loads and high solar generation (see Figure 11).
- June, September, and October also have high oversupply
- There is almost no oversupply risk in January and December with the current resource mix
- Peak solar hours produce the vast majority of renewable oversupply volume (see Figure 12).
- Oversupply shrinks over time as load grows and existing resources degrade.

Figure 11 - Average Annual Oversupply by Month ('24-'33)

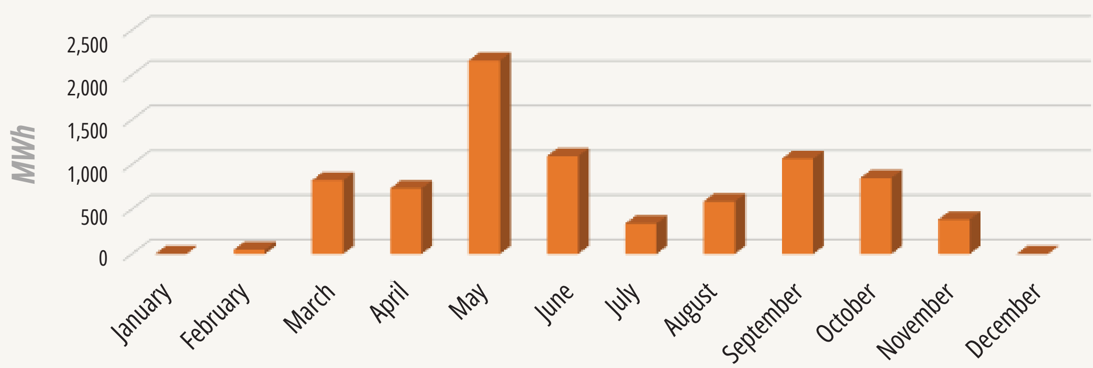
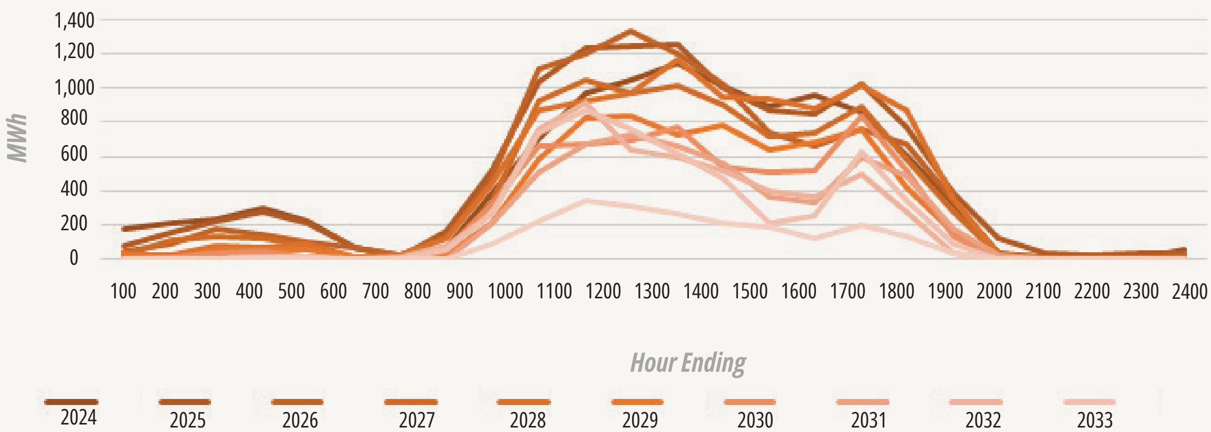


Figure 12 - Annual Oversupply by Hour



To further illustrate the correlation between oversupply and solar generation, Figure 13 shows a P50 predicted hourly profile during a single day, May 19th, 2024, from the base case hourly resource model.

Figure 13 - Forecasted Load and Generation from Base Case Resource Model
May 19, 2024

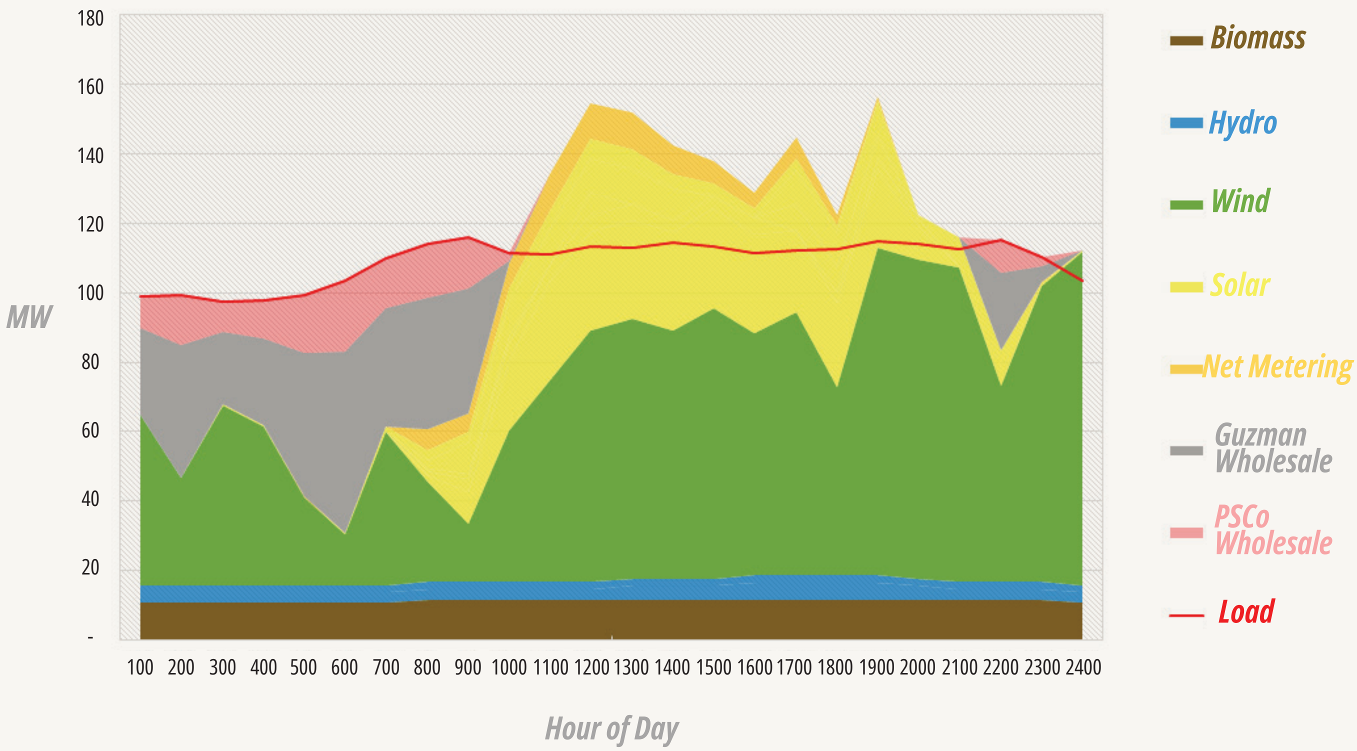


Figure 13 above shows the dispatch of the solar + storage resources, with charging occurring between hours 1100 and 1600, stopping once the batteries are fully charged for hour 1700, then discharging for the peak hours. This dispatch alleviates oversupply volume on this day but does not eliminate it. As such, with this high penetration of existing solar generation, any added PV resources will invariably add to the oversupply issue for HCE but will be less problematic if that generation is paired with storage.

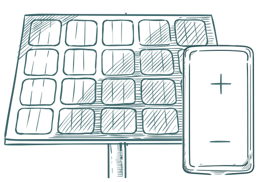
Generation Risk and Uncertainly

In addition to scenario analysis, assessing the uncertainty characteristics of HCE's current loads and resource portfolio across all portfolio simulations highlights hour by hour net load variability. As wind and solar make up a higher proportion of HCE's supply stack, weather becomes an even more important factor in net load variability. A drop in wind speeds or heavy clouding at PV facilities could cause a jump in net load.

While HCE is well hedged for managing oversupply and positive net load, oversupply represents an additional cost to HCE's procurement strategy. As a result, resource decisions should consider the tradeoffs between resource cost, whether the resource satisfies additional HCE load obligations, and how much additional oversupply the new resource would cause. Because wind and solar represent a significant proportion of HCE's contracted resources, resource decisions should take into account the uncertainty profile of new resources, and how those fit into the existing supply stack.

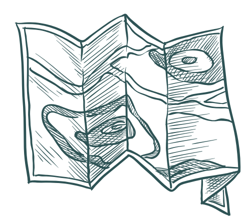
It is also important for HCE to consider the significantly lower winter capacity factor of solar, when average production falls by around half from mid-summer to December and January, which is the opposite of HCE's current net load position. As a result, while standalone PV can provide low-cost power, it's more likely to cause oversupply than other resources, while being less likely to serve load in the winter where HCE has the largest need for new generation. Thus, it is particularly important for any new solar to be paired with storage.

The following steps could help manage portfolio uncertainty in future resource decisions:



Pair new variable renewable resources with battery storage, and add battery storage to standalone sites, to give HCE the operational flexibility to shift energy away from likely oversupply hours to serve load.

Consider program development that increases HCE's operational flexibility to add load during potential oversupply hours, particularly in the summer.



Consider geographic diversity in new resource decisions. Geographic diversity leverages different weather conditions to mitigate risk and oversupply.

Resource Need Assessment

Resource Need Overview

HCE is fortunate to have flexibility in its all-requirements wholesale contract that provides for self-supplied energy, both on and off system. Because HCE has contracted with PSCO for its resource adequacy needs, the focus of new procurement concerns strategies is to reduce wholesale power supply costs while increasing renewable content. By the end of 2024, HCE will be obtaining approximately 90% of its energy from renewable sources in an average weather year. Different weather years will decrease or increase this renewable percentage metric over the next decade.

Renewable Energy Needed for 100x30

As HCE works toward its 100x30 goal, most of the remaining space for renewable content is during non-solar hours and in winter. In addition, one of the important factors that has elements outside of HCE's control is load growth. If HCE has too much renewable generation - creating hours of oversupply, there are financial consequences. If HCE has too little renewable generation, this places HCE further away from its 100x30 Goal. There is a tradeoff here, to gain more certainty in reaching the 100x30 Goal, the more HCE will need to spend and incur in oversupply costs. Maintaining the optimal balance of renewable generation while minimizing excess is a difficult task. Throughout this process, HCE is committed to maintaining system reliability and keeping rates low.

Competitive All-Source Solicitation

HCE expects to issue its next all source Request for Proposals (RFP) in late 2023 or early 2024, with proposal deadlines and resource selection occurring subsequently in 2024. The RFP will build on the resource assessment outlined in this roadmap, it will solicit new generation and storage resources to further HCE's 100x30 Goal.

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New Resource Assessment

The following recommendations summarize the results of this roadmap and are designed to best meet HCE's goals. The recommendations represent a synthesis of the portfolio modeling work completed, contractual abilities and limitations, distribution system constraints, and HCE goals.

1. **Explore using programs and rate design to create more flexible load.** For example, shifting load to the middle of the day or times of oversupply. This is likely the most cost-effective tool for managing a 90+% renewable power supply, more so than adding new bulk system resources.

2. **Flexibility is needed in new resources to mitigate oversupply.**

3. **New on system resources are advantageous, because HCE can absorb both energy and capacity benefits.**

4. **Seasonal contracts or swaps should be explored to buy up to 60,000 MWh of additional renewable energy in the winter, especially for the months of December and January.**

5. **Solar paired with battery storage is the preferred on-system resource type for new generation.** Solar best serves location specific on-system load and is the lowest-cost flexible resource. Utility-scale wind is infeasible given on-system locational constraints, new hydro development opportunities are limited, and hydrogen resources are currently cost prohibitive.

    a. The preferred volume of new on system utility-scale solar is 10-15 MW of nameplate capacity.

    b. The preferred duration of new battery storage is 3-4 hours. The cost of additional capacity beyond this duration generally outweighs the benefits, because: 1) shorter duration storage already captures the vast majority of the economic value to HCE based on peak capacity costs, 2) contracts are already in place for HCE's resource adequacy needs, thus, HCE does not need to duplicate that service, 3) the value of oversupply mitigation beyond 3-4 hours is relatively low.

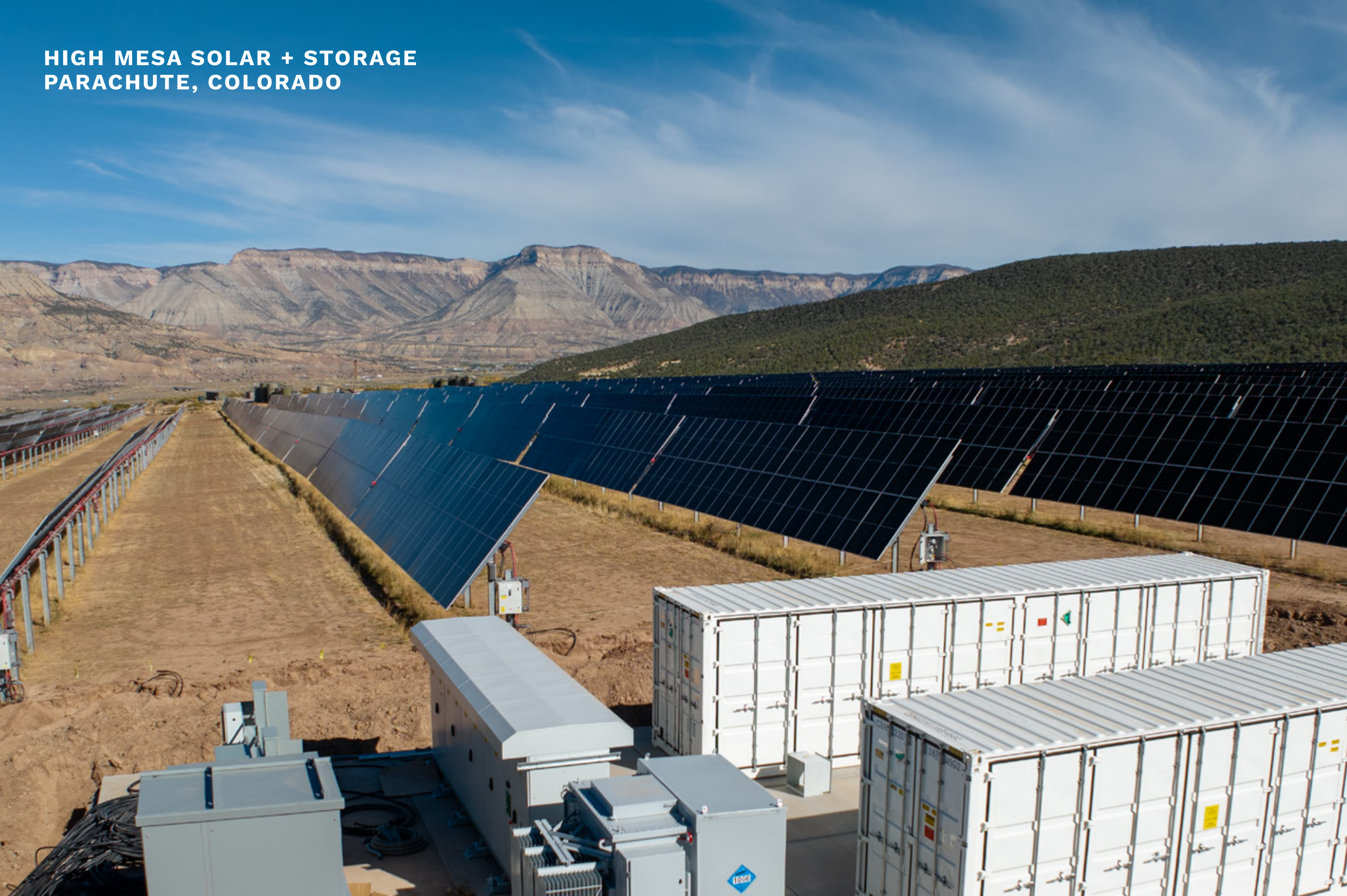
    c. HCE's locational preference for new utility-scale solar is in the Eagle Valley between Eagle and Avon, or the Roaring Fork Valley between Basalt and Aspen.

6. **Request proposals for adding battery storage to the Pitkin Solar array,** likely a 5 MW/ 15-20 MWh BESS system.

7. **Request proposals for 3-6 MW of firm renewable energy and capacity interconnected to the HCE or PSCO transmission systems that can be used as a CDP resource within HCE's WAPA allocation.**

8. **Explore the economic feasibility of additional coal mine methane electricity generation resources** on HCE's system.

9. **Monitor developments of novel technologies** such as hydrogen storage, iron-air batteries, other long-duration storage solutions, and large flexible loads, recognizing that near-term indications point to these resources as being uneconomic under HCE's current contractual landscape.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BRONCO PLAINS II WIND PROJECT
KIT CARSON COUNTY, COLORADO

2023
Power Supply Roadmap

CONTACT US

membercare@holycross.com
970.945.5491

Holy Cross Energy
3799 Highway 82
PO Box 2150
Glenwood Springs, CO 81602