Subcommittee on Long-Term Regional Planning Processes and Business Modeling

Climate Adaptation Master Plan for Water

August 22, 2023

Table of Contents

Climate Adaptation Master Plan for Water (CAMP4W)

WORKING MEMORANDUM 1

SUMMARY OF CAMP4W PROCESS

August 2023

Metropolitan staff developed this Working Memorandum #1 as a supplement to the discussion provided during the Climate Adaptation Master Plan for Water (CAMP4W) Board retreat (Workshop #1) held in February 2023 and subsequent meetings. This memorandum summarizes the CAMP4W process and identifies work completed to date and the next steps in the process.

This Memorandum is divided into the following sections:

- Section 1: Background
- Section 2: Overall CAMP4W Process
- Section 3: CAMP4W Year 1
- Section 4: CAMP4W Year 2 and Beyond

The current schedule for the development of the CAMP4W is illustrated in Figure 1. As shown, the schedule provides for regular engagement with Board members and Member Agencies, as well as the public. To capture the values of the communities served, public engagement will include listening sessions, community-led sessions, technical charettes, and sector-specific meetings.

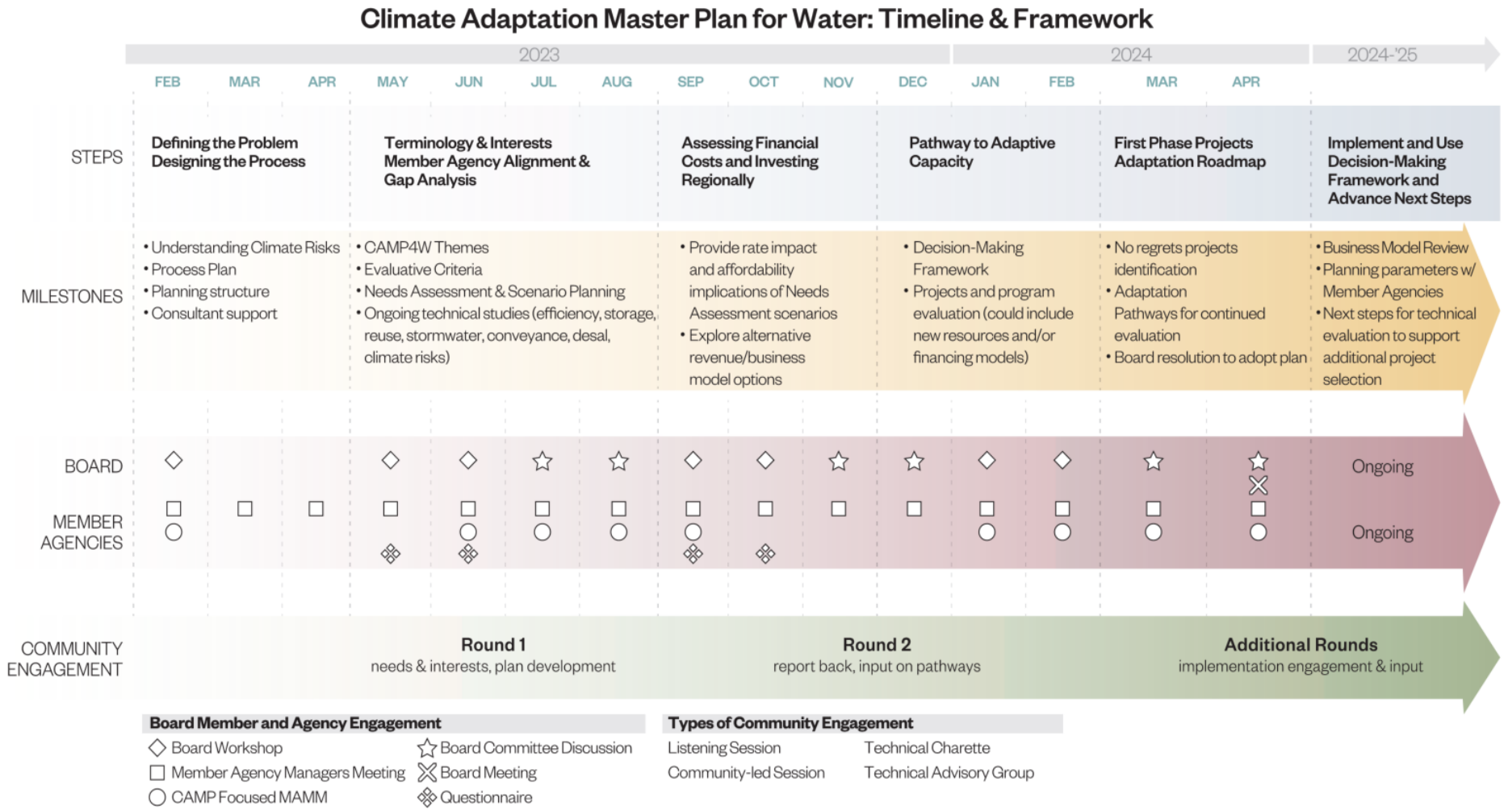


Figure 1. CAMP4W Timeline and Framework

Section 1: Background

In 2022, Metropolitan adopted an updated Integrated Water Resources Plan (IRP) Needs Assessment that examined the water supply implications of a range of water resource conditions and demand projections. Since the IRP update process started in 2020, many unprecedented events have occurred including both a record drought and record snow and rain in California, record drought conditions in the Colorado River system, and economic volatility caused by the pandemic. These events have made evident the need to plan for risks and opportunities on a grand scale. The increasing climatic variability and water supply uncertainty have prompted Metropolitan's Board of Directors (Board) to pursue the integration of climate and water resource planning with its financial plans.

The Board charged the leadership and staff of Metropolitan to expand the focus of water resource and financial planning to include climate adaptation strategies and to develop a Climate Adaptation Master Plan for Water (CAMP4W). The effort focuses on strengthening the resilience and reliability of Metropolitan, and its Member Agencies individually, in the face of a changing climate and the associated risks to our economic and environmental stability. As such, the information developed in the IRP Needs Assessment will be a key input to the CAMP4W as will the ongoing Vulnerability Assessment and Drought Mitigation Action Portfolios. The outcome of this process will be a holistic decision-making framework for setting investment plans to ensure the continued ability to fulfill Metropolitan's mission. This forward-looking and integrated approach allows Metropolitan to adaptively manage its resources so that investments remain appropriate to current conditions and additional insight about the future.

CAMP4W Problem Statement

Extreme weather conditions in recent years have presented Southern Californians with the stark reality of the challenges ahead – weather whiplash is abruptly swinging the state from periods of severe and extended drought to record-setting wet seasons, putting mounting pressure on the year-to-year management of all our available water resources. There is no question that climate change is here and is driving the need to strengthen and better integrate our existing infrastructure while building new water infrastructure designed for this century's climate. For example, in 2022, three consecutive dry years exposed extreme vulnerability in the State Water Project Dependent Areas inspiring Board action to pursue equitable water supply reliability through an interconnected and robust system of supplies, storage and programs and, in many ways, catalyzing this comprehensive planning process. To ensure the continued water supply reliability and resilience for all the communities we serve, Metropolitan is developing a Climate Adaptation Master Plan for Water that will determine near-term capital investments, inform adaptive management strategies, and guide the evolution of Metropolitan's business model as we confront our new climate reality in the years and decades ahead.

Considering the impacts of climate change and other hazards and the need to reduce these associated risks, CAMP4W will provide the basis for Metropolitan's policy and investment decisions in the near term to best serve its Member Agencies in the long term. This involves a multi-year iterative process in which various aspects of the process build upon one another. Preliminary objectives (that will be refined through the process) include to:

- Increase the resiliency and reliability of Southern California's water supplies,
- Build greater equity into our regional water storage and delivery systems, so that Metropolitan may have access to reliable water supplies, even in severe drought periods, for all our 26 Member Agencies.
- Pursue collaborative cost-sharing partnerships and promote affordability initiatives as we make the necessary investments to adapt Southern California's water infrastructure to the demands of the 21st century,
- Clearly understand the Metropolitan Member Agency network of water resource supplies and infrastructure to determine opportunities to provide additional connectivity,
- Understand the climate risks and vulnerabilities the network is facing,
- Identify adaptation strategies that strengthen the network and reduce vulnerabilities,
- Identify opportunities to expand water resources,
- Identify opportunities for strategic sharing of resources and infrastructure across member agencies to maximize all potential local supply options,
- Develop a financial strategy to fund capital investments and equitably share both water supplies and costs among Member Agencies, and
- Develop a business model that supports Metropolitan's role into the future.

Section 2: Overall CAMP4W Process

Development of the CAMP4W requires a series of tasks that will extend over multiple years. Figure 2 presents an overview of the components that are underway and how they will be integrated into the process. Section 3 provides details on the tasks to be completed during Year 1, which extends through the first quarter of 2024. The work completed in Year 1 will culminate in a CAMP4W Part 1 Report. Section 4 discusses Year 2 and beyond, which will result in a completed IRP Phase 2: CAMP4W Report (Part 1 and Part 2 combined). As a living document, the implementation of the plan will evolve beyond the completion of the Report, and it will be updated as time progresses and conditions change.

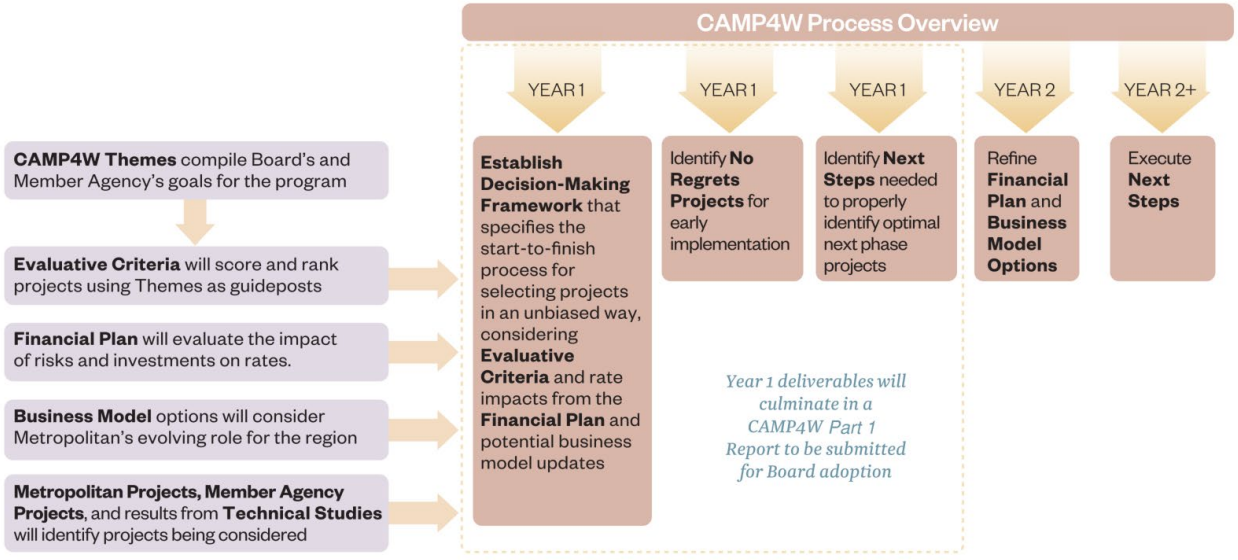


Figure 2. CAMP4W Process Overview

Section 3: CAMP4W Year 1

Year 1 of the CAMP4W process, extending through the first quarter of 2024, involves the development of the CAMP4W Part 1 Report. The pathway to completing this report involves a series of workshops with the Board to ensure the CAMP4W process and outcome aligns with its goals. Working memoranda (WM) will be developed to capture workshop outcomes, as applicable, or to serve as draft sections of the CAMP4W Part 1 Report. These would be working documents to facilitate ongoing discussion with the Board ahead of delivery of the final report.

Figure 3 presents a summary of the deliverables that will be provided to the Board as part of Year 1 (through quarter 1 of 2024). Each of these deliverables is further discussed below.

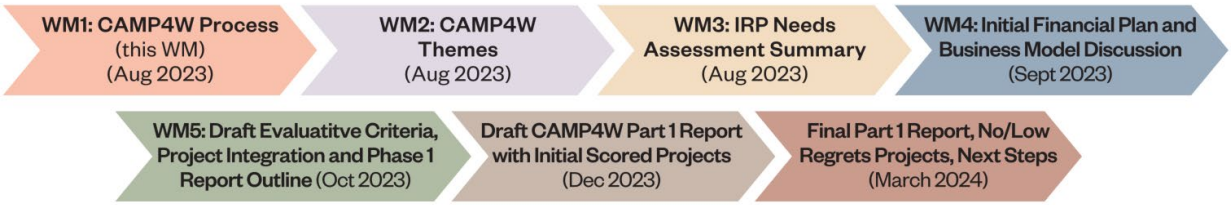


Figure 3. CAMP4W Year 1 Deliverables

WM2: CAMP4W Themes

Developed early in the CAMP4W process, Themes are intended to capture the Board and Member Agencies' preferences for what concepts and priorities should be incorporated throughout the CAMP4W development process. Initial ideas were captured at the Board retreat in February 2023 and the workshop held in May 2023 under the categories of reliability, resilience, financial sustainability, affordability, and equity (added following workshops). Subsequent discussions and a request for comments sent to Member Agencies in July 2023 led to the refinement of the Themes. The revised Themes are being presented to the Board in WM2.

As shown in Figure 2, the Themes will be used to inform the development of evaluative criteria, which will in turn inform the process for selecting projects. In this manner, the Board and Member Agencies' preferences and priorities will be carried through the CAMP4W process. The Themes are intended to be adaptable and flexible throughout the multi-year process and can be revised to allow continued alignment between the next steps and Board and Member Agencies' preferences.

WM3: IRP Phase 1: Needs Assessment Summary

The Integrated Resources Plan (IRP) Phase 1: Needs Assessment was completed by Metropolitan in 2020 and adopted by the Board in 2022. This effort involved comprehensive modeling to identify the storage and supply needs for the region across multiple planning scenarios. The planning scenarios were developed based on both population and demand forecasts, as well as the impacts of climate change. Member agencies were involved throughout the process, and they provided input on the modeling parameters, such as population, demand, and local supply forecasts.[1]

The June 2023 Board workshop included a presentation summarizing the Needs Assessment. WM3 summarizes this discussion and includes an overview of how it will be used in the CAMP4W process.

WM4: Initial Financial Plan and Business Model Discussion

A key part of the CAMP4W process involves integrating resource and climate planning with Metropolitan's ongoing financial plan and business model considerations. This will ensure Metropolitan's planning reflects the project and program costs needed to continue to provide a reliable and resilient system in the face of a changing climate.

Metropolitan is currently developing a financial plan that assesses the economic feasibility of proposed projects and the rate impact of developing projects to meet the volumes of water supply and storage identified in the Needs Assessment. In addition, as Metropolitan's role in the region resource planning evolves, such as through the implementation of the Pure Water program, updated business model options will be considered. WM4 will provide an overview of these elements, which will be discussed during subsequent Board workshops as presented in the timeline in Figure 1.

As the CAMP4W process progresses, the financial plan will be refined to consider specific projects needed to meet the storage and supply volumes identified in the Needs Assessment as well as additional infrastructure needed to be resilient and reliable across multiple climate risks (e.g., drought, stronger storms, flooding, wildfires, extreme heat, and sea level rise) and other hazards (e.g., earthquakes). Additional discussion on this process is provided in the next section.

WM5: Draft Evaluative Criteria and Integration of Additional Projects

Evaluative Criteria: The Evaluative Criteria will provide a method of scoring and ranking projects and programs based on criteria important to the Board and Member Agencies, as reflected in the Themes. Evaluative Criteria can be used to compare proposed projects and differentiate them from one another. Weighting factors will be applied to each Evaluative Criteria, where weighting factors increase or decrease their relative importance. These weighting factors will be based on the Themes, thereby incorporating the Board and Member Agency priorities into the evaluation process. For example, assigning a higher weight to providing connectivity within the network would reflect the Board's policy to address shortages in the Stade Water Project Dependent Areas. The initial evaluation of projects will be further evaluated on costs so that projects with the highest cost-benefit ratio can be identified.

[1] https://www.mwdh2o.com/how-we-plan/integrated-resource-plan?keywords=IRP

Integration of Additional Projects: Output from the IRP Needs Assessment is a key input in the CAMP4W evaluation process. The Needs Assessment: 1) addresses the climate impacts of increased incidence of drought and changing precipitation patterns from a water supply standpoint, and 2) identifies general volumes of storage and supply needs based on population and demand forecasts. The CAMP4W process will identify specific projects to meet those needs, which will be scored as discussed above.

In addition to storage and supply needs, other key inputs to the CAMP4W include potential climate change impacts beyond changing drought and precipitation patterns (e.g., wildfire, sea level rise, extreme heat and more) as well as other hazards (e.g., earthquakes) and an assessment of the additional projects needed to increase resilience to these impacts. Ongoing Vulnerability Assessments and Hazard Mitigation Plans will identify these additional vulnerabilities (including employee safety and customer resilience) within the system and may identify capital projects needed to harden and strengthen existing infrastructure or to add additional conveyance.

To illustrate how these parallel efforts integrate, Figure 4 displays the following:

1. Inputs used in the selection of potential low/no regrets projects (e.g., preliminary list of projects to fulfill the water volume requirements identified in the Needs Assessment ***plus*** projects to increase overall climate resilience of Metropolitan's infrastructure and operations identified during vulnerability assessments and hazard mitigation planning),

2. Identification of which data are informing the initial financial plan (discussed in WM4, and including only Needs Assessment volumes), and

3. How the CAMP4W process will progress to integrate both the **volume of additional storage and supply needed** with the **infrastructure and operations needs** to create a comprehensive process for selecting projects. This will result in an updated economic evaluation from the initial evaluation that accounts for storage and supply needs alone.

WM5 will provide a summary of the draft evaluative criteria and weighting factors, summarize how infrastructure projects are being incorporated, and will include an outline for the CAMP4W Part 1 Report. These elements will be discussed during subsequent Board workshops as presented in the timeline in Figure 1.

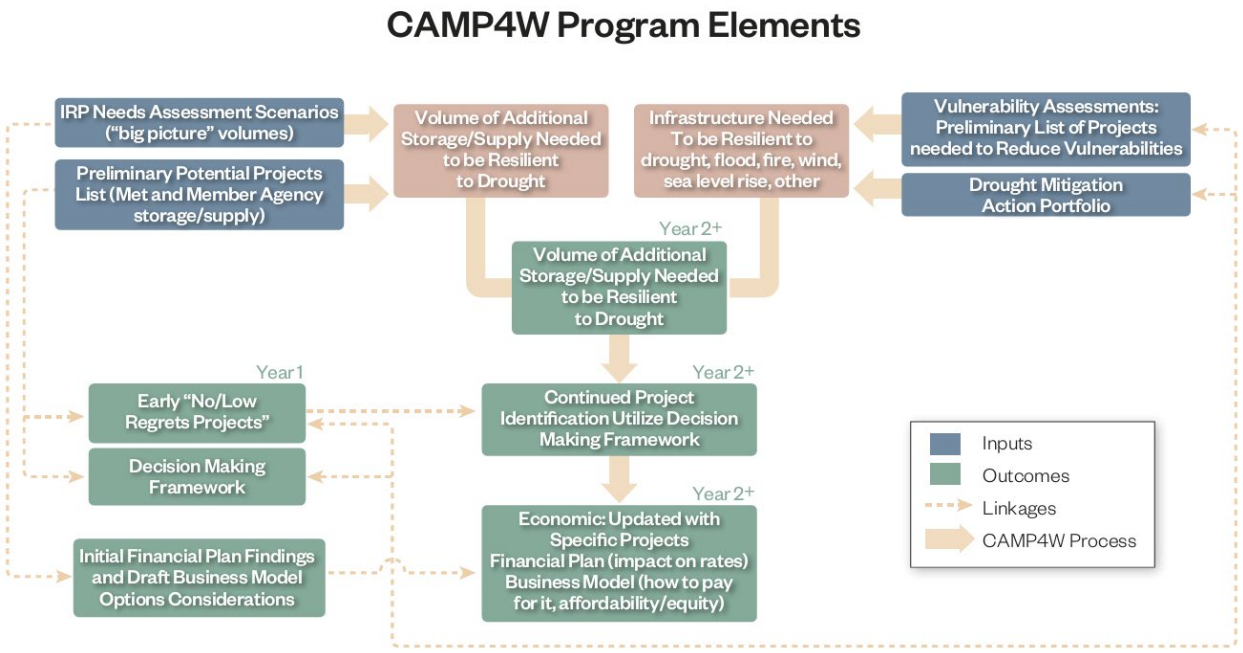


Figure 4. CAMP4W Inputs and Process

Draft and Final CAMP4W Part 1 Report

The CAMP4W Part 1 Report will summarize the work completed during Year 1 of the CAMP4W process. Part 2 will be developed in Year 2 and combined into a final CAMP4W Report.

The Draft Part 1 Report will incorporate the documentation provided in WMs 1-4 and will include a comprehensive decision-making framework that will compile all parts of the process into a stepwise approach for evaluating projects for implementation. This will include:

- Tools for scoring and ranking projects (Evaluative Criteria, WM5),
- Cost effectiveness assessment of scored and ranked projects,
- Methodology for compiling individual projects into portfolios of multiple projects (e.g., combining projects that address the State Water Project Dependent Areas), and
- Assessment of the impacts to rates and affordability based on implementing various portfolios of projects (Alternatives Analysis) using the financial plan currently being developed.

The Draft Part 1 Report will provide a list of projects scored using the evaluative criteria presented in WM5. Following submittal of the draft, Board discussions and input from Member Agencies will result in revisions to the document, to be incorporated into the Final Part 1 Report. In addition, the Final Part 1 Report will take the list of scored storage, supply, and infrastructure projects and identify low/no regrets projects based on assessments of cost effectiveness, economic feasibility/affordability, and impacts to rates. By identifying these projects early on, Metropolitan and its Member Agencies can begin their implementation in a timely manner.

These low/no projects will be presented to and discussed with the Board and Member Agencies at Member Agency Manager's Meetings and Board workshops (see timeline in Figure 1) prior to inclusion in the final report so that identified projects are properly vetted and selected. Identified projects can include both storage and supply projects or programs as well as infrastructure projects (such as those needed to harden existing infrastructure vulnerable to climate conditions).

In addition to the development of a Decision-Making Framework and a list of low/no regrets projects, the final report will include a detailed understanding of next steps that must be implemented moving into year two (beginning quarter 2 of 2024) and beyond.

The final report will be submitted to the Board for adoption (see timeline in Figure 1).

Section 4: CAMP4W Year 2 and Beyond

The CAMP4W process will continue directly into Year 2 (beginning quarter 2 of 2024), where the recommendations identified and adopted by the Board will be implemented and additional projects beyond the low/no regrets projects will be evaluated. Based on discussions to date, this may involve developing a methodology for identifying opportunities for Member Agencies to further collaborate, and a pathway for Metropolitan to facilitate this collaboration. Additional projects will become part of Metropolitan's Adaptive Management Process.

Figure 3 presents an illustration of adaptive management. As shown in the figure, real-world conditions will inform the process and selection of projects. Because projects often take years to plan and implement, there will be ample time for Metropolitan to reassess decisions based on both global and local assumptions which will serve to either:

1. Reduce the potential of stranded assets due to overdevelopment by having the ability to not construct a project that was preliminarily planned for but not needed, and
2. Reduce the potential of under preparedness if conditions require more infrastructure in the future by having planning phases underway early on to position Metropolitan to implement those projects if they are needed.

This adaptive management process provides optimal flexibility, which is critical in the face of a changing climate.

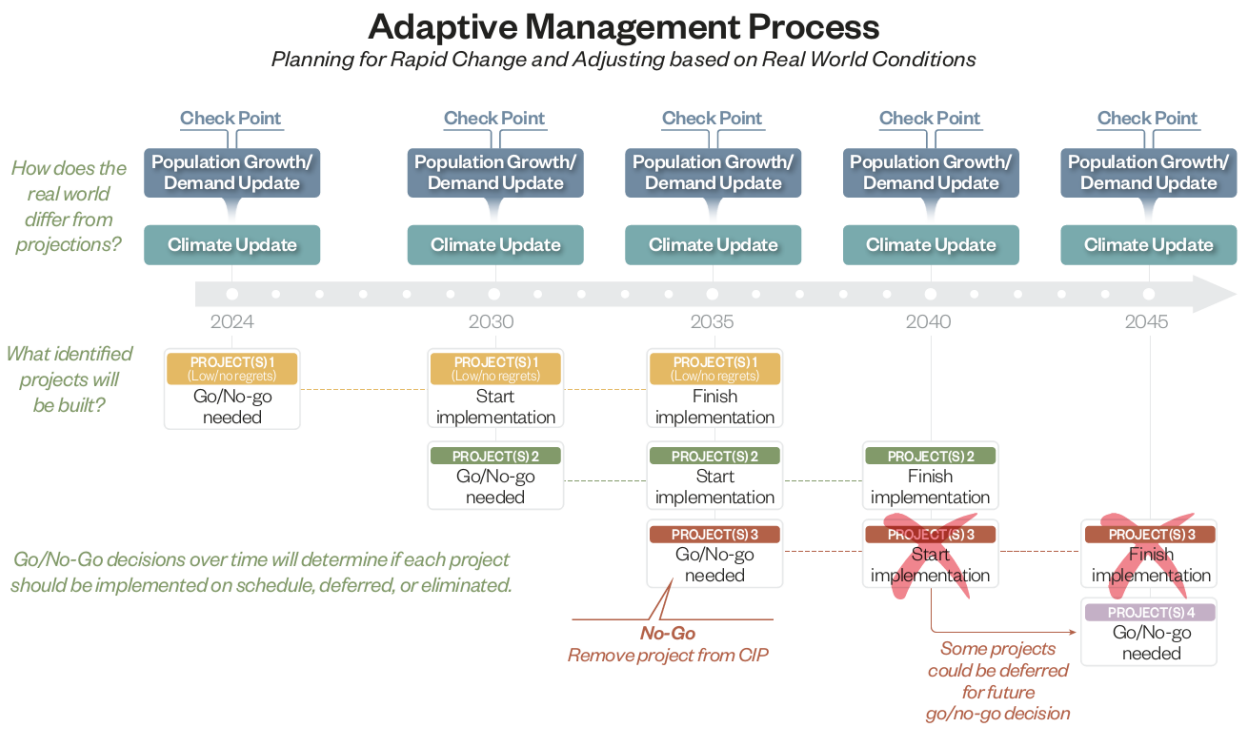


Figure 5. Adaptive Management Process

Climate Adaptation Master Plan for Water (CAMP4W)

WORKING MEMORANDUM 2

CAMP4W THEMES

August 2023

Stronger together. Metropolitan is developing a long-term Climate Adaptation Master Plan for Water (CAMP4W) to prepare Metropolitan and its Member Agencies for an uncertain future by developing a reliable and resilient supply of water and network of facilities. Founded on financial sustainability and equitable affordability, the plan will guide the region with collaboration and interconnectivity through a "stronger together" approach.

The CAMP4W Themes were developed based on discussions among the Board and Member Agencies regarding what concepts should be considered as the CAMP4W planning process progresses across ***reliability, resilience, financial sustainability, and affordability***. The ideas captured during those discussions were compiled into thematic statements that will serve as guideposts during the next steps, including the development of evaluative criteria. An additional category, ***equity***, was added following the discussions as it was identified as an important theme among participants.

The following presents the CAMP4W Themes. Though there is overlap, the themes are categorized as either overarching themes or themes most aligned with reliability, resilience, financial sustainability, affordability, or equity.

OVERARCHING THEMES

Overarching Themes that span all categories.

- Develop a path forward that prepares our region to mitigate, adapt and thrive in a changing climate.
- Recognize that reliability and resiliency, as well as affordability and equity, varies across member agencies and we must work as a single region to create equity.
- Develop a coordinated engagement strategy across Member Agencies and Metropolitan that builds relationships and trust in the communities we serve, provides meaningful information and solicits input throughout the process.
- Comprehensively evaluate alternatives utilizing available data, an understanding of Metropolitan and member agencies facilities, and opportunities for collaboration to make informed decisions on investments.
- Develop a Decision-Making Framework that is flexible and adaptable to varying climate scenarios and human behaviors and achieves multiple benefits.
- Create reliability and resilience by determining:
    - **"Will-build"** projects benefiting multiple planning scenarios (i.e., Low/No Regrets projects)
    - **"Can-build"** projects to be built depending upon further investigation
    - **"May-build"** projects to be built on the conditional occurrence of "trigger" conditions
- Develop portfolios of alternatives and an adaptive management framework designed to support the identified needs of Metropolitain's system considering benefits, costs, prior Board actions, and implementability in achieving resiliency and reliability.

RELIABILITY

Ability to always meet water demands.

- Develop regional and collaborative solutions that address various climate scenarios and consider:
    - Providing multi-benefits across member agencies,
    - Increasing our water reserves,
    - Serving both current and future customers,
    - Maintaining water quality,
    - Considering system and environmental improvements for imported water assets,
    - Diversifying our portfolio, and
    - Establishing system interconnectivity.
- Identify projects that reduce our regional dependence on imported water and that address areas in our system that rely on a single source of supply.
- Improve the reliability of the State Water Project Dependent Areas by upgrading infrastructure connectivity and access to water supply and storage assets.
- Recognize increased water use efficiency as a critical aspect of reliability regardless of varying climate scenarios and identify implementation methodologies.
- Ensure regional connectivity so that all agencies are able to directly access the region's resources and share equally in the regional benefits as well as the regional risks.

RESILIENCE

Ability to withstand and recover from disruptions.

- Identify infrastructure at risk of failure or vulnerable to climate impacts and other hazards and establish a methodology to continuously re-evaluate gaps to manage risks and proactively identify risks.
- Identify investments and partnership opportunities that facilitate collaboration among Metropolitan and Member Agencies.
- Improve the resiliency of the State Water Project Dependent Areas, and those areas with little or no redundancy for access to Metropolitan supplies, by upgrading infrastructure connectivity and access to water supply and storage assets.
- Develop opportunities for integration across water supply, infrastructure, workforce, ecosystems, power supply, and other areas.
- Create a cooperative approach to ensure system flexibility during disaster response and recovery.

FINANCIAL SUSTAINABILITY

Revenues sufficient to cover expenses over the short- and long-term.

- Consider business models that enable Metropolitan to fulfill its regional role and maintain a sufficient income stream to fund necessary projects and programs in partnership with its member agencies.
- Develop a financial plan that assesses rate impacts of various adaptation pathways.
    - Maintain sufficient reserves for liquidity and resilience to various climate scenarios impacting declining revenues, increasing costs, emergency conditions, and member agency demand patterns.
    - Develop a plan that includes managing risk exposure due to climate change to maintain credit worthiness for access to capital markets and debt financing.
    - Explore opportunities to increase non-rate revenues and credit worthiness across climate scenarios.
- Recognize the need to fund ongoing or increasing rehabilitation and repair project costs to maintain resiliency and reliability.
- Evaluate mechanisms that facilitate shared resources among member agencies, reduce individual agency exposure, and support member agencies in completing projects.

AFFORDABILITY

Relative cost burden and elastic ability to access (pay for) service and support member agency efforts to provide affordable supply to their customers.

- Evaluate revenue and rate alternatives that align with an updated business model.
- Consider each Member Agency's distinct financial profile based on their size, level of establishment (growing vs. established), rate capacity, reliance on Metropolitan's supplies, and their retail customer's capacity to pay.
- Explore options in program funding to address access and affordability for the most vulnerable customer segments in alignment with Metropolitan's policies and state law.
- Conduct regular evaluation on affordability factors to understand the discrepancy in affordability across member agencies.
- Evaluate mechanisms to streamline processes and increase efficiencies with innovative ideas for cost-savings.
- Identify opportunities for Metropolitan to actively participate in programs that would support affordability (e.g., programs at the State or Federal level).
- Practice fiscal care and responsibility to ensure MWD's component of the member agencies' water costs are as economical as possible.
- Evaluate projects based on the whole life-cycle costs (capital plus operation and maintenance) to assess long-term economic feasibility and cumulative impacts on affordability.

EQUITY

Fair, just and inclusive.

- Metropolitan will promote regional equity among all member agencies by understanding varying individual member agency needs related to:
    - Access to a reliable water supply that achieves an equivalent level of reliability and resiliency experienced across the region.
    - Access to funding options for projects necessary to achieve the standard of reliability and resiliency afforded to the rest of the region.
    - Access to an inventory of assets sufficient to store and convey water to achieve the same level of reliability and resiliency experienced across the region.
- Metropolitan will support member agencies' equity goals by:
    - Supporting member agencies in pursuing the Human Right to Water through affordability and access to water supplies.
    - Evaluating conservation and use efficiency programs for disadvantaged communities (such as access to rebates, direct install, and other programs).
    - Exploring legislative options to prioritize state and federal investments in disadvantaged communities.
    - Supporting member agencies conservation and water use efficiency programs including communication, funding, and program execution.

Climate Adaptation Master Plan for Water (CAMP4W)

WORKING MEMORANDUM 3

IRP 2020 REGIONAL NEEDS ASSESSMENT SUMMARY

August 2023

Summary

The 2020 Integrated Water Resources Plan (IRP) was organized into a Regional Needs Assessment (Phase 1) and an implementation phase (Phase 2). The Needs Assessment (**Attachment A**) was adopted by the Board in 2022 and established a tool for ensuring regional water reliability through 2045 and incorporated scenario planning to address wide-ranging uncertainties. Building upon this strong foundation of the IRP Needs Assessment, the implementation phase of the IRP will be coordinated through the Climate Adaptation Master Plan for Water (CAMP4W) process.

In collaboration with the Member Agencies, the Board of Directors, and other interested parties, the 2020 IRP Needs Assessment broadened Metropolitan's perspectives compared to past IRPs by constructing and modeling four plausible future scenarios. These scenarios explored uncertainties related to future climate conditions, population growth, regulatory requirements, and the economy. These scenarios represent divergent outcomes of imported supply stability and demands on Metropolitan and are illustrated in Figure ES-1 (see also page 17 of **Attachment A**).

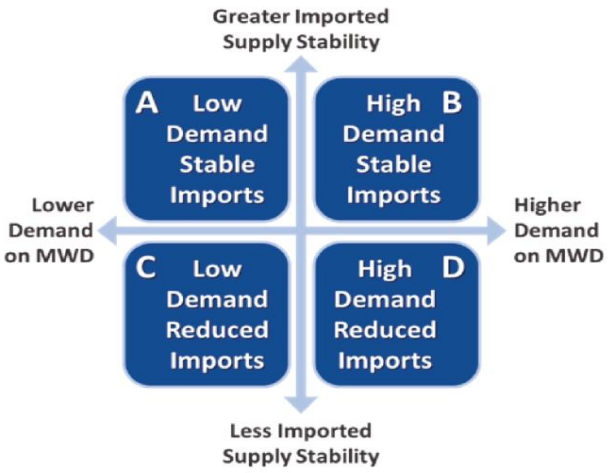


Figure ES-1. IRP Planning Scenarios

The scenario analyses revealed conceivable reliability outcomes through 2045. The potential annual net shortage ranged from none under Scenario A to as high as 1.2 million acre-feet (MAF) under Scenario D.

The IRP Needs Assessment identified three categories of supply:

Core Supply: A supply that is generally available and used every year to meet demands under normal conditions and may include savings from efficiency gains through structural conservation.

Flexible Supply: A supply that is implemented on an as-needed basis and may or may not be available for use each year and may include savings from focused, deliberate efforts to change water use behavior.

Storage: The capability to save water supply to meet demands at a later time. Converts core supply into flexible supply and evens out variability in supply and demand.

In order to address the gaps identified within each scenario, Metropolitan conducted a portfolio analysis to quantify the effect of various combinations of supply categories (core supply, flexible supply, or storage). Initial modeling utilized a single category analysis (core supply, flexible supply, or storage) to test how the supply-demand gap in each scenario could be met. After the portfolio categories were modeled in isolation, a mix of all three categories was modeled for each scenario. The analysis concluded that rather than relying on any single category of portfolio actions, it is more practical in every scenario to pursue a more balanced and diversified mix. For example, the analysis found that under rapid climate change Metropolitan and its Member Agencies would need to develop between 50 thousand acre-feet (TAF) and 650 TAF of new core supply to continue to meet the needs of the region assuming no additional storage is developed and a maximum of 100 TAF of flexible supply is developed. However, by expanding existing storage or by developing new storage programs and investments in Metropolitan's distribution system, the need for new core supply can be reduced.

The Needs Assessment further evaluated the impact of system distribution constraints on system reliability to establish the extent to which water supply shortages can be mitigated by removing those constraints. The analysis found that if distribution constraints were removed entirely, shortages decrease or are eliminated in years prior to 2040. However, in year 2040 and beyond, under Scenarios C and D, frequent shortages and fewer surplus conditions indicate that storage and conveyance capacity alone will not solve the reliability problem without supply improvements.

The Needs Assessment involved extensive modeling across multiple established platforms to conduct a reliability assessment to quantify potential gaps within each scenario. The Needs Assessment resulted in findings across the following five focus areas:

- Demand Management
- Storage Needs
- Imported Supplies
- Local Supplies
- Identification of Gaps by Major Load Area: Modeling by demand load area (the State Water Project (SWP) Dependent Area, the Colorado River Dependent Area, and the Blended Area). This led to findings related to the SWP Dependent Area as an area specifically impacted by future conditions (see page 26 of **Attachment A** for a figure showing the demand load areas).

Metropolitan acknowledges that CAMP4W will require continued close collaboration with Member Agencies to integrate local needs, projects, and priorities. CAMP4W is designed to provide an adaptive decision-making framework to facilitate the selection of projects and the sequencing and timing of each phase of implementation. Scenario planning developed in the IRP Needs Assessment provides a sound foundation for adaptive management. This will allow for flexibility and the opportunity to refine decisions over time so Metropolitan can continue to meet its mission to provide the entire service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way.

Section 1: Needs Assessment Framework and Scenarios

For nearly thirty years, Metropolitan has embraced integrated resources planning for developing a long-term strategy to provide the region with a reliable, high-quality, and affordable water supply. Between 1996 and 2015, Metropolitan recalibrated its IRP on several occasions, based on a single set of assumptions related to changing conditions and forecasts. Beginning with the 2020 IRP update, Metropolitan integrated scenario planning, which instead focuses on a range of assumptions. This important adjustment to the 2020 IRP allows Metropolitan to consider a wide range of uncertainty, based on several key assumptions, including future climate conditions, population growth, regulatory requirements, and the economy (see page 14 of **Attachment A**). To develop the scenarios used in the 2020 IRP Needs Assessment, there was extensive coordination and consultation with Member Agencies, and Board input was integrated throughout the process.

Recent severe drought in California followed by record rainfall provides a real-world example of the challenges facing the region and emphasizes the need to consider future climate change projections in the IRP process. The climate change assumptions were developed in consultation with an expert panel and based on IPCC Assessment Reports (and corresponding global climate models) using the most recent projections available at the time the IRP was developed.

Following is a list of key assumptions included in the IRP Needs Assessment. **Attachment B** provides a comprehensive summary of assumptions for each scenario.

- Assumptions related to future climate conditions:
    - RCP 4.5 represents moderate climate change (reflected in Scenarios A and B)
    - RCP 8.5 represents more pronounced climate change (reflected in Scenarios C and D)
- Assumptions related to population growth and water demands:
    - Low demands (represented in Scenarios A and C)
        - Aggressive conservation practices
        - Low economic growth and population growth
    - High demands (represented in Scenarios B and D)
        - Moderate conservation effectiveness
        - High economic growth which accelerates population growth
- Assumptions related to regulatory impacts:
    - Low regulatory impacts (less restrictive) (Scenarios A and B)
    - High regulatory impacts (more restrictive) (Scenarios C and D)
- Assumptions related to local supplies:
    - Higher local supplies
        - (Scenarios A and C assume higher local supplies relative to Scenarios B and D)
    - Diminishing local supplies
        - (Scenarios B and D assume lower local supplies relative to Scenarios A and C)

Uncertainty and the Establishment of Assumptions

There is **inherent uncertainty** whenever an assumption is made, and in the IRP Needs Assessment, each scenario is defined by numerous assumptions. **Scenario planning and adaptive management capture that uncertainty** in the space between each scenario – the spectrum along which real-world conditions are likely to unfold. Each scenario presents a data point along that spectrum, where any number of variables could shift the outcome in one direction or another.

By adapting and modifying investment decisions over time, **Metropolitan will align implementation with real-world conditions** to reduce the risk of over or under developing resources.

Utilizing these primary assumptions, Metropolitan developed four scenarios that represent potential futures, as shown in Figure 1.

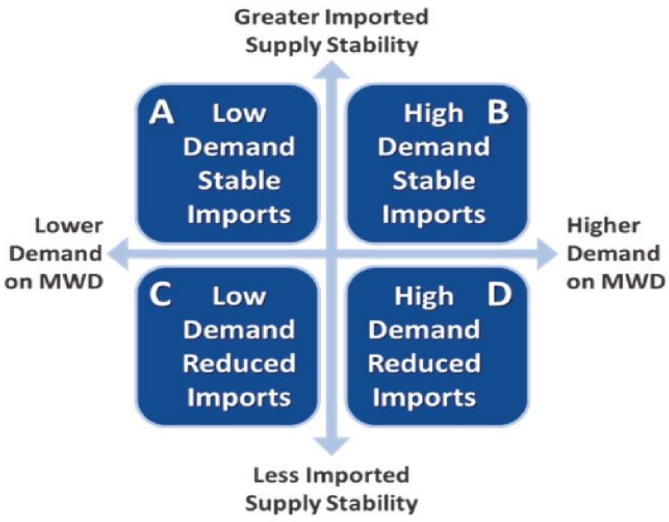


Figure 1. IRP Planning Scenarios

Section 2: 2020 IRP Regional Needs Assessment Evaluation Process

A key goal for Metropolitan is to provide all its Member Agencies with 100 percent water supply reliability through a combination of Metropolitan supplies, local supplies, and increased conservation. Scenario planning allows Metropolitan to consider multiple, plausible future scenarios with a corresponding range of possible shortcomings.

To establish and evaluate each of the four scenarios, the IRP Needs Assessment utilized several prominent modeling platforms to thoroughly analyze the impacts of each set of assumptions. Figure 2 presents a summary of the complex modeling process conducted during the Needs Assessment, followed by a summary of each input (see page 19 of **Attachment A**).

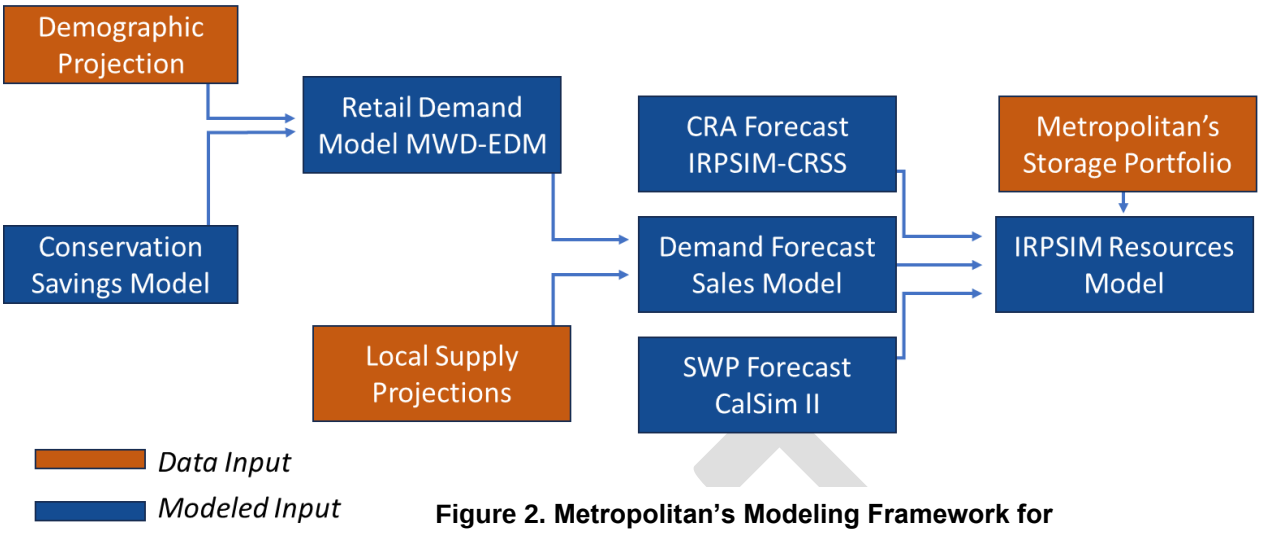


Figure 2. Metropolitan's Modeling Framework for Quantifying Uncertainties

MWD-EDM:

- Demographic growth projections were developed with support from the Center for Continuing Study of the California Economy (CCSCE), which utilizes studies published by the U.S. Census Bureau.
- Drivers for change were evaluated such as smaller lot sizes for future homes, future conservation, water use ethic and rebound behavior (where complete rebound assumed a 10 percent higher forecast compared to a forecast without rebound).
- Conservation savings (structural and behavioral conservation) were established using Metropolitan's Conservation Savings Model based on plumbing code compliance, Metropolitan and Member Agency conservation programs, and price-effect conservation.
- Demands from retail agricultural, seawater barrier, and replenishment were established considering climate change impacts within each scenario (e.g., additional seawater barrier needed when seawater levels increase, and additional supply is needed to combat increased hydraulic pressure).

Local supply projections:

- Includes groundwater, surface water, the Los Angeles Aqueduct, recycled water, groundwater recovery, and seawater desalination. Values were established based on Metropolitan's annual local supply surveys, coordination with local agency staff, and local Urban Water Management Plans.
    - Focused workshops were held with Member Agencies and groundwater management agency staff to gain valuable insights into challenges and reliability impacts of local supplies based on climate change, economic conditions, and regulatory restrictions.

Demand Forecast Sales Model:

- Model calculates the demands on Metropolitan by Member Agencies where local supplies are insufficient to meet retail demand.
- Model accounts for weather-related variations in demands and local supplies, resulting in a range of forecasted demands on Metropolitan.
- Climate expert consultants were engaged to develop techniques and ranges for incorporating climate change impacts into the local precipitation and temperature assumptions.

CRA Forecast IRPSIM-CRSS

- Model provides a base supply from the Colorado River Aqueduct (CRA) utilizing hydrological inputs provided by the United States Bureau of Reclamation, utilizing Metropolitan's generated surplus and shortage characterization of the Colorado River system.
- Based on consultation with climate experts and previous research, climate change is incorporated into CRA supplies by adjusting the Lake Powell and Lake Mead inflow hydrology and evaporation rates.
- Stability of Colorado River supplies were considered based on potential impacts of existing agreements related to operation of the Colorado River and cooperation between the lower basin states and Mexico, with some agreements expiring in 2026. Scenarios A and B assume extension of these agreements (stable imported supply), while Scenarios C and D assume some agreements expire (unstable imported supply) (see page 29 of **Attachment A**).

SWP Forecast-CalSim II

- Model produced by the Department of Water Resources and published in their 2019 Delivery Capability Report (DCR), which provides SWP supply estimates for 1) an existing condition that does not consider climate changes, and 2) an early long-term condition that does incorporate a fixed condition of climate change.
- IRP Needs Assessment utilized the 2019 DCR as a basis for incorporating guidance from climate experts to reflect the regulatory and climate change impacts used in the IRP scenarios to establish the supply estimates from the SWP.

IRPSIM Resources Model:

- IRPSIM is a water supply and demand mass balance simulation model, which analyzes the supply-demand gaps. It integrates inputs from the models described above, including:
    - CRA Forecast (using the IRPSIM-CRSS model)
    - SWP Forecast (using the CalSim II model)
    - Metropolitan's storage portfolio, where IRPSIM considers operational constraints, put and take capacities, contractual arrangements, and other operational considerations.

    - Demand Forecast Sales Model which provides the input for demands on Metropolitan, which uses retail demand (demographic projections and conservation considerations) and local supply projections.

- The IRPSIM model considers the availability and accessibility of its imported water supply sources, including storage, where forecasted demands were allocated to portions of Metropolitan's regional distribution system, referred to as demand load areas. Based on this, the model identified spatially where across the system gaps exist for each scenario modeled.
    - Three main demand load areas were identified including: SWP Dependent Areas, Colorado River Dependent Areas, and Blended Areas which are areas able to receive supply from both sources including their respective storage programs (see page 26 in **Attachment A** for a map of each demand load area).
    - During surplus years, excess SWP supply can be stored in SWP storage facilities and/or in blended areas, allowing Metropolitan to store imported supply within Colorado River storage facilities.
- To test reliability, IRPSIM utilizes 96 years of historical hydrology (1922-2017) to establish the probabilities of surpluses and shortages (defined in the model as insufficient supply to satisfy a demand or inaccessible supply). The scenario-based climate impacts were overlaid onto the sequential hydrology data within IRPSIM.

Section 3: 2020 IRP Regional Needs Assessment Findings

The modeling conducted first utilized a single category analysis (core supply, flexible supply, or storage), then category-specific tests were performed to understand the impact of utilizing multiple supply categories in a given portfolio. The analysis concluded that rather than relying on any single category of portfolio actions, it is more practical in every scenario to pursue a more balanced and diversified mix. For example, the analysis found that under rapid climate change Metropolitan and its Member Agencies would need to develop between 50 TAF and 650 TAF of new core supply to continue to meet the needs of the region, assuming no additional storage and a maximum of 100 TAF of flexible supply. However, by expanding existing or developing new storage programs and investments in Metropolitan's distribution system, the need for new core supply can be reduced.

The Needs Assessment further evaluated the impact of system distribution constraints on system reliability to establish the extent to which water supply shortages can be mitigated by removing those constraints. The analysis found that if distribution constraints were removed entirely, shortages decrease or are eliminated in years prior to 2040. However, in year 2040 and beyond, under Scenarios C and D, frequent shortages and fewer surplus conditions indicate that storage and conveyance capacity alone will not solve the reliability problem without supply improvements (see page 32 **Attachment A**).

A comprehensive discussion on findings is included in Attachment A (beginning on page 30), and below is a brief summary of findings across five key focus areas.

State Water Project Dependent Areas

- Vulnerabilities in the SWP Dependent Areas are more severe given reduced reliability of SWP supplies and Metropolitan distribution system constraints. Actions identified in the implementation phase must prioritize addressing the SWP Dependent Area's reliability challenge.
- New core supplies must be accessible to the SWP Dependent Areas. Greater access to existing core supplies can also increase SWP Dependent Area reliability.
- Enhanced accessibility to core supplies and storage, both existing and new, will improve SWP Dependent Area and overall reliability. This includes improvements to Metropolitan's distribution system and capacity to deliver non-SWP supply and storage.
- New storage must be accessible to the SWP Dependent Areas.

Storage

- Storage capacity, put/take capabilities, and accessibility are critical considerations in maintaining reliability under the region's current and future conditions, especially for SWP Dependent Areas.
- Maintaining Metropolitan's existing storage portfolio is critical, including the consideration of re-negotiating contracts when they expire.
- Expanding existing or developing new storage programs and investments in Metropolitan's distribution system can reduce the need for new core supply development to meet potential future shortages and adapt to climate change.
- When evaluating storage options, put/take capabilities are essential; even storage programs with modest put/take capabilities help reduce the need for flexible supply.

Retail Demand / Demand Management

- Metropolitan's future supply reliability may fluctuate based on demand increases and decreases.
- Variability in retail demand largely comes from changes in outdoor water use. Outdoor water use behavior is complex, influenced by weather and climate and by awareness of water scarcity and other conservation measures.
- It is important to pay attention to demand rebound, demand growth, and demand reductions, and take appropriate regional measures as necessary.
- Managing long-term demands through the efficient use of water reduces dependency on supplies, helps preserve storage, and helps reduce the need for extraordinary conservation measures.

Metropolitan Imported Supplies

- Existing imported supplies are at risk from various drivers of uncertainty.
- Maintaining existing imported supply reliability reduces the need for new core supply development and leverages years of investments.
- SWP supplies are highly susceptible to varying hydrologic conditions, climate change, and regulatory restrictions.
- Variability and capacity in SWP supplies provide opportunities to store water during wet periods for use in dry years, including Colorado River storage. Metropolitan's ability to distribute or store SWP supplies when they materialize will enhance the region's reliability, particularly the SWP Dependent Areas. The Colorado River system and Colorado River Aqueduct capacity do not offer the same opportunities concerning SWP storage.

- Shortages on the Colorado River will limit the reliability of Colorado River Aqueduct deliveries as a core supply in the future.

Local Supply

- Maintaining existing and developing new local supplies is critical in helping manage demands on Metropolitan.
- Impacts to reliability occur if local supply assumptions are not achieved; therefore, it is important to track the progress of local supply development as one of the signposts in the One Water Implementation phase.
- Additional actions may be needed should existing and future local supply levels deviate from IRP assumptions.

Section 4: Next Steps

Metropolitan's approach to reliability and resilience brings together Southern California's interests in managing finite water resources for both community and ecosystem needs. It goes beyond identifying the region's future water portfolio and embraces collaboration, diverse communities, and a unified approach to problem solving.

The IRP Regional Needs Assessment identified significant threats facing Southern California's water supply reliability through successive qualitative and quantitative analysis steps. The assessment sizes up the scope of reliability challenges and the management solutions that could be in store for the region by the year 2045 under a wide range of conditions, and it serves as a guide to the deeply uncertain future of Southern California's water supply.

The adoption of the Regional Needs Assessment is an essential precursor, and significantly informs, the CAMP4W implementation phase. This phase will involve the continuation of extensive collaboration among Metropolitan's Board, Member Agencies, and other interested parties to develop an adaptive management strategy and decision-making framework. CAMP4W will also establish a process for monitoring key reliability indicators and find joint approaches to the regional problems and resource needs identified in this assessment.

Attachment A

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

BOARD ACTION

- **Board of Directors**
  Integrated Resources Plan Special Committee

4/12/2022 Board Meeting

7-1

Subject

Adopt the 2020 Integrated Water Resources Plan Needs Assessment; the General Manager has determined that the proposed action is exempt or otherwise not subject to CEQA

Executive Summary

The 2020 Integrated Water Resources Plan (IRP) establishes a strategy for ensuring regional water reliability through 2045. The 2020 IRP incorporated scenario planning to address wide-ranging uncertainties rather than focusing on a single set of assumptions as in the past. In collaboration with the Member Agencies, the Board of Directors, and other interested parties, Metropolitan broadened its perspectives by constructing and modeling four plausible scenarios. Staff organized the 2020 IRP into a Regional Needs Assessment (Phase 1) and a One Water Implementation phase (Phase 2). The Regional Needs Assessment is now complete.

This letter recommends adoption of the 2020 IRP Regional Needs Assessment (**Attachment 1**), which includes findings in five broad categories (State Water Project Dependent Areas, Storage, Demand Management, Imported Supplies, and Local Supplies), quantifies supply/demand gaps, and examines the effectiveness of generalized portfolio categories. Adopting the Regional Needs Assessment allows the analysis and findings to serve as both a foundation and as guardrails for the next implementation phase.

Details

Background

The IRP serves as Metropolitan's long-term, comprehensive water resources strategy to provide the region with a reliable and affordable water supply. After its first adoption in 1996, the IRP was updated in 2004, 2010, and 2015 to adapt to changing conditions that affected water resource reliability. With each update, Metropolitan recalibrated to current conditions and incorporated the best information available to update its forecasts. These plans focused on a single set of assumptions about the future.

The 2020 IRP sought a new analytical framework to:

- Define and account for uncertainties affecting water reliability
- Develop a method to assess and communicate the impacts of those uncertainties
- Explain the uncertainties and their relevance in a clear and transparent way
- Allow integration with an adaptive management strategy that will provide ongoing decision support, information generation, and reporting as essential components

The 2020 IRP explicitly plans for a wide range of uncertainties through scenario planning and by embracing a One Water approach to planning and implementation.

2020 IRP – A Phased Approach for One Water Implementation

Although initially envisioned as a single assessment and planning effort, scenario planning required close coordination with the member agencies. Scenario planning departed from the prior single-scenario methods and needed extra time to help member agencies become comfortable with the approach. Additionally, staff valued

member agency input and refined the scenarios and analysis through multiple iterative steps. The Covid-19 pandemic also forced changes in outreach methods, dynamics of interacting with member agencies, and the work environment of staff conducting the analyses.

Concurrent with developing and analyzing the scenarios, California again slipped into a severe drought. Several scenarios under development showed that the State Water Project (SWP) dependent areas could experience shortages more quickly and deeply as the SWP imported supply became constrained. Eventually, it became clear that the Regional Needs Assessment could serve as a stand-alone guide to the deeply uncertain future of Southern California's water supply without completion of the implementation phase. Thus, the complete IRP was divided into two phases, and the needs assessment was completed.

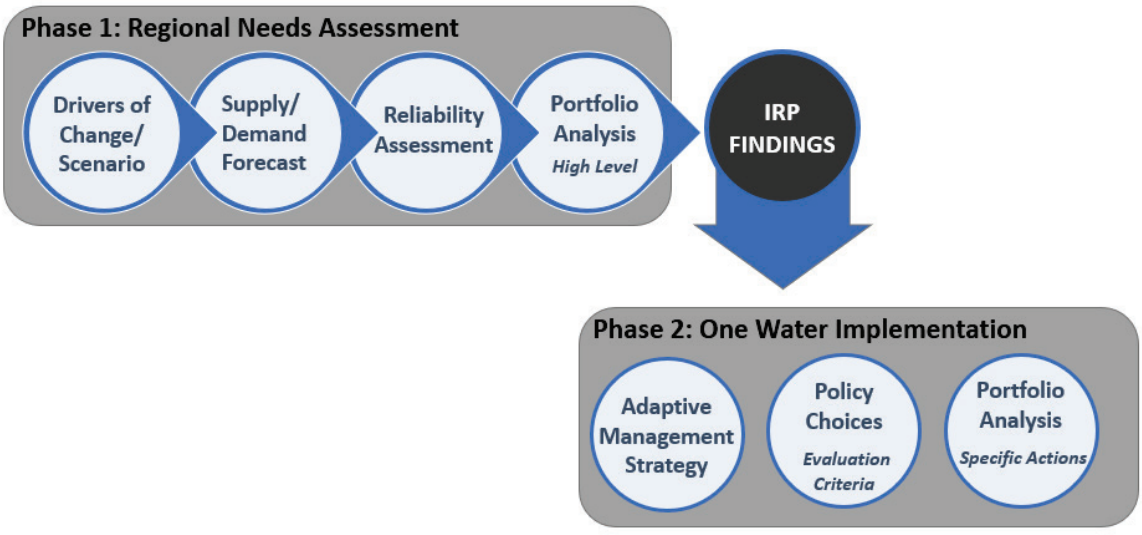
Figure 1 shows the two phases:

- Phase 1: Regional Needs Assessment
- Phase 2: One Water Implementation

The two-phase IRP allows Metropolitan to transition towards a new One Water approach to water reliability and resilience in Phase 2. The One Water approach will focus on balancing Southern California's broad interests in managing finite water resources for both community and ecosystem needs. It will embrace the region's diverse communities through a collaborative approach to addressing water challenges. Establishing a common understanding of the scope of potential water needs of Southern California over the next 25 years is key to the approach in Phase 2. By first defining and identifying a potential range of the region's problems, the IRP Regional Needs Assessment provides the technical foundation to enable the work of identifying specific actions in Phase 2.

Attachment 1 contains the final draft report of the IRP Regional Needs Assessment. It documents the scenario development and subsequent modeling efforts. It then offers a set of findings to inform deliberations and decision-making in Phase 2. In Phase 2, portfolios will be advanced by identifying policies, programs, and projects to address the findings. A comprehensive, adaptive management strategy will be developed in Phase 2 to guide these specific actions.

Figure 1: Process Diagram for Phases 1 and 2 of the 2020 IRP



Recommendation to Adopt Findings of the Phase 1 2020 IRP Regional Needs Assessment

The 2020 IRP Regional Needs Assessment outcomes can be summarized through a set of findings grounded in the scenario reliability analysis. These findings provide the foundation and guardrails for Phase 2. Grouped by topic, the following findings are offered for consideration by the Board:

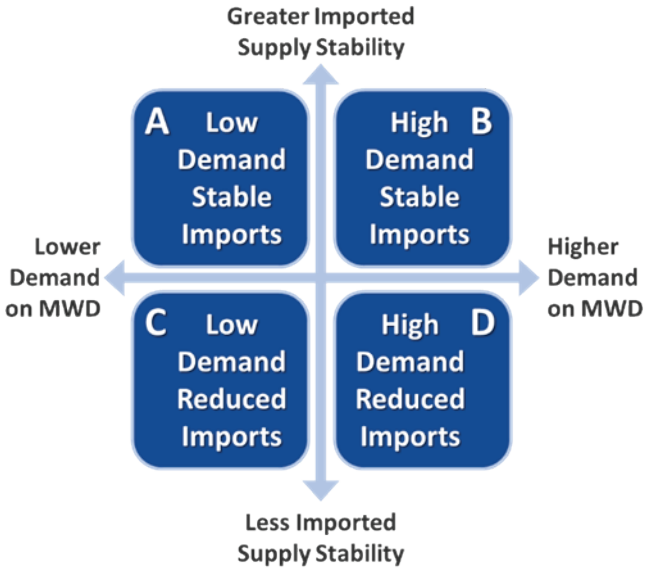
SWP Dependent Areas
• Vulnerabilities in the SWP Dependent Areas are more severe given reduced reliability of SWP supplies and Metropolitan distribution system constraints. Actions identified in the implementation phase must prioritize addressing the SWP Dependent Area's reliability challenge. • New core supplies must be accessible to the SWP Dependent Areas. Greater access to existing core supplies can also increase SWP Dependent Area reliability. • Enhanced accessibility to core supplies and storage, both existing and new, will improve SWP Dependent Area and overall reliability. This includes improvements to Metropolitan's distribution system and capacity to deliver non-SWP supply and storage. • Storage capacity, put/take capabilities, and accessibility are critical considerations for the SWP Dependent Area. New storage capacity and put/take capabilities should be consistent with the portfolio analysis. New storage must be accessible to the SWP Dependent Areas.
Storage
• Storage capacity, put/take capabilities, and accessibility are critical considerations in maintaining reliability under the region's current and future conditions, especially for SWP Dependent Areas. • Maintaining Metropolitan's existing storage portfolio is critical, including the consideration of re-negotiating contracts when they expire. • Expanding existing or developing new storage programs and investments in Metropolitan's distribution system can reduce the need for new core supply development to meet potential future shortages and adapt to climate change. • When evaluating storage options, put/take capabilities are essential; even storage programs with modest put/take capabilities help reduce the need for flexible supply.
Retail Demand/Demand Management
• Metropolitan's future supply reliability may fluctuate based on demand increases and decreases. • Variability in retail demand largely comes from changes in outdoor water use. Outdoor water use behavior is complex, influenced by weather and climate and by awareness of water scarcity and other conservation measures. • It is important to pay attention to demand rebound, demand growth, and demand reductions, and take appropriate regional measures as necessary. • Managing long-term demands through the efficient use of water reduces dependency on supplies, helps preserve storage, and helps reduce the need for extraordinary conservation measures.

Metropolitan Imported Supplies
• Existing imported supplies are at risk from various drivers of uncertainty. • Maintaining existing imported supply reliability reduces the need for new core supply development and leverages years of investments. • SWP supplies are highly susceptible to varying hydrologic conditions, climate change, and regulatory restrictions. • Variability and capacity in SWP supplies provide opportunities to store water during wet periods for use in dry years, including Colorado River storage. Metropolitan's ability to distribute or store SWP supplies when they materialize will enhance the region's reliability, particularly the SWP Dependent Areas. The Colorado River system and Colorado River Aqueduct capacity do not offer the same opportunities concerning SWP storage. • Shortages on the Colorado River will limit the reliability of Colorado River Aqueduct deliveries as a core supply in the future.
Local Supply
• Maintaining existing and developing new local supplies is critical in helping manage demands on Metropolitan. • Impacts to reliability occur if local supply assumptions are not achieved; therefore, it is important to track the progress of local supply development as one of the signposts in the One Water Implementation phase. • Additional actions may be needed should existing and future local supply levels deviate from IRP assumptions.

IRP Scenario Framework

Figure 2 shows the four scenarios used to characterize different outcomes of imported supply stability and demand on Metropolitan. Key drivers of change such as climate, regulatory requirements, and the economy are uncertain and may exert significant effects on both water supply and demands. These and other drivers of change were identified through a collaborative process involving member agencies, expert consultants, research by staff, and the input of other interested parties. The impacts of these drivers within each scenario were quantified using in-house models.

Figure 2. Four Scenarios Used in the IRP



Interaction with Other Planning Efforts

Metropolitan's 2020 Urban Water Management Plan was developed in coordination with the 2020 IRP. When both phases of the IRP are complete, the planning process will serve as Metropolitan's blueprint for long-term water reliability, including key supply development, infrastructure improvements, and water use efficiency goals.

Together, the IRP and the UWMP serve as the reliability roadmap for the region. The UWMP relied on demographic and climate inputs provided by other agencies such as the Southern California Association of Governments, San Diego Association of Governments, California Department of Water Resources, and the U.S. Bureau of Reclamation. The

IRP Regional Needs Assessment extended the planning horizon beyond the single scenario outcomes shown in the UWMP. But importantly, the factors and assumptions used to create the UWMP scenario fall within the bounds of this work.

The IRP Regional Needs Assessment informs other planning efforts and serves as boundary conditions to consider in other planning venues. For example, the IRP Implementation Phase will need to consider the performance of any portfolio under the four scenarios identified in this work.

The General Manager's priorities for the next biennium emphasize action to address findings of the IRP Regional Needs Assessment. For example, substantial effort is underway to provide each member agency access to an equivalent level of water supply reliability and to resolve the constraints of the SWP dependent areas.

Likewise, the portfolio selection will also need to consider Metropolitan's proposed emissions reduction goal in the draft Climate Action Plan to ultimately achieve carbon neutrality by 2045. Finally, the planned rate structure review will also need to ensure the business model can adapt to changing needs of the member agencies and support sustainable local and imported supplies under the same scenarios.

Next Steps

Adoption of the findings and analysis represents a critical juncture; however, the 2020 IRP is far from over. No specific actions are recommended or have been determined from the IRP Regional Needs Assessment. Following adoption of the IRP Regional Needs Assessment, Metropolitan will transition to implementation in Phase 2.

The One Water Implementation phase will take the results and findings of Phase 1 into a collaborative process to identify integrated regional solutions. Using a One Water approach, the implementation phase will translate the high-level portfolio analysis from Phase 1 into specific policies, programs, and projects to address the findings and mitigate the potential shortages. A comprehensive, adaptive management strategy and evaluation criteria will be developed to guide these specific actions. The adaptive management strategy will also establish a process for monitoring key reliability indicators to support decision-making.

Appendices for the 2020 IRP Regional Needs Assessment will be posted to Metropolitan's website at www.mwdh2o.com/IRP. These appendices serve as living documentation for the IRP Regional Needs Assessment, and they will be supplemented and refreshed with updated materials as they become available.

Policy

By Minute Item 14727, dated December 16, 1952, board adoption of a statement of policy with regard to the plans being proposed for the importation or development of large, additional water supplies for the area coming within the scope of this District.

By Minute Item 39412, dated January 14, 1992, board adoption of the revised mission statement of the Metropolitan Water District of Southern California.

By Minute Item 41734, dated January 9, 1996, board adoption of the Integrated Water Resources Plan.

By Minute Item 43810, dated December 14, 1999, board adoption of the Strategic Plan Policy Principles.

By Minute Item 45841, dated July 13, 2004, the Board approved the Integrated Water Resources Plan Update report and the regular interval of IRP Implementation Reports and IRP updates.

By Minute Item 48449, dated October 12, 2010, board adoption of the 2010 Integrated Resources Plan Update.

By Minute Item 50358, dated January 12, 2016, the Board adopted the 2015 Integrated Water Resources Plan Update.

Metropolitan Water District Administrative Code Section 11104: Delegation of Responsibilities.

California Environmental Quality Act (CEQA)

CEQA determination for Option #1:

The proposed action is not defined as a project under CEQA (Public Resources Code Section 21065, State CEQA Guidelines Section 15378(b)(2) and 15378(b)(5)) because it involves organizational or administrative activities and general policy and procedure making that would not result in a direct or indirect physical change to the environment.

CEQA determination for Option #2:

None required

Board Options

Option #1

Authorize the General Manager to adopt the 2020 Integrated Water Resources Plan Regional Needs Assessment.

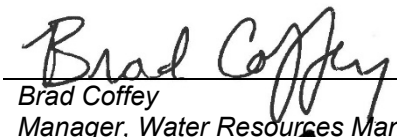
Fiscal Impact: No immediate impact; Metropolitan's long-term costs will depend upon individual project approvals following a forthcoming One Water Implementation Plan.
Business Analysis: Metropolitan's mission is to provide a reliable supply of water to its service area. The 2020 IRP Needs Assessment findings provide guidance on how Metropolitan may accomplish this mission for the next 25 years

Option #2

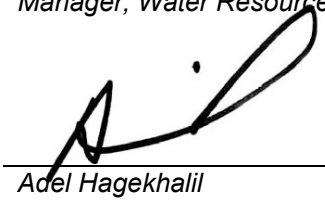
Do not adopt the 2020 Integrated Water Resources Plan Regional Needs Assessment.
Fiscal Impact: None
Business Analysis: This option reduces the ability of Metropolitan to consider and plan for major changes in the region's water resources.

Staff Recommendation

Option #1



3/16/2022
Brad Coffey *Date*
Manager, Water Resources Management



3/17/2022
Adel Hagekhalil *Date*
General Manager

Attachment 1 – 2020 IRP Regional Needs Assessment

Ref# wrm12685000

2020 IRP – Regional Needs Assessment

Draft

Executive Summary

Southern California's water future in a word — uncertain.

Higher temperatures in the Southwest have led to a dramatic reduction in Colorado River runoff this century. Variable weather in Northern California and stressed ecosystems have resulted in unprecedented low imports from the State Water Project (SWP). Likewise, in Southern California itself, less stormwater is percolating into groundwater basins, both from too much rain at times or not enough.

As a regional planner for water supply reliability for Southern California, the Metropolitan Water District relied on single, mid-range forecasts during planning efforts for over a generation. At this moment, with so many questions about what lies ahead, planning that narrows in on a single forecast does not capture the breadth of uncertainties.

Scenario Planning: A Fresh Approach

In collaboration with its 26 member agencies, other interested parties, and its Board of Directors, Metropolitan has broadened its perspectives with scenario planning and thoroughly analyzing four potential futures – all different, all plausible. In the scenarios, demands on Metropolitan's imported supplies varied due to different weather and demographic patterns, among other factors. Supplies varied as well, due to reasons such as climate change severity and regulatory impacts.

After analyzing these futures, a potential for water shortages emerged. The planning revealed that a large portion of Metropolitan's service area is vulnerable to Northern California drought and regulatory restrictions. At present, Metropolitan has limited capacity to move Colorado River water to the northern portions of the district's service area served by the SWP.

The member agencies in this area are the City of Burbank, Calleguas MWD, Eastern MWD, Inland Empire Utility Agency, Las Virgenes MWD, Los Angeles Department of Water and Power, San Fernando, Three Valleys MWD, Upper San Gabriel Valley MWD, and Western MWD. About a third of Metropolitan's six-county service area lives within the boundaries of this SWP Dependent Area.

As the scenario planning process identified the potential of water shortages for these communities, the threat began to play out in real life.

The 2020 and 2021 water years experienced record low supply from Northern California due to the drought – a 20 percent SWP allocation in 2020 followed by a historically low 5 percent last year. Metropolitan declared a drought emergency in 2021 because the Dependent Areas were approaching shortage conditions.

With experience confirming analysis, Metropolitan found the possibility of shortage in three of the four scenarios, after exhausting available and accessible supplies. Only in a future with low demands and stable imported supplies would Southern California avoid shortage without additional water supply and system reliability investments. The record low supplies so far this decade from Northern California,

coupled with the first-ever shortage declaration for the lower Colorado River in August 2021, suggest the region may not be so fortunate.

Scenario planning led to the following findings:

SWP Dependent Areas

- Vulnerabilities in the SWP Dependent Areas are more severe given reduced reliability of SWP supplies and Metropolitan distribution system constraints. Actions identified in the implementation phase must prioritize addressing the SWP Dependent Area's reliability challenge.
- New core[1] supplies must be accessible to the SWP Dependent Areas. Greater access to existing core supplies can also increase SWP Dependent Area reliability.
- Enhanced accessibility to core supplies and storage, both existing and new, will improve SWP Dependent Area and overall reliability. This includes improvements to Metropolitan's distribution system and capacity to deliver non-SWP supply and storage.
- Storage capacity, put/take capabilities, and accessibility are critical considerations for the SWP Dependent Area. New storage capacity and put/take capabilities should be consistent with the portfolio analysis. New storage must be accessible to the SWP Dependent Areas.

Storage

- Storage capacity, put/take capabilities, and accessibility are critical considerations in maintaining reliability under the region's current and future conditions, especially for SWP Dependent Areas.
- Maintaining Metropolitan's existing storage portfolio is critical, including the consideration of re-negotiating contracts when they expire.
- Expanding existing or developing new storage programs and investments in Metropolitan's distribution system can reduce the need for new core supply development to meet potential future shortages and adapt to climate change.
- When evaluating storage options, put/take capabilities are essential; even storage programs with modest put/take capabilities help reduce the need for flexible supply[2].

Retail Demand/Demand Management

- Metropolitan's future supply reliability may fluctuate based on demand increases and decreases.
- Variability in retail demand largely comes from changes in outdoor water use. Outdoor water use behavior is complex, influenced by weather and climate and by awareness of water scarcity and other conservation measures.

[1] Core supplies are resource management actions that augment supply or reduce Metropolitan demand and remain available each year.

[2] Flexible supplies are implemented as needed and include savings from deliberate efforts to change water use behavior

- It is important to pay attention to demand rebound, demand growth, and demand reductions, and take appropriate regional measures as necessary.
- Managing long-term demands through the efficient use of water reduces dependency on supplies, helps preserve storage, and helps reduce the need for extraordinary conservation measures.

Metropolitan Imported Supplies

- Existing imported supplies are at risk from various drivers of uncertainty.
- Maintaining existing imported supply reliability reduces the need for new core supply development and leverages years of investments.
- SWP supplies are highly susceptible to varying hydrologic conditions, climate change, and regulatory restrictions.
- Variability and capacity in SWP supplies provide opportunities to store water during wet periods for use in dry years, including Colorado River storage. Metropolitan's ability to distribute or store SWP supplies when they materialize will enhance the region's reliability, particularly the SWP Dependent Areas. The Colorado River system and Colorado River Aqueduct capacity do not offer the same opportunities concerning SWP storage.
- Shortages on the Colorado River will limit the reliability of Colorado River Aqueduct deliveries as a core supply in the future.

Local Supply

- Maintaining existing and developing new local supplies is critical in helping manage demands on Metropolitan.
- Impacts to reliability occur if local supply assumptions are not achieved; therefore, it is important to track the progress of local supply development as one of the signposts in the One Water Implementation phase.
- Additional actions may be needed should existing and future local supply levels deviate from IRP assumptions.

One Water: How a Comprehensive Solution Starts by Understanding the Need

Metropolitan's emerging One Water approach to reliability and resilience brings together all of Southern California's interests in managing finite water resources for both community and ecosystem needs. It goes beyond identifying the region's future water portfolio and embraces collaboration, diverse communities, and a unified approach to problem-solving. This 2020 IRP looks at multiple futures and builds a One Water foundation by understanding the potential needs of Southern California in the next quarter-century.

Metropolitan's stated goal is 100 percent reliability for all its Member Agencies. The first step toward achieving this goal is to identify potential shortcomings, which speaks to the wisdom of analyzing different plausible futures. The scenario analyses revealed conceivable reliability outcomes through

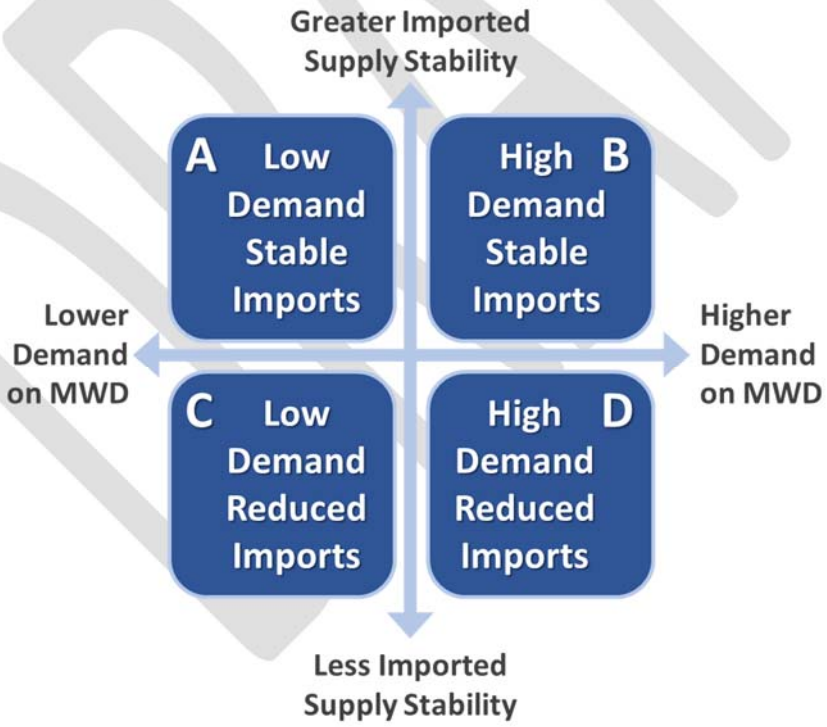
2045. The potential annual net shortage ranged from none under the Low Supply/Stable Imports Scenario (A) to as high as 1.2 million acre-feet (MAF) under the High Demand/Reduced Imports Scenario (D). As Metropolitan proceeds towards implementation in the next phase of the IRP, actions will address these gaps consistent with the portfolio category analysis presented in Chapter 4.

The IRP Regional Needs Assessment identifies significant threats facing Southern California's water supply reliability through successive qualitative and quantitative analysis steps. The assessment sizes up the scope of reliability challenges and the management solutions that could be in store for the region by the year 2045 under a wide range of conditions. The completion of this assessment launches the "One Water Implementation" phase, which will involve extensive collaboration among Metropolitan's Board, member agencies, and other interested parties to develop an adaptive management strategy will also establish a process for monitoring key reliability indicators and find joint approaches to the regional problems and resource needs identified in this assessment. For example, Metropolitan will continue to support the development of local supplies by Member Agencies during the One Water Implementation phase.

IRP Scenario Framework

As illustrated by **Figure ES-1**, the 2020 IRP is based on four scenarios characterized by divergent outcomes of imported supply stability and water demands on Metropolitan.

***Figure ES-1**: 2020 IRP Scenario Framework*



Key drivers of these outcomes include climate change, regulatory requirements, and the economy. These remain uncertain but significantly contribute to water supply and demands. These and other drivers of change were identified through a collaborative process. The impacts of these drivers within each scenario were quantified using Metropolitan's models.

The IRP scenarios serve as learning tools, not predictions. By contemplating four alternative but plausible outcomes, they shed light on what could happen between now and 2045. They also signal the need for future "signposts" to indicate emerging needs that may require the re-prioritization of future investments and other adaptive actions.

Technical Results

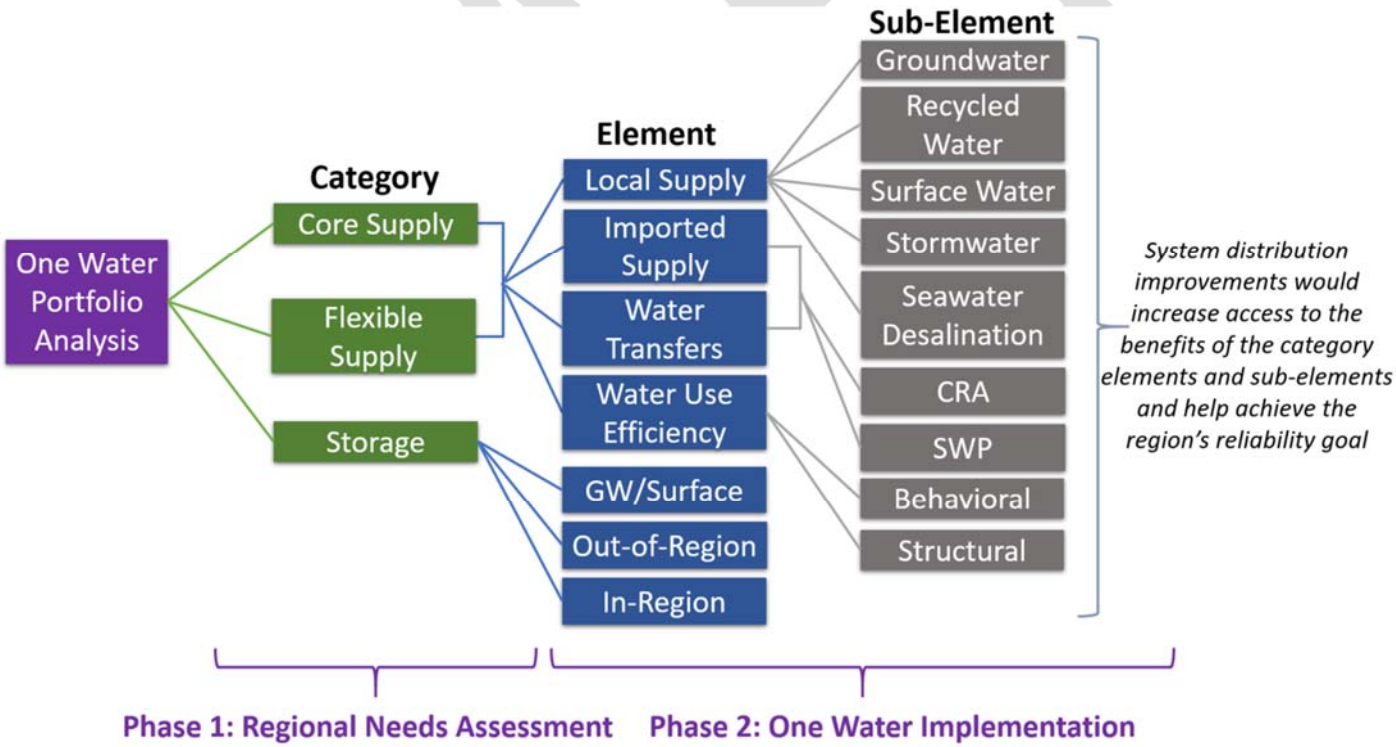
The technical results of the Regional Needs Assessment were based on two analytical processes:

- Reliability assessment to define and quantify potential "gaps" for each scenario, and
- Portfolio analyses to quantify high-level categories of actions that would be needed to achieve reliability in each scenario.

Scenario A (Low Demand/Stable Imports) posed the least challenge to reliability, Scenario D (High Demand/Reduced Imports) the greatest.

As shown in **Figure ES-2**, the portfolio analysis explored the effectiveness of supply categories to reduce or eliminate gaps. The three supply types include core, flexible, and storage. The evaluation determined an effective resource mix for each scenario at the category level.

Figure ES-2: *Levels of One Water Portfolio Analysis*



Note: The elements and sub-elements identified are examples and not meant to be an exhaustive list.

This report, which completes the IRP Regional Needs Assessment phase, offers findings, quantifies supply-demand gaps, and examines the effectiveness of generalized portfolio categories to inform implementation. The One Water Implementation phase will analyze solution portfolios at the Element and Sub-Element levels, consistent with the core supply, flexible supply, and storage configurations identified here.

These results and findings impart optimism for Southern California's water future. Metropolitan has identified the tools necessary to successfully adapt to various plausible futures using the full suite of available solutions — a comprehensive One Water approach. It is also well within Southern California's control to avoid a future with unsustainable increased per-capita water use and demands. With the development of an adaptive management strategy, Southern California can adjust its portfolio of water actions to keep up with our changing times.

Chapter 1 - Introduction

The Evolution of Metropolitan's Integrated Water Resource Planning

The Integrated Water Resources Plan (IRP) is Metropolitan's key planning effort that establishes a long-term, comprehensive water resources strategy to provide the region with a reliable and affordable water supply. At its core, the IRP process is a collaborative effort between key interested parties – Metropolitan, its Member Agencies, other local water agencies, and community, business, environmental, and agricultural interests – to identify preferred solutions to long-term water resource reliability challenges and develop strategies to address those challenges.

The IRP is adaptive – as regional water resource issues evolve, so does the IRP. Since the inaugural IRP in 1996, Metropolitan routinely monitors conditions and measures progress in achieving the plan's objectives. As such, the IRP has been periodically updated to expand Metropolitan's strategy to address changing conditions that affect water resource reliability.

Regional Assemblies and the 1996 IRP

The 1987-1992 drought (California Department of Water Resources, 2021, pp. 4-6) exposed Southern California to significant water supply challenges across six years, prompting a change in water management, investment, and planning. In response, Metropolitan initiated regional assemblies of Metropolitan's board and senior management, member agency managers, local water agencies, and invited public officials. The assemblies established principles for agencies in the service area that would guide the development and adoption of future IRPs:

- Every water supplier, to varying degrees, relies upon the regional imported water supply distribution and storage system.
- Metropolitan is a lead agency in the region's water management.
- Every water supplier is responsible for promoting a strong water ethic to their constituents and is committed to the transparent, equitable, and fair development and implementation of water management programs to achieve regional goals.

With this foundation, Metropolitan developed the first Integrated Water Resources Plan (MWDSC, 1996). The 1996 IRP identified a "Preferred Resource Mix" based on cost-effectiveness, diversification, and reliability to supply the region through 2020. This portfolio balanced the investments between imported supply, local supply, and conservation. Additionally, the 1996 IRP emphasized the need for a coordinated network of surface and groundwater storage.

2004 IRP Update

After the 1996 IRP, drought within the Colorado River Basin resulted in the loss of surplus supplies available to Metropolitan. In 2003, the Quantification Settlement Agreement (QSA) and other related agreements established water use caps for higher-priority users in California, enabling several new water transfer programs to augment Metropolitan's basic apportionment. The 2004 IRP Update updated the original goals set in 1996, quantified the impact of changing conditions, and revised resource development targets through 2025. This first update recognized the need to adapt to changing conditions and anticipate uncertainties. These uncertainties ranged from population and economic growth, increasingly stringent water quality regulations, endangered species protections, and a shifting climate and hydrology. The update addressed these uncertainties by including a planning buffer of

10 percent of regional demands (500,000 AF) that identified additional local supplies and imported supply transfers or exchanges that could be implemented as needed.

2010 IRP Update

By 2010, the Colorado River had experienced below-average precipitation for a decade. The SWP faced new environmental and water quality protections that reduced the Sacramento-San Joaquin Delta supplies, particularly during the 2007-2009 drought. The 2010 IRP Update established adaptive management as a strategy to meet demands under observed hydrology and future uncertainty to address these changed conditions. Elements of the adaptive management strategy included:

- **Core resources.** A strategy to maintain reliability under planned conditions such as published demographic forecasts and historical hydrology.
- **Supply buffer.** This strategy expanded the earlier concept of a planning buffer to respond to shorter-term variability outside of planned conditions. This preventive action included expanding water-use efficiency and local supplies beyond the core resources.
- **Future supply actions.** This new strategy addressed long-term uncertainty by accelerating the development of new water supplies through driving feasibility studies, technological research, and regulatory review.

With the 2010 IRP Update, Metropolitan's planning efforts began to lay the foundation for a more proactive strategy to address future uncertainties.

2015 IRP Update

The 2012-2016 drought (DWR, 2021) further strained imported supplies and local groundwater basins that were already in decline from extended dry conditions and regulatory constraints. However, the region entered this drought with a record quantity of water stored within Metropolitan's network of reservoirs and groundwater banks at the time, highlighting the success of Metropolitan's investments in storage guided by the IRP. These critically dry years acted as both a stress test for Metropolitan's adaptive management strategy and a further indication of the severe challenges the future could hold. The 2015 IRP Update revised resource targets, identified transfers and exchanges to address short-term risk, and reaffirmed the importance of taking action today to accelerate the development of new water supplies through future supply actions. As such, the 2015 IRP Update developed approaches for how Metropolitan could advance conservation and local resources development and maximize its storage reserves in a future that may see more severe and frequent drought.

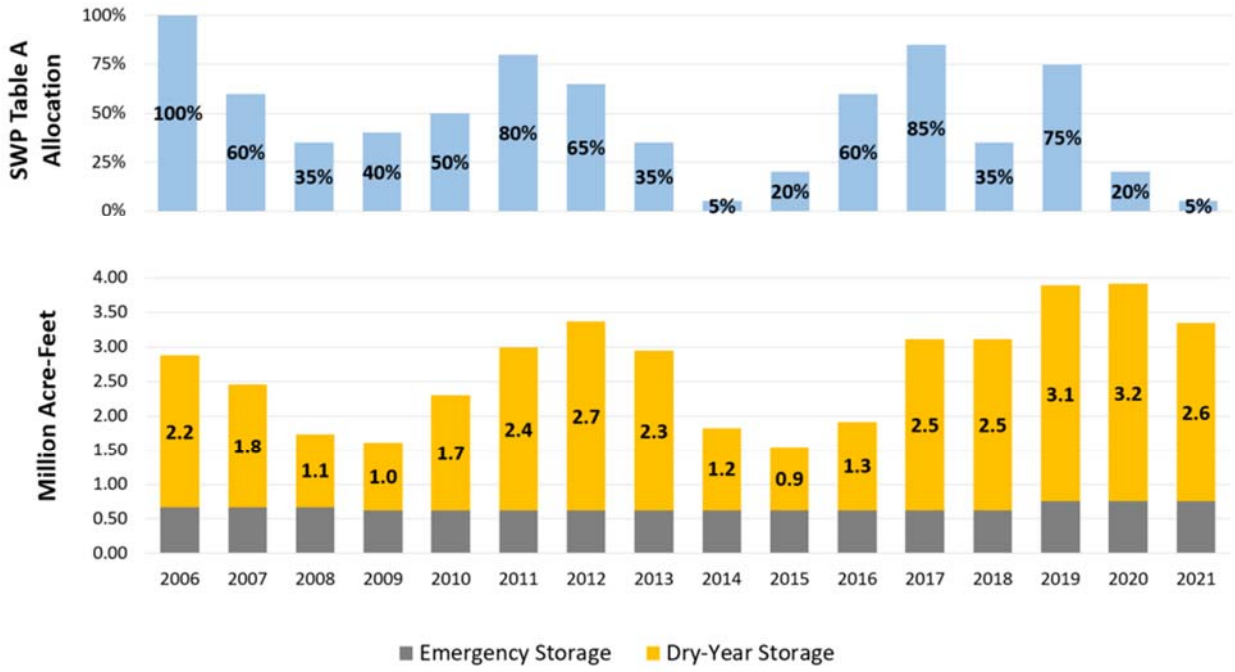
Conditions Underlying the 2020 IRP and Future Uncertainty

After the 2015 IRP Update, the region received a brief respite from drought. From 2016 to 2020, Metropolitan leveraged its prior investments in conservation, local projects, regional storage, distribution, and treatment infrastructure to rapidly improve its water supply position. Metropolitan moved a record amount of water into storage in 2017 and reached a record-high storage balance by the end of 2020 as shown in **Figure 1-1**. This figure also illustrates that Metropolitan has, through these investments, stored water in wet years when the SWP allocation was higher (2010-2012, and 2016-2017, and 2019) for use in drought years when the SWP

Metropolitan Imported Supplies Finding: *SWP supplies are highly susceptible to varying hydrologic conditions, climate change, and regulatory restrictions.*

allocation was lower (2008-2009, 2013-2015, and 2020-2021). Metropolitan's diverse portfolio investments guided by the IRP made this management of wetter hydrologic conditions possible. The region's ability to continue to effectively manage surplus water during wet years to quickly recover from dry conditions will prove vital for managing through future droughts.

Figure 1-1: *SWP Allocation and End of Year Storage Balance*



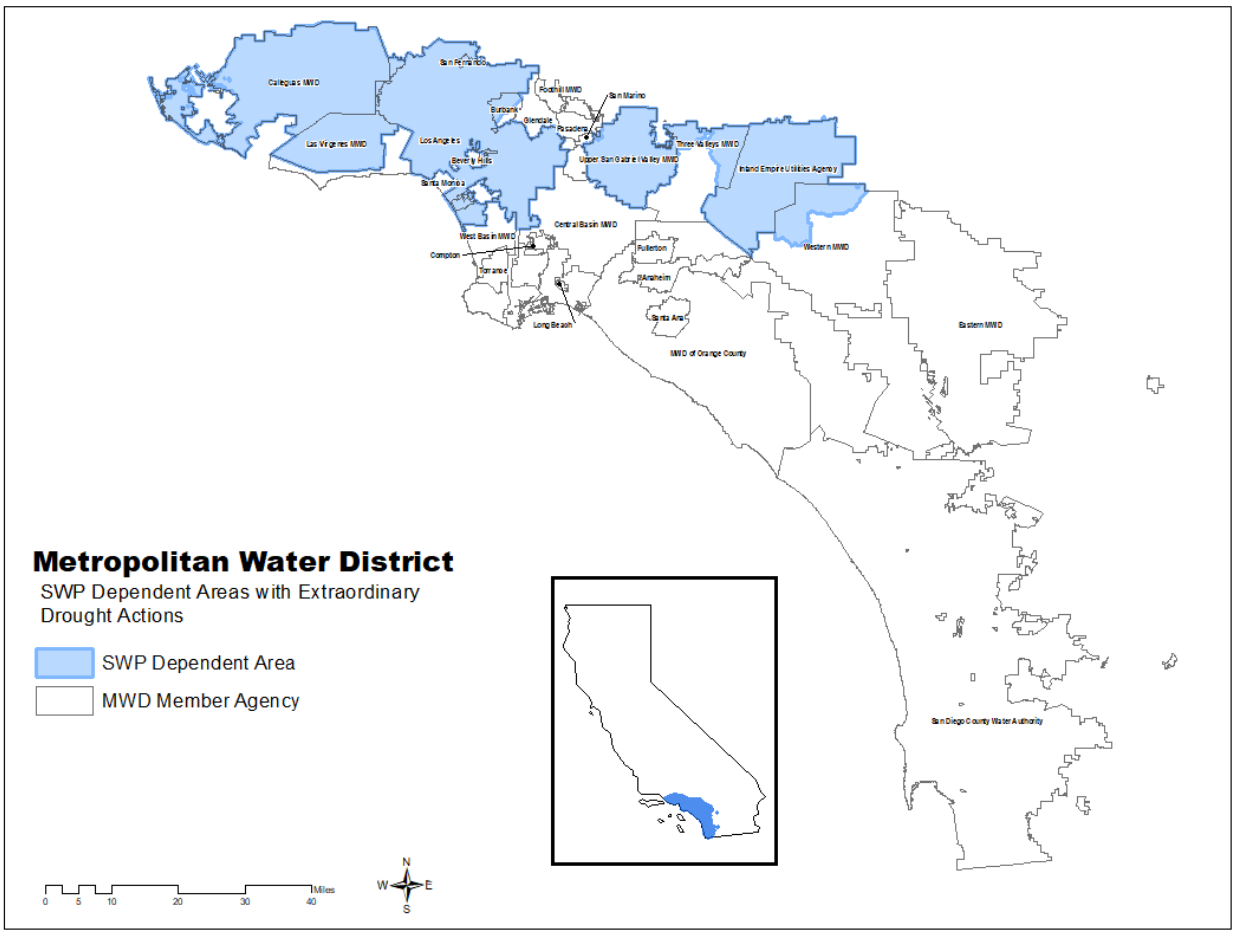
Note: End of year 2021 balance subject to DWR adjustments and USBR final accounting.

The current drought once again brought the need for regional planning sharply into focus. Despite the record amounts of water in storage at the end of 2020, consecutive low SWP allocations in 2020 (20 percent) and 2021 (5 percent) highlighted a critical vulnerability within Metropolitan's existing distribution system. Colorado River supplies cannot serve some parts of the service area that are not otherwise self-sufficient with local supplies. A key challenge for Metropolitan in 2021 was in meeting water demands in these "SWP Dependent Areas," shown in **Figure 1-2**. The very low SWP allocation of 5 percent made it imperative to safeguard the limited SWP supplies. A combination of storage withdrawals, voluntary conservation efforts, and expanded access to Colorado River supplies through extraordinary drought actions preserved SWP Table A supplies and SWP storage to meet SWP Dependent Area demands in 2021.

Vulnerability of the SWP Dependent Areas is both a near-term and long-term concern, as the findings of this 2020 IRP Regional Needs Assessment Report will emphasize. As of the writing of this report, ensuring water reliability for the SWP Dependent Areas continues to be a challenge. Metropolitan declared a regional drought emergency in November 2021 because the SWP Dependent Areas were approaching shortage. On December 1, 2021, the California Department of Water Resources (DWR) announced a zero percent initial SWP Table A allocation for 2022 based on low reservoir levels and dry hydrologic conditions; DWR later increased the 2022 SWP allocation to 15 percent in January 2022 after

favorable precipitation events in December[3]. Under a zero percent SWP allocation, there would have been insufficient SWP supplies to fully meet consumptive demands not deemed essential to human health and safety needs in the SWP Dependent Areas. Additionally, Metropolitan would be unable to replenish its regional storage in Diamond Valley Lake. As such, it is vital to maintain and preserve SWP deliveries to ensure reliability throughout Metropolitan's service area. If conditions for Metropolitan's crucial imported supply systems continue to worsen, then the region may increasingly face similar prospects in the future.

Figure 1-2: *State Water Project Dependent Areas with Extraordinary Drought Actions*



The extreme changes in hydrologic conditions since the 2015 IRP Update underscore why it is vital that the IRP evolves. While past investments have played a key role in managing through the changing conditions experienced over the past 25 years, the continued evolution of the IRP will be essential for guiding the next 25 years of investments. Today, as the forecasts of past IRPs draw inevitable comparisons to present conditions, there is a growing appreciation of the limitations inherent to any projection based on a single set of assumptions. An array of factors shaped water supply and demand trends between then and now, and many uncertainties out of Metropolitan's control loom on the

[3] As of this writing, the SWP allocation of 15 percent is not finalized for 2022. Continued dry conditions may result in a lowering of the allocation.

horizon. Mounting evidence of an increasingly varied climate and a proliferation of other external uncertainties suggest that previous IRPs may have relied on too narrow of a range of outcomes to ensure the avoidance of shortages in the future.

Figure 1-3: *Evolution of IRP Retail M&I Demand Forecast Range and Observed Historical Demand*

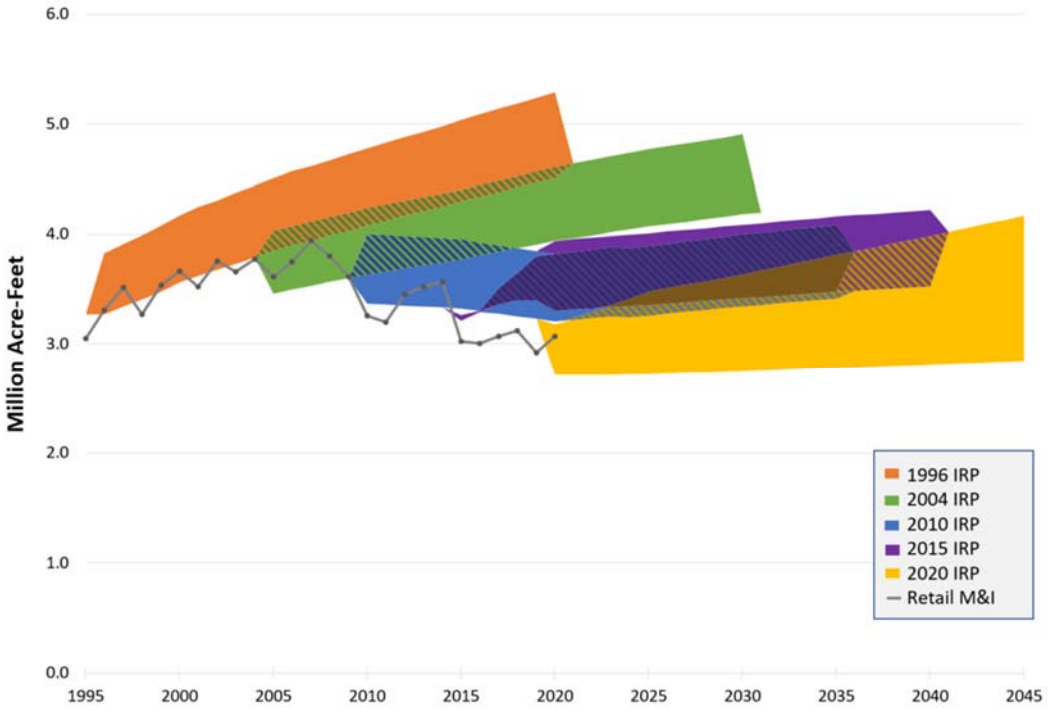


Figure 1-3 illustrates that Metropolitan recalibrated to current conditions as a baseline for each IRP update. Additionally, each IRP update incorporated new knowledge on uncertainties in the forecasts. The 2020 IRP in the yellow shaded area of the chart offers a wider range of retail demand forecasts than previous IRPs. It encompasses a range of assumptions comprising four distinct scenarios. It also takes a step forward from prior IRPs by examining a broader range of outcomes for these uncertainties, rather than just one set of assumptions as in past IRPs. For the 2020 IRP, all four scenarios launch and diverge over time from a common baseline of observed conditions leading up to the year 2020.

The 2020 Integrated Water Resource planning process features a regional needs assessment, as its first phase, that evaluates the impacts of future uncertainties on water resource reliability. This effort resulted in a comprehensive list of findings, the focus of this report, to help guide actions to address those uncertainties. Going forward, Metropolitan has the process and tools to evaluate specific investments and program actions under a range of future scenarios — developing an adaptive management strategy through the One Water Implementation that can guide implementation.

Chapter 2 – IRP Scenario Process

Planning for an Uncertain Future

It is increasingly clear that the underlying mechanisms and assumptions used to make past IRP projections are unpredictable. This means that a single long-term prediction on Southern California's water supplies and demands will provide an underestimation of the uncertainties and overconfidence in a specific presumed future. In this light, being aware of the range of alternative prospects is more useful than relying on a single projection. Thus, a new analytical framework was developed to:

- Define and account for uncertainties affecting water reliability
- Develop a method to assess and communicate the impacts of those uncertainties
- Explain the uncertainties and their relevance in a clear and transparent way
- Allow integration with an adaptive management strategy that will provide ongoing decision support, information generation, and reporting as essential components

Early on, scenario planning was selected to fulfill these objectives (Metropolitan Water District of Southern California, 2020g). Scenario building involves creativity, imagination, introspection, and reality checks based on political, economic, and scientific reasoning. To come up with a broad view of water-related uncertainties and plausible outcomes, Metropolitan undertook a comprehensive engagement process with its Board, member agency staff, other interested parties, and expert consultants.

In shaping the region's long-term water reliability, Metropolitan understood the importance of consensus on uncertainties and evaluating their impact. Public outreach and involvement for the 2020 IRP followed a different approach than before. Due to the onset of the COVID-19 pandemic in 2020, public outreach events pivoted to online presentations and workshops with additional information and public comment opportunities at IRP Committee meetings. The IRP microsite on Metropolitan's website provided access to expert panel discussions, data and analysis, presentations, and white papers. The online outreach broadened the opportunities for interested parties to engage throughout the IRP process.

Reliability Goal

Metropolitan's Board established the Integrated Resources Plan Special Committee (IRP Committee) to provide oversight and input during the development of the 2020 IRP. Early in the process, the IRP Committee reaffirmed a goal to provide 100 percent water supply reliability for the service area. This overarching goal set the tone for the IRP planning process and the basis for the subsequent analyses.

Given the Board's commitment to avoid shortages, scenario planning helped identify critical vulnerabilities and patterns that can mitigate potential shortages with timely interventions. The One Water Implementation phase will be designed to consider reliability measures under multiple scenarios.

Why Scenario Planning?

A look back since the previous 2015 IRP Update validated the collective, integrated efforts to secure water reliability for the 19 million people of Southern California (MWDSC, 2020e). When developing the 2015 IRP Update, California was enduring a historic drought, and the Colorado River watershed moved into its second decade of drought. But with a concerted drought response consistent with

Governor Brown's and the State Water Board's imposed mandatory conservation and Metropolitan's planning and policy efforts, the collective actions of water agencies throughout the region reduced per-capita water demands to historic lows. Combined with decades of planning and infrastructure investment since the original 1996 IRP, the area experienced a remarkable turnaround in water supply reliability. The efforts of individual consumers, local retail agencies, member agencies, and Metropolitan all contributed (MWDSC, 2020e).

Despite this success, long-term threats remain. Although persistently low demands since 2015 allowed storage to recover quickly, questions remain about whether per-capita demand will continue its downward trend. Further, the implication of continuing low demands on Metropolitan and the region's other potable and recycled water suppliers must be considered. For example, lower indoor use results in less wastewater with more highly concentrated effluent. This potentially increases the cost of recycling. Coming full circle, California again faces severe drought, conditions on the Colorado River worsen, and the disruption of the COVID-19 global pandemic has shaken society's conceptions of normality, perhaps causing yet unseen ripple effects in water-using behavior trends (AWWA and AMWA, 2020; MWDSC, 2020f; Smull et al., 2021).

The future can quickly move in unexpected directions. Reliability is a constant concern, both today and over the long term. Financial advisors warn investors that past performance is no guarantee of future results. Even the best-laid plans based on past and recent experience may not be resilient in a highly uncertain future. Because interventions to increase reliability come with different costs and benefits, decision-makers must consider affordability, environmental, and equity tradeoffs when deciding upon the timing and scale of those investments. Within this backdrop of emerging and unpredictable threats to water supply reliability and affordability, Metropolitan has considered the potential effects of major drivers and long-term threats as it moves into the IRP's One Water Implementation phase. Scenario planning offers a powerful tool to address these uncertainties.

With scenario planning, plausible futures are envisioned and explored. As described by Varum and Melo (2010), scenario planning helps one "gain confidence by 'pre-experiencing' future scenarios" (p. 361). This approach improves understanding of a broader range of potential outcomes. In turn, those outcomes allow a greater understanding of potential challenges to water supply reliability and the impacts of possible policy direction, helping to inform actions.

Throughout 2020 IRP's scenario planning process, the following points should be considered:

- Scenarios represent outcomes resulting from groupings of drivers of change, which are selected to be internally consistent and whose outcomes are outside of Metropolitan's control
- No scenario should be regarded as "most likely" or "preferred" as each scenario has outcomes that are entirely plausible relative to each other, and there are many other plausible scenarios that could be considered
- Each scenario reveals the potential challenges and choices that Metropolitan could face given the conditions of the scenario
- The value of scenario planning to Metropolitan is to increase awareness and preparedness, with no attempt to control, select, or predict the likelihood of the uncertain and uncontrollable conditions found in the scenario

As a decision support method, scenario planning provides Metropolitan a means to confront uncertain futures with choices that increase preparedness, improve resiliency, and manage vulnerabilities across a broad range of plausible outcomes. It also allows Metropolitan to properly weigh the tradeoffs and opportunity costs for those choices under a broad range of contingencies. Choices that perform well in several scenarios are potentially more beneficial than those that only perform well under a single group of assumptions.

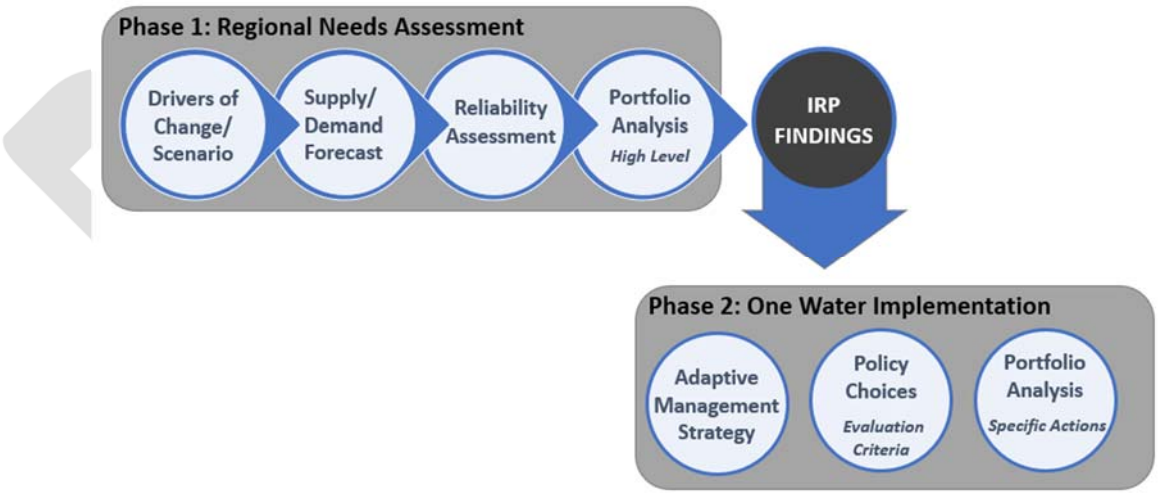
IRP Process Roadmap

With the 2020 IRP decision support method, Metropolitan explicitly examined underlying drivers of change for the water supply and demand outlook for Southern California. It used that knowledge to follow the causes and consequences of different outcomes logically. The 2020 IRP process followed the roadmap depicted in **Figure 2-1** and is divided into two phases:

- Phase 1: Regional Needs Assessment
- Phase 2: One Water Implementation

This report completes the IRP Regional Needs Assessment phase and offers findings to inform implementation. In the One Water Implementation phase, portfolios will be advanced by identifying policies, programs, and projects which provide regional solutions to the IRP Regional Needs Assessment findings. A comprehensive, adaptive management strategy will be developed in the One Water Implementation phase to guide these specific actions.

***Figure 2-1**: Roadmap for Phases 1 and 2 of 2020 IRP*



Identify Drivers of Change

The first step of the Regional Needs Assessment was to identify major sources of unavoidable and external uncertainty, or "drivers of change." This step included engaging stakeholders to help identify the drivers and select major ones to move forward into the scenario analysis. Key drivers such as climate change, regulatory requirements, population growth, and the economy have uncertain but potentially significant effects on both water supply and demands in Southern California. Outcomes of these factors greatly affect future water supply reliability.

Drivers of change were investigated through a collaborative and iterative process. Metropolitan staff engaged with the Board, member agencies, and other interested parties to solicit input on drivers of change. This involved defining and grouping a coherent set of drivers and assessing their relative impacts on Southern California's water supplies and demands. This process included an online survey collecting input from Board, member agencies, and other interested parties, asking respondents to indicate the relative importance of drivers of change. The most important drivers that emerged from the process ultimately became the basis for the IRP Scenarios discussed in this report. **Table 2-1** shows the rank order of the drivers of change based on the survey (MWDSC, 2020c).

Table 2-1: *Metropolitan's Drivers of Change Survey, Ranked by Cohort*

Board Members	%	Member Agencies	%	External Interested Parties	%
Colorado River Cooperation	95%	Colorado River Cooperation	91%	Hydrologic Variations	92%
Hydrologic Variations	90%	Stress on River Basins	87%	Outages & Disasters	87%
Stress on River Basins	90%	Direct Potable Reuse	83%	Stress on River Basins	84%
Emerging Regulations	86%	Hydrologic Variations	83%	Direct Potable Reuse	81%
Direct Potable Reuse	76%	Groundwater Contamination	78%	Groundwater Contamination	78%
Outages & Disasters	76%				

Note: Percentages are based on responses that indicated each driver of change to be either "extremely important" or "very important."

Develop Scenarios

The next step of Phase 1 was to establish alternative planning scenarios. This involved the development of separate sets of assumptions for the key drivers of change. These sets of assumptions became the basis for IRP scenarios.

Metropolitan then developed three increasingly refined iterations of IRP scenarios. The first iteration used hypothetical "Strawman Scenarios" as a proof of concept to demonstrate the feasibility of constructing scenarios from the drivers of change (MWDSC, 2020a). In September 2020, staff presented a draft set of "preliminary scenarios" that used initial drivers of change assumptions (MWDSC, 2020b). Staff incorporated extensive feedback by Board members, member agency staff, groundwater basin managers, and experts in demographics, water demand, and climate science. This process resulted in the "refined scenarios." The refined scenarios are the final scenarios that formed the basis for the reliability assessment analyses and resulting findings discussed in this report.

Supply and Demand Forecasts

The work to this point was largely qualitative. The next step was to quantify the impacts on supply and demand given the drivers-of-change assumptions for each scenario. Metropolitan conducted extensive modeling to forecast the region's retail demand, local supply projections, and resultant demand on Metropolitan over the 25-year time horizon. Additional modeling was performed to determine Metropolitan's imported supply capability for the conditions reflected in each scenario. For each of the three iterations of the four scenarios leading up to the "refined scenario," a corresponding set of retail demand forecasts, local supply projections, demands on Metropolitan, and supply capability were produced and presented to the Board IRP Committee, member agencies, and external workshops.

Reliability Assessment

After the scenarios were quantified in terms of supply and demand, the next step was to perform the reliability assessment. This began by establishing what was projected to occur if the trends identified in the scenarios continued without intervention. These was labeled the "Take No Action" case. Here, "Take No Action" means what would happen to water supplies and demands without intervention and as a result of the scenario's assumptions such as externalities outside of Metropolitan's control. The "Take No Action" case showed what would happen if Metropolitan relied solely on existing supply resources and trends. The resulting difference between supplies and demands became the "supply-demand gap," which quantifies levels of reliability.

This analytical technique isolated reliability problems posed by each scenario from the influence of presupposed solutions, allowing like-for-like comparisons between scenarios. The next analytical step enabled a clean slate for applying quantified solutions appropriate to each scenario's unique circumstances. The reliability assessment modeling was performed on each scenario to quantify the supply-demand gap projected to occur over a 25-year planning horizon ending in 2045. Reliability assessments for the preliminary and refined scenarios were presented to the Board IRP Committee in December 2020 and June 2021, respectively (MWDSC, 2020d; MWDSC, 2021a).

High-Level One Water Portfolio Analysis

The final step of the IRP Regional Needs Assessment was completing a portfolio analysis. This analysis examined each scenario to determine, in concept, what combinations of investments would be necessary to fill the gaps identified in the reliability assessment. This analysis used three mutually exclusive supply categories: core, flexible, and storage. These categories encompass different characteristics, and all resource management options are subsets of these categories. **Core supplies** are resource management actions that augment supply or reduce Metropolitan demand and remain available each year. **Flexible supplies** are implemented as needed and include savings from deliberate efforts to change water use behavior. **Storage supplies** are the capability to save water supply to meet demands later. Using a combination of three supply categories allows for a more diverse and balanced portfolio approach.

The results of these high-level portfolio analyses were presented to the Board IRP Committee in July and September 2021 (MWDSC, 2021a, 2021c). Draft findings were presented at the November 2021 Board IRP Committee (MWDSC, 2021b). The quantitative work of the Regional Needs Assessment is described in detail in Chapter 4, "Results: Phase 1 Regional Needs Assessment" of this report. Findings from the Phase 1 Regional Needs Assessment are discussed in Chapter 5, "Findings."

Phase 2: One Water Implementation

The next phase of the IRP will take the results and findings of the Phase 1 Regional Needs Assessment into a collaborative, deliberative process to come up with regional, integrated solutions. Using a One Water approach, the implementation phase will translate Phase 1's high-level portfolio analysis into potential policies, programs, and projects needed to address the findings and mitigate the potential shortages identified in this work. A comprehensive, adaptive management strategy and evaluation criteria will be developed in the implementation phase to guide these specific actions. The adaptive management strategy will also establish a process for monitoring key reliability indicators to support policymaking.

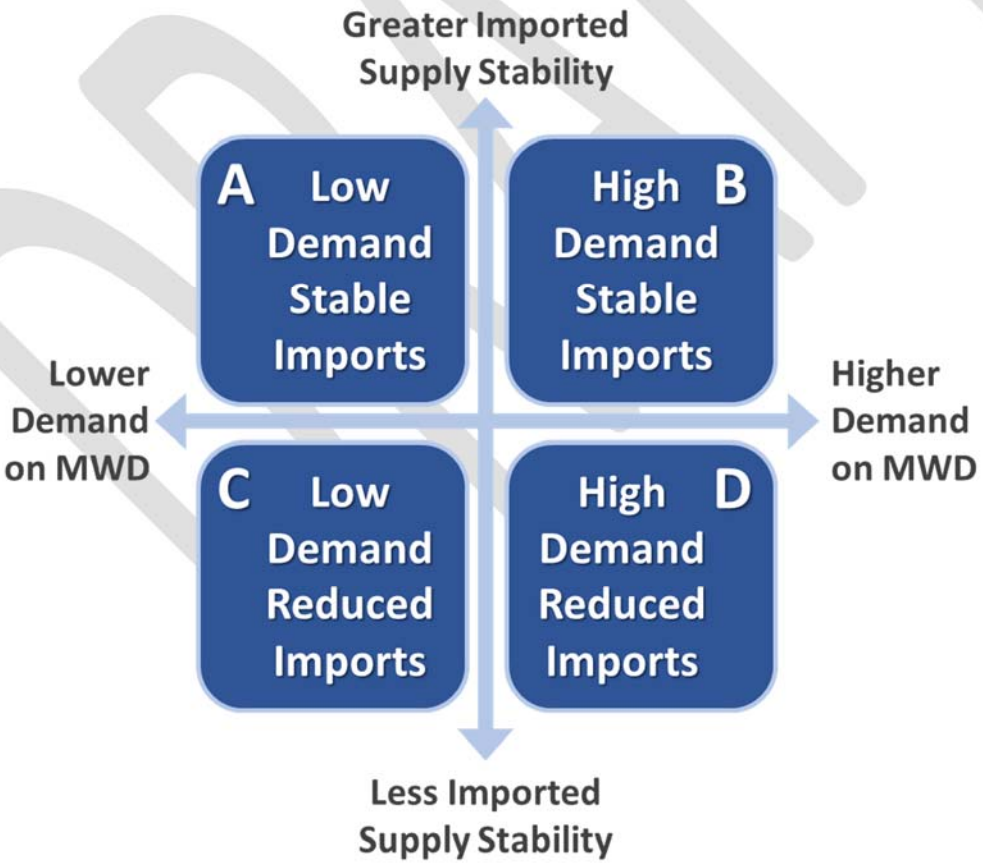
Chapter 3 – Quantifying Uncertainties

Scenario Framework and Descriptions

Quantifying uncertainties began with developing scenarios built on a comprehensive identification of drivers of change that affect supply stability and demands on Metropolitan. These drivers of change encompass basic phenomena such as climate change, economic trends, regulations, and demographic growth outside of Metropolitan's ability to control (i.e., exogenous) but fundamentally shape water reliability. Drivers of change were quantified where possible and defined to avoid double-counting their individual effects and establishing linkages between drivers.

Building on input received from the Board, member agencies, and the expert consultants, **water demands on Metropolitan** and **stability of imported supply** were identified as being the most impactful to water reliability for the region. Metropolitan then examined the drivers of change within this framework, ensuring internal consistency. This resulted in four plausible scenarios. Metropolitan then quantified the associated assumptions to reveal supply-demand gaps, against which actions could be tested. These four scenarios are shown in **Figure 3-1**.

***Figure 3-1**: 2020 IRP Scenario Framework*



As illustrated by **Figure 3-1**, the scenario framework contrasts four distinct plausible scenarios for water supply reliability planning in Metropolitan's service area. Each scenario examined a range of plausible high/low water demand coupled with a range of potential stable/reduced imported water supplies to meet the region's water demand. Inherent in determining demands on Metropolitan are consideration of local supply resources.

The major themes and narrative for the four scenarios are:

- **Scenario A – Low Demand/Stable Imports:** Gradual climate change impacts, low regulatory impacts, and slow economic growth.

  This scenario is characterized by lower retail water demands and stable regional and local supplies. Demands are impacted by lower economic and demographic growth and a continuing water use ethic across the region. Both regional and local supplies show more stable production due to less severe climate change, less restrictive regulatory constraints on existing water supply projects, and relatively robust implementation of new water supply projects at the local level.

- **Scenario B – High Demand/Stable Imports:** Gradual climate change impacts, low regulatory impacts, high economic growth.

  This scenario is characterized by higher retail demands and stable regional and local supplies. Demand is impacted by higher economic and demographic growth and a rebound of water use. Both regional and local supplies show more stable production due to less severe climate change impacts, less restrictive regulatory constraints on existing water supply projects, and relatively robust implementation of new water supply projects at the local level.

- **Scenario C – Low Demand/Reduced Imports:** Severe climate change impacts, high regulatory impacts, slow economic growth.

  This scenario is characterized by lower retail water demands and less stable imported supplies. Demand on Metropolitan is suppressed by lower economic and demographic growth and successful efforts among member agencies to manage water-use behavior and drought-proof local supplies. This scenario couples a struggling economy (i.e., slow growth) with the rapid onset of climate change impacts affecting imported supplies more than less-vulnerable local supplies.

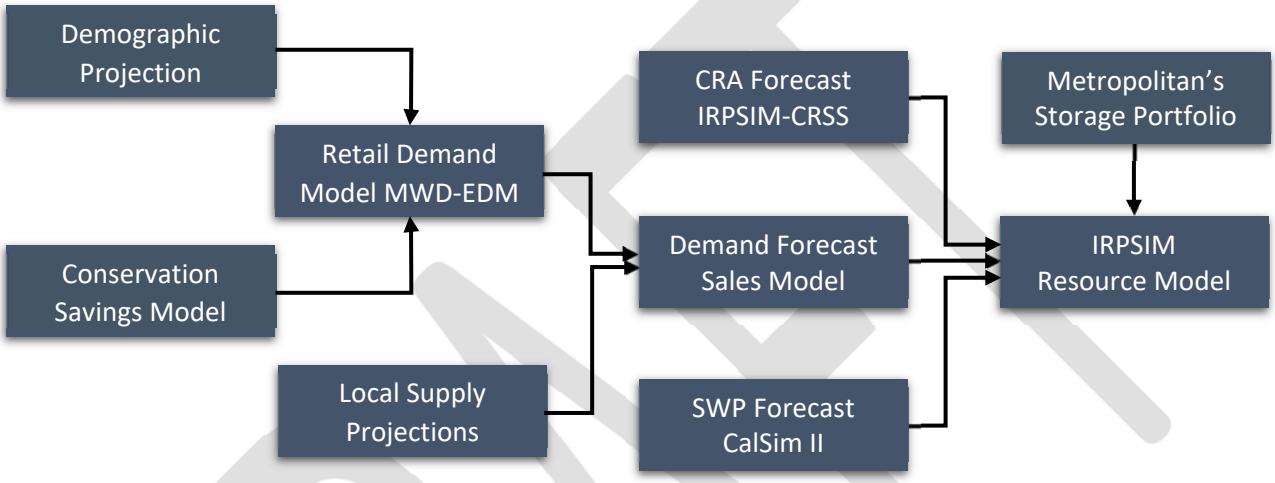
- **Scenario D – High Demand/Reduced Imports:** Severe climate change impacts, high regulatory impacts, and high economic growth.

  This scenario is characterized by higher retail demands, unstable imported, and diminishing local supplies. Demands are impacted by higher economic and demographic growth and a rebound of water use. In this scenario, severe climate change impacts both imported and local supplies. Demands on Metropolitan are increasing due to rapidly increasing demands and diminishing yield from local supplies. Local efforts to develop new local supplies are unable to mitigate these losses. Losses of regional imported supplies are equally dramatic.

Forecasting Supplies and Demands

Reliability means meeting all of the region's water demands through a combination of Metropolitan supplies, local supplies, and increased conservation. The Regional Needs Assessment quantified the range of plausible future water needs for the region through a detailed projection of demographic growth, conservation, local supply production, and the resultant need for imported water. **Figure 3-2** shows the modeling components which create the demand forecast. The demand forecast is then combined with the imported supply forecasts and the storage portfolio to assess reliability.

Figure 3-2: *Metropolitan's modeling framework for quantifying uncertainties.*



Total Retail Demand

Total demand includes M&I, agriculture, seawater barrier, and replenishment uses. Metropolitan's IRP modeling framework assesses each demand category by member agency based on characteristics unique to the member agencies.

Retail M&I Demand Forecast

Metropolitan uses a retail demand model, known as MWD Econometric Demand Model (MWD-EDM), to forecast future retail municipal and industrial (M&I) demands for each scenario using projected demographic growth and conservation savings for each of the four IRP scenarios. Metropolitan constructed demographic growth projections for Southern California with assistance from the Center for Continuing Study of the California Economy (CCSCE). CCSCE's projections were based on studies published by the U.S. Census Bureau. In addition to demographic growth, MWD-EDM also included drivers of change such as smaller lot size for future homes, future conservation, and water use ethic and rebound. MWD-EDM produces retail M&I forecasts for each scenario and member agency.

Conservation savings input for MWD-EDM were estimated using Metropolitan's Conservation Savings Model to produce post-conservation forecasts. The model calculates savings from plumbing code compliance, savings from conservation programs administered by Metropolitan and member agencies, and from price-effect conservation where water saving is realized by retail customers attributable to the effect of changes in the price of water. The Conservation Savings Model calculated conservation savings for each scenario and member agency.

At the retail consumer level, some types of water use vary more than others. Much more variability (i.e., discretion) in water using behavior is associated with outdoor use than indoor use. Because most outdoor use is for watering lawns and gardens, it makes sense that outdoor use and overall water use would increase during warmer and drier weather conditions, all else being equal. Metropolitan's modeling framework simulates the effects of weather conditions on retail demand over time.

Retail Demand/Demand Management Findings:

1) *Variability in retail demand largely comes from changes in outdoor water use. Outdoor water use behavior is complex, influenced by weather and climate and by awareness of water scarcity and other conservation measures.*
2) *It is important to pay attention to demand rebound, demand growth, and demand reductions, and take appropriate regional measures as necessary.*

However, not all things are held equal over time. Consumer behavior and ethics appear to have changed significantly since the 2015 IRP Update, as can be inferred from regional per capita water use that has remained relatively low since the 2015 drought. Consumers are influenced to reduce their water using behaviors through greater environmental awareness, rising water prices, and conservation messaging and restrictions. These consumer signals have been increasing in frequency and intensity, coinciding with the severity of recent droughts, which in turn may be a symptom of climate change. For instance, with incentives from Metropolitan and local water agencies and perhaps encouraged by the example of early-adopter neighbors, more and more Southern California residents have taken action to permanently reduce outdoor water use by removing their lawns since 2015. Conscientious outdoor water use reinforced by ongoing drought conservation measures, combined with the improving efficiency of new water using devices, have kept the region's retail water demands relatively low every year through 2019, the year that Metropolitan used to calibrate its demand projections for the 2020 IRP Regional Needs Assessment. This is despite fluctuations in weather conditions that would have otherwise driven demands higher. This is not to say that consumer ethic would not revert back to higher-use, especially in the absence of continued intervention. With regard to scenario planning, consumer water use ethic will continue to be a considerable force for greater or lesser water reliability, and future trends are uncertain in a long-term planning horizon. This uncertainty is reflected in the scenarios.

MWD-EDM calibrates the forecast to 2019 M&I water use by member agency, which serves as the anchor point of the forecast. Calibrating the model to 2019 assumes that the water-use ethic from 2019 would continue. However, the IRP scenarios also assume some rebound in water use. Conservation savings were categorized as (1) **structural** based on efficiency improvements such as replacing water fixtures with more efficient ones, and (2) **behavioral** reflecting changing consumer water use behavior in response to conservation messaging and education. Structural conservation is more permanent and unidirectional, while behavioral conservation can fluctuate over time. For example, outdoor behavioral conservation such as reducing the number of watering days for lawns during a drought reduces water use. Returning to previous watering schedules after the drought would increase water use which can be described as a demand rebound. If a complete rebound were to occur, overall retail demand would be more than 10 percent higher than a forecast without any rebound.

Other Retail Demand Forecast

In addition to retail M&I demand, the IRP reliability assessment considered retail agricultural, seawater barrier, and replenishment demands. Retail agricultural demand consists of water use for commercial irrigation of crops. Uncertainties about agricultural use include land-use changes, regulatory requirements, and economic conditions, which ultimately impact the operation cost for agricultural water users. Higher costs for agriculture could plausibly lead to a decline in water use. Additionally, a warmer climate could increase the water use requirements of existing crops. For the 2020 IRP, Metropolitan coordinated with member agencies to develop agricultural demand projections.

Seawater barrier demand prevents seawater intrusion into coastal groundwater basins. Metropolitan worked with groundwater basin managers to determine the barrier requirements based on groundwater levels, injection wells, and regulatory permits. Uncertainties include climate change impacts from rising sea levels. For example, overcoming hydraulic pressure from rising seas necessitates increasing seawater barrier demands from local recycled water projects and supplementing imported water. For the 2020 IRP, Metropolitan assumed seawater barrier demands could plausibly increase in scenarios with higher relative sea-level rise associated with severe climate change impacts.

Replenishment demand maintains sustainable groundwater basin health and production. Metropolitan quantified replenishment demand only from recycled water and imported water. Replenishment demand projections provided by member agencies are informed by groundwater basin management policies, groundwater production, and natural and artificial recharge assumptions. For the 2020 IRP, Metropolitan held workshops with groundwater basin managers and member agencies to discuss impacts to replenishment demands, including climate change and regulatory requirements. Outcomes of these discussions highlighted the importance of the timing and implementation of indirect potable reuse and stormwater capture projects and potential changes to natural and artificial recharge due to climate change. Feedback from these workshops was incorporated into replenishment demand projections for each scenario.

Local Supply Projections

Local supplies are produced to meet individual agency demands and are key to determining how much Metropolitan supply is needed. They include groundwater, surface water, the Los Angeles Aqueduct, recycled water, groundwater recovery, and seawater desalination. Local supply projections use information from several sources, including local Urban Water Management Plans, Metropolitan's annual local supply survey, and coordination with local agency staff.

For the 2020 IRP, Metropolitan held focused workshops with the member agencies to gain insights on the challenges facing local supplies and the potential impact on water reliability. These workshops discussed the same drivers identified earlier (economic conditions, climate change, and regulatory restrictions). Through these workshops, the effect of the drivers on existing local supplies and the timing and implementation of future local supply projects was considered.

From these discussions, Metropolitan developed local supply projections that examined the degradation of existing supplies in combination with different timing and implementation of the inventory of future

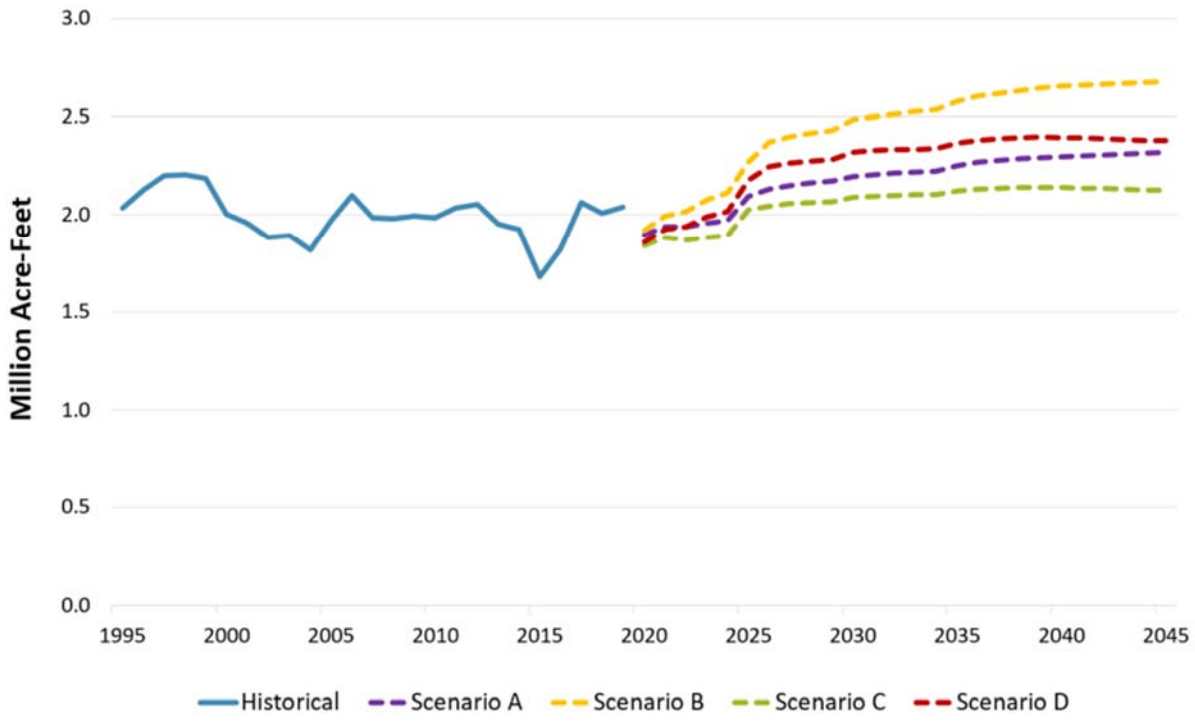
local supply projects provided by member agencies. One example of local supply degradation is decreased groundwater production due to a loss of replenishment from changing precipitation patterns or reduced return flows from outdoor irrigation. Additionally, while there was a large inventory of future local supply projects, many still require additional permitting and design. Thus, there remains uncertainty in when projects will come online and how much new water those projects will produce.

Figure 3-3 demonstrates the broad range of potential outcomes of local supply production. Depending on the region's success in implementing new projects and preventing the degradation of existing supplies, the region may continue to see modest growth in local production. The level of growth in future local supply is important to offset varying levels of growing demands, as any growth in demand that cannot be offset by new local supply adds additional demand on Metropolitan.

Local Supply Findings:

1) *Impacts to reliability occur if local supply assumptions are not achieved; therefore, it is important to track the progress of local supply development as one of the signposts in the One Water Implementation phase.*
2) *Additional actions may be needed should existing and future local supply levels deviate from IRP assumptions.*

Figure 3-3: *Total Local Supply under Average Conditions*



Determining Demands on Metropolitan

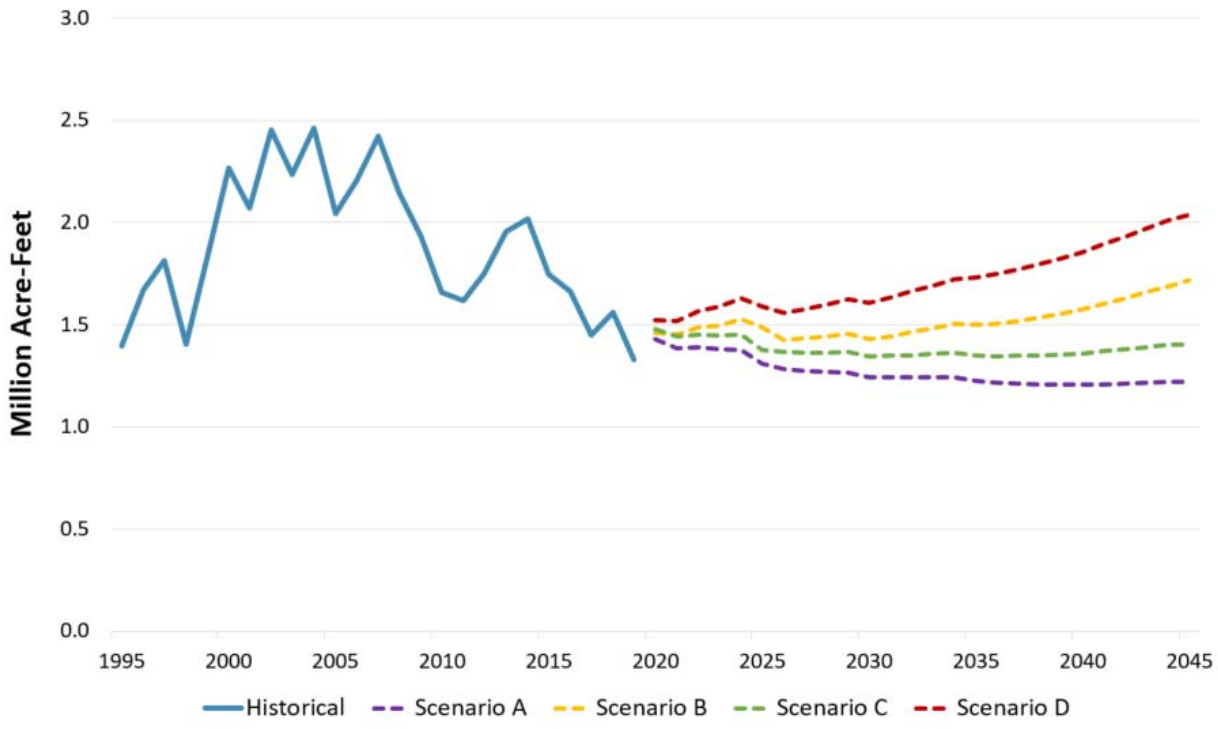
Once retail demand forecasts and local supply projections are developed, the next step is to calculate future demand on Metropolitan. Imported water from Metropolitan serves as a supplemental supply source for its 26 member agencies. For some member agencies, their primary sources of water are

produced locally. When local supplies are insufficient to meet retail demands, member agencies purchase supplemental water from Metropolitan. These purchases constitute the demands on Metropolitan.

Demands on Metropolitan are calculated using Metropolitan's Sales Model. This model accounts for weather-related variations to retail demands and local supplies and ultimately produces a range of forecasted demand on Metropolitan. For the 2020 IRP, Metropolitan engaged with climate expert consultants to develop techniques to incorporate climate change impacts to local precipitation within the Sales Model's existing 96 hydrologic sequence methodology. These modifications increased the frequency and intensity of dry years and decreased the frequency of wet years (but increased their intensity) while maintaining a similar long-term average precipitation. The Sales Model forecasts a range of demands on Metropolitan for each IRP scenario as shown in **Figure 3-4**.

Retail Demand/Demand Management Finding:
Metropolitan's future supply reliability may fluctuate based on demand increases and decreases.

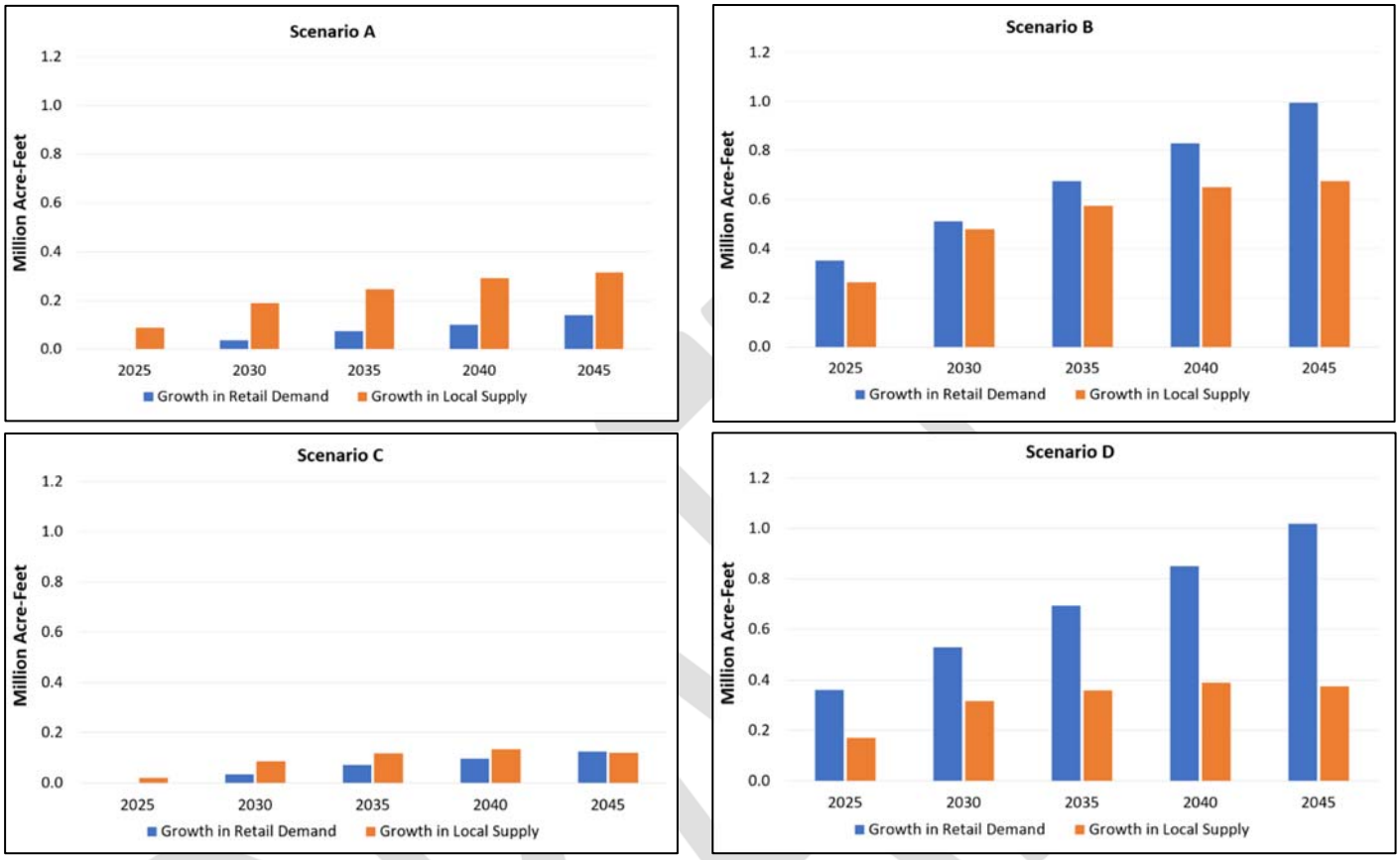
Figure 3-4: *Total Net Demand on Metropolitan*



Local Supply Finding:
Maintaining existing and developing new local supplies is critical in helping manage demands on Metropolitan.

Demand on Metropolitan is driven by the relative growth of the region's retail demand and local supply production. The difference between retail demand and local supply production is the assumed demand on Metropolitan. **Figure 3-5** shows the relative growth compared to 2020 of retail demand versus local supply production growth for each scenario. In Scenarios B and D, where retail demand growth is high, the proportion of unmet demand needed to be satisfied by Metropolitan is larger than the proportion for the lower demand Scenarios A and C. Despite having the highest assumed local supply growth in Scenario B, retail demand growth outpaces local supply production growth and additional actions would be needed to manage growing demands on Metropolitan in that scenario. In Scenarios A and C, the projected growth in local supply production is greater than the forecasted growth in demand, highlighting the importance in growing and maintaining local supply production in all scenarios.

Figure 3-5: *Growth in Demand vs. Growth in Local Supply Production Relative to 2020 in Average Conditions, Scenarios A, B, C, and D*

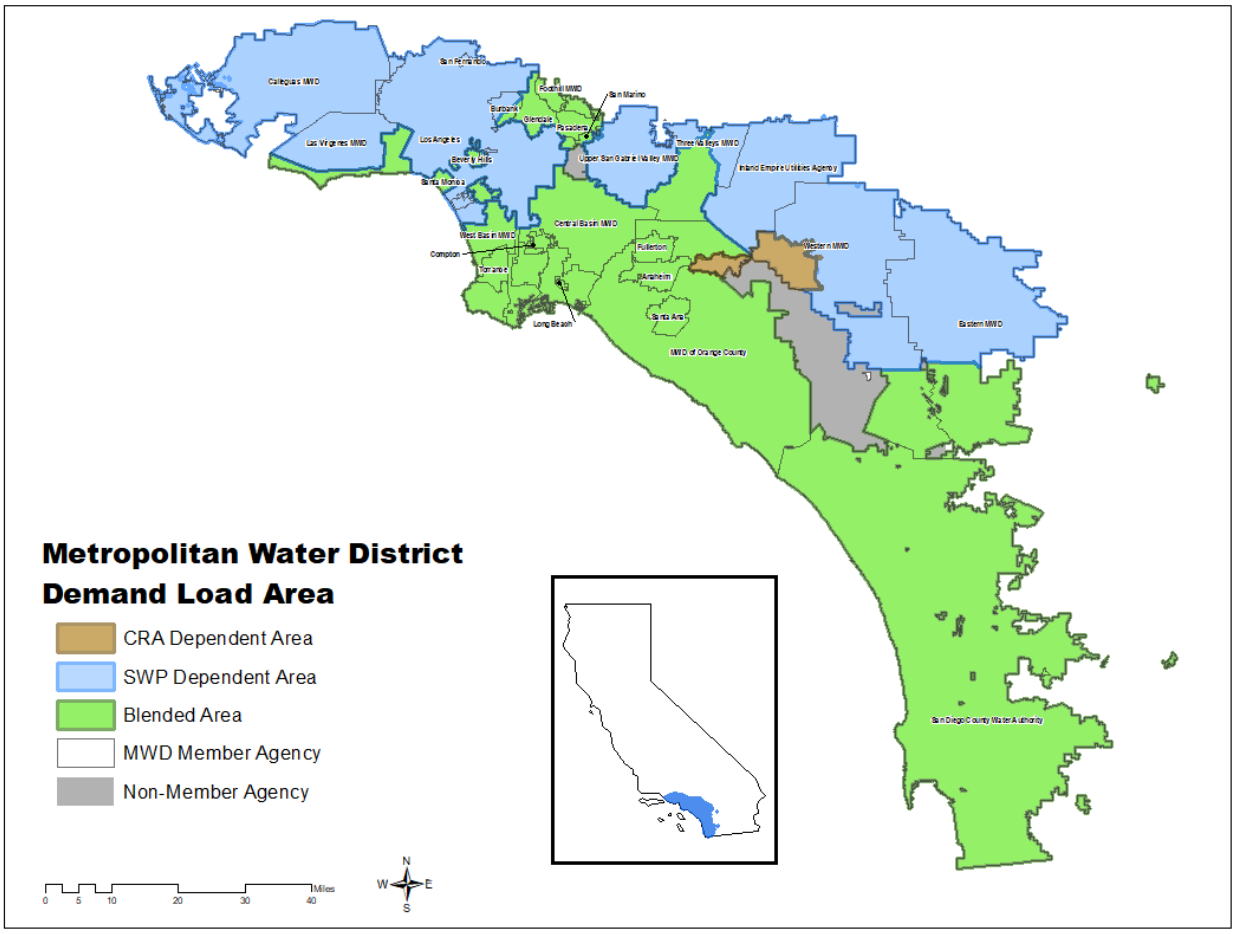


IRPSIM Resource Model

Water supply-demand gaps for the scenarios were analyzed with IRPSIM Resource Model (IRPSIM). IRPSIM is a water supply and demand mass balance simulation model. IRPSIM simulates water resources needed to meet demands, which allows Metropolitan to identify supply-demand gaps and measure whether a potential resource mix is likely to be reliable. IRPSIM considers the availability and accessibility of its imported water supply sources, including its storage portfolio to the demand load areas. The forecasted demands on Metropolitan are allocated to different portions of Metropolitan's regional distribution system, referred to as demand load areas.

IRPSIM models three primary demand load areas. The first is the "SWP Dependent Area," shown in **Figure 3-6**, where demands can only be satisfied with SWP supplies and associated storage programs. The second and smallest is the "Colorado River Dependent Area," where demands can only be satisfied with Colorado River supplies and associated storage programs. The third and largest is the "Blended Area," where demands can be satisfied by both SWP and Colorado River supplies and their respective storage programs.

Figure 3-6: *Demand Load Area Map*



Through entitlements and the development of long and short-term supply programs, Metropolitan has secured the ability to deliver the full capacity of the Colorado River Aqueduct of roughly 1.2 million acre-feet in any given year. In conjunction with local supply production and storage, this supply can satisfy demands in the blended areas. The SWP has system capacity and hydrologic variability that creates an annual supply that historically ranged from 100 TAF to 1.9 MAF. When the SWP supply exceeds the SWP Dependent area demand, water can be stored directly into SWP storage facilities and/or used in the blended areas, enabling Metropolitan to store imported supply within Colorado River storage facilities.

Metropolitan Imported Supplies Finding: *Variability and capacity in SWP supplies provide opportunities to store water during wet periods for use in dry years, including Colorado River storage. Metropolitan's ability to distribute or store SWP supplies when they materialize will enhance the region's reliability, particularly the SWP Dependent Areas. The Colorado River system and Colorado River Aqueduct capacity do not offer the same opportunities concerning SWP storage.*

IRPSIM uses a sample of 96 years of historical hydrology (1922--2017) as a reliability test. This methodology generates 96 different outcomes for each forecast year and thus allows Metropolitan to evaluate the probabilities of surpluses and shortages over the 25-year planning horizon. IRPSIM generates the magnitude and frequency of shortages, which is the metric of reliability used in the reliability assessment analyses. Shortages within an IRPSIM simulation occur when there is insufficient supply to satisfy a demand or when available supplies are not accessible, resulting in an unmet need within Metropolitan's service area.

As represented in **Figure 3-2,** IRPSIM has four key inputs: demands on Metropolitan, SWP supply, CRA supply, and Metropolitan's storage portfolio. The Sales Model provides the input for demands on Metropolitan as described in the previous section. IRPSIM is where scenario-specific impacts related to Metropolitan's Colorado River and SWP imported water supplies are considered in the analysis. In addition, IRPSIM simulates Metropolitan's entire storage portfolio by considering operational constraints, put and take capacities, contractual arrangements, and other operational considerations. IRPSIM balances the needs for imported supply and storage as detailed below.

SWP Forecast-CalSim II

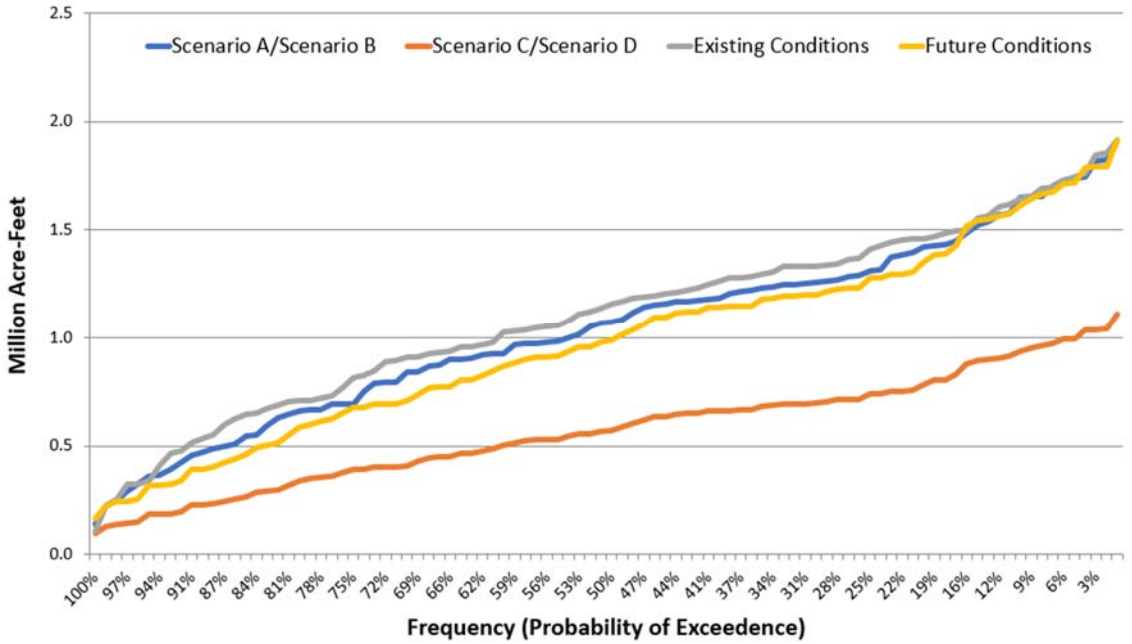
Forecasts of SWP supplies were based on modeling studies produced by DWR using their CalSim-II model. The results of the CalSim-II model are published in DWR's 2019 Delivery Capability Report (DCR) (DWR, 2020). The 2019 DCR provides SWP supply estimates for an existing condition that does not include climate change and a future condition that includes climate change. As shown in **Figure 3-7**, the SWP reliability curve for Scenarios A and B reflect a moderate climate change and regulatory future while Scenarios C and D reflect severe climate change and regulatory impacts.

Metropolitan Imported Supplies Finding: *Existing imported supplies are at risk from various drivers of uncertainty.*

Metropolitan used the 2019 DCR existing and future study projections as a starting point and guidance from climate experts to reflect the regulatory and climate change impacts assumed in the IRP scenarios.

The resulting SWP deliveries for Metropolitan in 2045 are shown in **Figure 3-7** and compared to the 2019 DCR existing and future condition projections.

Figure 3-7: *Metropolitan's 2045 SWP Imported Supply Reliability Based on the 2019 DCR*



CRA Forecast - IRPSIM and CRSS

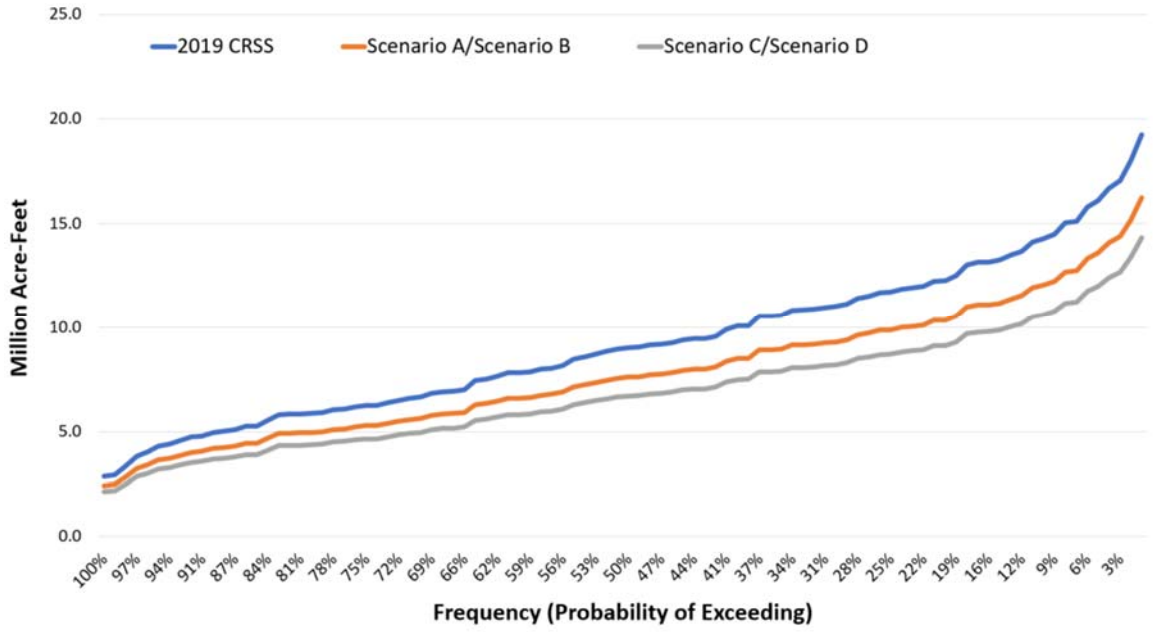
Forecasts of base supplies from the Colorado River were generated within IRPSIM with hydrological inputs provided by the United States Bureau of Reclamation (USBR).

In prior IRPs, projections for Colorado River supplies were generated directly by the Colorado River Simulation System Model (CRSS) and used in IRPSIM. This is a modeling package developed, maintained, and used by USBR to simulate future operations and deliveries of the Colorado River reservoir system. Given major changes in the operations of the Colorado River and to better reflect Metropolitan's use of its Intentionally Created Surplus storage account, Metropolitan now generates its own surplus and shortage characterization of the Colorado River system. IRPSIM still uses the same inputs as CRSS, including initial reservoir conditions and hydrologies for Lake Powell and Lake Mead. The model inputs used in the 2020 IRP are used in USBR's January 2020 official CRSS run (USBR, 2021).

As previous chapters have discussed, Scenarios A and B are characterized by stable imported supplies, and Scenarios C and D by unstable imported supplies. For future Colorado River supplies, this stability is influenced by differing assumptions for climate change and future cooperation between the lower basin states in Colorado River operations.

Climate change is incorporated into CRA supplies by adjusting the Lake Powell and Lake Mead inflow hydrologies and evaporation rates. Through consultation with climate change experts and previous research, a relationship between the decrease in runoff and increase in atmospheric temperature was incorporated in the hydrology (Woodhouse, et al 2021). **Figure 3-8** shows the reduction of Powell inflows due to modeled climate change for the IRP scenarios.

Figure 3-8: *2045 Lake Powell Inflows*



Future operations of the Colorado River and cooperation between the lower basin states and Mexico also influence the stability of Colorado River supplies. The Interim Guidelines, Binational Agreement 323 and the Drought Contingency Plan (DCP) all act to stabilize the elevation of Lake Mead and prevent shortages. The 2007 Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines), DCP and Minute 323 will expire in 2026. Without a future agreement taking its place this could lead to a greater chance of shortage and less available Colorado River water in the future. For Scenarios A and B that reflect stable imported supply, these three agreements were assumed to extend through the life of the forecast. For Scenarios C and D that reflect less stable imported supplies, the Interim Guidelines were extended, but the DCP and Minute 323 were modeled to expire in 2026.

Chapter 4 – Results: Phase 1 Regional Needs Assessment

Technical results for the Regional Needs Assessment were based on two distinct analytical processes:

1. Reliability Assessment
2. High-Level Portfolio Analysis

The reliability assessment defined and quantified the problems presented by various scenarios. The high-level portfolio analysis explored how different categories of actions could address the reliability needs of each scenario. These results inform the forthcoming IRP One Water Implementation phase. This chapter provides details of the results and explains how to interpret those results (**Figures 4-1** through **4-3**).

Reliability Assessment

The reliability assessment used IRPSIM to quantify the frequency and magnitude of shortage or surplus for each scenario on an annual basis between 2020 through 2045. For ease of interpretation, results are either presented in five-year increments (beginning with 2025 and ending in 2045) or in a single year (2045). The assessment also considers Metropolitan's storage capacity. The terms "gross" and "net" are used to describe the types of surplus and shortage conditions that occur. **Gross shortage** refers to supply-demand gaps before any take from available storage; **net shortage** refers to the remaining supply-demand gap after using available storage. Similarly, **gross surplus** refers to supplies before filling storage, while **net surplus** refers to surplus supplies that occur after all available storage has been filled. The following section summarizes the results for each scenario.

Low Demand/Stable Imports Scenario A

Scenario A was characterized by **low** demands on Metropolitan and **stable** local and imported supplies. The reliability assessment for Scenario A highlights how gaps can be addressed with existing resources and storage programs/supplies. As a result, there are no net shortages throughout the forecast horizon through 2045, as seen in **Figure 4-4**.

Scenario A reliability assessment details are shown for the forecast year 2045 in **Figures 4-5** and **4-6** with highlights listed below:

- All of the gross shortages are met with available storage, leaving no net shortage.
- Metropolitan's existing conveyance and storage capacity would only manage a portion of the gross surplus supplies, leaving up to 770 TAF of net surplus supply occurring 50 percent of the time.
- End-of-year storage is expected to be full 87 percent of the time.
    - Supplies above capacity regularly remain after satisfying the supply-demand gaps identified in this scenario and present an opportunity for new exchanges or to fill new storage capacity and improve water reliability in the Southwest.

High Demands/Stable Imports Scenario B

Scenario B is characterized by **high** demands on Metropolitan and **stable** imported supplies. Net shortages occur between 1 to 5 percent of the time during the planning horizon, as shown in **Figure 4-7**. All net shortages occur in the SWP Dependent Areas (**Figure 3-6**). There are no net shortages in the blended areas (areas that receive both SWP and CRA water) or areas that receive just

CRA water, indicating that accessibility or lack thereof to CRA water is not driving shortages. When system constraints are removed in IRPSIM (e.g. when Colorado River water and blended area storage is allowed to reach SWP Dependent Areas) the shortages in Scenario B are eliminated as seen in **Table 4-8**. This further supports the finding that for Scenario B, the projected shortages may be reduced with system flexibility investments.

Scenario B reliability assessment details are shown for the forecast year 2045 in **Figures 4-8** and **4-9** with highlights listed below:

- A majority of the gross shortages can be reduced with available storage, decreasing the probability of net shortage to 5 percent.
- Maximum net shortage is expected to be up to 300 TAF.
- Metropolitan's existing conveyance and storage capacity would only manage a portion of the gross surplus, leaving up to 400 TAF of net surplus supplies occurring 25 percent of the time.
- The end-of-year storage is expected to be full approximately 45 percent of the time.
    - Metropolitan would face challenges storing available supplies, presenting an opportunity for new exchanges or to fill new storage capacity and improve water reliability in the Southwest.

Low Demands/Reduced Imports Scenario C

Scenario C is characterized by **low** demands on Metropolitan and **reduced** imported supplies. Net shortages occur between 1 to 5 percent of the time during the planning horizon, as shown in **Figure 4-10**. Note that no net shortages occur in the forecast year 2030, due to the Arvin-Edison Banking Program assumed to return online in 2025. With low demands in this scenario, the additional storage capacity provided by this banking program is sufficient to meet the supply-demand gap in 2030. Similar to Scenario B, all shortages occur in SWP Dependent Areas. When system constraints are removed in IRPSIM, the shortages are eliminated as seen in **Table 4-8**. This further supports the finding that for Scenario C, the projected shortages may be reduced with system flexibility investments.

Scenario C reliability assessment details are shown for the forecast year 2045 in **Figures 4-11** and **4-12,** with highlights listed below:

- The majority of the gross shortages can be reduced with available storage, leaving a 5 percent probability of net shortage.
- The maximum net shortage is expected to be up to 200 TAF.

SWP Dependent Area Findings:

1) *Vulnerabilities in the SWP Dependent Areas are more severe given reduced reliability of SWP supplies and Metropolitan distribution system constraints. Actions identified in the implementation phase must prioritize addressing the SWP Dependent Area's reliability challenge.*
2) *New core supplies must be accessible to the SWP Dependent Areas. Greater access to existing core supplies can also increase SWP Dependent Area reliability.*
3) *Enhanced accessibility to core supplies and storage, both existing and new, will improve SWP Dependent Area and overall reliability. This includes improvements to Metropolitan's distribution system and capacity to deliver non-SWP supply and storage.*

- After filling gross surplus supplies in available storage, Metropolitan could still expect up to 350 TAF of net surplus supplies occurring 25 percent of the time.
- The end-of-year storage is full roughly 41 percent of the time.
    - Metropolitan would face challenges storing available supplies presenting an opportunity for new exchanges or to fill new storage capacity and improve water reliability in the Southwest.

High Demands/Reduced Supplies Scenario D

Scenario D is characterized by high demands on Metropolitan and **reduced** imported supplies. Shortages occur between 2 to 66 percent of the time during the planning horizon, as seen in **Figure 4-13**.

Before 2035, the net shortages occur exclusively in the SWP Dependent Areas. After 2035 the likelihood and magnitude of these net shortages increase, but net shortages also emerge in blended areas. The expanded net shortages point to impacts from not enough Colorado River supply. Shortages occurring in both the SWP Dependent and blended areas in later forecast years highlight that current imported supplies may be insufficient for Metropolitan to meet its reliability goal for the entire service area.

Metropolitan Imported Supplies Finding: *Shortages on the Colorado River will limit the reliability of Colorado River Aqueduct deliveries as a core supply in the future.*

When system constraints are removed in IRPSIM, the shortages are eliminated or decreased in years prior to 2040 as seen in **Table 4-8**. However, the same analysis does not show a decrease in shortages in the later years and also shows that there is a slight increase in shortages in 2040 and 2045. This further supports the finding that for Scenario D, the projected shortages may be reduced with system flexibility investments until such time where challenges to Colorado River and other blended area supplies become more severe. The later increase in shortage magnitude is a result of Colorado River water being utilized to meet demands in the SWP Dependent Areas in earlier years. Because of this, there is less Colorado River and blended area supplies being stored and available to meet the total demands of the service area in later years.

Scenario D reliability assessment details are shown for the forecast year 2045 in **Figures 4-14** and **4-15** with highlights listed below:

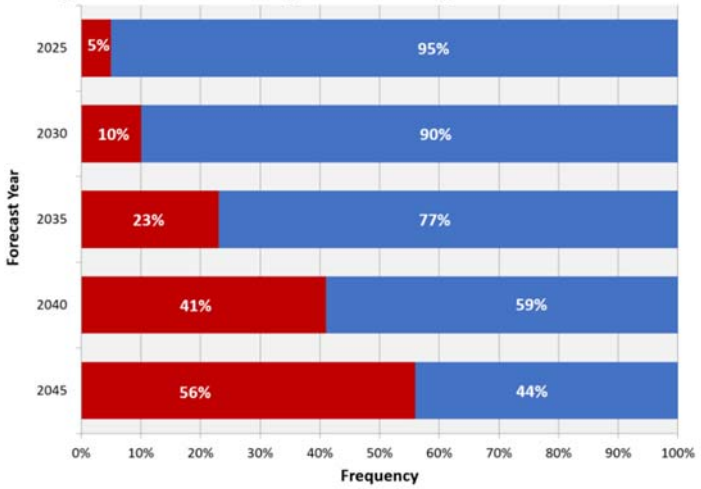
- The majority of the gross shortages cannot be reduced with available storage, leaving a 66 percent probability of net shortage conditions.
- The maximum net shortage is expected to be up to 1.22 MAF.
- Under Scenario D, frequent shortages and fewer surplus conditions indicate that storage and conveyance capacity alone will not solve the reliability problem without supply improvements.
- Scenario D shows there will not be enough surplus water for Metropolitan to fill storage.
    - This stems from the impacts of climate change and regulatory restrictions limiting imported water supply development, paired with the need to use stored supplies to satisfy demands.

The next section shows a series of example graphs and their related interpretations, followed by detailed graphs corresponding to each scenario.

Detailed Reliability Assessment Results

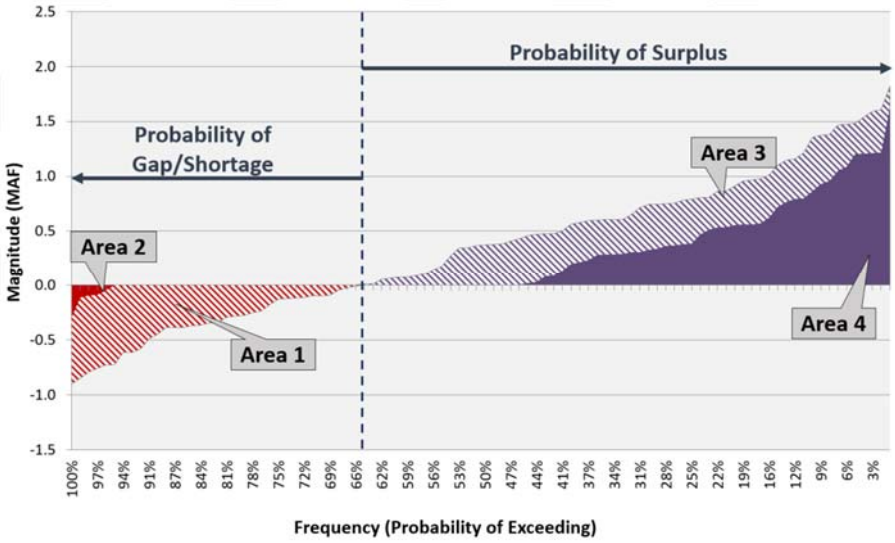
Figures 4-1 to **4-3** are examples of the three graphics that detail the reliability assessment results. These examples are illustrative to aid the reader in interpreting the later graphs.

***Figure 4-1**: Example **Net Shortage** Assessment through the Planning Horizon*



Net Shortage Assessment – This graph shows the frequency and timing of net shortage conditions (red) and all other conditions (blue). Net shortages are defined when all available supplies, including accessible storage, are depleted and there remains an unmet demand. All other conditions are defined when storage is withdrawn to satisfy a demand, and/or when water is available and stored to manage supplies not needed to meet a demand.

***Figure 4-2**: Example **Shortage/Surplus** Probability Assessment for 2045*

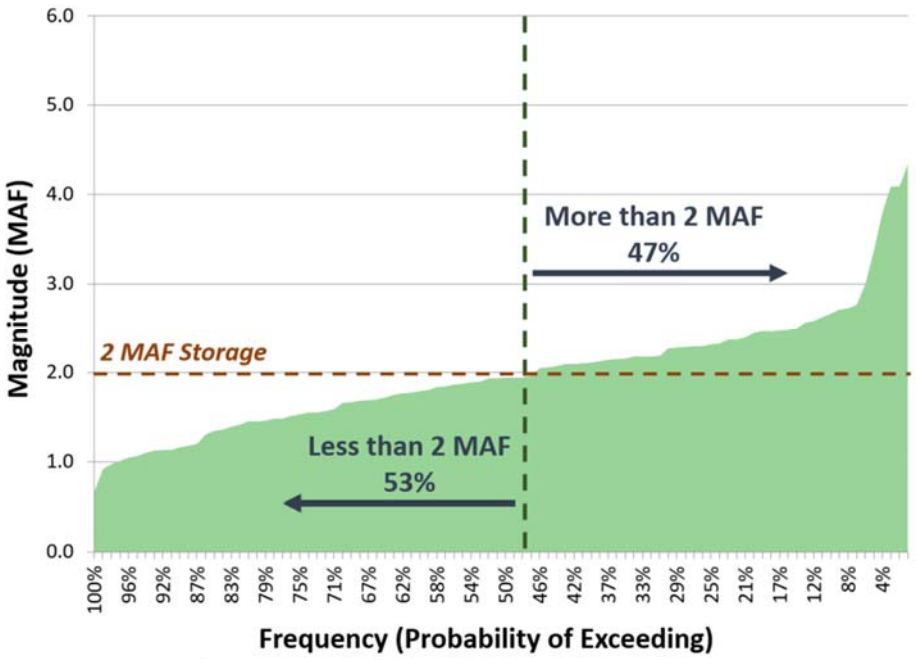


Shortage/Surplus Probability Assessment – This exceedance curve provides magnitude and probability of gross and net shortages/surpluses and the impact of storage actions.

Area 1 & 2 – Gross Shortage: Magnitude and frequency of supply-demand gap prior to taking from available storage
Area 2 – Net Shortage: Magnitude and frequency of supply-demand gap after taking from available storage
Area 3 & 4 – Gross Surplus: Magnitude and frequency of surplus prior to putting into available storage
Area 4 – Net Surplus: Magnitude and frequency of surplus after putting into available storage

Actions that decrease shortage probabilities and magnitudes generally appear as an increase in surplus probability and/or magnitude. Eliminating shortage requires an increased probability/magnitude of surplus.

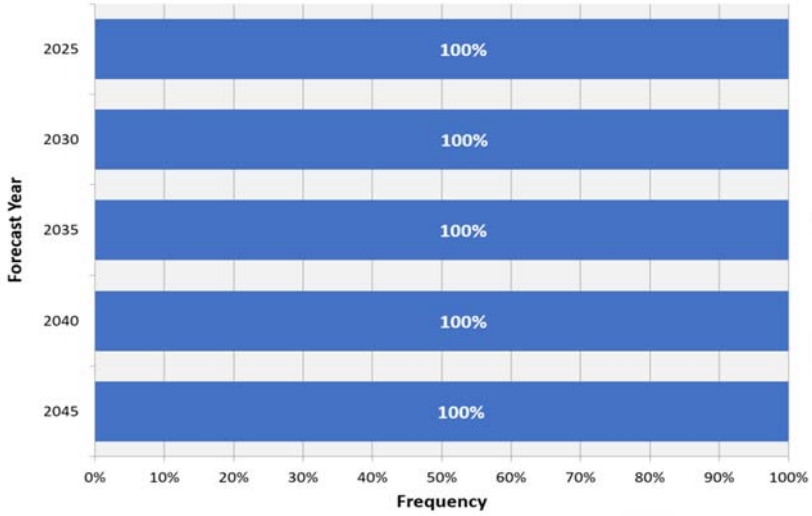
***Figure 4-3**: Example **Storage** Graph for 2045*



Storage Graph – This graph shows end of year storage level probabilities. The probability of a given end of year storage level can be determined by locating the intersection of a selected storage level (y-axis) with the storage curve (green shaded region). To the left of the intersection shows the probability of an end of year storage less than the desired amount, while the right of the intersection shows the probability of more than the desired amount. The volume of water necessary to achieve full storage varies by scenario based on hydrologic conditions, contractual arrangements, and program operations.

Low Demands/Stable Imports Scenario A Reliability Assessment Results

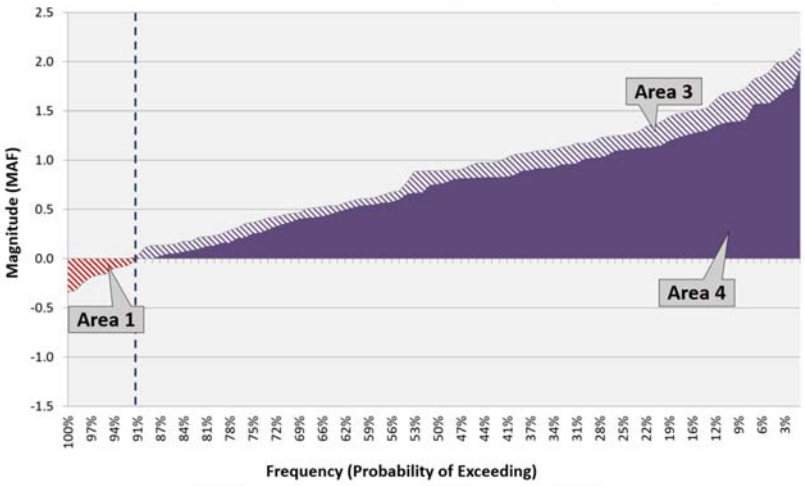
Figure 4-4: *Scenario A – **Net Shortage** Assessment through the Planning Horizon*



Scenario A: **Low** demands
Stable imports

All supply-demand gaps can be managed through available storage. This scenario shows 100% reliability across the planning horizon.

Figure 4-5: *Scenario A – **Shortage/Surplus** Probability in 2045*



Prior to taking available storage actions, surplus conditions have a 91% frequency and shortages conditions have a 9% frequency.

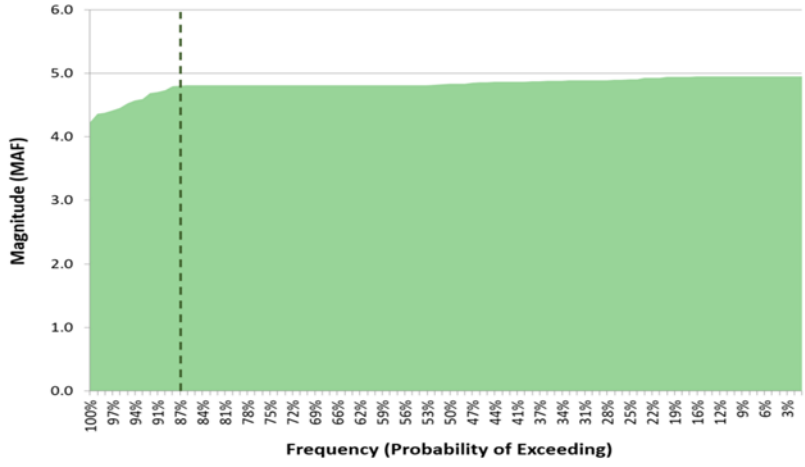
Area 1 & 2 – All supply-demand gaps are managed by taking from available storage

Area 2 (Not shown) – No net shortage

Area 3 & 4 – Gross surplus

Area 4 – Up to 770 TAF of net surplus supply occurs 50% of the time

Figure 4-6: *Scenario A – **Storage** Probability in 2045*

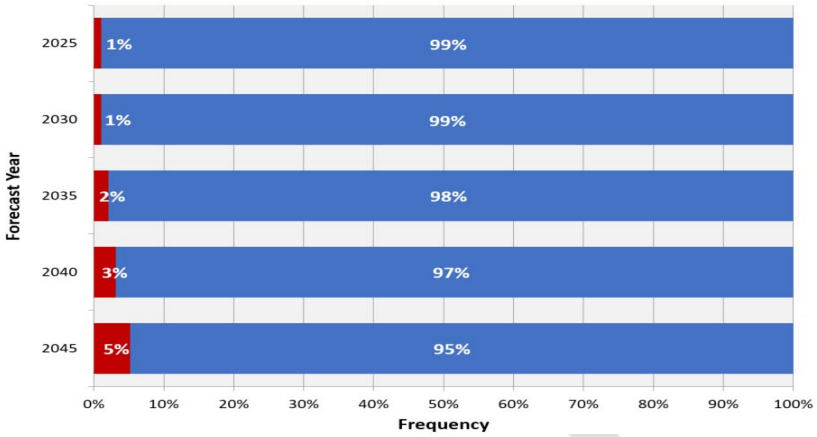


Storage expected full 87% of the time.

The probability of total storage less than 1.0 MAF is 0%.

High Demands/Stable Imports Scenario B Reliability Assessment Results

Figure 4-7: *Scenario B – **Net Shortage** Assessment through the Planning Horizon*



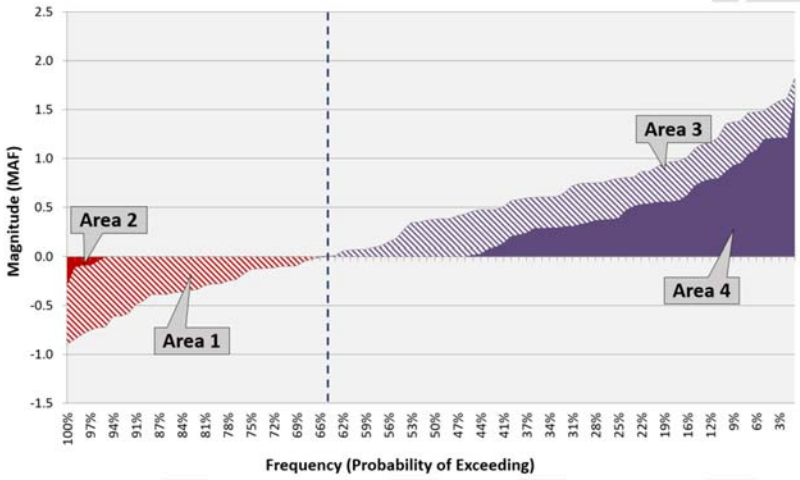
Scenario B: **High** demands
Stable imports

Net shortages possible across entire planning horizon.

Net shortage probability grows from 1% in 2025 to 5% in 2045.

Net shortages occur only in **SWP Dependent Areas**.

Figure 4-8: *Scenario B – **Shortage/Storage** Probability for 2045*



Prior to taking available storage actions, surplus conditions have a 65% frequency and shortage conditions have a 35% frequency.

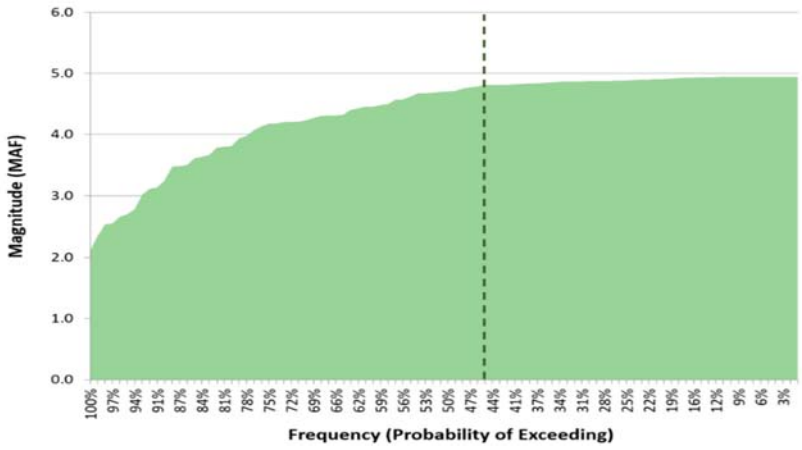
Area 1 & 2 – Gross shortage

Area 2 – Net shortages occur 5% of the time with a maximum magnitude of 300 TAF

Area 3 & 4 – Gross surplus

Area 4 – Up to 400 TAF of net surplus supply occurs 25% of the time

Figure 4-9: *Scenario B – **Storage** Probability for 2045*

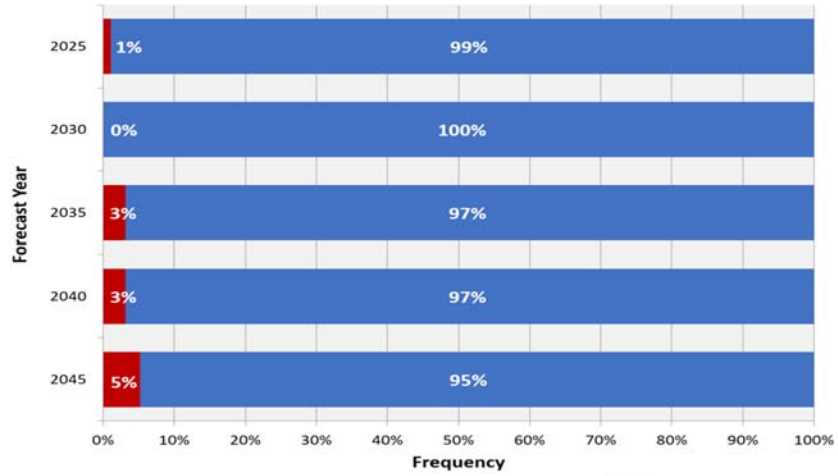


Full storage expected 45% of the time.

The probability of total storage less than 1.0 MAF is 0%.

Low Demands/Reduced Imports Scenario C Reliability Assessment Results

Figure 4-10: *Scenario C – **Net Shortage** Assessment through the Planning Horizon*



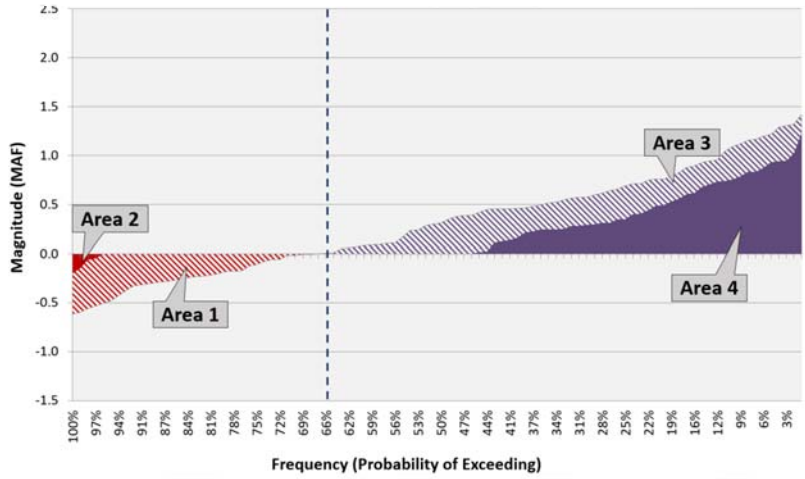
Scenario C: **Low** demands
Reduced imports

Net shortages possible across entire planning horizon.

Net shortage probability grows from 1% in 2025 to 5% in 2045.

Net shortages occur only in **SWP Dependent Areas**.

Figure 4-11: *Scenario C – **Shortage/Surplus** Probability for 2045*



Prior to taking available storage actions, surplus conditions have a 66% frequency and shortage conditions have a 34% frequency.

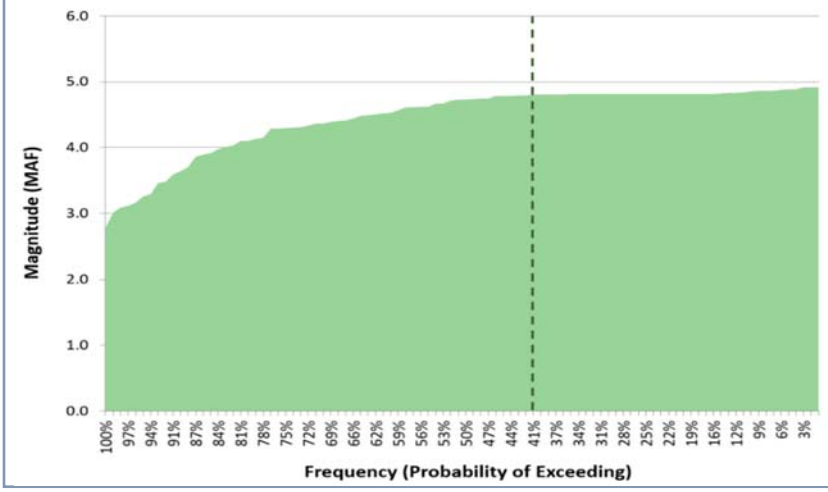
Area 1 & 2 – Gross shortage

Area 2 – Net shortages occur 5% of the time with a maximum magnitude of up to 200 TAF

Area 3 & 4 – Gross surplus

Area 4 – Up to 350 TAF of net surplus supply occurs 25% of the time

Figure 4-12: *Scenario C – **Storage** Probability for 2045*

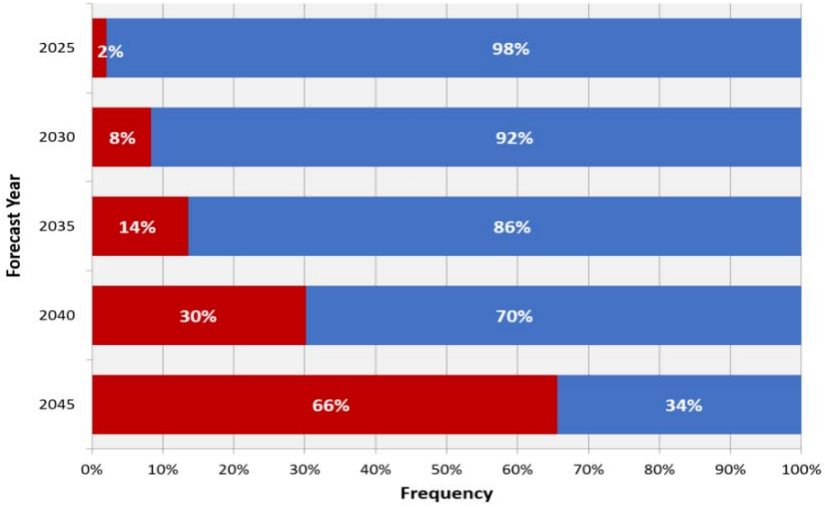


Full storage expected 41% of the time.

The probability of total storage less than 1.0 MAF is 0%.

High Demands/Reduced Imports Scenario D Reliability Assessment Results

Figure 4-13: *Scenario D –* ***Net Shortage*** *Assessment through the Planning Horizon*



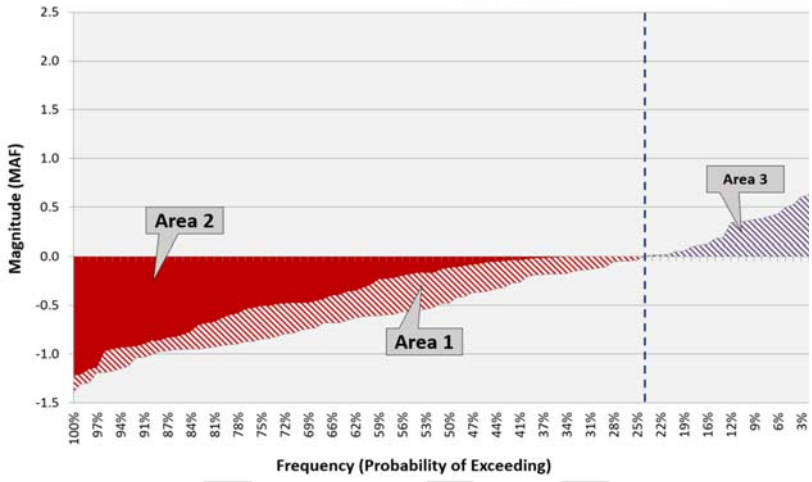
Scenario D: **High** demands
Reduced imports

Net shortages possible across entire planning horizon, and greater than 10% after 2030.

Net shortage probability grows sharply from 2% in 2025 to 66% in 2045.

Net shortages occur **system-wide** beyond 2035.

Figure 4-14: *Scenario D –* ***Shortage/Surplus*** *Probability for 2045*



Prior to taking available storage actions, surplus conditions have a 24% frequency and shortage conditions have a 76% frequency.

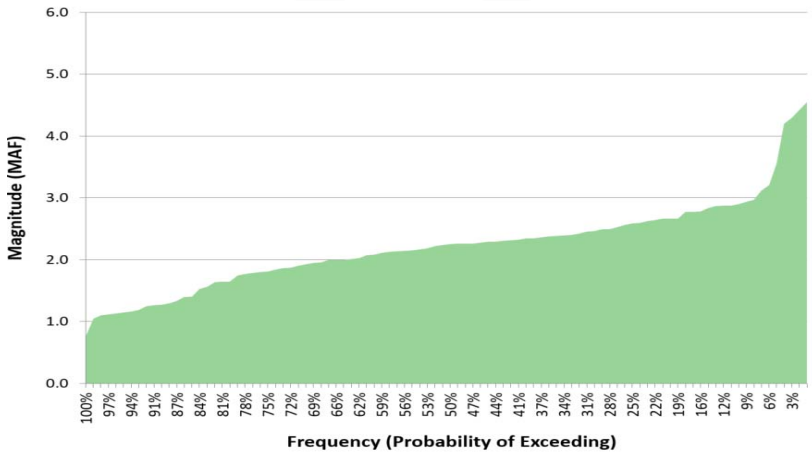
Area 1 & 2 – Gross shortage

Area 2 – Net shortages occur 66% of the time with a maximum magnitude of 1.22 MAF

Area 3 – Gross surplus

Area 4 (Not shown) – Does not exist in this scenario. Supplies, when available, can be stored

Figure 4-15: *Scenario D –* ***Storage*** *Probability for 2045*



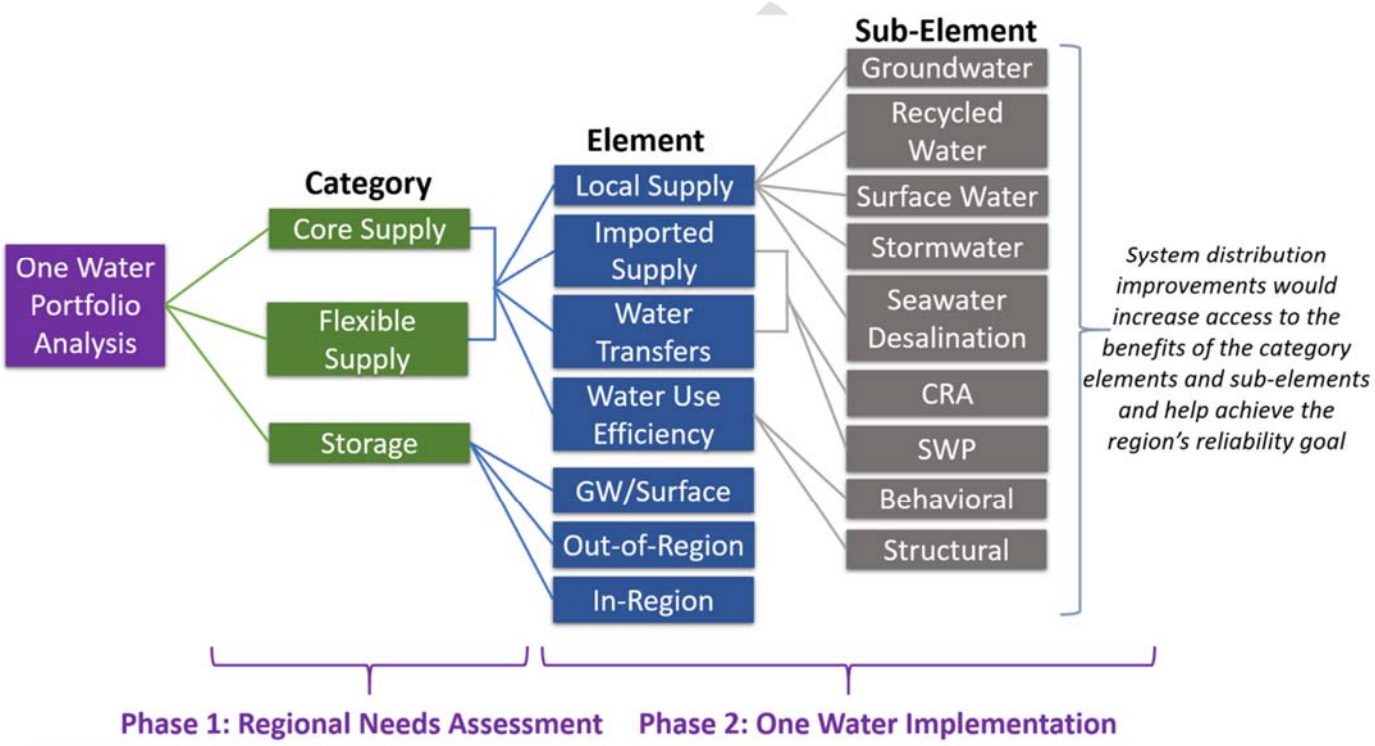
Full storage not expected in 2045. Limited imported supply along with the need to use stored supplies to satisfy demands prevents this scenario from filling storage capacity.

The probability of total storage less than 1.0 MAF is less than 2%.

High-Level One Water Portfolio Analysis Results

While the reliability assessment identified the potential shortages in each scenario, the portfolio analysis aimed to determine a high-level resource mix that tackles the supply-demand imbalances faced within each scenario. Eliminating the identified shortages would allow Metropolitan to meet its 100 percent reliability goal.

Figure 4-16: *Levels of One Water Portfolio Analysis*



Note: The elements and sub-elements identified are examples and not meant to be an exhaustive list.

The 2020 IRP's One Water portfolio analysis uses a hierarchical framework, shown in **Figure 4-16**, to characterize the different actions and investments. Metropolitan tested configurations at the highest "Category" level as part of the Regional Needs Assessment. Each category refers to one of three different types of supply (core, flexible, and storage), further defined in **Table 4-1**. With the preferred technical feasibility determined at the category level in the Regional Needs Assessment, further policy direction will be sought in the One Water Implementation phase to establish the basis for a more specific resource mix from the full spectrum of elements and sub-elements that comprise a holistic One Water approach. Below the "Category" level, element-level resource options such as water use efficiency can sometimes fulfill the role of either core supply or flexible supply but not both at the same time. Whether it serves the function of a core supply or flexible supply depends on the nature of the project or program. For example, structural water use efficiency programs that replace fixtures and repair leaks resemble a core supply because they provide a reliable, constant stream of water savings into the future. A conservation media campaign to encourage conscientious water consumption during a drought resembles a flexible supply because it is implemented on an as-needed basis.

Table 4-1: *Category Definitions*

Category	Definition	Notes	Examples
Core Supply	A supply that is generally available and used every year to meet demands under normal conditions and may include savings from efficiency gains through structural conservation.	High reliability and value if used often. Expensive otherwise.	• Colorado River basic apportionment • IID/Metropolitan conservation agreement • Code-based conservation
Flexible Supply	A supply that is implemented on an as-needed basis and may or may not be available for use each year and may include savings from focused, deliberate efforts to change water use behavior.	Expensive if used too much or too often. Better value if used occasionally.	• Palo Verde Land Management, Crop Rotation, and Water Supply Program • North-of-Delta annual transfers • Water Supply Alert • Conservation advertising campaigns
Storage	The capability to save water supply to meet demands at a later time.	Converts core supply into flexible supply. Evens out variability in supply and demand.	• Diamond Valley Lake • SWP Article 56 carryover • SWP flexible storage • Antelope Valley-East Kern High Desert Water Bank

Several assumptions were incorporated into the methodology to determine appropriate high-level resource mixes for Scenarios B, C, and D. Resource mixes for new portfolio actions are comprised of three categories: 1) core supply, 2) flexible supply, and 3) storage (see **Table 4-1** above).

The Regional Needs Assessment showed that net shortages were occurring in the SWP Dependent Areas (areas that cannot receive Colorado River supplies) for Scenarios B, C, and D. As such, additional core supply and storage were modeled as supplies that could reach the SWP Dependent Areas. These modeled supplies could also be used to meet water demand in the blended area (areas that receive SWP and Colorado River water). The additional flexible supply is not location-specific but is assumed to be available wherever the shortage is occurring (SWP Dependent or blended).

The portfolio analyses tested how the supply-demand gap in each scenario might be met using each category (core, flexible, and storage) separately. ***These category-specific tests enabled Metropolitan to conclude that rather than relying on any single category of portfolio actions, it is more practical in every scenario to pursue a more balanced and diversified mix.*** This provided a valuable starting point in determining the most suitable resource mix for each scenario.

After the portfolio categories were modeled in isolation, a mix of all three categories was modeled for each scenario. This analysis examined a range of additional storage to identify a more practical core and

flexible supply requirement. The following methodology was used in the portfolio analysis to determine the high-level resource mix for each scenario:

1. **Flexible Supply**
   Identify an achievable, flexible supply threshold not to be exceeded in any given year

   - The flexible supply threshold was set at 100 TAF and represents a realistic supply that can be secured in dry years when they are likely to be needed. Past experience has shown that SWP transfers supplies, an example of flexible supply, has limited availability, high cost, and losses associated with securing those supplies.
   - Absent core supply and storage development, the flexible supply identified is equivalent to the maximum shortage amount in any given forecast year.
   - Development of core supply and storage helps reduce the need for flexible supplies and achieve the established threshold.

2. **Storage**
   Establish a range of additional storage to complement core supply development for each scenario

   - The assessment looked at an additional storage capacity of 0, 100, 250, and 500 TAF.
   - Put/takes for the additional storage were defined as half of the capacity (e.g., 50 TAF put/take for a capacity of 100 TAF). This represents a realistic "middle-of-the-road capability"(between a surface water reservoir and a groundwater banking type program) appropriate for planning purposes.
   - The additional storage was modeled to come online in 2035 to provide a realistic timeline for acquisition, permitting, construction, and other implementation-related requirements. Existing storage programs were extended through 2045 with the assumption that current contracts will be renewed with the same terms.

3. **Core Supply**
   Determine core supply needed to achieve the reliability goal by testing the range of additional storage while not exceeding the flexible supply threshold

   - This core supply is not static and may increase throughout the forecast to ensure that the maximum flexible supply target (shortage amount) is not surpassed.

Low Demands/Stable Imports Scenario A Portfolio Analysis Results

Scenario A is characterized by **low demands** on Metropolitan and **stable local and imported supply**. In this future, there is no net shortage and no intervention is needed by Metropolitan; the reliability goal is achieved through consumer demand reduction efforts and sufficient local supply development. As such, no new investments in core, flexible or storage are necessary.

High Demands/Stable Imports Scenario B Portfolio Analysis Results

The challenges presented in Scenario B mainly result from **increasing demands** throughout the service area. The portfolio analysis first looked at the development needed for each portfolio category alone to achieve reliability, as shown in **Table 4-2** for the forecast year 2045.

Table 4-2: *Scenario B – Forecast Year 2045 Portfolio Category Need – Not Combined*

New Storage	New Flexible Supply	New Core Supply
TAF 500 TAF (250 TAFY put/take capacity)	300 TAF	150 TAF

The results revealed that upwards of 300 TAF of flexible supplies would be needed to achieve reliability, or a new 500 TAF storage capacity surface reservoir would be required. It was deemed unrealistic and risky to depend on such a large amount of flexible supply in a dry year when these supplies would typically be needed, and excessive to build a reservoir similar in size and scope as Diamond Valley Lake. Instead, to identify possible efficiencies gained through combining these portfolio categories, a mix of these categories was investigated. The results of that analysis are shown in **Table 4-3**.

Table 4-3*: Scenario B – Forecast Year 2045 Portfolio Category Need – Combined*

Modeled Storage	Core Supply Needed by 2045
0 TAF	100 TAF
100 TAF	70 TAF
250 TAF	30 TAF
500 TAF	30 TAF

Table 4-3 illustrates how various surface reservoir sizes impact core supply development need while staying within the flexible supply threshold. Without new storage, 100 TAF of additional core supply is needed by 2045 to eliminate net shortages. The core supply need reduces from 100 TAF to 30 TAF with 250 TAF of new storage capacity. The analysis also reveals no additional reduction in the core supply need if new storage capacity is increased to 500 TAF. This suggests that a new storage capacity above 250 TAF is unnecessary to reduce the core supply need and may be an overinvestment.

Low Demands/Reduced Imports Scenario C Portfolio Analysis Results

Scenario C is characterized by **low demands** on Metropolitan and **unstable local and imported** supplies due to a more severe climate change future. The shortages in Scenario C are mainly due to decreasing local and imported supplies. The magnitude of the net shortages in Scenario C are slightly less than those in Scenario B and indicate that higher demands have a more significant impact on reliability than the modeled unstable local and imported supplies. **Table 4-4** shows the development of each portfolio category alone for the forecast year 2045 to achieve 100% reliability.

Table 4-4: *Scenario C – Forecast Year 2045 Portfolio Category Need – Not Combined*

New Storage	New Flexible Supply	New Core Supply
TAF 500 TAF (250 TAFY put/take capacity)	200 TAF	100 TAF

Results show that developing 100 TAF of new core supply could alone eliminate net shortages in this scenario without the need for additional storage or flexible supply. Additionally, approximately 200 TAF of flexible supplies would be needed to achieve reliability, or a 500 TAF storage capacity surface reservoir would be required. Like Scenario B, the amount of additional storage or flexible supply alone was too great to be a realistic solution in a dry year and a combination of these portfolio categories was examined. The results of that analysis are shown in **Table 4-5**.

Table 4-5: *Scenario C – Forecast Year 2045 Portfolio Category Need – Combined*

Modeled Storage	Core Supply Needed by 2045
0 TAF	50 TAF
100 TAF	15 TAF
250 TAF	15 TAF
500 TAF	15 TAF

Scenario C required less additional core supply than Scenario B under all modeled storage conditions. If no additional storage is contemplated, 50 TAF of additional core supply is needed by 2045 to eliminate net shortages. The core supply need reduces from 50 TAF to 15 TAF with the addition of 100 TAF of new storage capacity. The analysis also reveals no additional reduction in the core supply need if new storage capacity is increased to 250 TAF. This suggests that a new storage capacity above 100 TAF is unnecessary to reduce the core supply need and would be a potential over-investment.

High Demands/Reduced Imports Scenario D Portfolio Analysis Results

Scenario D experiences larger impacts than the other three scenarios due to both **higher demands** on Metropolitan and **unstable imported supplies**. The compounded effects lead to shortages of substantially greater magnitude with a higher likelihood. The efficacy of the individual portfolio categories was determined by first modeling them separately, with results shown below in **Table 4-6**.

Metropolitan Imported Supplies Finding: *Maintaining existing imported supply reliability reduces the need for new core supply development and leverages years of investments.*

Table 4-6: Scenario D – Forecast Year 2045 Portfolio Category Need – Not Combined

New Storage	New Flexible Supply	New Core Supply
Storage up to 1.5 MAF with put/take capacity of 750 TAF/year still does not provide 100% reliability.	1.2 MAF	650 TAF

Adding new storage up to 1.5 MAF with a put/take capacity of 750 TAF were modeled. As the amount of modeled storage increased, results showed diminishing returns regarding decreasing probability and magnitude of net shortage. ***This led to the conclusion that there is no realistic amount of additional storage that could be modeled that would eliminate net shortage in Scenario D.*** Results also indicate that it would take 1.2 MAF of flexible supply or 650 TAF of new core supply to eliminate net shortage

alone, both of which are unrealistic management strategies. Even more than Scenarios B and C, a combination of portfolio categories is vital to eliminating net shortages. As with the other scenarios, a combined approach was modeled, and the results of this combination of portfolio categories is shown below in **Table 4-7**.

Table 4-7: Scenario D – Forecast Year 2045 Portfolio Category Need – Combined

Modeled Storage	Core Supply Needed by 2045
0 TAF	650 TAF
100 TAF	600 TAF
250 TAF	550 TAF
500 TAF	500 TAF

Storage Finding: *Expanding existing or developing new storage programs and investments in Metropolitan's distribution system can reduce the need for new core supply development to meet potential future shortages and adapt to climate change.*

Scenario D highlights the need for investments in a combination of core, flexible, and storage supplies. Additions of new core supply and storage work together in tandem; more water in storage reduces how much core supply is needed, while in turn, more core supplies mean water is readily available in non-dry years to accumulate in storage over time. More specifically, Scenario D requires significantly greater amounts of additional core supply than Scenarios B and C. With 500 TAF of additional storage capacity, there is still a need for an additional 500 TAF of core supply by 2045. When extra storage is reduced, the corresponding core supply increases.

Table 4-8: *Probability of Shortage With and Without Distribution System Constraints*

Year	Scenario B		Scenario C		Scenario D	
	Constraints	No Constraints	Constraints	No Constraints	Constraints	No Constraints
2025	1%	0%	1%	0%	2%	0%
2030	1%	0%	0%	0%	8%	0%
2035	2%	0%	3%	0%	14%	5%
2040	3%	0%	3%	0%	30%	31%
2045	5%	0%	5%	0%	66%	67%

Table 4-8 shows the probability of shortage with and without distribution system constraints that restrict deliveries of Colorado River water and other blended area supplies to portions of Metropolitan's service area. This was analyzed by comparing two IRPSIM model runs. The first run contained the existing system configuration that reflects current capacity to deliver water to the SWP Dependent areas. The second run reflects a theoretical removal of these system constraints.

General Observations

The portfolio category analysis revealed similar patterns across scenarios. As a general rule, less core and flexible supply were necessary to achieve the reliability goal when after adding storage. Additionally, there was a notable drop in the flexible supply need in the forecast year 2025 when the Arvin-Edison Banking Program is assumed to return to service after being shut down due to water quality concerns. ***This shutdown shows how important SWP banking programs are to Metropolitan's reliability in light of vulnerabilities in the SWP Dependent Areas.***

Currently IRPSIM models all SWP banking programs to operate throughout the planning horizon. The Arvin-Edison Banking Program result shows that ***extending the contract terms for the other SWP banking programs is vital to Metropolitan's long-term reliability.*** Maintaining existing imported supplies that utilize existing storage programs, including SWP banking, is necessary and may reduce the need for new core supply development and leverages years of investments.

SWP Dependent Areas and Storage Finding:

Storage capacity, put/take capabilities, and accessibility are critical considerations for the SWP Dependent Area. New storage capacity and put/take capabilities should be consistent with the portfolio analysis. New storage must be accessible to the SWP Dependent Areas.

Storage Findings:

1) Maintaining Metropolitan's existing storage portfolio is critical, including the consideration of re-negotiating contracts when they expire.
2) When evaluating storage options, put/take capabilities are essential; even storage programs with modest put/take capabilities help reduce the need for flexible supply.

Chapter 5 - Findings

The IRP's goal in guiding Metropolitan's investments is to avoid retail water shortages and mandatory end-user cutbacks. This reliability goal recognizes that although tolerance for voluntary conservation measures varies among member agencies, Southern Californians clearly distinguish voluntary and responsible conservation from mandatory cutbacks. A vision for regional success is for every Southern California consumer and business to have access to affordable, high-quality water at all times. To this end, the Regional Needs Assessment highlights important areas of vulnerability to Metropolitan's reliability goal. Findings from the Regional Needs Assessment fall within five key focus areas:

1. SWP Dependent Areas
2. Storage
3. Retail Demand/ Demand Management
4. Metropolitan Imported Supplies
5. Local Supply

These findings are summarized and discussed below. The scenario analyses found plausible reliability outcomes by the year 2045, with potential shortages ranging from no net shortage at all under Scenario A to as high as 1.2 MAF under Scenario D. As Metropolitan proceeds towards implementation in the next phase of the IRP, specific actions must address these gaps in a manner consistent with the portfolio category analysis identified in Chapter 4.

SWP Dependent Areas Findings

- *Vulnerabilities in the SWP Dependent Areas are more severe given reduced reliability of SWP supplies and Metropolitan distribution system constraints. Actions identified in the implementation phase must prioritize addressing the SWP Dependent Area's reliability challenge.*
- *New core supplies must be accessible to the SWP Dependent Areas. Greater access to existing core supplies can also increase SWP Dependent Area reliability.*
- *Enhanced accessibility to core supplies and storage, both existing and new, will improve SWP Dependent Area and overall reliability. This includes improvements to Metropolitan's distribution system and capacity to deliver non-SWP supply and storage.*
- *Storage capacity, put/take capabilities, and accessibility are critical considerations for the SWP Dependent Area. New storage capacity and put/take capabilities should be consistent with the portfolio analysis. New storage must be accessible to the SWP Dependent Areas.*

Water demand in Metropolitan's service area is met by combining its imported supplies via the SWP and Colorado River Aqueduct, storage reserves, and local supply production. These spatially diversified water supplies increase reliability by buffering supply impacts with any one source. In general, when one or more supply sources are challenged, the other sources are depended on more to satisfy the region's demand.

Portions of Metropolitan's service area, however, cannot receive water from both imported supply sources and do not have enough local supply to meet demand. Those portions of Metropolitan's service area where Colorado River supply cannot access, referred to as "SWP Dependent Areas" as shown in **Figure 3-6**, are of particular concern if low SWP Table A Allocations become more frequent.

A crucial finding of this IRP recognizes that SWP Dependent Areas present a severe vulnerability to regional water reliability. Across scenarios, this vulnerability emerges as a common thread among foreseeable risks. Whenever shortages occur in any scenario, they involve a mismatch between accessible supplies and demands in the SWP Dependent Areas. This puts additional pressure on the Colorado River, local, and storage supplies to satisfy a larger proportion of the regional demand. Consequently, resolving reliability issues for the SWP Dependent Areas will address the larger reliability issues for the entire region.

As SWP core supplies become less reliable over time, as analyzed in the four scenarios, the risks to reliability posed by the SWP Dependent Areas are exacerbated. Because of these vulnerabilities, actions identified in the One Water Implementation phase should prioritize addressing SWP Dependent Areas. New core supplies and new/or existing storage must first address and reach SWP Dependent Areas. However, investing in conveyance and distribution to improve core, local, and storage supply access to the SWP Dependent Areas should also be evaluated to determine if overall system reliability is compromised. Additionally, potential shortages in the Colorado River, as seen in Scenario D, can limit the effectiveness of system improvements.

Storage Findings

- *Storage capacity, put/take capabilities, and accessibility are critical considerations in maintaining reliability under the region's current and future conditions, especially for SWP Dependent Areas.*
- *Maintaining Metropolitan's existing storage portfolio is critical, including the consideration of re-negotiating contracts when they expire.*
- *Expanding existing or developing new storage programs and investments in Metropolitan's distribution system can reduce the need for new core supply development to meet potential future shortages and adapt to climate change.*
- *When evaluating storage options, put/take capabilities are essential; even storage programs with modest put/take capabilities help reduce the need for flexible supply.*

Storage is vital to reliability under current and plausible future conditions. Core supplies and storage capabilities work together in tandem; dependable core supplies are needed to fill and refill storage before and after dry years, and ample storage capacity is needed to make the most of opportunities for core supplies when they become available. Three major conclusions related to storage emerge from the IRP analysis:

1. Expanding existing or developing new storage programs will be needed to help balance new core supply development and mitigate future shortages. This may include policies and programs enabling Metropolitan's use of local storage during drought conditions.
2. A holistic approach is essential when evaluating storage options. Evaluation of put-and-take capabilities should take into account the amounts and timing of water that can be moved and

spatial considerations, such as the source of water and access to the various parts of Metropolitan's distribution system. New storage development and or expanding distribution flexibility to move existing storage to the SWP Dependent Areas should be investigated in the implementation phase.

3. Furthermore, several of Metropolitan's existing storage programs will expire over the next 15 years, within the planning horizon of the 2020 IRP. Without further action to extend these agreements, Metropolitan will lose more than 1.6 MAF of total storage volume by 2037. The IRP reliability analyses assume that these programs will remain in place. Still, their possible expiration remains a threat to regional reliability until such programs are extended or replaced. This is an example of the active management that is constantly required and highlights the ongoing need for collaboration with Metropolitan's banking partners. These known administrative risks are apart from other, more uncertain operational risks, such as contamination, new regulatory restrictions, and seismic disturbances.

Retail Demand/Demand Management Findings

- *Metropolitan's future supply reliability may fluctuate based on demand increases and decreases.*
- *Variability in retail demand largely comes from changes in outdoor water use. Outdoor water use behavior is complex, influenced by weather and climate and by awareness of water scarcity and other conservation measures.*
- *It is important to pay attention to demand rebound, demand growth, and demand reductions, and take appropriate regional measures as necessary.*
- *Managing long-term demands through the efficient use of water reduces dependency on supplies, helps preserve storage, and helps reduce the need for extraordinary conservation measures.*

Conservation has long underpinned Metropolitan's long-term water supply reliability strategy. Metropolitan administers regional conservation programs and co-funds member agency conservation programs designed to increase water use efficiency and bolster water conservation ethics. Conservation comes from two areas of change: structural conservation which involves increases in water use efficiency, and behavioral conservation, which involves modifying consumer water-using behavior through messaging, education, pricing, and mandates. Of these two forms of conservation, structural conservation is more permanent, akin to a core supply. Water-efficient device retrofits, landscape conversions, plumbing codes, and leak prevention contribute to ongoing structural water savings. Conservation device retrofits help recover storage in future years by lowering demands in all years, not only drought years. In contrast, behavioral conservation is less permanent and can wax and wane due to various influences outside of Metropolitan's direct control. The IRP recognizes water use behavior, represented by per capita water use, as a major uncertainty for regional demands over time. The IRP scenarios confirm that Metropolitan's future reliability is highly sensitive to changes in water demands. Under Scenario A, with low demands and

Retail Demand/Demand Management Finding:
Managing long-term demands through the efficient use of water reduces dependency on supplies, helps preserve storage, and helps reduce the need for extraordinary conservation measures.

stable imports, no net shortages are anticipated through the year 2045. Demands also remain low in Scenario C, with low frequencies of net shortages occurring throughout the planning horizon. Meanwhile, Scenarios B and D consider what might happen if per capita water demands rebound to levels approaching historical usage. While Scenario B shows similar frequencies of net shortages as Scenario C, the magnitudes of such shortages are greater. Under Scenario D, where there is both increase in demands on Metropolitan and significant loss of imported core supply, there is a high risk of shortage and an inability to ever refill storage to capacity by the year 2045.

Increased demands, whether from growth or from per capita use, represent a major risk to reliability. Demands can increase from rebounding per capita water use, but even with efficient use, total demands can still increase as the population and economy grow over time. Variability in retail-level demands mostly comes from outdoor water use, which is influenced by weather and climate and other factors that affect water-using behaviors. Baseline conservation programs help with every scenario. Monitoring demands and intervening as appropriate will be critical. Managing demands through efficient use of water reduces dependency on costly supplies, helps preserve storage, and defers the need for disruptive extraordinary conservation measures such as emergency declarations and water supply allocations.

Metropolitan Imported Supplies Findings

- *Existing imported supplies are at risk from various drivers of uncertainty.*
- *Maintaining existing imported supply reliability reduces the need for new core supply development and leverages years of investments.*
- *SWP supplies are highly susceptible to varying hydrologic conditions, climate change, and regulatory restrictions.*
- *Variability and capacity in SWP supplies provide opportunities to store water during wet periods for use in dry years, including Colorado River storage. Metropolitan's ability to distribute or store SWP supplies when they materialize will enhance the region's reliability, particularly the SWP Dependent Areas. The Colorado River system and Colorado River Aqueduct capacity do not offer the same opportunities concerning SWP storage.*
- *Shortages on the Colorado River will limit the reliability of Colorado River Aqueduct deliveries as a core supply in the future.*

Imported supplies remain essential as core supplies to the region. They are a valuable legacy of decades of planning and investment. As source waters, they provide good water quality and supply benefits that, once lost, are very difficult to replace. Metropolitan's core supplies from the Colorado River Aqueduct are generally less susceptible to volatility from year-to-year hydrologic conditions than Metropolitan's core supplies from the SWP. However, all of the region's imported supplies face significant threats from various drivers of uncertainty, including climate change. While there is little scope for obtaining new additional imported core supplies, taking action to preserve the region's legacy imported supplies is crucial for several reasons.

Imported supplies, primarily the SWP supplies, uniquely reinforce reliability by their ability to leverage Metropolitan's storage capacity in wet periods for use in dry years and by diversifying supply sources across multiple watersheds. Because water resources available to the Metropolitan service area come from three geographically distinct regions—Northern California, the Colorado River, and local

resources—a relatively dry year affecting one of these three regions can be offset by relatively abundant supplies from the other two regions. For example, a year of ample precipitation within Metropolitan's service area tends to depress demand and enhances local water resources, further reducing demands on imported supplies. A wet year in the Sacramento-San Joaquin watersheds increases the SWP Table A allocation, facilitating reduced diversions from the Colorado River in favor of storing supplies in Lake Mead or in the Desert Water Agency/Coachella Valley Water District Advanced Delivery Account.

Conversely, a shortfall on the SWP may require system operational modifications to maximize Colorado River diversions and the delivery of Colorado River supplies to the SWP Dependent Areas. Each increment of existing imported supply reliability prevented from loss offsets the need to develop new alternative core and flexible supplies that may be more costly, may take considerable lead time to bring online, and may not be easily integrated into the region's water distribution system. SWP Dependent Areas are so-called because they currently rely on SWP water to meet at least part of their demands; any practical alternative supplies to meet SWP Dependent Area demands would also have to be potable and accessible to those relatively isolated portions of Metropolitan's distribution system.

Local Supply Findings

- *Maintaining existing and developing new local supplies is critical in helping manage demands on Metropolitan.*
- *Impacts to reliability occur if local supply assumptions are not achieved; therefore, it is important to track the progress of local supply development as one of the signposts in the One Water Implementation phase.*
- *Additional actions may be needed should existing and future local supply levels deviate from IRP assumptions.*

Demand on Metropolitan's imported supplies are a function of total regional demands and the local supplies available within the region to meet them. Local supplies are the front line in securing regional reliability. Local supplies regularly meet roughly half of the region's total urban demands; in some years it can be more than 60 percent. Because imported core supplies cannot be expected to increase even in the face of population and economic growth, the region's reliance on existing and new local supplies relative to imported supplies will only grow in the future. The IRP scenarios reveal that safeguarding the region's vast inventory of existing local supplies is as crucial as preserving existing imported supplies.

Continued performance of local supplies cannot be taken for granted, for as with imported supplies, many factors can impede local supply development and production, including funding, contamination, changing regulatory requirements, and climate change. For example, there has been a decline in groundwater production in the past 20 years, affected by limited availability of imported supplies for replenishment, variability in natural replenishment from rainfall, and emerging contaminants. At the same time, the region has made substantial gains in recycled water development, but continued success will be more difficult moving forward. This is due to the reduction of available of wastewater effluent, which stems from conservation, constraints in distribution systems, and rising costs from increasing salinity.

The region's reliability is highly sensitive to local supplies, as it comprises such a large portion of the region's total supply. As a part of the Regional Needs Assessment, Metropolitan engaged with member

agencies and basin managers to identify the potential timing and implementation of planned projects and operation of groundwater basins appropriate for each IRP scenario. Impacts to reliability will occur if local supply assumptions are not achieved; therefore, it will be important to track progress of local supply development as part of the signposts in the One Water Implementation phase. Metropolitan currently fosters local supplies through various programs and funding support, including its Local Resources Program. Metropolitan will continue to support the development of local supplies by Member Agencies.

Conclusion: Reason for Optimism with a *One Water Approach*

Collectively, these findings instill a sense of optimism about Southern California's water future. Metropolitan has identified the tools necessary to adapt to a variety of plausible futures successfully. It is also well within Southern California's control to avoid a fate with increased per-capita water use and higher demands that would prove unsustainable.

One Water is the collaborative, community approach that matches the right tools for the emerging needs of the future. The precise combination of actions will emerge as more is known about the future that we actually face. Southern California is poised to be agile enough to adjust its portfolio of water actions to keep up with our changing times.

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Attachment B

DRAFT Refined Analysis Assumptions used to Model Retail Demands for Scenarios A, B, C, & D

Data Link: ***Refined Data June 2021***

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
↓	*This scenario is characterized by lower retail water demands and stable regional and local supplies. Demands are impacted by lower economic and demographic growth and a continuing water use ethic across the region. Both regional and local supplies show more stable production due to less severe climate change and less restrictive regulatory constraints on existing water supply projects, and a relatively robust implementation of new water supply projects at the local level.*	*This scenario is characterized by higher retail demands, stable regional and local supplies. Demand are impacted by higher economic and demographic growth and a rebound of water use ethic. Both regional and local supplies show more stable production due to less severe climate change and less restrictive regulatory constraints on existing water supply projects, and a relatively robust implementation of new water supply projects at the local level.*	*This scenario is characterized by lower retail water demands and less stable imported supplies. Demands are impacted by lower economic growth, demographic growth and with successful efforts among member agencies to manage water use behavior and drought-proof their local supplies. It couples a struggling economy with the rapid onset of climate change impacts that have affected imported supplies more drastically than less-vulnerable local supplies.*	*This scenario is characterized by higher retail demands, unstable imported and diminishing local supplies. Demand are impacted by higher economic and demographic growth and a rebound of water use ethic. In this scenario severe climate change impacts both imported and local supplies. Demands on Metropolitan are increasing due to rapidly increasing demands and diminishing yield from local supplies. Efforts to develop new local supplies to mitigate losses of underperforming projects. Losses of regional imported supplies are equally dramatic.*
Retail Demand - Demographics The level of demographic (population, households, housing types, employment) growth is an important driver to water demand	• Lower demographic growth ▪ Utilized Center for Continuing Study of the California Economy's (CCSCE's) low growth forecast developed for the 2020 IRP	• Higher demographic growth ▪ Utilized CCSCE's high growth forecast developed for the 2020 IRP	• Same as Scenario A	• Same as Scenario B
Retail Demand - Immigration Immigration is the most important factor for national population growth, California share of national growth stays consistent across scenarios, not impacted by climate change issues.	• CCSCE's forecast considers climate change impacts on international immigration and migration to California ▪ No basis to change population forecast or regional share growth due to climate impacts at this time	• Same across all scenarios	• Same across all scenarios	• Same across all scenarios
Retail Demand - Households New households are modeled separately from existing households to reflect increasing	• This scenario projects a total of **903,000** additional new households. • Assumes a median lot size of 5,000 sq. ft. for new housing units (approximately 30%	• This scenario projects a total of **2.6 million** additional new households. • Same median lot size assumption as Scenario A	• This scenario projects a total of **907,000** new households • Same median lot size assumption as Scenario A	• This scenario projects a total of **2.8 million** new households. • Same median lot size assumption as Scenario A

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
efficiency and smaller sizes of new homes and lots. These new households include single family, multi family, and Accessory Dwelling Units (ADUs).	reduction compared to the existing median lot size) to reflect smaller lot sizes and more efficient outdoor use. Reduced lot size equates to less irrigable area.			
Retail Demand - Overcrowding In addition to normal housing growth to accommodate population growth, one-time additional housing units a "catch-up" factor is projected to reduce overcrowding, minimize cost burdened households, and bring vacancy rate back to normal level.	• This scenario assumes the lowest success rate, **340,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a struggling economy and low population growth	• This scenario assumes a moderate success rate, **516,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a strong economy and population growth	• This scenario assumes a low success rate, **344,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a weak economy and slow population growth	• This scenario assumes the highest success rate, **696,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a strong economy and population growth
Retail Demand – Behavioral Retention The lower retail demands observed since the last drought are driven by a structural and behavioral water use component, of which behavior is more reversible or at risk to rebound. Retail demands reflect both use per person and the number of people. Total demand can increase even without a degradation in efficient water use behavior.	• Efficient water use behavior is retained at a high level • Behavioral component: **90% retention** of the behavioral component of the observed reduced demand is retained reflecting continued strong water use ethic. • Structural Component: This permanent reduction in demand is accounted for based on demographic assumptions including a shift from single family homes toward multifamily construction with smaller lot sizes, ADUs, less irrigable area, and increased adoption of device-based conservation	• Efficient water use behavior is retained at a moderate level • Behavioral component: **50% retention** of the behavioral component of the observed reduced demand is retained reflecting a plausible rebound in water use ethic. • Structural Component: This permanent reduction in demand is accounted for based on demographic assumptions including a shift from single family homes toward multifamily construction with smaller lot sizes, ADUs, less irrigable area, and increased adoption of device-based conservation	• Same as Scenario A	• Same as Scenario B

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
Retail Demand - Agricultural Demand A hotter and drier climate will impact irrigation needs	• Consistent with member agencies' 2020 UWMP and reflects discussions with member agencies ▪ No additional adjustments assumed	• Same as Scenario A	• Hotter and drier conditions coupled with increased regulatory constraints result in higher operation costs and ag land coming out of production. ▪ 20% decrease in demand by 2045 due to fewer farming operations ▪ 10% increase in irrigation requirements for remaining farms by 2045 due to hotter and drier conditions	• Same as Scenario C
Retail Demand - Seawater Barrier Demand Mitigating overdraft challenges will lead to higher demands on Metropolitan	• No modifications based on member agency discussions	• Same as Scenario A	• Climate change stresses will increase demand • Increased by 10% by 2045. The increase in demand is tempered by lower overall demands in this scenario and less overdraft challenges	• Climate change stresses will increase demand • Increased by 20% by 2045. The increase in demand reflects higher overall demands in this scenario and significant overdraft challenges
Imported Replenishment Demand Changes in natural recharge volume and patterns along with recycled water availability will impact demands on Metropolitan	• Replenishment water purchases from MWD is based on past discussions with member agencies and groundwater basin managers to meet their imported replenishment needs to supplement their natural recharge • Reflects scenario-based climate change impacts on natural recharge • Also reflects recycled water availability for replenishment demands (see recycled water assumption) • Though assumptions are the same across all scenarios, values used vary per scenario			

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
Local Supply - Precipitation Precipitation is a major driver on future water supply. Metropolitan's modeling methodology requires use of annual weather variations over time (1922-2017). Adjustments were made to the historic record to reflect climate expert feedback on potential future impacts.	• Historical variation in precipitation from 1922-2017 will continue through 2045	• Same as Scenario A	• Modified 1922 – 2017 precipitation to reflect more extreme conditions. This will impact surface water reservoir and groundwater supply ▪ Increased the frequency and intensity of dry years ▪ Decreased the frequency and increased the intensity of wet years ▪ Kept 1922-2017 average similar	• Same as Scenario C
Desalination – Existing Local Projects	• Claude "Bud" Lewis (Carlsbad Desalination Plant) ▪ Assumed facility to operate at ~85% of capacity in normal and wet years, and full capacity during dry years. ▪ Normal, wet, and dry years vary by scenario	• Same across all scenarios	• Same across all scenarios	• Same across all scenarios
Desalination – Future Local Projects	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • No planned projects incorporated in this scenario	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • Includes Doheny Ocean Desalination Project, Huntington Beach Seawater Desalination Project, and West Basin Seawater Desalination Project • Operation assumed to be **85% of yield** in normal and wet years, full ultimate yield in dry years • Wet, normal, and dry years vary by scenario	• Same as Scenario A	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate foreach scenario • Includes Doheny Ocean Desalination Project, Huntington Beach Seawater Desalination Project, and West Basin Seawater Desalination Project • **Reduced yield by 20%** to approximate impacts from severe climate change and regulatory constraints • Operation assumed to be **85% of yield (after 20% reduction)** in normal and wet years, full ultimate yield in dry years • Wet, normal, and dry years vary by scenario

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
Groundwater Recovery - Existing Local Projects	• Engaged with member agencies to confirm yield of projects currently in operation • No modifications to yield in this scenario	• Same as Scenario A	• Engaged with member agencies to confirm yield of projects currently in operation • **Decreased yield by 20%** to approximate increased regulatory requirements and severe climate change impacts to groundwater basins	• Same as Scenario C
Groundwater Recovery – Future Local Projects	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 30%** in this scenario to reflect lower need to develop additional projects due to low demands.	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 10%** in this scenario in recognition of strong project implementation	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 20%** in this scenario to approximate the impact of regulatory requirements, but an increase in local project need due to reduced imports	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 20%** in this scenario to approximate the impact of regulatory requirements, but an increase in local project need due to reduced imports • Though assumptions are the same for Scenario C and D, values used vary per scenario based on member agency feedback
Recycled Water - Existing Local Projects	• Engaged with member agencies to confirm yield of projects currently in operation • **Reduced yield by 20%** to approximate impact of decreased wastewater availability from low demands	• Engaged with member agencies to confirm yield of projects currently in operation • **No change to yield**	• Same as Scenario A	• Same as Scenario B

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
Recycled Water - Future Local Projects	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 30%** to approximate the impact of decreased wastewater availability from low demands and less need to develop projects due to stable imports ▪ 30% is based on observed local project development within the service area	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 10%** in this scenario in recognition of strong project implementation	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 30%** to approximate the impact of decreased wastewater availability from low demands and less need to develop projects due to stable imports ▪ 30% is based on observed local project development within the service area • Though assumptions are the same for Scenario A and C, values used vary per scenario based on member agency feedback	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate foreach scenario • **Reduced yield by 20%** in this scenario to approximate the impact of regulatory requirements, but an increase in local project need due to reduced imports
LA Aqueduct Supply	• Estimates based on single trace LAA Forecast provided by LADWP in 2020 ▪ Reduced modeled output for each hydrology by 13,000 acre-feet to adjust for approximated bias from what was provided in 2020 and what LADWP used in their UWMP ▪ Note: MWD uses a 96-year hydrology as opposed to LA's 30-year hydrology for modeling methodology purposes	• Same as Scenario A	• Estimates based on single trace LAA Forecast provided by LADWP in 2020 ▪ Reduced modeled output for each hydrology by 13,000 acre-feet to adjust for approximated bias from what was provided in 2020 and what LADWP used in their UWMP ▪ Note: MWD uses a 96-year hydrology as opposed to LA's 30-year hydrology for modeling methodology purposes • Applied annual climate change factor of 0.1652% to reduce LAA supplies per LADWP UWMP	• Same as Scenario D
Surface Water Supply	• Used San Diego Surface Model to approximate annual variance around their UWMP long-term average (43,928 AFY) ▪ Based on 1922-2017 precipitation (see precipitation for local supply assumption) • For all other member agencies used provided scenario specific projections • Though assumptions are the same across all scenarios, values used vary per scenario			

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
Groundwater Supply	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed long-term Basin Production Percentage (BPP) goal of 85% ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2010-2019 Production Average or UWMP production data when available	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed Basin Production Percentage (BPP) of 85% to 2030; reduced by 5% every 5 years afterwards to adjust for growing demands ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2010-2019 Production Average or UWMP production data when available	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed long-term Basin Production Percentage (BPP) goal of 85% ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2015-2019 Production Average or UWMP production data when available	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed Basin Production Percentage (BPP) of 85% to 2030; reduced by 5% every 5 years afterwards to adjust for growing demands ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2015-2019 Production Average or UWMP production data when available
State Water Project Supply Used DWR's Delivery Capability Report (DCR) projected SWP deliveries as basis for the scenario analysis. The DCR Existing Condition modeling result reflects SWP deliveries without climate impacts. The DCR Future Condition modeling result reflects SWP deliveries with climate impacts by using the Representative Concentration Pathway (RCP) 8.5 with 1.5 ft of sea level rise.	• Used a hybrid of the DCR Existing Condition (no climate impacts) and Future Condition (climate impacts) modeling results to project "moderate" climate change impacts to SWP deliveries ▪ Used 50% of the difference between Existing Condition and Future Condition deliveries	• Same as Scenario A	• Used a hybrid of the DCR Existing Condition (no climate impacts) and Future Condition (climate impacts) modeling results to project "severe" climate change impacts to SWP deliveries ▪ Move from Existing Condition deliveries to Future Condition deliveries linearly to 2035 • Additional degradation factor by 25% by 2035 to represent future regulations/unknowns/low cooperation	• Same as Scenario C

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)

Colorado River Supply
 	
Utilized expert input to identify evaporative losses, a range of temperature increases (Lukas and Payton, 2020) and a range of runoff decreases to reflect moderate to severe climate impacts (Milley and Dune, 2020)
	• Moderate climate change impacts using Representative Concentration Pathway (RCP)4.5
	  ▪ Linear increase in temp to 2.1 °C by 2045
	  ▪ 15.6% decrease in runoff by 2045 (Powell and Mead inflows)
	  ▪ 4.5% increase in Lake Mead and Lake Powell evaporation by 2045
	• High cooperation-Drought Contingency Plan (DCP) continues after 2026, interim guidelines extended
		• Same as Scenario A	• Severe climate change impacts using Representative Concentration Pathway (RCP) 8.5
			  ▪ Linear increase in temp to 2.75 °C by 2045
			  ▪ 25.6% decrease in runoff (Powell and Mead inflows)
			  ▪ 4.5% increase in Lake Mead and Lake Powell evaporation by 2045
			• Low cooperation- Drought Contingency Plan (DCP) ends after 2026, interim guidelines extended
				• Same as Scenario C

Climate Adaptation Master Plan for Water (CAMP4W)

SUMMARY OF COMMENTS FROM MEMBER AGENCIES

CAMP4W THEMES

August 2023

The following pages document Member Agency comments on the CAMP4W Themes.

PURPOSE OF CAMP4W THEMES

Feedback	Response
No comment	n/a
Any decision-making framework that involves scoring must provide: Clarity – easy to understand/follow connections between qualitative aspects and translation into scores/ranking. Also, communicate how sensitive, or not, decisions are to added importance of one or more criteria. Transparency – consensus on how inputs become scores/rankings	Agreed and noted.
Overall, I think the five CAMP4W Theme Categories (reliability, resilience, financial sustainability and affordability) are on-point and accurately reflect the discussions among the Board and Member Agencies. With respect to the purpose, I agree that the Themes will inform a decision-making framework and the establishment of next steps in the CAMP4W process. However, I am less certain about the concept of developing "Evaluative Criteria so that the scoring of projects reflects these themes." I'm not there yet – and think it is premature to conclude that we are going to develop a prescriptive point scoring system for projects based on these themes that will be used to make "go-no go" decisions. Certainly, the themes should inform the decision-making process for all MWD investments but that may not translate to a point scoring system on a project-by-project basis. More discussion is needed on this element of the purpose and proposal.	Noted.
No comment	n/a
We appreciate staff's ongoing efforts to support the CAMP4W process; however, we believe that the main input many board members and member agencies have provided, especially on the need for close coordination and integration with member agencies' current positions and plans and how MWD can best facilitate a future that assures climate protection and preparedness, and equity, at the lowest possible cost is missing. General Manager Hagekhalil said at the June 27 workshop that, "we're going to work as staff working with the member agencies on developing the options," but that's not happened. He further stated that this process "is really focused on member agency alignment and looking at the gaps when it comes to water supply through our needs assessment tool" – but the IRP Needs Assessment does not make clear the distribution of the gaps, if they exist, and the extent of the gaps. Member agencies and board members have repeatedly asked staff to identify the nature of the reliability and resiliency problems and where they are located, yet this information has not been provided. We also continue to lack a baseline based on the actual needs of our respective member agencies. We do not agree that approval of "themes" is the best way to accomplish the board's objectives, or that approval of "themes" is the extent of the board's	We acknowledge the need for close coordination with MAs and are designing the process to address your concerns.

Feedback	Response
role until staff brings back a list of projects to address climate. A more focused analysis of the impacts of climate on our existing asset portfolio and the services member agencies want MWD to provide is needed in order to assess where best to invest our ratepayer dollars going forward. We view this analysis as needed to support the board's decision-making role in how to meet the needs of the member agencies with a changing climate. In reviewing the July 20 MAM presentation, we do not believe the description of "board direction" at the June workshop is entirely accurate (slide 3). To plan for climate change using adaptive management and affordability criteria is correct; however, we cannot plan adaptively nor consider affordability without more data about the nature, location, and extent of our challenges, which has not been presented (if analyzed). Failure to identify the challenges at an appropriate level of detail is what resulted in the past planning process not meeting the region's needs, which was to a large extent, blind to the challenges of the SWPDA. It wasn't the board, but staff who suggested that the business model options could be considered "in parallel to adaptation planning processes," in response to a question posed by the Chair. We believe the board should understand what the business model is and who will pay before, not after the board authorizes more projects. The Water Authority's MWD Delegates have expressed concerns about the expedited public engagement effort prior to more meaningful progress on the board's CAMP4W process. We do support close coordination with our member agencies in whatever public outreach is done. Referring to slide 11 of the July 20 MAM presentation, we note without more information about where the reliability and resiliency problems are and the extent of those problems, the board will not be able to assess the most efficient and fair way to accomplish needed investments. For example, it is impossible to say that "new storage development" can reduce the problem, in fact, it may be the wrong investment depending on the facts and circumstances. We have a similar question on the benefit for Pure Water Southern California for that same reason.	
During discussions among the Board and Member Agencies, many differing, and sometimes conflicting, ideas, definitions, and concepts were mentioned. There needs to be alignment on definitions, themes, the problem statement (i.e. what is the supply-demand gap, what is causing the gap – distribution infrastructure constraints? population growth?) before moving to the next step. Additionally, there are certain descriptions of themes that are beyond Metropolitan's control such as individual retail agency water rates and strategic objectives. Clarity on the process and efforts to seek alignment are necessary prior to finalizing themes.	WMs 1 and 3 will provide clarity and consistency of terms.
No comment	n/a

Feedback	Response
I do not have much comments on the themes per-say, overall, they were very well put-together, but I did want to offer a few suggestions for incorporation if aiming for a wholistic approach: I did not see "innovation" captured in any of the themes, by that I mean any new innovative ideas & technology that could potentially help streamline processes hence, expenditures. Perhaps this would fall under "Affordability"; a bullet indicating to evaluate mechanisms to streamline processes and increase efficiencies with innovative ideas for cost-savings, which will eventually free up funding for capital projects. Also, there is a challenge that is facing the engineering market in general with many recent & upcoming retirements and a market dry from experienced engineers to handle the volume of infrastructure rehab/improvements needed. I do not expect the CAMP4W to have a solution for this workforce challenge but it I believe this is a key consideration during the process, and can be part of the dialogue, but I could be wrong?	Noted. Bullet added to affordability.
No comment	n/a

OVERARCHING THEMES

Overarching Themes that span all categories.

Feedback	Response
Last bullet above (10th): add the words "based on the firm demands on Metropolitan" as one of the considerations after benefits and costs. This is a general theme that should be included in bullets 6 – 9 as well – projects that will address the firm demands on Metropolitan; providing reliability and resilience for member agency's firm demands on Metropolitan should be the highest priority.	Adopted.
Balance looking at both resources and projects. Portfolios can have varying degrees of resources in combination, for example: in-region/out-region storage, IPR, DPR, demand management, etc. Each portfolio's varying degrees of resources can provide different levels of benefits. This allows you to evaluate the sensitivity or marginal benefit of one resource versus another. Once you have that knowledge, you can begin to assemble the will/can/may build list of projects for each resource, and see how close you come to one or more portfolios, and their benefits. It then allows you to assess what remains "on the horizon" to explore, in terms of projects, if one portfolio's resource mix is truly more beneficial to the region, if only projects can be created.	Noted.
Regarding the last bullet, development of preferred portfolios must consider prior commitments made by the Board of Directors. On August 16, 2022, the Board adapted a call to action and a resolution to upgrade infrastructure connectivity, so the SWP-dependent agencies have equitable access to water supply and storage assets. In addition to water resource development,	Adopted language change and noted.

Feedback	Response
storage, and demand management, Metropolitan must upgrade its infrastructure connectivity in order to adequately address the impacts of climate change in the SWP-dependent areas.	
No comment	n/a
The themes do not have enough specificities to understand what they mean as applied. We highlighted the comments we believe most helpful. Please see prior comments about "themes" generally.	Noted.
Overarching themes must not devalue prior commitments made by the Board, such as the August 2022 resolution. There is an urgent need to fix the SWPDA connectivity problem so that no agency is isolated or left behind. Regional connectivity is of even higher priority than a "Will-build" (Low/No Regrets) project as it would create reliability and resilience throughout the region in all planning scenarios. We have already seen the sign-post and trigger condition last year with the SWPDA isolated shortage, so regional connectivity is a "Must-build" project that is a higher priority than a "Will-build" project. Additionally, Metropolitan's Board committed to fixing this issue last August, and therefore should not be part of the CAMP4W evaluation process.	Noted.
2nd Bullet: Comment: As described in previous comments from Calleguas, it is important to recognize that reliability, resiliency, affordability and equity are context specific to member agencies and will be defined by inter-relationships among these foundational terms. Further, their expression in Metropolitan's policies will be most successful if it is expressed in adaptive alternatives for member agencies to better reflect their unique resource mixes and management at different scales, with different exogenous and endogenous drivers, than Metropolitan as a whole. 3rd Bullet: Comment: Engagement strategies will require close coordination with member agencies to reflect that member agencies have a more direct relationship with local communities and their political representation than those communities have with Metropolitan's governance and decision making process. Just as Metropolitan has unique issues distinct from the Colorado River lower basin states or the California Colorado River users, member agencies have unique economies of interest at the local member agency level 10th Bullet: Comment: "The preferred path" forward suggests that sufficient information will be available to inform decisions that are occurring in a uncertain and volatile hydrologic and institutional environment. It might better be characterized as dynamic adaptive pathways rather than a preferred path	Noted. 10th bullet edited to add adaptive management concept.

Feedback	Response
forward. Adaptive pathways offer more robust strategies for reliability and resilience under uncertain and volatile conditions.	
First bullet: why "builds upon existing programs and projects"? Can we not have new programs and/or projects? We need to allow for creativity beyond what already exists. Change: To prepare our region to mitigate, adapt and thrive in a charging climate develop a path forward that builds upon existing programs and projects and permit the creation of new programs and projects. Second bullet: Definition of equity is needed. Is it rate equity, raw water access equity, service connection within agencies' boundaries, redundant capacity, etc.? All of the preceding?	Adopted. Noted. Equity is further discussed in a later section.

RELIABILITY

Ability to always meet water demands.

Feedback	Response
2nd bullet: should it be just "solely receive SWP water" or be more encompassing such as single source of supply or single connection? Reducing regional dependence on imported water has implications associated with stranded investments that need to be addressed and cannot be a standalone objective. Reducing dependence while creating new (regional or local?) supplies will result in additional financial burden along with stranded assets. Any new supplies created and paid for by Metropolitan should be part of the regional Metropolitan water supply portfolio.	Changes made to second bullet to add in single source of supply. Noted.
Resource diversity can increase reliability. Infrastructure development can enhance access to imported water systems. Resource development can make a region less dependent on imported water overall, reducing the pressure on infrastructure investments. Demand management must adapt and innovate. Many demand management features will be code-based or state mandate based. Metropolitan must identify what areas remain for regional investment that can add to demand management benefits, while addressing access and equity.	Noted.
Add new bullet, as follows, in place of "…and that address areas in our system that solely received SWP water": "Improve the reliability and resiliency of the SWP-dependent areas by upgrading infrastructure connectivity and access to water supply and storage assets"	Adopted.
Water quality appears out of place here –Recommend amending this concept to be "access to MWD water to address local water quality issues". MWD supplies a high quality of water, certain member agencies may have issues	Noted and adopted.

Feedback	Response
with their own supplies. Recommend clarifying "water reserves" to make clear if this is an increase in Metropolitan storage, flexible supplies, or both. Reliability should also include "system and environmental improvements to increase the reliability of MWD's current imported water assets". Metropolitan's system has demonstrated a need for conveyance and other system improvements to sustain MWD's core supplies under climate change scenarios.	
These comments are fine in the abstract but lack meaning as applied. We do support recognizing increased water use efficiency as a critical aspect of reliability and water supply planning generally; we believe it is important to account for all water usage in MWD Programs and planning.	Noted.
Reliability should include "Ensure regional connectivity so that all agencies are able to directly access the region's resources and share equally in the regional benefits as well as the regional risks." Regional connectivity would provide multi-benefits across member agencies, increase water reserves, serve both current and future customers, and diversify member agency water portfolios.	Adopted.
2nd Major Bullet: Further clarification on the role of SWP supply in the overall resource mix would be helpful. It's clear from 2023 that the SWP supply has unexamined opportunities to support Metropolitan's reliability and affordability goals. The unrealized utilization of SWP supply in 2023 is equivalent to ~2.5 times the proposed annual yield of Pure Water SoCal. Use of this SWP resource, recognizing the past investment and existing longer term contractual use has a place in a One Water approach, particularly as it supports overall affordability and statewide solutions. With general climate change projections suggesting a greater range of variability and timing of SWP water availability, Metropolitan's Climate Adaptation Master Plan for Water should consider how to adapt to the changing performance profile of the SWP with appropriate storage and infrastructure investments.	Noted.
Bullet 2 should be broken into two bullets: Identify projects that reduce our regional dependence on imported water in the whole service area should be one bullet. Address areas in our system that solely receive SWP water should be another bullet. Do we also want to identify areas that have no or limited redundancy during a catastrophic event here or below? Bullet 4: Because of the possibility of raw water augmentation with recycled water in Met's distribution system, there may be problems using the raw water for groundwater replenishment by agencies due to impacts to basin water quality or downstream wells. Water quality should include both raw and treated water from Metropolitan	Adjusted language in bullets.

RESILIENCE

Ability to withstand and recover from disruptions.

Feedback	Response
No comment	n/a
No additional comments in this section	n/a
Add new bullet, as follows: "Improve the reliability and resiliency of the SWP-dependent areas by upgrading infrastructure connectivity and access to water supply and storage assets."	Adopted.
No comment	n/a
Before we start considering more projects and partnerships, we should identify with as much specificity as possible as part of our climate analysis the infrastructure most at risk of failure and appropriate planning adjustments to address that.	Noted. Change made to first bullet to include 'other hazards'.
There is now a greater probability of supply sources to be simultaneously at risk, which elevates the importance of interconnected regional infrastructure with sufficient carrying capacity to ensure resilience to unpredictable, unprecedented near- and long-term challenges resulting from earthquake, drought, climate change, etc.	Noted.
2nd Bullet: Collaborative investments and partnerships can offer cost-effective opportunities to improve both resilience and reliability. The inter-relationship between resilience and reliability properly understood can provide benefits along both issues. For example: Was the 2022 constraint to the SWP dependent member agencies a reliability problem or a resilience problem? Viewed from a SWP supply perspective, it could be described as a reliability problem. However, the loss of production from the SWP project was not essentially different from the loss of that supply from an interruption by earthquake. The lack of developed infrastructure to provide a more resilient Metropolitan system would have been able to provide stored reserves, and hence from this perspective, the 2022 experience demonstrated a lack of resilience in the regional system	Noted.
Add a bullet: Identify areas with no or little redundancy for access to Metropolitan supplies and build infrastructure to service area boundary so agency can access the supplies.	Adjusted language in existing bullets.

FINANCIAL SUSTAINABILITY

Revenues sufficient to cover expenses over the short- and long-term.

Feedback	Response
3rd bullet: Needs to include language regarding 100% fixed cost recovery on a fixed capacity basis, thereby reducing revenue fluctuations resulting from variable volumetric sales. Fluctuations in volumetric sales will be more pronounced as we continue through climate change conditions.	Noted. We will have future discussions on this topic in September and October.
Business model, financial plan, and rates are the framework for how member agencies provide revenue to Metropolitan. Clarity. Relationships between revenue sources and services Metropolitan provides should be clear to member agencies. Transparency. A member agency should be able to see how its charges/costs/revenues for Metropolitan services will fluctuate over time, depending upon how they utilize, or access, Metropolitan services. Pay for how you use Metropolitan's services. If a member agency can understand and believe their costs reflect how they use the system, and how other member agencies use the system, they can support the business model, financial plan, and rates	Noted. We will have future discussions on this topic in September and October.
No comment	n/a
Recommend add language to the third bullet similar to "Maintain sufficient reserves for liquidity and resilience to various climate scenarios impacting declining revenues, increasing costs, emergency conditions, and member agency demand patterns, including short term swings on and off the MWD systems and member agencies with declining long-term needs for MWD water" to the end third bullet point." Recommend the addition of a concept to this theme regarding Metropolitan's member agencies each paying an equitable and fair share of MWD's costs commensurate with the services and benefits received.	Third bullet edited to include member agency demand patterns. This will be an input to the financial aspects of the process and considered as the project continues. Kicking off in September workshop.
Without sound planning taking into account the plans of member agencies, neither MWD nor its member agencies can be fiscally sustainable. MWD should expand its role to be a facilitator to accommodate what each member agency wants and needs, which is not uniform or one-size-fits all as MWD current planning model seems to assume.	Noted.

Feedback	Response
Revenues must be based on cost of service to build and operate a resilient and reliable system to meet all customers' full-service demands, which will insure sales revenue necessary to maintain Metropolitan's fiscal integrity. If there were no SWPDA isolated shortage allocation last year, Metropolitan would not have had to withdraw from its reserves. Future investments need to prioritize fixing conveyance infrastructure deficiencies to eliminate SWPDA, as approved by the Board.	Noted.
Comment: It would be useful to further investigate the value of a business model that recognizes the differences among member agencies in how they use Metropolitan's regional resources. The diversity among member agencies in the value that Metropolitan provides, given that member agency's resource mix and access to Metropolitan's system, should be reflected in the cost of service. Discussions of financial sustainability should consider that Metropolitan's governance structure may result in decisions that do not balance benefit to cost at the member agency level. It's a structural issue that has been largely ignored in regional sustainability discussion.	Noted. We will have future discussions on this topic in September and October.
Add bullet: Develop rate structure that incorporates hydrology when needed so customers will respond to climate extremes and Met's revenue stream will be protected. Add bullet: Consider rate structure with fixed charge to cover 100% Metropolitan capital costs based on ability to access Metropolitan system.	Noted but not adopted. We will have future discussions on this topic in September and October.

AFFORDABILITY

Relative cost burden and elastic ability to access (pay for) service and support member agency efforts to provide affordable supply to their customers.

Feedback	Response
No comment	n/a
The most important theme is life-cycle cost evaluation of competing alternatives, where each alternative, or portfolio of alternatives, meets the same levels of benefits in the other Themes listed here.	Noted.
No comment	n/a

Feedback	Response
Recommend removing the third bullet or at a minimum modifying it to be similar to: "Explore options in program funding to address access and affordability for the most vulnerable customer segments that are in alignment with Metropolitan's Cost of Service and applicable state law". The definition of affordability being the "Relative cost burden and elastic ability to access (pay for) service," is a retail customer-based definition. It is recommended that since MWD is a wholesale agency, the definition instead should be in a MWD wholesale context and focus on "practicing fiscal care and responsibility to ensure MWD's component of the member agencies' water costs are as economical as possible."	Adopted and Noted.
The themes as stated do not begin to address the scope of the problem or potential solutions. We look forward to board engagement at a meaningful level going forward.	Noted. Comment on first bullet was not incorporated but has been noted as well.
Costs seen by customers at a retail level should take into consideration all costs paid for water service including commodity rates, fixed charges, and historical contributions. These costs must be considered and be equitably applied to avoid the shifting of both costs and risk onto the customer by their water service provider. Water used for basic, essential daily needs should be made affordable by retail water providers to end use residential customers. Affordability can only be truly addressed at a retail level, as retail agencies set their individual agency rates which directly impact retail customers.	Noted.
Comment: The affordability theme would profit from further discussion of Metropolitan's role at the retail level, especially given the lack of direct relationship and accountability to the retail customer in its rate-making process. A better delineation of accountability and corresponding roles between Metropolitan and its member agencies would be helpful for further discussion.	Noted.
In second bullet: Metropolitan's delivery location as an assessment factor. Those agencies not receiving Metropolitan water within or at service area boundaries pay a much higher capital cost since they must maintain facilities that Metropolitan should be maintaining. Overall: Metropolitan needs to explore its legal ability to address affordability at the retail level and develop alternatives to meet needs which could include a push for a tax to address statewide affordability needs.	Noted.

EQUITY

Fair, just and inclusive.

Feedback	Response
1st Paragraph: Providing reliability, resilience and equity should be based proportional to the member agency's reliance on Metropolitan or to the extent the member agency has a commitment to purchase such water. This will ensure that regional facilities are neither stranded nor become the burden of the other agencies that have firm purchase commitments with Metropolitan. Suggested wording: "Metropolitan will promote regional equity among all member agencies based on their dependence on Metropolitan and by understanding varying individual member agency needs related to:	Adopted. We will have future discussions on this topic in September.
Exploring institutional and legislative options for additional investment in disadvantaged communities will also be critical to the themes of affordability and financial sustainability.	Noted.
Add bullet, as follows: "Taking necessary actions to give the SWP-dependent agencies a level of infrastructure and water supply reliability equivalent to that of Metropolitan's other member agencies."	This is covered by the existing text.
In some ways this theme appears redundant and already incorporated into other themes such as Affordability, Financial Sustainability, and Reliability. The use of the term exploring "institutional" investments should be clarified to not to mean MWD. This statement should also be amended to read "legislative options to prioritize state and federal investments in disadvantaged communities." This is a more appropriate role for MWD as the wholesaler. MWD's role in supporting member agencies pursuing the Human Right to Water should be clarified to be "through the affordability of and access to MWD's portion of member agencies' supplies," not just affordability. The focus of this statement should be MWD's role and not MWD taking on the responsibilities of the retail agencies.	Noted and adopted.
This is a good start for a board discussion as applied.	Noted.
In August 2022, Metropolitan Board approved a resolution to fix regional conveyance infrastructure deficiencies to eliminate the SWPDA. Regional connectivity is necessary to provide equitable reliability so that all agencies are able to directly access the region's resources and share equally in the regional benefits as well as the regional risks. Until this fix is achieved, certain member agencies will not have equitable service and reliability from Metropolitan.	Noted.

Feedback	Response
Comment: Any equity discussion should include Metropolitan's governance structure. How Metropolitan's weighted voting system based on assessed valuation reflects equity decision-making without structural bias for equity concerns is underdiscussed. The original basis for Metropolitan's decision-making on an assessed valuation basis and the changed conditions social, fiscal, and environmental conditions since Metropolitan's founding is an important part of the equity discussion and Metropolitan's future	Noted. We will have future discussions on this topic in the fall.
In my opinion, this theme needs much more work to be beneficial and not be something that is argued over once CAMP is completed. As stated above: equity needs to be defined. Equity means different things to different agencies, and this is where the CAMP can fail. Once adopted, the definition of equity becomes the issue in not moving forward with recommendations. Bullet 1: Where is the access to the reliable water supply? Metropolitan has adopted a principle that it will take its distribution system to a member agency's boundaries but it has not in three instances. Considering that the facilities are constructed, should Metropolitan take over those facilities? Also, does water supply mean both raw and treated water? Some agencies only receive treated water and cannot recharge groundwater basins because of cost and the need to dechloraminate the supplies adding another layer of cost. Should they be provided raw water supplies? Bullet 2: If Metropolitan has provided a standard of reliability and resiliency to some agencies but not others, it should be the one funding projects to get them to the same standard. It is not right to leave it up to the agency and Metropolitan provide funding options which usually means the agency pays for most of the project. Bullet 3: Metropolitan and its member agencies paid for the inventory of assets discussed in this bullet. If a certain portion of the asset is to be accessed by one agency or a group of agencies under their name, it should be paid for under either the wheeling rate or new rate so that the other agencies can be paid back that portion for which they have paid.	Noted. These concepts will be discussed as part of the CAMP4W process.

Bios

Nolie Templeton, Ph.D., P.E., is a Planning Analyst in Central Arizona Project's Colorado River Programs Department, focused on protecting and augmenting CAP's Colorado River Supply through engagement in hydrology, climate, climate adaptation, and water policy issues. She serves as CAP's Water Utility Climate Alliance (WUCA) staff representative. Dr. Templeton earned a B.S. in Environmental Engineering from the University of California, San Diego, and a M.S. and Ph.D. in Civil, Environmental, and Sustainable Engineering from Arizona State University. She is a registered Professional Engineer in Arizona.

Stephen Torres is a Principal Manager leading SCE's Climate Adaptation planning efforts for SCE's assets, operations and services, responsible for developing SCE's first Climate Adaptation Vulnerability Assessment (CAVA), and incorporating the CAVA findings into our key planning and investment processes. Previously Stephen managed the Analytics function within Resource and Environmental Planning & Strategy, supporting the development of SCE's Clean Power and Electrification Pathway and Pathway 2045, which depict the most feasible and cost-effective paths to achieve California's GHG reduction goals.

Prior to SCE, Mr. Torres led project development efforts for several global solar manufacturers and Independent Power Producers (IPPs), responsible for origination, development, engineering, construction, operation, and financing of distributed solar assets across the US. Mr. Torres has also served as Vice-President of Magnetek (NYSE: MAG), Inc. and General Manager of its Alternative Energy division, developing innovative power conversion solutions for the solar and wind industries.

Stephen is experienced in wholesale and retail energy markets, GHG scenario development, climate adaptation and resilience planning, integrated resource planning, renewable energy, and building electrification.

Mr. Torres received a Mechanical Engineering degree from the University of Washington and an MBA from the Anderson School of Management at UCLA. He is also a Certified Energy Manager (CEM).

Nathan Bengtsson is the Senior Manager of Climate Resilience at Pacific Gas & Electric Company, where he leads the company's efforts to plan for and adapt to more frequent and severe natural hazards driven by climate change.

Nathan served as PG&E's chief representative to the California Public Utilities Commission's Rulemaking 18-04-019, one of the first regulatory efforts in the nation to establish how energy sector investor-owned utilities may be expected to assess and manage the projected physical impacts of climate change. PG&E will submit its first Climate Vulnerability Assessment pursuant to R. 18-04-019 in May 2024. Southern California Edison submitted their

Vulnerability Assessment in May 2022. Phase II of R. 18-04-019 was announced by the Commission in February 2023.

Nathan joined PG&E in 2015 as a representative to the California Energy Commission and California Air Resources Board, advocating for environmentally and economically sustainable energy policies including the refinement and extension of California's landmark Cap-and-Trade Program. He is a graduate of Claremont McKenna College and the CORO Fellows Program in Public Affairs (Bay Area, '13) and is a proud Teach for America alum (San Antonio, '12). He currently resides in Sacramento, California with his wife, Sarah, and rescue dog, Romeo.

Utility Information

Central Arizona Project. Central Arizona Project (CAP) delivers water to nearly 6 million people, more than 80% of the state's population, in Maricopa, Pinal and Pima counties. CAP carries water from Lake Havasu near Parker to the southern boundary of the San Xavier Indian Reservation southwest of Tucson. It is a 336-mile-long system of aqueducts, tunnels, pumping plants and pipelines.

Southern California Edison. Please also see attached factsheet for more details.

Who We Are

- An Edison International company
- One of the nation's largest electric-only utilities (no natural gas distribution), SCE is an investor-owned utility, a private company owned by shareholders/investors and regulated by the California Public Utilities Commission and Federal Energy Regulatory Commission
- Headquarters in Rosemead, California
- 135 years of history

Who We Serve

- 50,000 square miles of SCE service area across Central, Coastal and Southern California
- 184 cities, 15 counties and 13 Native American tribes
- 15 million residents
- 5 million customer accounts

Pacific Gas and Electric. Pacific Gas and Electric Company, incorporated in California in 1905, is one of the largest combined natural gas and electric energy companies in the United States. Based in Oakland, the company is a subsidiary of PG&E Corporation.

There are approximately 23,000 employees who carry out Pacific Gas and Electric Company's primary business—the transmission and delivery of energy. The company provides natural

gas and electric service to approximately 16 million people throughout a 70,000-square-mile service area in northern and central California.

Pacific Gas and Electric Company and other energy companies in the state are regulated by the California Public Utilities Commission. The CPUC was created by the state Legislature in 1911.

Fast Facts

- Service area stretches from Eureka in the north to Bakersfield in the south, and from the Pacific Ocean in the west to the Sierra Nevada in the east.
- 106,681 circuit miles of electric distribution lines and 18,466 circuit miles of interconnected transmission lines.
- 42,141 miles of natural gas distribution pipelines and 6,438 miles of transmission pipelines.
- 5.5 million electric customer accounts.
- 4.5 million natural gas customer accounts

PG&E Climate Strategy Report

June 2022

Contents

Message from the CEO

Patti Poppe
CEO, PG&E Corporation

Sustainability and climate action have long been part of PG&E's DNA.

We were the first company in our industry to take the stand that climate change is real, and it was time to take action.

That was a bold step for an energy company in 2006.

Sixteen years later, we've made good on that commitment.

Today, the electricity that we deliver to the 16 million people we serve is among the cleanest in the world, with 93 percent from greenhouse gas-free sources in 2021. We're also leading in key areas of clean energy adoption, including rooftop solar installations, electric vehicle adoption and grid-level energy storage, such as our leading-edge battery installation near Monterey Bay. And in our gas business, we are a national leader in leak reduction, which has driven down our overall emissions.

Yet for all the progress that we've made, we know that it won't be enough. We need to do more, and we need to do it faster.

As recent events have made clear, California is not just on the forefront of acting on climate change, but also of its destructive effects. We can no longer be content with merely adapting to those harms. We must slow them down. We need to put the climate machine into reverse and begin undoing the damage.

It's time for PG&E to take another bold step, in pursuit of a new, breakthrough vision.

This Climate Strategy Report is our guiding document and action plan for what comes next.

It presents a roadmap for an energy system that's net zero by 2040, five years ahead of California's already aggressive carbon neutrality goal.

But we're not stopping there.

We're committing to be "climate positive"—actively removing more greenhouse gases than we emit—by the year 2050.

Along the way, we've set specific milestones, including accelerating the adoption of renewable energy, unleashing the full potential of electric vehicles, and reducing emissions across the energy economy. We're pledging to reach these targets by 2030—just eight years from now.

We also recognize that, in order to be viable, these goals must be affordable for our customers, and we're committed to executing these goals in a cost-effective manner with minimal impact to customer bills and in a way that's consistent with our long-term affordability commitments.

In the pages that follow, you can read more about our goals, and how we plan to work with our customers to reach their own clean-energy ambitions.

Together, we can take aim at the next objective on our climate-action agenda—not only protecting the planet, but helping it begin to heal.

That's a stand that I—and all of my co-workers at PG&E—am proud to take.

Patti Poppe

About the Report

PG&E Corporation developed this *Climate Strategy Report* as part of our long-standing commitment to lead the way on addressing climate change. This document is designed for our customers, policymakers, investors, and other stakeholders and shares our goals, actions, and progress to address climate change.

This report provides information on PG&E's strategy and the steps we are taking to meet the challenge of climate change on behalf of the more than 16 million Californians who rely on PG&E to deliver their energy. The report describes the risks and opportunities PG&E faces from a changing energy landscape—along with the potential physical impacts of a changing climate and associated weather patterns. It also describes how PG&E governs climate-related issues and manages climate-related risks.

The report aligns with the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD). Throughout this report, when we refer to "PG&E," we are discussing all of PG&E Corporation and its subsidiaries, including Pacific Gas and Electric Company.

Introduction

About PG&E and Our Triple Bottom Line

Pacific Gas and Electric Company, a subsidiary of PG&E Corporation, is a combined natural gas and electric utility serving more than 16 million people across 70,000 square miles in Northern and Central California.

Map of PG&E's Service Area

Coworkers

- 26,000 employees

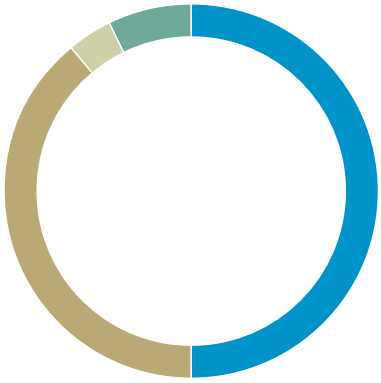
Customer Accounts

- 5.6 million electric distribution
- 4.5 million natural gas distribution

System

- 7,652 MW of owned hydroelectric, nuclear, natural gas, and solar generation
- Nation's largest investor-owned hydroelectric system
- 108,000 circuit miles of electric distribution lines and 18,000 circuit miles of electric transmission lines
- 43,800 miles of gas distribution pipelines, 6,200 miles of backbone and local gas transmission pipelines, and various gas storage facilities
- 3.3+ GW of energy storage under contract

2021 Electric Power Mix*



50% Renewable†
39% Nuclear†
4% Large Hydro†
7% Natural Gas

† These resources are greenhouse gas-free and/or renewable.

PG&E delivers some of the nation's cleanest electricity to customers, with 93% from greenhouse gas-free resources in 2021. The associated emissions rate is nearly 90% cleaner than the latest national average among energy providers.

* Refers to estimated total net deliveries of electricity to customers; data is sourced from PG&E Corporation's and Pacific Gas and Electric Company's 2021 Annual Report on Form 10-K.

PG&E's Triple Bottom Line

PG&E's responsibilities as an energy provider go far beyond our core mission of providing safe, reliable, affordable, and clean energy to our 16 million customers. We also have a responsibility to build a better future for everyone whose lives we touch.

This means delivering for our hometowns, serving our planet, and leading with love. It means making it right and making it safe. It means helping drive clean energy technologies, while also ensuring that their benefits are accessible to all. And it means helping communities build resilience against climate change today—as well as tackling climate change—in ways that leave no one behind.

We approach this work through the "triple bottom line" framework of serving people, the planet, and California's prosperity—supported by strong operational performance.

Urgent Need for Climate Action

From extreme weather to rising tides, California—like the rest of the planet—is experiencing the significant and increasing effects of a changing climate. The latest report from the Intergovernmental Panel on Climate Change has been called a "code red for humanity." With the growing threat of climate change comes the urgent need for action to stabilize the climate.

California has long recognized this challenge and has been at the forefront of national and global efforts to protect our planet. In keeping with that commitment, California set an ambitious goal: to achieve carbon neutrality by 2045 and net negative emissions thereafter. Achieving this goal will require transformative changes across all sectors of the economy, including the energy sector.

As a state, we've made significant progress decarbonizing the electric system—scaling renewable energy, rooftop solar installations, electric vehicle adoption, and battery energy storage to among the highest levels in the nation.

To rise to the challenge, we must build on this progress in other sectors—while also achieving deeper penetration of renewable energy combined with investments in the grid and energy storage, dramatic improvements in energy efficiency, and evolving the natural gas system to integrate cleaner fuels and accommodate a massive shift to electrifying vehicles and buildings.

The commitments outlined in this report reflect our plan to bring about a clean energy future in partnership with our customers and others. It will be our guiding document and our action plan for the years ahead.

At the same time, we'll need to build a more climate-resilient energy network, as California and the world continue to experience the impacts of climate change.

Our Commitment: Helping to Heal the Planet

As the state's largest energy provider, we embrace our foundational role in transitioning California to a decarbonized and more climate-resilient economy. There are many ways that we can be a force for change, and our size and scale enable PG&E to be a vital part of the solution.

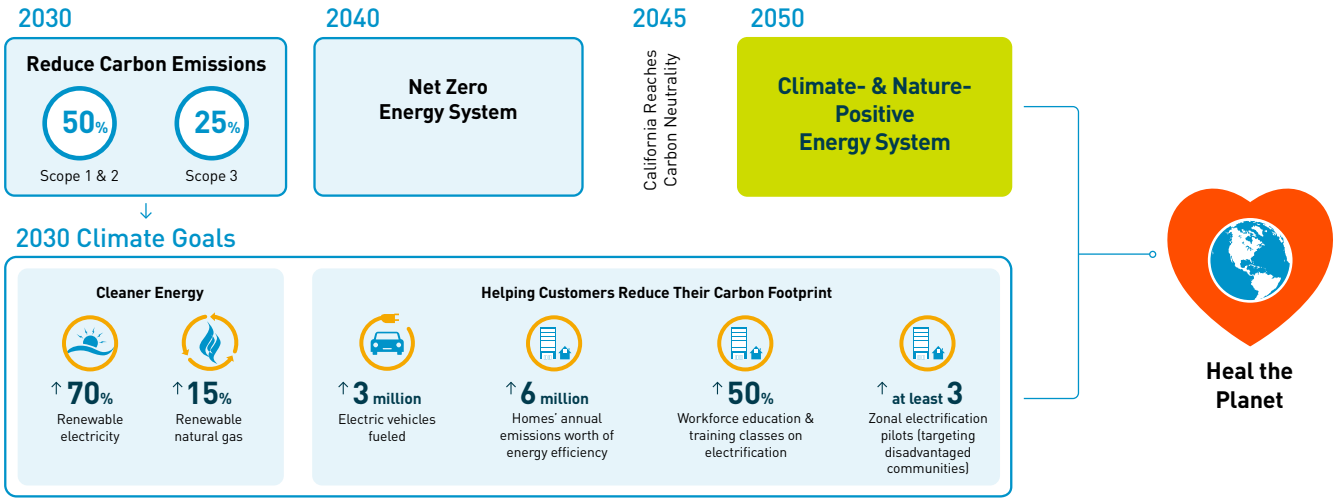
We have a proven performance record on clean energy, delivering electricity to our customers in 2021 that was 93% greenhouse gas emissions-free. Today, one in every five solar rooftops in the country is in PG&E's service area, and one in six electric vehicles in the nation plugs into PG&E's grid.

We believe clean energy should be affordable for and inclusive of all economic and social backgrounds—and we're excited about the growth opportunities that a cleaner future presents for PG&E and our customers.

PG&E is committed to helping to heal the planet by achieving:

- A climate- and nature-positive energy system by 2050.
- A net zero energy system in 2040—five years ahead of California's current carbon neutrality goal.
- A series of 2030 climate goals to reduce PG&E's operational carbon footprint and enable our customers and communities to reduce their carbon footprints:
  - Reduce Scope 1 and 2 emissions by 50% from 2015 levels
  - Reduce Scope 3 emissions by 25% from 2015 levels
  - Achieve "Scope 4" goals to enable customer emission reductions

Our Commitment: Helping to Heal the Planet



Notes:
Scope 1: *Direct* emissions from PG&E's operations.
Scope 2: *Indirect* emissions from facility electricity use and electric line losses.
Scope 3: Emissions resulting from *value chain activities* not owned or controlled by PG&E but that can be *indirectly* impacted by PG&E actions.
"Scope 4": An emerging term for categorizing emission reductions enabled by a company. PG&E can make a significant contribution by enabling these emission reductions in our service area.

2050: A Climate- and Nature-Positive Energy System

As recent events have made clear, California is not just on the front line for acting on climate change, we're also on the front line of its destructive effects. That's why we're declaring a bold, breakthrough vision for PG&E and the growing number of innovative partners who share our sense of urgency.

Our commitment to becoming "climate positive" by 2050 will take us further than net zero carbon emissions—meaning that PG&E will work to reduce and remove more greenhouse gases than we emit and help enable our customers and hometowns to shrink their carbon footprint, as well. We're excited about the opportunities to co-create this future together with our many stakeholders.

We're also renewing our focus on biodiversity through a long-term commitment to be "nature positive" as a company. This means going beyond avoiding impacts and having no net impact on the natural environment—instead, it requires investing in projects, environmental initiatives and research, and partnerships to restore biodiversity across ecosystems and habitats.

Importantly, we're committed to making this transition through specific initiatives—land, air, water, and habitat—that are cost-responsible and prioritize collaboration. Work on these goals is underway—and we plan to announce our environmental stewardship goals next year.

2040: Net Zero Energy System

We're committed to reaching a net zero energy system in 2040—five years ahead of California's carbon neutrality goal. What this means is that, by 2040, we aim to substantially reduce our Scope 1, 2, and 3 greenhouse gas emissions—and then neutralize any remaining residual emissions in 2040 and thereafter. In essence, we plan to remove as many greenhouse gas emissions from the atmosphere as we produce.

Our commitment goes beyond reducing our own emissions and includes achieving substantial "Scope 4" reductions by enabling the customers and communities we serve to reduce their carbon footprints, as well. To track progress, we will continue our rigorous effort to complete a comprehensive, verified greenhouse gas emissions inventory each year across our Scope 1, 2, and 3 emissions.

Leveraging a Diverse Mix of Resources

To meet our longer-term climate goals, PG&E plans to significantly scale our efforts to decarbonize the electric system—to accommodate a game-changing shift to vehicle electrification, integrate a proliferation of distributed energy resources, and achieve next-level penetration of renewable energy combined with investments in the grid and energy storage.

We also plan to transition to cleaner fuels, increasingly target gas delivery for hard-to-electrify customer sectors, and support efforts to ramp up building electrification. Our objective is to do so in an orderly manner to achieve a positive customer and community experience, while reducing gas system investments in targeted electrified communities.

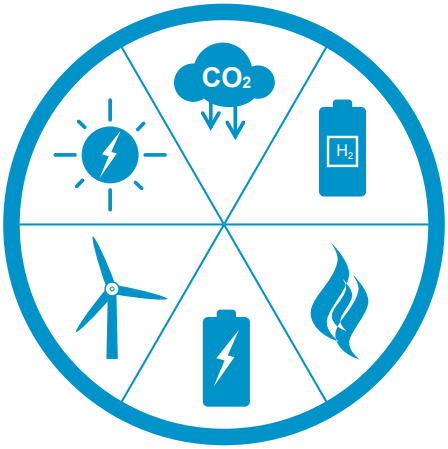
We envision a net zero energy system in 2040 made possible and affordable by:

- A combination of maturing technologies.
- Updated infrastructure to enable a diverse supply of cleaner fuels.
- Regulatory and financing innovations geared towards reducing unnecessary new costs for the energy system and recovering necessary costs in a sustainable, equitable, and affordable manner.

To make the transition, we expect a diverse mix of resources to be available—from broad electrification to cleaner fuels such as RNG and hydrogen to nature-based solutions and carbon capture, storage, and utilization.

Over the next two decades, innovations in technology and markets will inform the most beneficial balance of these resources to meet the evolving needs of our customers. Fundamentally, we believe it's a matter of "how much" of each resource will be deployed versus "if" we will use a diversity of resources. How much will be driven by factors such as customer acceptance, technology maturity, and cost.

Clean and Diverse Energy Mix



Shaping the Future Energy Delivery System

Achieving a net zero energy system by 2040 will have significant implications for PG&E's energy delivery system over the coming decades. As the operator of a dual-commodity energy system, PG&E is uniquely positioned to lead this transition and shape the future—all with a continued focus on helping our customers and hometowns prosper.

For the last century, we've managed a changing energy system, which we are making cleaner by investing in technology and infrastructure to integrate more low-carbon and resilient energy sources. We're also gaining greater visibility into the system to improve operational performance.

PG&E's gas strategy focuses on a diversity of win-win options that will be needed to meet our climate goals—and those of California. Our vision is to evolve the gas system to be an affordable, safe, and reliable net zero energy delivery platform. While we are planning and investing for the system to evolve—to deliver cleaner fuels to meet gradually declining customer demand—over the coming decades, our gas system infrastructure will continue to play a vital role for our customers and the state as a storage, reliability, and resiliency resource.

To achieve this vision, we're focused on strategies that will reduce our carbon footprint, while also reducing costs, identifying alternative revenue sources, and leveraging innovative financial mechanisms.

With the electric system, we embrace the role we will play in enabling and scaling a decarbonized grid. Customers with EVs and electric heating and cooling systems use about double the annual electricity of households without—driving unprecedented growth in electrification.

To enable this dramatic growth, our vision is to make the electric grid smarter, more dynamic, and more flexible—incorporating new energy technologies and giving our customers increased flexibility, choice, and value. We recognize the need to reimagine the grid to meet varying and evolving needs—from accelerating renewable energy integration and decarbonization to adapting our system to mitigate growing wildfire and other physical climate risks.

During this energy transition, as a provider of electricity and natural gas to millions of Californians, we are uniquely positioned to:

- **Optimize overall household energy costs** over time (including transportation) by balancing the decarbonization solutions we offer customers across electricity, natural gas, and transportation.
- **Work with policymakers** to deliver smart policies that allow for timely recovery of energy system costs, while mitigating rate impacts—necessary focus areas to ensure safe and affordable outcomes for all customers as we transition the electric and natural gas systems over the coming decades.

California's Energy System in Transition

PG&E is actively participating in a number of CPUC proceedings on the future of the gas and electric systems:

Electric System:

- **Integrated Resource Planning** proceeding to plan the state's electricity supply resources across all load-serving entities and meet electricity sector greenhouse gas emission targets.
- **High Distributed Energy Resources (DER) Future OIR** to modernize the state's electric grid to integrate a high number of DERs, including EV charging.
- **Transportation Electrification Framework** to develop a holistic planning process for investor-owned utility transportation electrification investment.

Gas System:

- **Building Decarbonization OIR** to develop a plan to assess the feasibility of significantly reducing greenhouse gas emissions from buildings.
- **Gas System Planning OIR** to address system reliability standards, market structure and regulations, gas infrastructure, gas revenues and rate design, and workforce issues.

PG&E is also participating in a California Energy Commission (CEC)-led Gas Working Group with state-wide stakeholders and a CEC-funded project to identify strategic pathways for tactical decommissioning of portions of gas infrastructure in our service area.

Note: OIR refers to Order Instituting Rulemaking.

2030 Climate Goals

This decade is a critical time for meaningful climate change action—and to make collective progress towards stabilizing the climate.

We are committed to doing our part—and to sharing what we learn and learning from others on the path to achieving net zero energy and beyond. We approach this work through the "triple bottom line" framework of serving people, the planet, and California's prosperity—underpinned by strong operational performance.

Our strategy is to reduce emissions from the energy delivered through our wires and pipelines and increase electrification technologies and value for our customers with support from a localized, diverse workforce.

Reduce Our Operational Carbon Footprint:

- Reduce Scope 1 & 2 emissions by 50% from 2015 (Emission reductions: 51% electric & 46% natural gas operations)

Enable Customers to Reduce their Carbon Footprint:

- Reduce Scope 3 emissions by 25% from 2015 (Emission reductions: 40% electricity & 20% natural gas supply)
- "Scope 4" goals to enable customer emission reductions

2030 Climate Goals: Scope 1 and 2 Emissions

PG&E is deploying different strategies to reduce our Scope 1 and 2 emissions by 50% from 2015 levels:

Strategic Focus Area	2030 Goal
Reduce methane emissions from the gas system	**Reduce methane emissions by 45%** from 2015 by further detecting and repairing leaks, replacing targeted pipeline segments and equipment, and improving our operations to avoid and reduce "blowdowns" where natural gas is released to the atmosphere.
Reduce sulfur hexafluoride (SF_6) emissions from the electric system[1]	**Accelerate the installation of SF_6-free equipment** ahead of California's stringent requirements. **Actively reduce emissions** from SF_6-filled equipment.
Electrify PG&E's vehicle fleet	**100%** of light-duty fleet **50%** of medium-duty fleet **20%** of heavy-duty fleet
Reduce emissions from buildings and facilities	**Reduce emissions by 10%** from 2015 through LED lighting retrofits, lighting control upgrades, PV solar installations (paired with battery storage), and electrifying space and heating equipment.
Reduce emissions from our owned natural gas generation resources	**Reduce output and emissions from PG&E's owned natural gas plants by 40%** from 2015 to accommodate greater penetration of renewable energy resources and energy storage on the grid.
Reduce emissions from our gas compressor stations	**Retire our Tionesta compressor station** in 2025. **Explore replacing our Los Medanos storage compressor unit** in 2026 with an electric motor-driven unit.

1. PG&E's SF_6 emissions are projected to increase, largely due to electric load growth, and generation and energy storage interconnections, which increase the inventory of SF_6-filled equipment on the electric system.

2030 Climate Goals: Scope 3 and "Scope 4" Emissions

PG&E is taking a strategic, collaborative approach to reduce our Scope 3 and "Scope 4"[1] customer emissions:

Continue to Green the Power Sector toward Delivering Decarbonized Electricity 24 x 7 x 365

Deliver 70% Renewables Portfolio Standard (RPS) clean electricity, which is above the RPS compliance obligation of 60%.

Facilitate the use of Diablo Canyon Power Plant transmission infrastructure to support new carbon-free generation.

Manage energy demand as a reliable, cost-effective alternative to traditional power generation solutions in a way that enables broad reach, minimal impact to the daily lives of our customers, and bill savings.

Accelerate Electrification of the Transportation Sector

Be the global model in the industry by fueling at least 3 million EVs in our service area—leading to a cumulative reduction of 58+ MMT of carbon emissions:[2]

- **Proactively prepare the grid for 12,000 GWh of EV-related electric load and improve processes** to enable rapid, safe EV energization and interconnection.
- **Enable 2 million EVs to participate in vehicle-grid integration applications**, allowing EVs to be a cornerstone of reliability and resilience, while unlocking additional revenue streams for PG&E customers to lower the lifetime and household cost of EV ownership. We will target hard-to-reach customers while building a balanced portfolio of program offerings that is innovative and affordable for customers.
- **Repurpose at least 500 MWh of second-life batteries for grid-connected energy storage**, providing a low-cost flexible resource to PG&E and enabling customers to maximize the value of their EV.

Enable Building Electrification in an Orderly Transition and Shape the Future Natural Gas Delivery System

Achieve 48 MMT of lifecycle carbon emission reductions through comprehensive energy efficiency and decarbonization strategies, with an increasing focus on building electrification:

- Align customer building electrification programs with the timing, scope, and goals of PG&E's targeted gas system transition.
- Aim for 50% of the topics in PG&E's Workforce Education and Training programs to focus on building knowledge and skills for electrification—with a continued commitment that 60% of the participants will be from disadvantaged communities.
- Take a proactive, policy leadership position in developing and publicly advocating for federal, state, and local electrification codes and standards for buildings and appliances.

Execute zonal electrification and create a repeatable model on how to best perform it:

- Evaluate gas capital projects for electrification as an alternative to the planned gas projects and pursue electrification for the projects evaluated as feasible and cost-effective.
- Commit to a new program that seeks to zonally electrify three to five communities, with a specific focus on the decarbonization of vulnerable communities.

"Green" the Gas Supply for Hard-to-Electrify Customers

Reduce cumulative carbon emissions by 2.5 MMT by proactively converting industrial and large commercial customers unable to electrify from dirtier burning fuels to natural gas, prioritizing sites in or adjacent to disadvantaged communities.

Deliver 15% Renewable Natural Gas (RNG) in PG&E's core gas throughput.[3]

Maximize readiness for hydrogen blending:

- Operationalize a hydrogen pilot project by 2024 using different vintage gas pipes in a stand-alone system so we can test different hydrogen blends in pipes used in our system—and help inform a safe level of hydrogen we can blend into the existing system by 2030.

Pledge $25M toward sustainable uses for woody biomass in collaboration with other partners:

- R&D on converting wood waste to RNG and biomass carbon removal and other byproducts.

1. "Scope 4" is an emerging term for categorizing emission reductions enabled by a company.
2. "MMT" refers to million metric tons, and "carbon emissions" refers to carbon dioxide equivalent (CO_2-e) emissions.
3. Represents a minimum volume of approximately 27 billion cubic feet per year.

A Clean Energy Future for All: Leading an Equitable and Viable Transition

Climate change impacts the life of all Californians, but it's been shown time and time again that the worst effects often fall upon those least able to prepare and respond.

Heat waves, wildfires, and other climate-driven events have all had an outsized impact on disadvantaged and vulnerable communities, and many of the solutions to combat climate change, like electric vehicles or programmable technologies, remain financially out of reach for these groups.

As PG&E works to heal our planet, we remain committed to ensuring an equitable transition, and delivering on our stand that a healthy environment and carbon neutral energy system shall be a reality for all Californians.

We recognize that creating an equitable transition can't be done alone.

To ensure we're hearing the right voices in the larger conversation on climate action, PG&E is committed to partnering with a broad spectrum of stakeholders, including our customers, coworkers, and community organizations, to co-create plans that will help ensure equity as we move toward a climate-and nature-positive energy system in 2050.

We recognize that, to deliver on our stand, our actions to address climate change must be affordable for all of our customers. In setting these goals, we have kept affordability in mind, and we're committing to executing our climate goals in a cost-effective way and with minimal incremental impact to customer bills.

Our plan is for the climate goals outlined in this report to not only help curb the devastating impacts of climate change felt by disadvantaged communities, but to also provide a pathway to a more equitable and affordable energy future.

Measuring Progress Through 2030

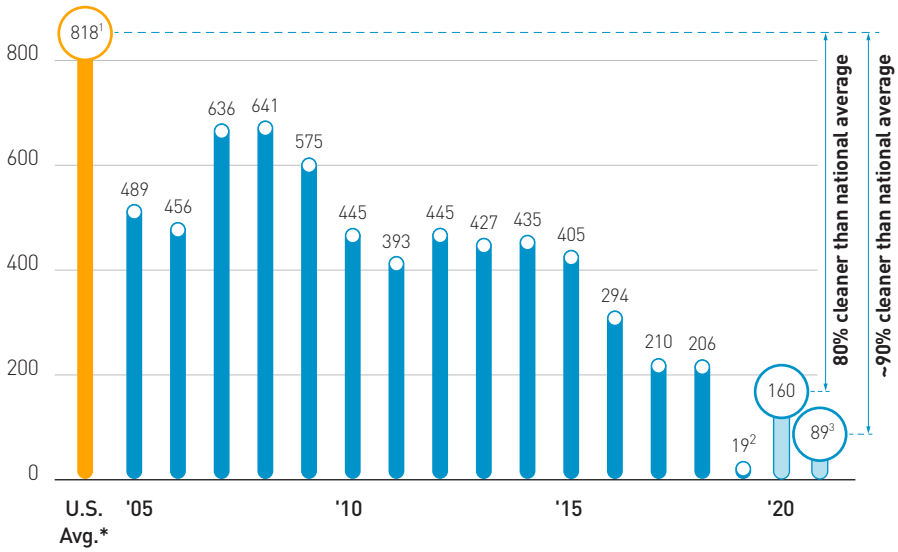
PG&E has a long history of measuring, independently verifying, and publicly reporting our Scope 1, 2, and 3 greenhouse gas emissions. Under mandatory reporting requirements, PG&E reports certain greenhouse gas emissions to the California Air Resources Board (CARB) and the U.S. Environmental Protection Agency (EPA) on an annual basis. On a voluntary basis, PG&E reports our annual corporate greenhouse gas emissions inventory with The Climate Registry, a nonprofit organization.

Progress to Date

PG&E delivers some of the nation's cleanest energy. In 2020, the carbon dioxide (CO_2) emission rate for PG&E's delivered electricity was **160 pounds of CO_2 per megawatt-hour**, which is about **80% cleaner than the latest national average among energy providers**. This is PG&E's most recent third-party verified emission rate. **And our preliminary 2021 CO_2 emissions rate is nearly 90% cleaner than the national average.**

Benchmarking PG&E's Emissions For Delivered Electricity

Pounds CO_2 per MWh



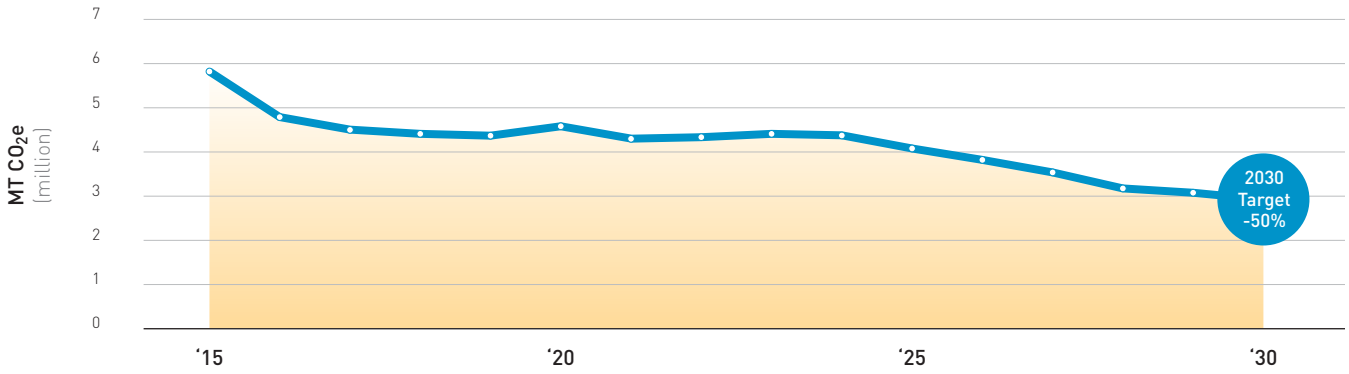
1. Source: U.S. Environmental Protection Agency eGRID 2020.
2. Beginning with our 2019 emissions reporting, PG&E used the CEC's Power Source Disclosure program methodology to calculate the CO2 emission rate associated with the electricity delivered to retail customers. This methodology differed from prior reporting years and may result in lower emissions rates.
3. Source: PG&E's Power Source Disclosure Report, filed with the California Energy Commission on June 1, 2022. This figure is preliminary and is subject to an independent audit and verification for regulatory compliance. Additionally, the figure is pending verification as part of PG&E's 2021 voluntary corporate greenhouse gas emissions inventory with The Climate Registry.

Looking Forward: PG&E's 2030 Climate Goals

PG&E's Scope 1 and 2 Goal: Reduce emissions by 50% from 2015 levels[1] by 2030

PG&E's Scope 1 and 2 Emissions Reductions

- Scope 1: *Direct* emissions from PG&E's operations
- Scope 2: *Indirect* emissions from facility electricity use and electric line losses



More than 90% of the reductions in Scope 1 and 2 emissions are projected to come from three categories:

- Owned natural gas generation
- Methane emissions from the natural gas system
- Electric transmission and distribution line losses

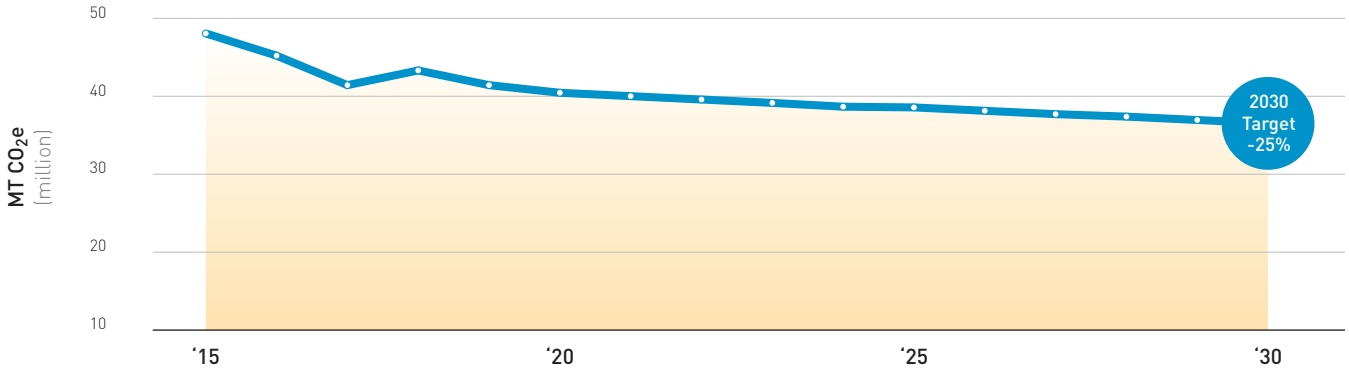
Other areas of focus include:

- Gas compressor stations
- Vehicle fleet emissions
- SF_6 emissions from electrical equipment
- Facility electricity and natural gas usage

PG&E's Scope 3 Goal: Reduce emissions by 25% from 2015 levels[1] by 2030

PG&E's Scope 3 Emissions Reductions

- Scope 3: Emissions resulting from *value chain activities* not owned or controlled by PG&E but that can be *indirectly* impacted by PG&E actions



More than 99% of the Scope 3 emissions reductions are projected to come from two categories:

- Natural gas supplied to PG&E customers
- Electricity purchased on behalf of PG&E customers

Other areas of focus include:

- Business air travel
- Employee commuting
- Waste emissions

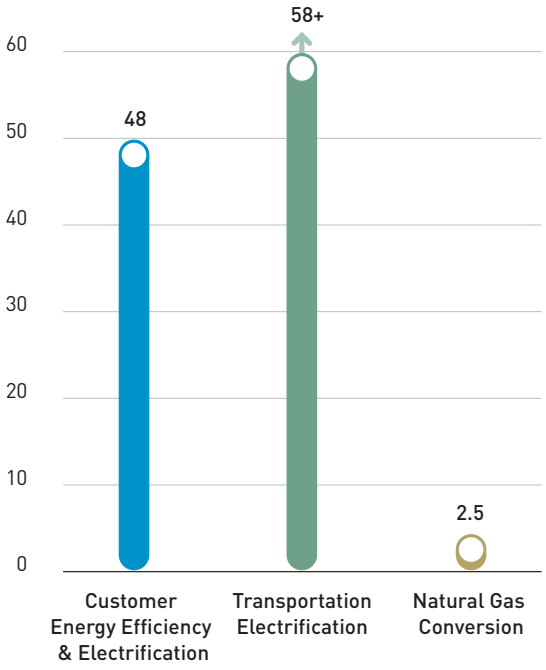
1. PG&E set 2015 as the baseline year to align with mandatory methane emissions reporting to the CPUC, achieve a better comparison given improved emissions accounting methods in recent years, and meet the Science-Based Target Initiative (SBTi) guidance, which stipulates that the baseline year must be 2015 or more recent.

"Scope 4" Goals: Enabling Emission Reductions in Other Sectors

PG&E has also set goals to enable further emission reductions—and support the state's climate goals—by supporting customers through:

- Offering energy efficiency and electrification programs
- Unleashing the full potential of electric vehicles
- Converting industrial and large customers from high carbon-intensity fuels to natural gas

Timeframe: 2022 – 2030



Customer Energy Efficiency and Electrification

48 million metric tons CO_2-e
Lifecycle emission reductions through comprehensive customer energy efficiency and decarbonization strategies, with an increasing focus on electrification

Transportation Electrification[1]

58+ million metric tons CO_2-e
Cumulative annual emission reductions from fueling at least 3 million EVs within PG&E's service area

Industrial Conversion to Natural Gas

2.5 million metric tons CO_2-e
Cumulative avoided emission reductions by proactively converting customers unable to electrify from higher carbon-intensity fuels to natural gas

1. The overall emissions impact could be significantly higher if a greenhouse gas accounting methodology was used that is more similar to customer energy efficiency. This is an important topic for future consideration.

PG&E Supports a Growing Number of School Districts Adopting Electric Buses

Through our EV Fleet program, PG&E is helping school districts in our service area as they transition to electric buses, supporting cleaner air, lower maintenance costs, and quieter rides. The program aims to support the adoption of 6,500 medium- and heavy-duty electric vehicles, including school buses.

Our Plan: 2030 Climate Goals

Scope 1 & 2: Reduce Our Operational Carbon Footprint

To meet the climate challenge, PG&E recognizes the need to reduce our own operational carbon footprint and achieve more sustainable operations. We need to raise the bar for ourselves and find new and innovative ways to reduce greenhouse gas emissions from our operations.

PG&E's goal is to reduce our Scope 1 and 2 emissions by 50% from 2015 levels by 2030. We're excited about the opportunities this presents to engage our coworkers in pursuit of this goal, along with our suppliers, as we step up efforts to source more sustainable goods and services.

Scope 1 and 2: Our Approach

We are taking a broad-based approach to reducing our operational carbon footprint.

Reduce Methane Emissions from the Gas System

When there's a leak on our natural gas system or we release gas for operational activities, methane is released into the atmosphere, contributing to climate change. PG&E is taking a variety of steps to reduce methane emissions by 45% by 2030:

- Finding and fixing methane leaks on our system—leveraging technologies, including mobile systems, drones, and advanced leak survey strategies to focus our efforts and maximize results.
- Replacing targeted pipeline segments and equipment.
- Implementing drafting, cross compression, flaring, and project bundling—separately and in combination—to reduce "blowdowns" or the amount of natural gas released to the atmosphere during construction and repair projects on our gas transmission system.

We can drive additional emission reductions through further leak detection and repair and improvements in operations to avoid and reduce blowdowns. Beyond these strategies, we will also focus on improving methods to measure the emission reductions.

Reduce Sulfur Hexafluoride (SF_6) Emissions from the Electric System

Sulfur hexafluoride—or SF_6—is commonly used by PG&E and other energy companies as an electrical insulating material in high-voltage circuit breakers and gas-insulated switchgear. But if it escapes to the atmosphere, it is a potent greenhouse gas.

PG&E is taking a multi-pronged approach to tackle SF_6: repairing the highest leaking circuit breakers, implementing SF_6 cylinder best management practices, and accelerating the installation of SF_6-free equipment ahead of California's stringent requirements. This includes installing equipment such as the industry's first 123 kV circuit breakers with clean-air vacuum technology, which arrived at PG&E in 2021.

Electrify PG&E's Vehicle Fleet

PG&E operates one of the cleanest transportation fleets in the energy industry, with over 1,250 alternative fuel vehicles that range from hybrid-electric bucket trucks to fully electric vehicles. As part of our broader commitment to accelerating EV adoption, PG&E commits to further electrify our vehicle fleet by 2030:

- 100% of light-duty fleet
- 50% of medium-duty fleet
- 20% of heavy-duty fleet

Types of Fleet Vehicles

Light-Duty	Medium-Duty	Heavy-Duty
• Passenger vehicles • SUVs • Pickup trucks	• Trouble trucks • Gas service & field metering trucks • Pickup trucks	• Large bucket trucks • Digger derricks • Dump trucks

To expand our portfolio of low-emission vehicles, we are integrating the latest available technologies and partnering with automakers to meet needs unique to our fleet operations and reduce emissions and operating costs. For vehicles




that cannot be electrified, PG&E will continue to use renewable diesel and RNG over standard fuels, and explore opportunities for hydrogen vehicles as the market develops.

Reduce Emissions from Buildings and Facilities

We're continually working to reduce the carbon footprint of our buildings and facilities through sustainable design, increasing the efficiency of our energy usage, and engaging our coworkers in reducing energy waste. We've also expanded our use of on-site renewable energy by installing solar photovoltaic systems at seven large sites, giving PG&E a total of 2.7 million kWh of solar electric capacity in 2021. To date, we've earned LEED certifications for 21 facilities.

To meet our 10% emissions reduction goal, we are building on this progress and upgrading building automation and technology, participating in load shedding programs, and adjusting HVAC set points at our facilities. We're also building out an expanded portfolio of PV solar installations potentially paired with battery storage, helping to drive down grid electricity usage. Future opportunities also include LED lighting retrofits, lighting control upgrades, and electrifying facility space and water heating.

Reduce Emissions from Our Owned Natural Gas Generation Resources

PG&E owns and operates three natural gas-fired power plants totaling 1,400 MW with best-in-class emissions levels. These highly efficient facilities provide safe and reliable energy, as well as the operational flexibility required to augment variable renewable energy sources and ensure we can meet the current and future energy needs of our customers.

As flexible combined-cycle power plants, the Colusa and Gateway Generating Stations are an essential part of PG&E's efforts to successfully integrate more renewable resources into the energy grid. When wind or solar production varies during the day, these facilities can ramp up quickly to meet customers' electricity demand. Our Humboldt Bay Generating Station is located in a relatively isolated section of California's north coast region and provides a significant majority of the area's electrical capacity, with operational flexibility and low emissions.

Looking ahead, the dynamics of California's energy landscape continue to evolve as policy and market forces drive greater penetration of renewable energy resources and energy storage technologies onto the grid. With these changes, we project a roughly 40% decline in output and emissions from our natural gas-fired facilities by 2030, relative to a 2015 baseline.

While we anticipate the facilities will run less frequently throughout the year, we expect they will remain available to serve local and system peak demand when needed. We plan for these facilities to continue to provide safe, reliable, and low-cost electricity to our customers during the clean energy transition.

Reduce Emissions from Our Gas Compressor Stations

PG&E's integrated natural gas system includes a fleet of 41 compressor units, across multiple compressor stations located on our gas transmission pipeline system and at various underground gas storage facilities. These facilities receive and move natural gas through our pipeline network.

Through recent system planning assessments of compression demands on the gas transmission system, we identified the Tionesta compressor station unit for retirement. Doing so is part of our strategy to remove facilities (whether gas or electric) that are no longer required for safe and reliable system operations and that will result in more efficient operation of the energy system.

Retiring the Tionesta compressor station in 2025 is expected to reduce emissions while also generating future cost savings as the units will no longer need to be maintained or replaced. We also plan to replace our Los Medanos storage compressor unit in 2026. With Los Medanos, we will explore the potential to replace the unit with an electric motor versus a natural gas-fired engine, which would further reduce emissions.

Progress to Date: ***Addressing Our Own Carbon Footprint***

PG&E's **Million Ton Challenge** is a voluntary five-year carbon reduction goal to avoid one million tons of cumulative greenhouse gas emissions from our operations from 2018 through 2022.

After four years, we've already exceeded one million tons—and are pursuing additional reductions in the final year by reducing methane emissions from natural gas operations, deploying clean fleet vehicles, promoting energy-efficient and more sustainable facilities, and adopting environmentally responsible products and services, with a focus on SF_6-free substation equipment.

PG&E is finding and fixing methane leaks on our system—leveraging technologies, including mobile systems, drones, and advanced leak survey strategies to focus our efforts and maximize results.

Scope 3 & 4: Enable Our Customers to Reduce their Carbon Footprint

Continue to Green the Power Sector toward Delivering Decarbonized Electricity 24 x 7 x 365

Today, electricity represents about 14% of the state's carbon emissions—and when it comes to renewable energy, California continues to demonstrate leadership. California's Renewables Portfolio Standard (RPS) target is 60% by the end of 2030 and the state requires 100% of retail sales to come from eligible renewables or zero-carbon resources by the end of 2045.

In recent years, the dynamics of California's energy landscape have changed, highlighted by the expansion of retail customer choice, advancing energy storage technologies, declining use of conventional power plants, and the growth of distributed generation, such as private rooftop solar. Utility-scale renewable energy has also flourished.

Currently, there are times during the middle of the day when California's renewable resources can generate more electricity than customers need. It's a challenge that requires a system-level solution, including energy storage which allows PG&E and other utilities to store excess solar or wind power for use later.

In the coming decades, a confluence of anticipated changes means that California will need the right energy resources, in the right places, at the right times to attain a clean and reliable energy future. These needs are not simply for sheer capacity on the bulk power system. They include more flexible resources to accommodate greater amounts of renewables, more distributed resources at the right locations on the electric grid, and a cost-effective pathway to implementing these changes.

Importantly, customers must be part of the solution—and we're committed to serving them with clean and reliable energy. As we integrate more intermittent, renewable resources onto the electric grid, *when* customers use energy increasingly drives electric system emissions and costs. This is because the system's greenhouse gas emissions and energy prices can vary significantly across hours in the day, across days, and even across seasons.

The ability for customers to easily and automatically shift their energy usage to lower-cost and less greenhouse

2030 Climate Goals

Deliver 70% Renewables Portfolio Standard (RPS) clean electricity, which is above the RPS compliance obligation of 60%.

Facilitate the use of Diablo Canyon Power Plant transmission infrastructure to support new carbon-free generation.

Manage energy demand as a reliable, cost-effective alternative to traditional power generation solutions in a way that enables broad reach, minimal impact to the daily lives of our customers, and bill savings.

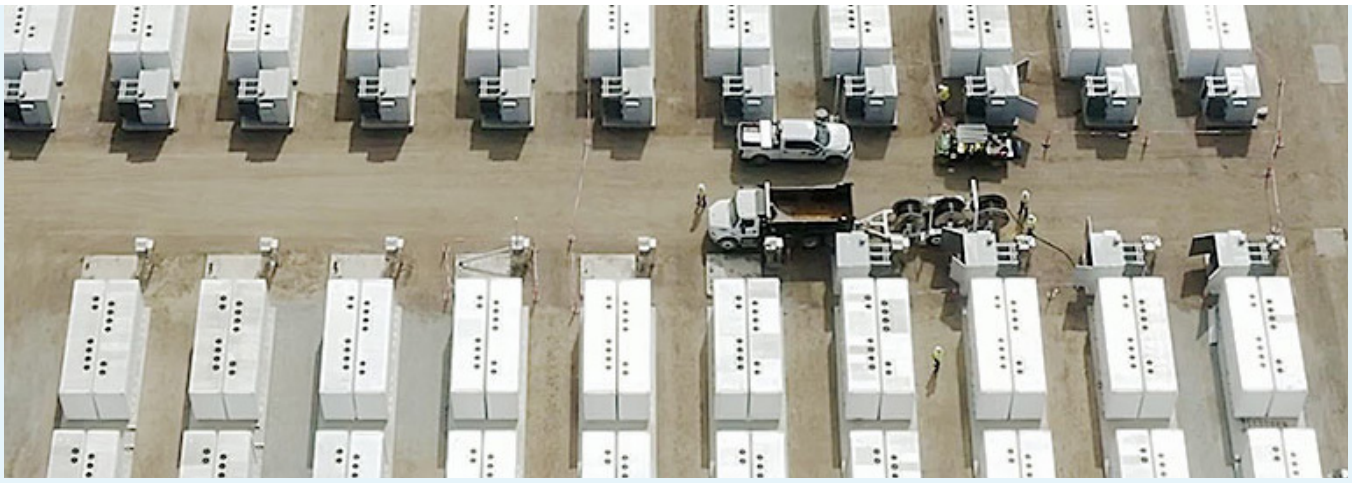


Photo of PG&E's Elkhorn Battery in Monterey County, a 182.5 MW battery energy storage system that is one of the largest utility-owned, lithium-ion battery energy storage systems in the world.

gas-intensive times is particularly important as Californians switch from fossil-fuel based technologies—such as gasoline-powered vehicles or older, inefficient heating systems—to higher efficiency and electric alternatives.

Our Approach

Working with our customers, communities, and other partners, we are transforming California's energy landscape—and have created a robust renewable energy market and reduced greenhouse gas emissions across the state.

As a result of the changing energy landscape, PG&E will increasingly rely on a diversity of resources, including distributed energy resources, out-of-state resources, and more energy storage for our power mix. Adding energy storage will enable higher penetrations of renewables on the electric grid, paving the way to a healthier environment and a more reliable, net zero energy system for customers.

In addition, a major focus will be providing customers the opportunity to take an active role in reducing their carbon footprint and their electricity bill with minimal impacts to their daily lives. Our vision is that managing customer energy demand becomes a reliable, cost-effective alternative to traditional power generation solutions as capacity needs arise.

Our strategy involves leveraging dynamic pricing, distributed energy resources, and emerging technologies to help customers lower their energy bills by aligning their electricity usage with the hours and days that have lower-cost and lower-emitting electricity:

- We plan to use rates to send signals to devices that will automatically enable customers to use more electricity during hours when we might otherwise "curtail" or export excess solar energy and to use less electricity during hours when the highest emitting natural gas plants would otherwise operate.
- We will dispatch behind-the-meter resources, which when paired with storage can reduce demand on the electric grid and reliance on natural gas.
- We plan to automatically program new technologies to time home cooling and heating, water heating, and electric vehicle charging to save our customers money and reduce emissions—all without inconveniencing the customer.

As we develop rate options and pilot new technologies, PG&E will share what we learn and continue to learn from others. In this way, our customers will not only reduce their carbon footprint and bills, but also inform innovative energy management strategies outside of California.

PG&E strongly supports California's clean energy policies, renewable goals, and vision for a sustainable energy future. We also stand ready to ensure the clean energy future is reliable and have a strong conviction we can do both. Today, PG&E's mix of electricity sources remains among the cleanest in the nation and, based on current forecasts, we're on track to meet and planning to exceed the state's renewable and carbon-free requirements under Senate Bill (SB) 100, including delivering 70% of our electricity from eligible renewable resources by 2030.

Among the market reforms needed, we advocate for enhanced integration of the Western grid to accommodate shifts in demand and supply-side energy. A strong regional interconnection will help lower costs and increase flexibility and energy reliability, especially as climate conditions become more extreme.

Looking ahead, we expect our greenhouse gas-free energy supply mix of renewable, large hydroelectric, and nuclear generation resources to remain elevated while Diablo Canyon—our utility-owned nuclear power plant—continues to operate. Once Diablo Canyon ceases operations, we expect our percentage of greenhouse gas-free electricity to decrease before rebounding as we bring more renewable energy online.

The CPUC coordinates the planning of supply resources through the Integrated Resource Planning (IRP) proceeding and has determined that replacing the power generated by Diablo Canyon is the responsibility of all load-serving entities within the CAISO. PG&E plans to procure greenhouse gas-free resources to satisfy our share of this responsibility, increasing our clean energy supply to meet California's IRP targets and exceed California's RPS target.

Progress to Date: ***Clean Energy, Battery Energy Storage Helping to Build a Climate-Resilient Grid***

Clean Energy

We have a proven performance record on clean energy, exceeding California's RPS goal for each utility to deliver 33% renewable energy by the end of 2020. In 2021, about 50% of our customers' electricity came from specified eligible-renewable resources—including biopower, geothermal, small hydroelectric, solar, and wind power—and, overall, 93% came from greenhouse gas-free resources.

At 54% of the total renewable energy power, large-scale solar energy accounted for the largest portion of PG&E's total renewable energy power mix. We have over 250 RPS-eligible power purchase contracts, totaling over 6,500 MW of renewable energy nameplate capacity. Of that, about two-thirds is solar energy. PG&E also owns 438 MW of eligible-renewable generation, including 13 solar power plants, which are mainly located in California's Central Valley and generate up to 152 MW of clean power.

Additionally, PG&E has connected more than 600,000 customers with rooftop solar to the electric grid.

Batteries: The New Frontier

PG&E continues to invest in battery energy storage, which enhances overall grid reliability, integrates renewables, and helps customers save energy and money. We have contracts for battery energy storage projects totaling more than 3,300 MW (13,200 MWh) of nameplate capacity to be deployed through 2024.

To date, 955.5 MW of battery storage nameplate capacity has been connected to California's electric grid, including PG&E's Elkhorn Battery in Monterey County, a 182.5 MW battery energy storage system.

Customer Battery Energy Storage

In addition to large, grid-scale battery storage, PG&E is leading in residential, behind-the-meter battery storage capacity deployment, and connects more new systems to the grid each month. More than 33,000 PG&E residential and business customers have installed and connected behind-the-meter battery storage systems to the grid in PG&E's service area, totaling more than 360 MW of capacity. These customers can, on average, rely on over 10 hours of critical backup power using their storage system.

A portion of these systems are funded through California's Self-Generation Incentive Program (SGIP), through which PG&E provides financial incentives for business and residential customers installing new, qualifying equipment for generating and storing energy. This is one way that customers can be prepared for extreme weather events and possible Public Safety Power Shutoff events due to the rapidly changing environmental conditions in California.

PG&E has connected more than 600,000 customers with rooftop solar to the electric grid, and supports customers with resources before, during, and after they go solar. One in every five solar rooftops in the country is in PG&E's service area.

Accelerate Electrification of the Transportation Sector

The transportation sector is California's largest source of greenhouse gas emissions, contributing to over 40% of the state's overall emissions. Powering vehicles with electricity that is increasingly sourced from zero-emission resources is one of the most impactful measures California can take to reduce greenhouse gas emissions and other pollutants. Doing so will also promote healthy communities by reducing air pollution from transportation—which disproportionately impacts lower-income communities.

Electric vehicles (EVs) represent an industry-changing inflection point, with the potential to provide increased reliability and resilience for a changing climate on a scale we have never experienced—providing grid resiliency benefits through vehicle-grid integration applications and enabling customers to use their EVs to power their home during a grid outage.

We're excited about the potential for customers to lower their household's overall energy costs by switching from gasoline to EVs, which are less costly to maintain and operate. Customers will also have the potential to save money by charging their EVs at lower-cost, "off-peak" periods, like overnight and during the day when the grid is powered by clean renewable energy, and then use their EVs to power their household during "peak" times of high energy demand on the grid.

We also advocate for improving the energy efficiency of EVs as the market evolves, which can significantly reduce emissions further. Improving the average fuel efficiency of EVs will build upon the decades of success advancing energy efficiency in buildings and appliances.

Today, about one in six of all EVs in the U.S. can be found in PG&E's service area. This equated to approximately 330,000 EVs connected to PG&E's grid at the end of 2021. But there is still more to do.

California's Goals[1]

- 100% sales of light-duty ZEV by 2035
- 100% medium- and heavy-duty ZEVs in operation by 2045
- 100% off-road ZEVs and equipment in operation by 2035

1. As laid out in Executive Order N-79-20 and reinforced in the state's latest plan to achieve carbon neutrality by 2045; ZEV refers to zero emission vehicles.

2030 Climate Goals

Be the global model in the industry by fueling at least 3 million EVs in our service area—leading to a cumulative reduction of 58+ MMT of carbon emissions[1]:

Proactively prepare the grid for 12,000 GWh of EV-related electric load and improve processes to enable rapid, safe EV energization and interconnection.

Enable 2 million EVs to participate in vehicle-grid integration applications, allowing EVs to be a cornerstone of reliability and resilience, while unlocking additional revenue streams for PG&E customers to lower the lifetime and household cost of EV ownership. We will target hard-to-reach customers while building a balanced portfolio of program offerings that is affordable for customers.

Repurpose at least 500 MWh of second-life batteries for grid-connected energy storage, providing a low-cost flexible resource to PG&E and enabling customers to maximize the value of their EV.

1. Covers the period from 2022 to 2030.

Our Approach

We're committed to providing clean transportation programs and incentives that are easy to use and affordable—and that help redefine the energy landscape to support California's clean air and greenhouse gas emission reduction goals and collective action on climate change.

Our core focus is on the customer experience by proactively preparing the grid, increasing access to EV infrastructure, and supporting EV adoption through rates, rebates, tools, and education.

To unleash the full potential of EVs for our customers, we're focused on accelerating equitable EV adoption by:

- **Prioritizing grid readiness and proactively building grid capacity to accommodate new EV demand** through a multi-year grid investment plan. We believe novel regulatory approaches may be needed to underpin this investment.
- **Rapidly accelerating EV-enabling technology** by partnering to explore and scale low-cost grid and infrastructure solutions, vehicle-grid integration technology, second-life battery programs, autonomous EVs, and other technologies that enable a clean energy future.
- **Partnering with innovators across the entire EV value chain** to build the large-scale electric infrastructure needed to incorporate EV charging systems into the energy grid and enable customers to use their EVs to power their homes and communities.

We're deploying cost-efficient, targeted customer programs to accelerate equitable EV adoption with the aim to:

- **Increase access to EV infrastructure**, by deploying chargers to support all of PG&E's customers and setting aside budgets in each program for underserved communities.
- **Reduce the total cost of EV ownership for customers** through innovative rate structures, like PG&E's real-time EV rate for business customers.
- **Increase EV customer awareness** by partnering with community organizations to understand local education needs and tailoring tools and materials to drive EV adoption.
- **Seamlessly integrate EVs with the grid**, enabling vehicle-grid integration, EV market participation, and grid support.

We're excited to collaborate with the broader EV ecosystem of vehicle OEMs, EV supply equipment providers, and others to create robust marketplaces where many can thrive. This includes an MOU with industry, government, and labor leaders to accelerate "vehicle-to-everything" technologies. We embrace engaging with coalitions to advocate for policy and regulatory positions that enable accelerated and equitable EV adoption, market integration, and customer affordability.

To be successful, our efforts depend upon:

- Ongoing state and federal policy support and funding;
- Approval of customer programs, grid readiness initiatives, and the ongoing ability to invest in EV infrastructure;
- Continued EV market acceleration and innovation; and
- Collaboration on next generation technology R&D and deployment.

Progress to Date: ***Accelerating EV Adoption***

With more than 330,000 EVs on the road today, we're well into our journey to prepare the grid for growing electrification.

We're partnering with industry leaders to advance innovation at scale and have announced EV charging technology partnerships with both Ford and GM. We're working with a growing number of OEMs to reimagine the use of EVs as backup power sources for customers:

- Piloting the use of GM EVs as on-demand power sources for homes.
- Exploring how Ford's new F-150 Lightning EV can interact with the electric grid and provide electric reliability benefits to PG&E's customers.

We also continue to implement a suite of EV charging programs, dedicating resources for underserved communities:

- We installed nearly 5,000 Level 2 charging ports at workplaces and multi-family dwellings through our **EV Charge Network program,** with 39% of the chargers located in disadvantaged communities (DACs).
- **EV Fleet** aims to support the adoption of 6,500 medium- and heavy-duty EVs, investing at least 25% of the infrastructure budget in DACs.
- **EV Fast Charge** aims to install between 30 and 40 plazas for direct-current (DC) fast charging in corridor and urban sites, with at least 25% of the sites in or adjacent to DACs.
- We proposed **EV Charge 2** to install 16,000 Level 2 and DC fast charging ports to support multi-family housing residents with onsite, workplace, and public-destination charging.

PG&E will test bidirectional charging technology in a variety of settings.

Enable Building Electrification in an Orderly Transition and Shape the Future Natural Gas Delivery System

Today, residential and commercial buildings represent about 14% of California's greenhouse gas emissions. Electrification of the building sector is one of California's key strategies to reach its ambitious climate goals—and doing so has important implications for our customers, both in terms of potential costs and the customer experience of the transition. We approach this transition in a strategic and collaborative manner—and in a way that coordinates closely with the evolution of the natural gas system.

As part of our engagement on the future natural gas delivery system, PG&E actively participated in *California's Gas System in Transition*, a stakeholder process facilitated by the non-profit Gridworks. The initiative identified a long-term trend towards decreased natural gas throughput, driven by increased climate temperatures, improved efficiency of gas appliances, increased building electrification, and reduced demand for natural gas to generate electricity.

At the same time, it's expected that capital investment and ongoing maintenance costs of the gas delivery system will increase. To combat this, PG&E has been working diligently since early 2020 to identify and execute cost reduction strategies to minimize potential long-term gaps between revenues collected and the revenue requirement for maintaining the remaining gas system.

Our Approach

PG&E is developing energy efficiency strategies and aligning our gas business with California's decarbonization and carbon neutrality goals. This includes delivering customer programs and advocating for federal, state, and local support for decarbonization. It also includes exploring strategic alternatives to significant new investments that are not otherwise needed for safety and reliable system operations.

2030 Climate Goals

Achieve 48 MMT of lifecycle carbon emission reductions through comprehensive energy efficiency and decarbonization strategies, with an increasing focus on building electrification[1]:

- Align customer building electrification programs with the timing, scope, and goals of PG&E's targeted gas system transition.
- Aim for 50% of PG&E's Workforce Education and Training programs to focus on building knowledge and skills for electrification—with a continued commitment that 60% of the participants will be from disadvantaged communities.
- Take a proactive, policy leadership position in developing and publicly advocating for federal, state, and local electrification codes and standards for buildings and appliances.

Execute zonal electrification and create a repeatable model on how to best perform it:

- Evaluate gas capital projects for electrification as an alternative to the planned gas projects and pursue electrification for the projects evaluated as feasible and cost-effective.
- Commit to a new program that seeks to zonally electrify three to five communities, with a specific focus on the decarbonization of vulnerable communities.

1. Covers the period from 2022 to 2030.

Delivering for Customers and Supporting Decarbonization

PG&E is leading on strategies to broaden access to energy efficiency programs, improve customer affordability, and continue supporting a carbon-neutral energy transition. The primary focus of all our initiatives is to better serve our customers.

↑ **6 million**

Homes' annual emissions worth of energy efficiency[1]

We're focused on delivering excellent customer experiences by providing a broad array of energy- and money-saving solutions to help meet the diverse needs of our customers across all sectors. Our plan makes it easier for customers to participate in energy efficiency programs and drives increased engagement in these solutions through more personalized customer experiences.

PG&E aims to achieve 48 MMT of lifecycle carbon emission reductions by 2030 through comprehensive energy efficiency and decarbonization strategies, with an increasing focus on electrification. PG&E's plan supports our customers through the transition to electrification, ensures equity for all customers, and advocates for critical changes to federal, state, and local building codes and appliance standards.

Electrification in Disadvantaged Communities

PG&E is implementing an electrification pilot in the San Joaquin Valley. The effort is designed to reduce pollution and lower overall energy costs by eliminating the use of propane and wood burning appliances in several disadvantaged communities without access to natural gas.

1. This equivalency converts the 48 MMT emissions reduction total to the CO_2 emissions from powering 6 million homes for a single year using national averages. Source: U.S. EPA Greenhouse Gas Equivalencies Calculator.

We plan to align our customer electrification programs with the timing, scope, and goals of PG&E's targeted gas system transition. This will include implementing new programs for commercial building electrification that target locations that reduce gas system transition costs—and for residential customers targeting disadvantaged communities.

We will help enable the workforce of tomorrow by aiming for 50% of PG&E's Workforce Education and Training programs to focus on building knowledge and skills for electrification—helping to prepare for the transition necessary to reach California's climate goals and covering topics such as induction cooking, heat pump technologies, EVs, and energy storage. This will be an increase from today's total of 20%. In addition, we will maintain an ongoing commitment that 60% of the participants will be from disadvantaged communities.

We will also take a proactive, policy leadership position in developing and publicly advocating for federal, state, and local pro-electrification codes and standards for buildings and appliances. This will continue our decades-long work in this area and focus PG&E's technical research, customer outreach, and public advocacy towards supporting state and local objectives.

This includes:

- Support to cities, counties, and state agencies that employ policy tools, including local ordinances and the Energy Code to reach goals that will impact both newly constructed buildings and retrofits for existing homes and businesses.
- Support for state and federal appliance standards rulemakings that require performance levels in alignment with California's decarbonization objectives.

Zonal and Targeted Electrification

Electrifying "zones" to eliminate the need for natural gas infrastructure benefits our customers by allowing for a coordinated approach to electrification that minimizes customer disruptions. It also has the potential to reduce gas system operating costs and allow PG&E to decommission gas pipelines or downrate local transmission lines.

At a small scale, PG&E has been conducting targeted electrification projects since 2018 with a focus on the customer experience and to avoid gas capital expenditures or reduce operating costs of the gas system. PG&E's 2030 commitment related to zonal and targeted electrification revolves around ensuring that electric alternatives are always considered within PG&E's gas planning process, and that PG&E actively pursues all electrification projects that are feasible and cost-effective, taking into account ratepayer, impacted customer, and non-traditional funding.

To help contribute to the solution, PG&E will seek to zonally electrify three to five communities, with a specific focus on the decarbonization of vulnerable communities. This pilot program will help PG&E better understand the costs

associated with these types of projects and gain insight into the planning and technical challenges to help inform improvements for future projects.

PG&E plans to identify high-potential zonal electrification candidates using a range of data related to the gas system, customer propensity, policy, and other factors. However, identifying high-potential locations is only the first step in successful zonal electrification; other challenging barriers exist to decommissioning pipelines at a larger scale:

- Customer acceptance
- PG&E's regulatory obligation to serve both gas and electricity to customers
- Cost of zonal electrification projects and the availability of funding sources other than customer bills
- Many different local decommissioning regulations

Advancing Building Electrification

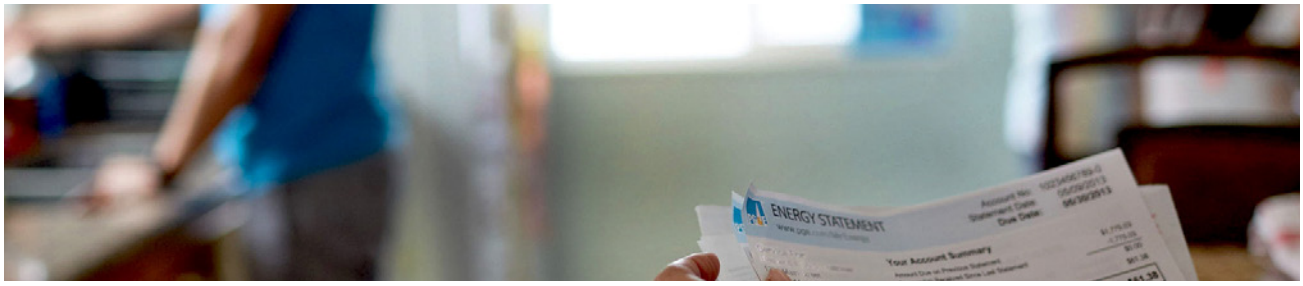
PG&E recognizes the value of building electrification as an important tool in meeting California's climate goals, and we have begun to incentivize low-carbon solutions in the building sector. For PG&E, our primary objectives with building electrification are to reduce greenhouse gas emissions and customer costs, while creating a positive customer experience.

We have been pleased to lend our support for local efforts to promote all-electric new construction as a way to help reach our climate goals, partner with communities, and reduce future gas system costs, and we have offered letters of support for all-electric new construction codes or ordinances to dozens of cities and counties.

Electrification of existing buildings comes with its own set of challenges. Decarbonizing California's existing building stock has the potential to impact the affordability of energy service for remaining natural gas customers if not properly managed. By adopting a strategic, proactive approach focused on zonal electrification and whole-building electrification retrofits, PG&E can reduce or avoid future gas system costs; reduce the costs of needed system upgrades, installations, and removals by efficiently coordinating and planning work; and help to stabilize gas rates.

In addition to mitigating potential overall cost increases, a strategic, proactive approach to building electrification can also provide more equitable solutions. As Energy and Environmental Economics, Inc. (E3) highlights in their report *The Challenge of Retail Gas in California's Low-Carbon Future*, declining throughput on the gas distribution system could lead to "unsustainable increases in gas rates and customer energy bills…after 2030, negatively affecting customers who are least able to switch away from gas, including renters and low-income residents." A targeted approach to building electrification can help avoid disproportionate cost increases for our most vulnerable customers.

PG&E recognizes the importance of co-creating the building decarbonization future with local, state, and federal partners to achieve meaningful outcomes for customers based on shared building decarbonization goals.



"Green" the Gas Supply for Hard-to-Electrify Customers

Today, California's industrial sector, which largely relies upon natural gas, represents about 24% of the state's greenhouse gas emissions; residential and commercial buildings, which also use natural gas, represent another 14%.

Using cleaner fuels is a key strategy to decarbonize California's natural gas system and reduce emissions for these customers. Doing so will reduce reliance on fossil-based natural gas, while taking advantage of the state's extensive natural gas infrastructure system.

RNG is a renewable energy resource that is produced from organic matter like agricultural crop waste, forestry waste, wooden construction waste, and manure. Major sources of RNG are dairies, non-hazardous landfills, wastewater treatment plants, and other organic sources.

Woody biomass has also become a major challenge in California due to an ongoing extended period of drought and bark beetle infestations in California forests, as well as the wildfires that increasingly result from these conditions. Finding ways to use the excess wood material as a source of RNG aligns with our future decarbonization goals.

Longer-term, "green" hydrogen has the potential to support our decarbonized future. Produced from a renewable source, green hydrogen has several potential applications, including as fuel for the transportation market—especially in heavy-duty vehicles, marine, and rail—and as long-duration energy storage.

2030 Climate Goals

Reduce cumulative carbon emissions by 2.5 MMT by proactively converting industrial and large commercial customers unable to electrify from dirtier burning fuels to natural gas[1], prioritizing sites in or adjacent to disadvantaged communities.

Deliver 15% RNG in PG&E's core gas throughput.[2]

Maximize readiness for hydrogen blending:

- Operationalize a hydrogen pilot project by 2024 using different vintage gas pipes in a stand-alone system so we can test different hydrogen blends in pipes used in our system—and help inform a safe level of hydrogen we can blend into the existing system by 2030.

Pledge $25M toward sustainable uses for woody biomass in collaboration with other partners:

- R&D on converting wood waste to RNG and biomass carbon removal and other byproducts.

1. Covers the period from 2022 to 2030.
2. Represents a minimum volume of approximately 27 billion cubic feet per year.

Our Approach

PG&E is actively working to transition the gas system to transport and deliver cleaner fuels such as RNG and hydrogen to help decarbonize PG&E's operations and the energy used by our customers.

Renewable Natural Gas

PG&E is committed to increasing the percentage of RNG supplied to our core gas customers to 15% by 2030, which will also enable PG&E to meet new requirements for California utilities.

Injecting RNG into our gas pipelines displaces fossil natural gas, resulting in a cleaner natural gas supply for customers. It can also serve customers interested in converting their vehicle fleets from diesel to cleaner burning compressed natural gas (CNG), reducing emissions from the transportation sector.

Decarbonizing Large Gas Customers

PG&E is working with industrial and large commercial customers that will not be able to electrify—setting a goal to reduce cumulative carbon emissions by 2.5 MMT by converting these customers from dirtier burning fuels to natural gas. We also recognize the clean air benefits of this work to the surrounding communities. That's why, as we do this work, we will continue to prioritize sites that are in or adjacent to disadvantaged communities.

We're helping customers move from emission-intensive fuels to cleaner burning natural gas. Doing so enables emissions reductions in other sectors in support of California's longer-term drive towards carbon neutrality. Many of these customers need natural gas for their production processes and we can leverage portions of the gas system to reduce emissions from these facilities, while sustaining important economic activity that provides jobs for Californians.

R&D Toward Sustainable Uses for Woody Biomass

We also pledge a commitment of $25 million through 2030 in R&D toward sustainable uses for woody biomass, working in collaboration with other partners to build upon and ramp up PG&E activities.

One promising area is the opportunity to convert woody biomass to a source of RNG. In fact, the CPUC recently required PG&E to file an application for at least one pilot project converting woody biomass from forest, agricultural, and/or urban sources to RNG. To date, PG&E has funded several of these types of R&D projects at a small scale with a focus on economic analyses and proof of concept physical demonstration projects. Additional R&D funding will enable PG&E to more proactively help advance these demonstration projects into full scale pilots.

Further research is also needed to explore other sustainable uses for woody biomass, such as biomass carbon removal. We plan for this effort to build upon

Progress to Date: ***PG&E Helps Advance Renewable Natural Gas Sources for Customers***

PG&E is working to add RNG to the gas pipeline system in a way that is both safe and helps California address climate change.

Under a partnership between PG&E, Maas Energy Works, and California Energy Exchange, PG&E completed a first-of-its-kind interconnection that bridges RNG-producing dairies and PG&E pipelines, removing the historic barrier between producers and customers. This was one of two projects resulting from the state's SB 1383 Dairy Biomethane Pilot Program, designed to demonstrate the collection of biomethane from dairy digesters and its injection into natural gas pipelines.

PG&E anticipates we will have six RNG projects connected to our system by the end of 2022, and several more in the next few years. In total, projects with anticipated operational dates in 2022 or 2023 are expected to provide over 60,000 million cubic feet of gas per day, which represents about 3% of daily system throughput.

current research being funded through the EPIC 3.47 program, where PG&E is embarking on a new R&D project to demonstrate technology innovations for woody biomass. PG&E is requesting proposals in 2022 for projects related to small-scale mobile torrefaction (densifying and pre-processing biomass for other value-added conversion), wood baling, and other promising solutions.

Hydrogen

PG&E has launched the nation's most comprehensive end-to-end hydrogen study and demonstration facility to prepare for the hydrogen future and gain experience in different aspects of handling hydrogen.

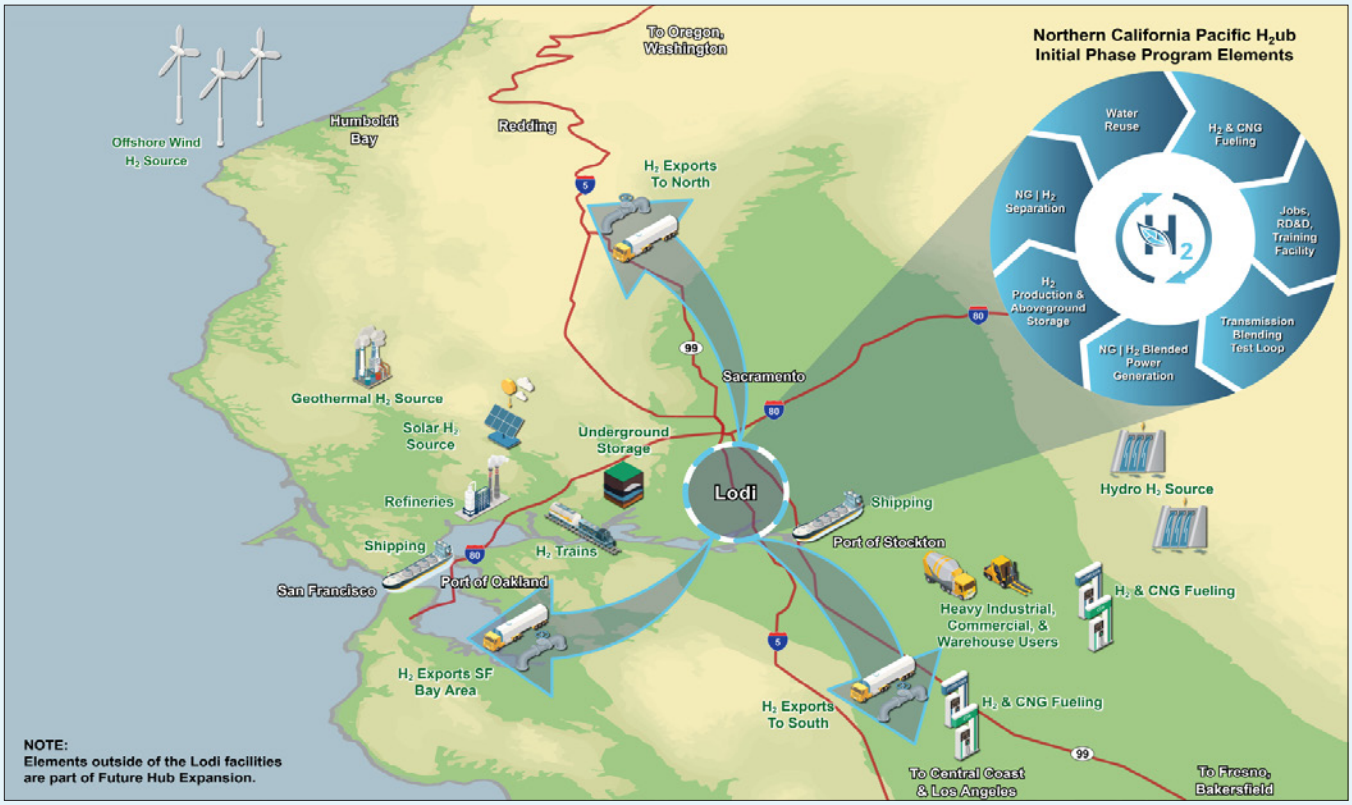
The centerpiece of the study, known as **Hydrogen to Infinity (H2∞)**, is a large-scale project designed to blend hydrogen and natural gas in a stand-alone transmission pipeline system. Partners include Northern California Power Agency, Siemens Energy, the City of Lodi, GHD Inc, and the University of California at Riverside.

Through the pilot project, we plan to study different levels of hydrogen blends in a multi-feed, multi-directional natural gas pipeline system that is independent from our current natural gas transmission system.

H2∞ will also include plans for a new 130-acre facility located in Lodi, California, that will serve as a study laboratory that incorporates production, pipeline transportation, storage, and combustion.

Potential California Hydrogen Hub

PG&E is contemplating the new demonstration facility in Lodi being an integral piece of a potential California Hydrogen Hub.



Reducing Supply Chain Emissions

For many years, PG&E has worked to embed environmental sustainability into our sourcing processes and align these efforts with PG&E's commitment to serving people, the planet, and California's prosperity.

Progress to Date

Since 2007, PG&E has worked to reduce the environmental impact of the products and services we purchase. We monitor supplier sustainability performance through requests for proposals, by reviewing supplier scorecards, and by engaging suppliers in an annual sustainability assessment. We use the assessment as part of our supplier scorecard process and to develop tools and training to help suppliers improve environmental performance.

We also continue to partner with industry peers through the Electric Utility Industry Sustainable Supply Chain Alliance (Alliance), a consortium of 24 electric energy providers that we cofounded to advance sustainable business practices among utilities and industry suppliers.

Focusing on Greenhouse Gas Hotspots

We partnered with the Alliance to perform a greenhouse gas hotspot assessment of our non-energy related purchased goods and services. We learned that our suppliers in the construction services, vegetation management, and manufacturing industries represent over 60% of these Scope 3 upstream emissions.

To further reduce emissions in our supply chain, we're focused on partnering with these suppliers through our annual assessment and by offering them in-depth greenhouse gas emissions training to help measure their carbon footprint.

Roadmap for 2030

Looking ahead, we've established a roadmap through 2030 that focuses on engaging with suppliers in the construction services, vegetation management, and manufacturing industries to measure their Scope 1 and 2 greenhouse gas emissions and establish reduction goals.

Key aspects of the roadmap include:

- Our plan to require these targeted suppliers to share their emissions data and reduction goals with PG&E starting in 2025.
- Our 2030 goal to have 100% of these supplier partners establish a science-based target or a longer-term net zero goal.

California, PG&E Lead Transition to Greenhouse-Gas Free Electrical Equipment at Substations

PG&E is working with suppliers to integrate innovative SF_6-free equipment into our system ahead of California's stringent requirements. This includes installing the industry's first 123 kV circuit breakers with clean-air vacuum technology.

Building Career Pathways

PG&E is focused on developing a workforce with the skills and expertise to operate our business safely, while also meeting the evolving needs of our customers—amidst an energy industry that is undergoing a rapid transformation. We're excited about the opportunities to partner with our coworkers, communities, and others to optimize the workforce transition to a net zero energy system.

Through our talent identification efforts, robust training offerings, and targeted efforts at building workforce pipelines such as PowerPathway™, PG&E remains poised to have the talent needed to achieve a decarbonized future.

We're helping coworkers grow in their careers and offering leadership development programs to prepare leaders for the challenges of an ever-changing utility industry. We're also working to localize and diversify our workforce, building a workforce that is further reflective of the communities we serve.

Through our PowerPathway™ program, we continue to partner with local workforce development organizations to develop local diverse talent invested in our communities. Created in 2008, PowerPathway™ targets those who are out of work or under-employed and has a strong focus on enhancing opportunities for women and those who have served in the military. Students enrolled in the program receive industry-specific training that addresses the academic, vocational, and physical abilities students will need to enter the energy industry workforce.

PG&E also made local hiring commitments as part of recent settlement agreements related to the 2019 Kincade Fire and 2021 Dixie Fire. We will hire roughly 200 employees in designated counties for wildfire or other operations-related work over the next five years, which will reinforce our hometown-oriented workforce. We will also support local community college partnerships for both a fire technology training program and a vegetation management training program.

Workforce Development on Tribal Lands

PG&E partnered on a pilot to train Native American tribal members on vegetation management—leveraging traditional and cultural learnings—through a four-week course held on the ancestral lands of Robinson Rancheria. This effort is part of our broader effort to strengthen relationships and partnerships with Native American tribal governments and communities.

As we look to the future, we're working to better understand the workforce implications of a net zero energy system—and the anticipated changes to PG&E's workforce composition and skillsets over the coming decade and beyond. We look forward to partnering with our coworkers and other stakeholders to meet the workforce needs, challenges, and opportunities ahead and incorporate these workforce considerations into our longer-term business strategy.

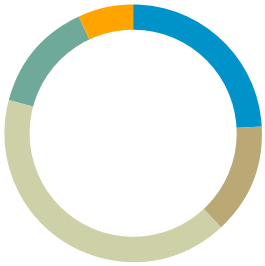
PowerPathway™ By the Numbers

- **Graduated 1,000+ people**
- **83% hired by PG&E or within the utility industry**
- **Nearly 50% are veterans**
- **More than 10% are female**
- **68% are people of color**

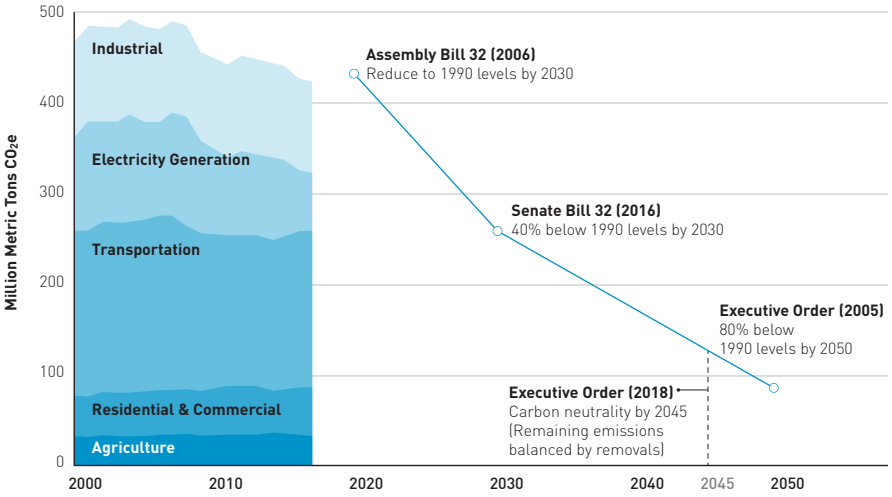
Supporting California's Clean Energy Vision

PG&E is committed to California's vision of a sustainable energy future. This commitment includes our support for the state's implementation of SB 100 and carbon neutrality by 2045 in a reliable and cost-effective manner for our customers. SB 100 includes increased Renewables Portfolio Standard (RPS) objectives and clean energy goals, and Executive Order B-55-18 sets a statewide goal to achieve economy-wide carbon neutrality no later than 2045.

California's 2019 Greenhouse Gas Emissions



- 24% Industrial
- 14% Electricity Generation
- 41% Transportation
- 14% Residential & Commercial
- 7% Agriculture



California's cap-and-trade program sets a declining cap on greenhouse gas emissions covering three-quarters of California's emissions, including most greenhouse gas emissions from PG&E's electric and natural gas businesses. The program requires covered entities such as PG&E to hold compliance instruments (i.e., allowances and offsets) equal to their covered greenhouse gas emissions and establishes markets for these compliance instruments through which a price on carbon emerges.

PG&E is actively participating in CARB's process to update the plan for how the state will achieve its short- and long-term greenhouse gas emission reduction targets.

Key California Climate and Clean Energy Milestones

2020

- 33% renewable electricity (SB 2X1)
- Economy-wide carbon emissions below the 1990 level (AB 32)

2030

- 5 million zero emissions vehicles on the road (EO-B-55-18)
- 60% renewable electricity (SB 100)
- Double energy efficiency in existing buildings (SB 350)
- Economy-wide carbon emissions 40% below the 1990 level (SB 32)

2035

- End the sale of new gasoline-powered passenger cars and light-duty trucks (EO N-79-20)

2045

- 100% carbon-free electricity (SB 100)
- Transition 100% of medium- and heavy-duty fleet to zero emission vehicles, where feasible (EO-N-79-20)
- Economy-wide carbon neutrality (EO B-55-18)

Scenario Analysis: Statewide Carbon Neutrality

As an input to developing our own climate strategy for our customers and communities in Northern and Central California, PG&E commissioned a study to identify pathways to achieving statewide carbon neutrality by 2045. This study evaluated numerous scenarios and portfolios for effectiveness and cost. The results generally align with other studies to date conducted within and beyond the state of California.

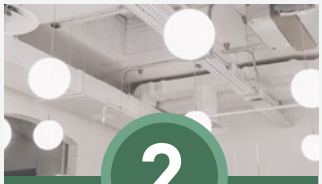
Four Pillars to 100% California Carbon Neutrality by 2045

The study identified four pillars for how California can achieve carbon neutrality at the lowest cost to society by 2045.

1

Decarbonize Electricity Supply

- Accelerate investment in solar, wind, and energy storage technologies—and in the electric transmission that will be needed.
- Scale up hydrogen production over the longer-term as an energy storage solution and as a means to decarbonize key sectors.
- Invest in state-of-the-art clean, emission-free thermal technologies to help maintain reliable electric service.



2

Adopt Energy Efficient Products and Technologies

- Cut economy-wide energy demand by investing in—and adopting—energy efficient products and technologies for homes, businesses, and vehicles.

3

Electrify Vehicles and Buildings

- Convert vehicles and buildings from fossil fuels to zero-carbon energy and fuels, with a primary focus on electrification.
- Shift customer energy use away from periods of low renewable energy generation and towards periods of high renewable energy generation.
- Make the necessary electric grid and gas system upgrades and enhancements to support growing electricity demand, maintain reliable electric service, and integrate hydrogen technologies.

4

Scale Up Carbon Capture, Utilization and Sequestration

- Capture remaining carbon emissions from the economy for other end uses or sequester emissions through underground storage.
- Use direct air capture technology to remove carbon from the atmosphere.

Key Insights

The study provided greater clarity on what needs to happen over the next several decades to decarbonize California's economy—and the general sequence and timing of changes necessary to do so at the lowest cost to society. At the same time, it will be important to remain flexible to different pathways, processes, and technologies that could emerge.

The study identified that:

- **Transportation electrification is key** to enabling California's decarbonization goals between now and 2035 because transportation makes up about 40% of the state's carbon emissions.
- **The transition to a carbon neutral economy will require substantial investment** in renewable generation, electric transmission and distribution, carbon capture, and electrification of vehicles and buildings.
- With increasing electricity demand from buildings and transportation, **California must also substantially invest in thermal generation with clean fuels and/or carbon capture and storage to maintain reliability.**
- **New, cross-sectoral partnerships will be needed**, including the **potential for hydrogen to be produced from electrolysis powered by surplus renewable energy** on the grid.

Distributed energy resources (DERs), such as rooftop solar and behind-the-meter energy storage, will also contribute to reaching carbon neutrality.

PG&E's Climate Policy Principles

These Climate Policy Principles guide us on the path to achieving our climate goals.

Meeting the challenge of climate change is central to PG&E's ability to deliver on our "triple bottom line" approach of serving people, the planet, and California's prosperity—underpinned by strong operational performance.

Consistent with this framework, PG&E works to reduce greenhouse gas emissions and environmental impacts from our operations and acts as a valuable partner and enabler to do so with our customers, the State of California, and beyond. PG&E also builds climate resilience by adapting to and preparing for a changing climate and associated weather patterns that could affect our assets, infrastructure, operations, coworkers, and customers.

PG&E is committed to achieving more sustainable operations and enabling our customers to reduce greenhouse gas emissions by:

- Making our facilities more energy efficient and sustainable, increasing clean vehicles and fuels in our fleet, and adopting environmentally responsible products and services.
- Reducing emissions of methane, a potent greenhouse gas released from the operation of natural gas infrastructure, by implementing SB 1371 and 1383, which address leak abatement and short-lived climate pollutants, respectively.
- Evolving the natural gas system by supporting emerging renewable gas technologies to decarbonize the gas system coupled with critical low-carbon thermal generation to supply electricity during peak electric demand.
- Supporting all-electric building codes and standards for new construction and identifying opportunities for strategic electrification.
- Engaging with our customers to help them use less energy and better manage their energy footprint through solutions that include energy efficiency and demand response; clean and renewable energy and fuels; storage; and low-carbon transportation fuels and fueling infrastructure.
- Integrating climate science into PG&E's decision-making and asset planning to mitigate climate risks and build resilience to long term climate-driven impacts.

PG&E advocates for policies that:

- Position California to achieve economy-wide carbon neutrality by 2045 and support nation-wide decarbonization efforts consistent with science-based emissions reduction targets to achieve carbon neutrality by 2050 or sooner.
- Support cost-effective achievement of greenhouse gas emission-reduction goals through clean energy and technology-neutral and flexible strategies that foster innovation and technology, including California's Low Carbon Fuel Standard.
- Support well-designed carbon pricing mechanisms, including California's cap-and-trade program, with environmental integrity, cost containment, and recognition of early actions.
- Support disadvantaged and vulnerable communities and the workforce in an equitable and just transition to a carbon neutral future.
- Support strategies that also lead to community-level local air quality improvements.
- Promote research and development of natural climate solutions and new technologies needed to enable decarbonization, including hydrogen production, carbon capture, energy storage, renewable natural gas, and other power-to-gas/liquids technology.
- Support policies that will enable the unprecedented infrastructure build rates and the associated transmission system that will be necessary to decarbonize the economy.
- Support PG&E's ability to invest in and adaptively manage a modern and resilient energy system that can better withstand climate-related impacts and enable PG&E to continue providing safe, reliable, affordable, and clean energy in the face of a changing climate.
- Support market reforms and changes to the regulatory structure that enable deep decarbonization, including building codes and appliance standards, policies to address gas and electric system affordability, and enhanced integration of the Western grid to accommodate demand and supply-side shifts in energy.
- Promote and support customer incentives that do not unduly shift costs to other customers, including energy efficiency, building electrification, and zero emission vehicle adoption and fueling infrastructure installation.

PG&E aligns and allocates its resources by:

- Supporting candidates who are committed to the environment.
- Providing charitable resources to organizations dedicated to improving our environment and addressing the climate crisis.
- Engaging in coalitions and trade associations in support of our policy principles.

Mitigating Physical Climate Risk Today

A "New Normal" of Climate Impacts

According to California's Fourth Climate Change Assessment, the science is highly certain that California and the world will continue to warm and experience greater impacts from climate change in the future.

PG&E's infrastructure spans more than 70,000 square miles and is already facing a variety of physical hazards worsened by a changing climate, including heat waves, more frequent and extreme storms and wildfires, drought, subsidence, and rising sea levels, as well as compounding and cascading impacts of these hazards.

PG&E refers to the projected increase in the frequency and intensity of climate-driven hazards as physical climate risk.

Record-breaking extreme heat and heat waves are increasingly a regular occurrence throughout California. In the past two decades, PG&E's electric distribution system has experienced multiple, major outage-causing events associated with heat waves and peak loads on the system. These issues are projected to increase with rising temperatures due to direct impacts of ambient temperatures on equipment and direct impacts on electricity demand driven by rising air conditioning installation and usage.

Climate change will continue to intensify the potential for wildfires throughout California. Additionally, PG&E's assets on the coast and in or near watersheds face potential increased exposures to coastal, riverine, and precipitation-related flooding because of climate-driven changes in precipitation and sea-level rise. Encroaching salt water may also increase corrosion of coastal equipment.

	CLIMATE IMPACT	DIRECTION	SCIENTIFIC CONFIDENCE FOR FUTURE CHANGE
	TEMPERATURE	WARMING ↗	Very High
	SEA LEVELS	RISING ↗	Very High
	SNOWPACK	DECLINING ↘	Very High
	HEAVY PRECIPITATION EVENTS	INCREASING ↗	Medium-High
	DROUGHT	INCREASING ↗	Medium-High
	AREA BURNED BY WILDFIRE	INCREASING ↗	Medium-High

Effectively managing physical climate risk will become increasingly critical to the success of PG&E's mission as the physical impacts of climate change become increasingly severe over the coming years in California.

Source: California's Fourth Climate Change Assessment, August 2018 (www.climateassessment.ca.gov).

Our Approach to Building Climate Resilience

At PG&E, our stand is that everyone and everything is always safe. For this to be true, PG&E must be resilient to the physical impacts of climate change, which have the potential to threaten the safety and reliability of the energy system, as well as the safety of our customers.

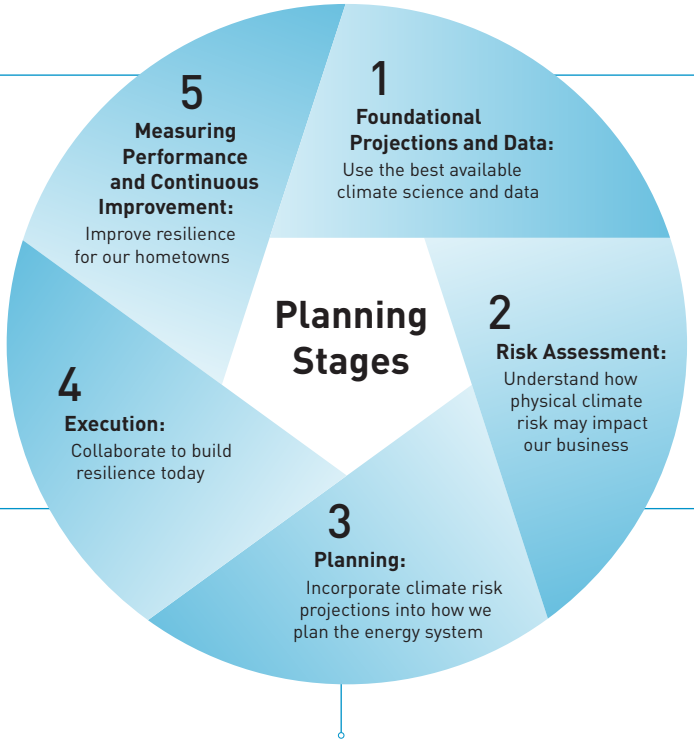
Climate resilience is often defined as the ability to anticipate, absorb, recover, and learn from climate-driven hazard events that disrupt the normal functioning of a system or community. In practice, at PG&E, becoming climate resilient means that we systematically account for the physical risks of climate change in how we plan, invest in, and operate the energy system on behalf of the communities we serve.

Given the pressing realities of climate-driven natural hazards in California, we are actively working to integrate climate resilience into PG&E's strategy to prepare our energy system for the future in a way that delivers energy safely for all of our hometowns.

The physical hazards exacerbated by climate change are mostly familiar. PG&E has over a century of experience with storms, floods, wildfires, and many other natural hazards endemic to Northern and Central California. However, climate change impacts these hazards in varying and uncertain ways that make effective planning more challenging, especially as many hazards become more frequent and severe.

Through PG&E's climate resilience program, we are working to ensure that all relevant decision-making is informed by the best available climate science. Our climate resilience team is responsible for implementing PG&E's program and acts as a support and catalyst to enable PG&E's energy system engineers and operators to systematically account for physical climate risk in their work. We are integrating PG&E's climate resilience program with our risk management and strategic planning processes to foster continuous improvement.

Building Climate Resilience Within PG&E



Resilience Highlights:

- We're using a climate resilience capability model to assess the maturity of existing capabilities important to building climate resilience and prioritize areas for improvement.
- We're collaborating with Institute of Electrical and Electronics Engineers and Electric Power Research Institute working groups to develop utility industry climate resilience metrics.

Resilience Highlights:

- We're actively partnering at the local level to address mutual hazards, including a recent joint application for federal funding from FEMA's BRIC program.
- Our charitable giving program is supporting community-identified resilience needs.

Resilience Highlights:

- We added a dedicated climate resilience chapter to our 2023 General Rate Case (GRC) filing in recognition of likely future resilience-focused projects; we plan to do so again in our next GRC.
- We're developing climate-informed design guidance to enable PG&E to plan our system for projected future conditions, to reduce costs and improve service reliability.

Resilience Highlights:

- We rely on Cal-Adapt, California's designated source for locally downscaled climate projections.
- We collaborate with academic and government partners to conduct original research into the potential impacts of climate change on key hazards, such as wildfires.

Resilience Highlights:

- We consider physical climate hazards a cross-cutting risk factor and are integrating climate risk into our enterprise risk models.
- We're conducting a multi-hazard, service area-wide Climate Vulnerability Assessment to capture a comprehensive view of physical climate risk.

Measuring and Mitigating Physical Climate Risk Today

Quantifying the physical risks driven by climate change is a key part of PG&E's portfolio of climate resilience actions. PG&E considers physical climate risk a cross-cutting factor that influences our enterprise risk models. Adequately accounting for physical climate risk in our risk assessment efforts is foundational to effective, resilient utility planning and investment going forward.

On a regular basis, PG&E files a Risk Assessment and Mitigation Phase (RAMP) report with the CPUC to provide greater visibility and stakeholder engagement around plans for mitigating top safety risks. The RAMP process and required methodologies are applicable to all of California's investor-owned utilities. PG&E will file our third RAMP report in 2024.

Each filing is an opportunity to further develop our base risk models and integrate the climate risk cross-cutting factor.

In our 2020 RAMP filing, PG&E accounted for climate change in our wildfire risk model by incorporating the overall increase in wildfire risk due to climate change and how climate-driven changes may impact the risk of ignition and the spread and intensity of future wildfires. PG&E also factored the impact of changing climate conditions into the risk that natural hazards—such as extreme heat events, major rain events, and extreme wind—may cause electric distribution overhead assets to fail.

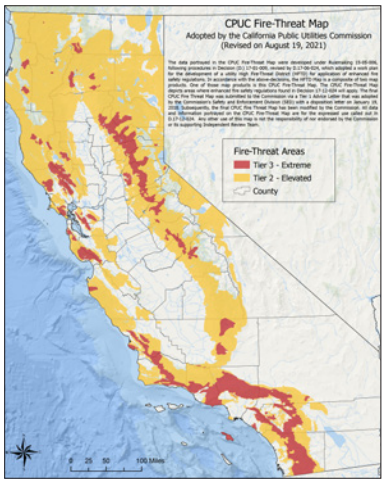
Effectively integrating physical climate risk into our enterprise risk models is a complex task. Marrying climate hazard projections with risk models requires a robust understanding of both dynamics and is an area of continuous improvement at PG&E.

Photo of PG&E's Ravenswood substation, which is at risk of flooding from sea-level rise due to climate change. To address this challenge, PG&E partnered with the City of Menlo Park, the San Franciscquito Joint Powers Authority, and Meta, to submit a grant application to FEMA's Building Resilient Infrastructure and Communities program. This grant—the Menlo Park SAFER Bay project—seeks to protect the substation and surrounding communities from flooding associated with sea-level rise.

Increasing Wildfire Risk

California continues to experience an increase in wildfire risk and a longer wildfire season. The risk posed by wildfires has increased in PG&E's service area as a result of an ongoing extended period of drought, bark beetle infestations in the California forest, wildfire fuel increases due to rising temperatures and record rainfall following drought conditions, and strong wind events, among other environmental factors.

High winds can cause tree branches and debris to contact energized electric lines, damage our equipment, and cause a wildfire. Today, more than half of our service area is in a High Fire-Threat District (HFTD), as designated by the CPUC.



Source: CPUC High Fire-Threat District Map

CPUC Fire-Threat Map

The Fire-Threat Map identifies areas across California that have the highest likelihood of a wildfire impacting people and property, and where additional action may be necessary to reduce wildfire risk:

- **Tier 3 areas** are at extreme risk for wildfire
- **Tier 2 areas** are at elevated risk for wildfire

PG&E's Community Wildfire Safety Program

We all need to work together—PG&E, our government, and all Californians—to adapt our electric system to the growing threat of wildfires, while also helping our customers prepare for and mitigate service interruptions. We all rely on electricity every day, and we will continue to work with our customers on solutions that minimize risks to our infrastructure during times of high fire-threat.

For the safety of our customers and communities, we may need to turn off power during severe weather to help prevent wildfires. This is called a Public Safety Power Shutoff or PSPS and it continues to be a necessary tool as a last resort.

We have also unveiled two new initiatives to further reduce the risk of wildfires: Undergrounding and Enhanced Powerline Safety Settings.

PG&E's Community Wildfire Safety Program includes short-, medium-, and long-term plans to reduce wildfire risk and keep our customers and communities safe. Key areas include:

- Supporting customers and communities before, during, and after PSPS events by providing more resources and working year-round and nonstop to improve our PSPS Program.
- Meeting and exceeding state vegetation standards with our Enhanced Vegetation Management Program to manage trees and other vegetation located near power lines that could cause a wildfire or power outage.
- Continuing to build a safer and more resilient system by hardening lines and installing sectionalizing devices that help to reduce the size of PSPS events.
- Testing and using new tools and technologies to pinpoint how to best prevent and respond to the risk of wildfires.

Undergrounding 10,000 Miles

PG&E is undertaking a major new initiative to underground approximately 10,000 miles of powerlines in high fire risk areas. This commitment represents the largest effort in the United States to underground powerlines to reduce wildfire risk. Benefits are expected to include:

- *Safety* by reducing the risk of wildfires.
- *Dependability* by reducing the need for PSPS and Enhanced Powerline Safety Settings outages and improving service reliability.
- *Resilience* to a changing climate.
- *Sustainability* by saving trees and beautifying our hometowns.

We plan to underground approximately 3,600 miles between 2022 and 2026 as the work scales from 175 targeted miles in 2022 up to 1,200 miles in 2026. At the same time, the increased scope, gained efficiencies, and integrated best practices are projected to decrease the cost per mile for undergrounding from $3.75 million per mile in 2022 to $2.5 million per mile in 2026.

Enhanced Powerline Safety Settings (EPSS)

Starting in July 2021, to help prevent wildfires during the hot and dry season, we started adjusting the sensitivity settings on some of our circuits in high fire threat areas to turn off power quickly and automatically if the system detects a problem.

We saw immediate impacts. With the new safety measures in place in 2021, CPUC-reportable ignitions were down approximately 40% across all 800 circuits (~25,000 miles) traversing HFTDs versus the past three-year average and down approximately 80% on the 169 EPSS-enabled circuits (~11,000 miles) versus the past three-year average.[1]

For 2022, we have enabled the EPSS setting on all circuits in high fire risk areas.

1. Refers to the three-year average for the period of July 28 through October 20.

Scenario Analysis: Understanding Future Physical Climate Risk

PG&E is conducting a multi-year, service area-wide Climate Vulnerability Assessment, using the best available climate projections for California to evaluate climate hazards and risks to PG&E's assets, operations, and services. We are doing so in compliance with the CPUC's first proceeding focused specifically on climate adaptation and resilience. PG&E expects to file the results of the assessment with the CPUC in 2024.

Importantly, PG&E will engage with disadvantaged and vulnerable communities throughout this process. Starting in 2021 and continuing through 2023, PG&E is conducting regionalized community engagement campaigns throughout our service area to understand how some of the most vulnerable communities we serve think about climate hazards and adaptation. This critical information will help PG&E plan adaptive climate action informed by customer and community perspectives.

PG&E's Climate Vulnerability Assessment will identify and help us prioritize climate-driven physical hazards projected to threaten PG&E's ability to deliver safe, affordable, reliable, and increasingly clean energy to customers.

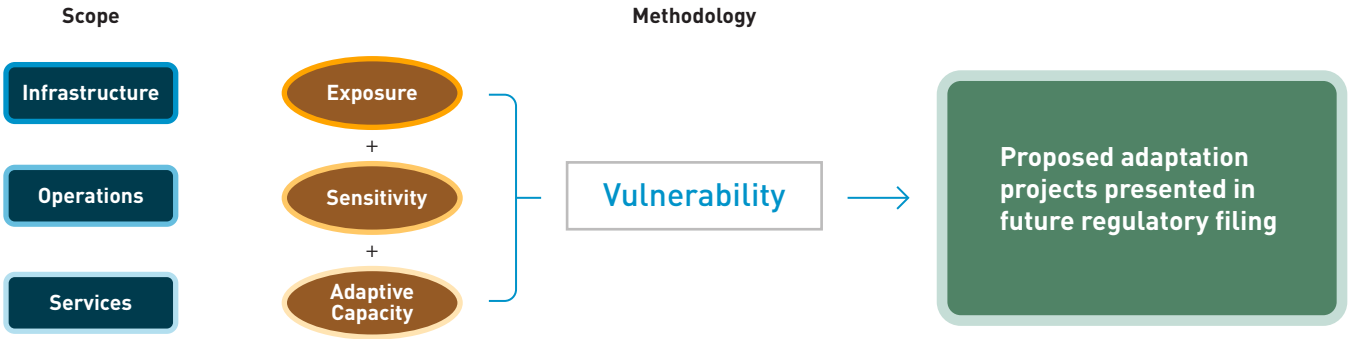
By comparing today's energy network with the environmental conditions projected for 2050, the assessment is evaluating where and what type of assets are most vulnerable to climate hazards, providing an outline for the magnitude and type of adaptation measures that may be required.

This section includes examples of PG&E's ongoing assessment of the climate hazards and risks to our electric and gas infrastructure related to wildfires, sea-level rise and coastal flooding, rising ambient temperatures and extreme heat events, and drought-driven subsidence.

As part of this assessment, PG&E is reviewing our critical operations and services to understand how future climate conditions may impact PG&E's ability to deliver energy to customers.

PG&E's Climate Vulnerability Assessment

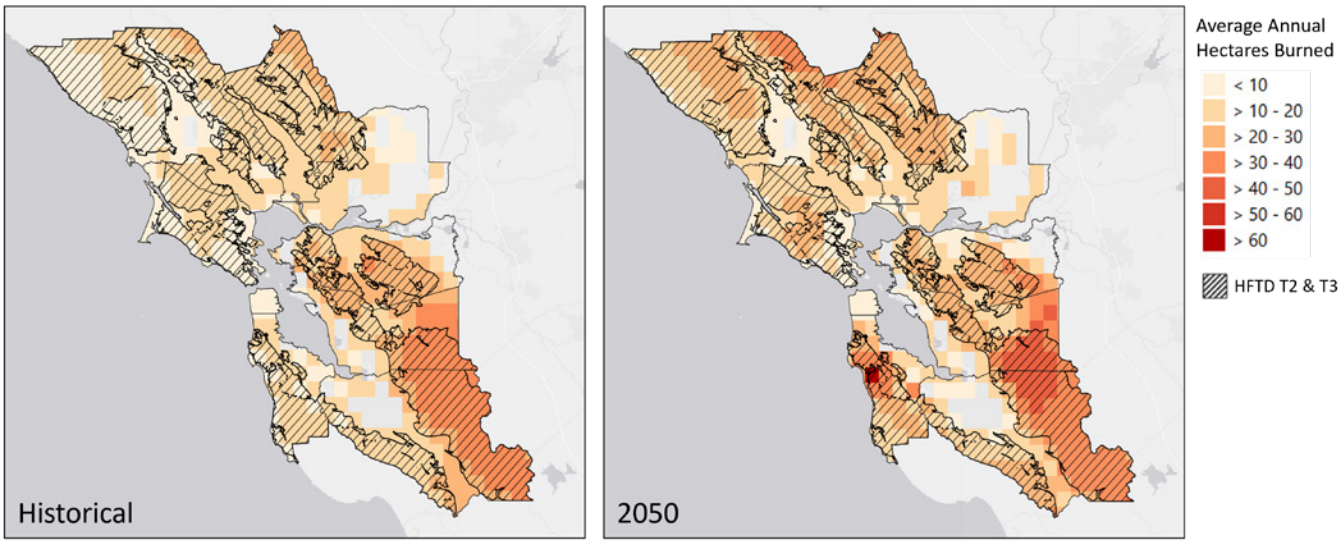
PG&E is conducting a multi-year, service area-wide climate change vulnerability assessment and will engage with disadvantaged and vulnerable communities throughout the process, so that proposed adaptation options include the perspectives of the communities we serve.



Wildfires

PG&E relies on the CPUC's HFTD maps as the basis for wildfire mitigation activities. To inform future planning, we are evaluating the projected change in wildfire acreage burned in 2050 relative to present day HFTD-designated areas.

This will enable PG&E to factor future conditions into both our near- and longer-term planning.

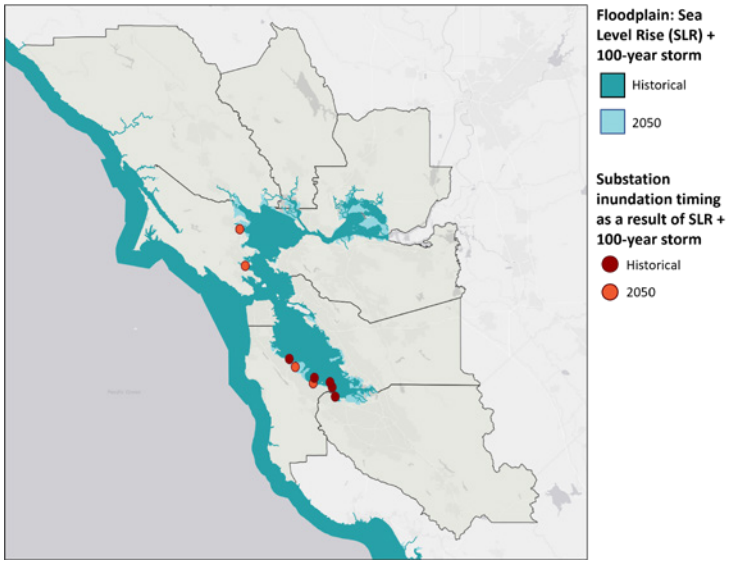


In the San Francisco Bay Area, the number of acres burned by wildfire is projected to increase in 2050 both inside Tier 2 (T2) and Tier 3 (T3) HFTDs (hashed areas), as well as outside these areas.[1]

Sea-Level Rise and Coastal Flooding

The San Francisco Bay Area is the most densely populated region within PG&E's service area. With climate change, the same coastal flooding hazards that threaten the area's vibrant communities also threaten the assets PG&E relies upon to serve these communities. With the projected sea-level rise by 2050, coastal flooding will pose an increasing hazard in the decades to come.

Given the Bay Area's population density, relocating substations exposed to coastal flooding would be a prohibitively expensive adaptive option. Rather, PG&E is actively partnering with public and private local stakeholders to address the shared threat of coastal flooding, allowing for electric service reliability and supporting community plans to sustainably manage coastal flooding.



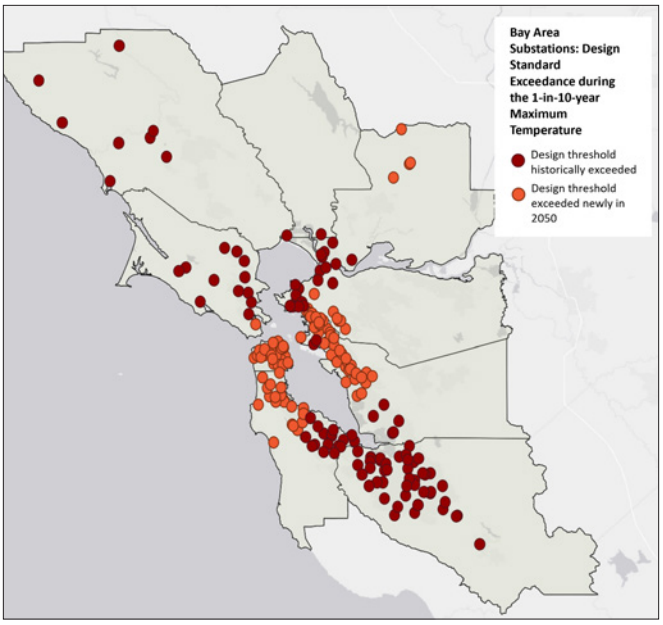
The number of PG&E substations along the San Francisco Bay coastline that are exposed to flooding during a 100-year storm is projected to increase over time due to sea-level rise. This figure shows these substation locations overlayed on the projected extent of coastal inundation over time.[1]

1. The figures assume a high climate change scenario.

Rising Ambient Temperatures and Extreme Heat Events

There is broad agreement that average temperatures will rise in the coming decades and that extreme heat events will become more frequent. Given the sensitivity of many electric grid assets to high temperatures, it's critical to consider these temperature changes in the integrated grid planning process.

In the coming years, PG&E plans to replace aging equipment with assets rated for future temperature conditions. To that end, PG&E is developing climate-informed design guidance to support energy system engineers in updating equipment standards so that the grid becomes sufficiently resilient.



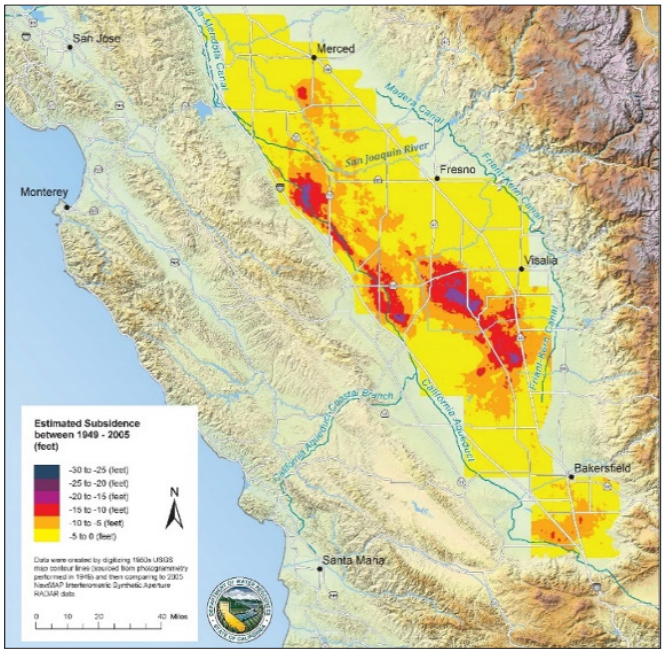
This figure shows PG&E substations in the San Francisco Bay Area. PG&E uses an ambient temperature design assumption for substations. The number of substations that will be exposed to temperatures greater than this design assumption will increase over time.[1]

1. The figures assume a high climate change scenario.

Drought-Driven Subsidence

Drought conditions can impact the energy network in a number of ways, including from land subsidence. As droughts continue, we project that increasing amounts of groundwater will be pumped out of natural underground storage aquifers. Over time, if the need for pumping persists and the aquifers are not restored by long periods without drought, the ground itself may subside.

PG&E's underground gas pipeline assets are sensitive to major geological shifts. Areas of greatest subsidence concern are in California's Central Valley. PG&E's geosciences and climate resilience teams are partnering to adequately assess and manage this hazard.



This figure shows the estimated subsidence in California's Central Valley (1949-2005) from the California Department of Water Resources.

Collaborating on Resilience Solutions

PG&E Helps Lead Multi-Year Climate Resilience Effort

PG&E has joined with other utilities to sponsor Climate READi: Power, a three-year initiative of the Electric Power Research Institute (EPRI) aimed at addressing power system climate resilience and adaptation as extreme weather events continue to increase.

The program brings together global energy companies, climate scientists, regulators, and other stakeholders to proactively analyze and apply climate data, allowing for the planning, design, and operation of resilient energy systems of the future.

This initiative will facilitate strong collaboration across sectors and will allow for convening global thought leaders and industry representatives to develop a common framework to address this challenge. Ultimately, this effort will embody one of the most comprehensive, integrated approaches to physical climate risk assessment to date.

Resilience Grants for Communities

Through the Better Together Resilient Communities grant program, The PG&E Corporation Foundation supports local climate resilience initiatives, with a particular focus on disadvantaged, vulnerable, and historically underserved communities. In 2021, the program awarded four grants to support wildfire prevention, disaster response preparation, and local emergency cooling for extreme heat events:

- **Tribal EcoRestoration Alliance's** project to build capacity and provide Native American tribal members with relevant firefighting certifications to participate in prescribed burns, purchase equipment, and share traditional tribal knowledge and techniques.
- **Blue Lake Rancheria's** project to fund 12-months of rapid start-up activities for the recently formed Humboldt County COAD network, designed to help local non-governmental organizations prepare and coordinate for disaster response.
- **Yurok Tribe's** project to use prescribed and cultural burns to collect scientific data on the impacts and serve as a framework for future studies and wildfire mitigation plans. The project will also support food security by creating a traditional foods calendar to plan for climate-driven changes in seasonality.
- **City of Richmond's** project to increase access to cooling centers by installing cooling misters and canopies in local parks or community centers. Unsheltered residents will be trained and hired to staff the cooling centers and do outreach, along with a broader public education effort.

The Better Together Resilient Communities grant program provided $2 million over five years to support local initiatives to build greater climate resilience.

Governing and Managing Climate-Related Risks

PG&E has robust governance, operational, and strategic structures in place to manage the transition to a lower carbon economy and build climate resilience.

Governance of Climate-Related Policies and Programs

At PG&E, climate-related policies and programs are overseen by the Boards of Directors of PG&E Corporation and Pacific Gas and Electric Company (together, the "Boards") and senior management, facilitated by interdisciplinary teams, and implemented by each functional group.

Boards of Directors

The Sustainability and Governance Committee of the PG&E Corporation Board of Directors has primary oversight over matters related to environmental, social, and governance (ESG) issues, including climate change and climate resilience planning. This includes oversight of climate-related policies and programs, PG&E's disclosure on ESG practices and performance, as well as an annual review of PG&E's ESG practices and performance and climate risk. The committee is comprised entirely of independent directors.

The Safety and Nuclear Oversight Committees of the Boards oversee risks arising from operations, including wildfire, employee and public safety, electric, gas and generation operations, other risks associated with facilities, emergency response, and cybersecurity. This includes oversight of the risks associated with the impact of climate change on operations, assets and facilities, and planned mitigations.

In addition, the CPUC requires that members of the PG&E Corporation Board of Directors oversee climate adaptation planning for infrastructure, operations, and services.

Executive Leadership

PG&E Corporation's Chief Executive Officer (CEO) has the overall responsibility for climate change issues for PG&E.

Reporting to the CEO is PG&E Corporation's Executive Vice President of Corporate Affairs and Chief Sustainability Officer, who is responsible for developing and implementing strategies for all aspects of corporate affairs, including climate change-related regulatory, government relations, public policy, and charitable giving. This individual co-chairs PG&E's internal Sustainability Leadership Council, a cross-departmental committee focused on reducing the greenhouse gas footprint of PG&E's operations.

PG&E's Chief Sustainability Officer also convenes an external Sustainability Advisory Council to seek ongoing feedback and guidance on issues that span our business, including climate change and clean energy. Established in 2016, the diverse group is made up of recognized leaders, including environmental and sustainability advocates, energy policy experts, and industry authorities and meets regularly with PG&E leaders to share insights and feedback.

Pacific Gas and Electric Company's Executive Vice President of Engineering, Planning, and Strategy is responsible for PG&E's near-term engineering priorities and long-term planning, including oversight of the utility's gas system and electric infrastructure. This work includes oversight of PG&E's climate resilience objectives and work to ensure the continued safe, reliable, and affordable operation of PG&E's system in the face of a changing climate.

Management of Climate-Related Risks and Opportunities

Leveraging the Lean Operating Model

PG&E is employing a Lean operating model to drive more effective and responsive decision-making by improving visibility, control, and predictability across our work. This model is fundamental to our ability to manage climate-related risks and opportunities by helping us identify gaps and quickly develop plans to support the teams performing the work.

PG&E is transitioning to the Lean operating system, which includes four basic "plays": visual management, operating reviews, problem solving, and standard work. PG&E implemented the first two plays in 2021 and expects to roll out the second two plays in 2022. Visual management allows teams to see how they are performing against their most important metrics using real-time data. PG&E holds over 2,000 daily operating reviews, beginning with crews closest to the work and cascading up to senior leadership. For example, this system helped us identify patterns in the conditions of wildfire ignitions and led to the implementation of EPSS.

PG&E's climate-related risk management is also driven by an increased focus on alignment on shared outcomes among our leadership and within the organization.

PG&E has also implemented the Regional Service Model to bring operational leadership closer to our customers. The Regional Vice Presidents lead cross-functional local teams across each PG&E region to address local issues and incorporate the needs and concerns of our customers

into operating decisions. Working with our centralized functions, these leaders assist with customer and community projects, including decarbonization activities.

Risk Management Program Implementation

At PG&E, risk management processes—including those related to climate risk—are facilitated by a central group, implemented by each functional group, and overseen by senior management and the Boards. Functional groups also manage climate-related opportunities through the strategic business planning process, including for customer energy solutions and transportation electrification.

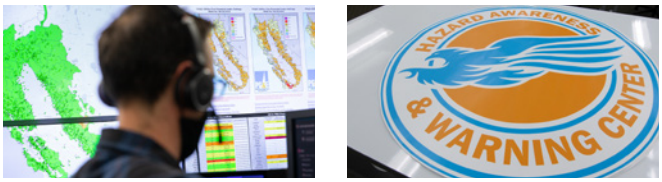
The full Boards' oversight of risk management programs ensures that programs are designed and implemented by management appropriately, and are functioning as intended. Oversight begins with the Audit Committees, which review the full spectrum of key enterprise risks on an annual basis. The Audit Committees allocate responsibility for an in-depth review of each enterprise risk to various Board committees, based on the scope of each Committee's charter. The specific allocation of Board-level risk oversight was most recently reviewed by the Audit Committees in December 2021.

Management provides regular reports to the Committees on the effectiveness of risk mitigations for each risk, including looking ahead and planning for future conditions. Each committee provides a report of its activities to the Boards.

Within management, the Executive Vice President and Chief Risk Officer (CRO) of PG&E Corporation and Pacific Gas and Electric Company oversees the Enterprise and Operational Risk Management (EORM) program; the CRO reports directly to the PG&E Corporation CEO. Senior management categorizes enterprise risks and recommends the most serious risks for Board-level review at least once every 12 months. The EORM program, including enterprise risks, is overseen by senior management and the Boards of Directors.

With guidance from a central program office, PG&E maintains a risk register of event-based and cross-cutting risks. We follow a consistent enterprise-wide approach to identify, evaluate, respond to, and monitor risks. With our evaluation methodology, PG&E calculates a baseline risk score and evaluates different mitigation strategies on their ability to reduce this score. This evaluation methodology prioritizes the highest safety risks while also accounting for energy system reliability and financial risk.

The risk of PG&E assets or activities initiating a catastrophic wildfire represents the risk with the highest baseline risk score. PG&E's annual Wildfire Mitigation Plan and our PSPS, EPSS, and undergrounding programs are intended to reduce the risk of wildfires to infrastructure, property, communities, and the environment.



Our Hazard Awareness and Warning Center (HAWC) supports wildfire prevention and response and readiness for a variety of potential natural disasters and emergencies.

We track risk mitigations throughout the year, and refresh risk assessments periodically to capture the impact of mitigation strategies and to reflect changes to the operating environment. This risk management program provides risk reduction transparency and accountability. Risk and compliance committees, which include senior leaders, are an important element of PG&E's risk management program and provide leadership, strategic guidance, and oversight for each functional group.

Climate Adaptation and Resilience:

On an ongoing basis, PG&E assesses the potential physical risks of climate change to our system. PG&E's cross-functional climate resilience team is headed by the Executive Vice President of Engineering, Planning, and Strategy and coordinates work across enterprise risk management; internal culture, integration, and planning; and external engagement.

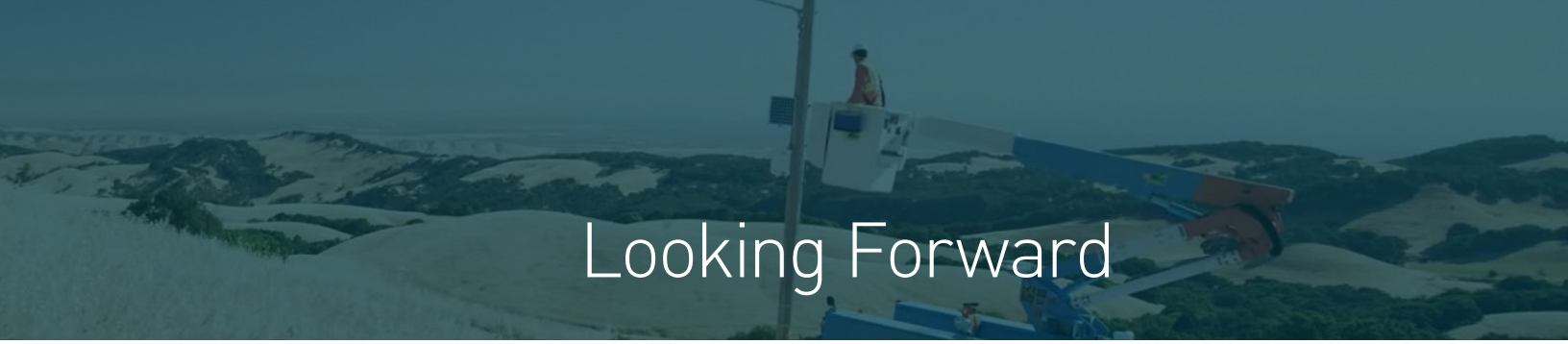
PG&E maintains emergency response plans and procedures to address a range of near-term risks and uses our risk-assessment process to prioritize infrastructure investments for longer-term risks associated with climate change.

Assessment:

We proactively track and evaluate climate-related risks. In 2020, PG&E launched a multi-year Climate Vulnerability Assessment, the results of which are designed to help PG&E target investments to infrastructure that is most vulnerable to climate impacts and that could significantly impact customers in the event of service disruption.

As part of this effort, in 2021, PG&E's climate resilience team began a multi-year effort to engage on the technical analysis of the assessment with disadvantaged and vulnerable communities region by region. PG&E will continue this process as we work towards a submittal to the CPUC by 2024.

As part of this assessment, PG&E is reviewing our critical operations and services to understand how future climate conditions may impact PG&E's ability to deliver energy to customers. This will also include an assessment of critical non-energy assets and is designed to cover the level of risk, adaptive capacity, and hazards to physical assets and employee health and safety.



Looking Forward

We stand ready to do our part to meet California's evolving clean energy policies and standards. We also stand ready to ensure the clean energy future is reliable and have a strong conviction we can do both.

With a longer-term goal of a climate- and nature-positive energy system, we're committed to reducing our own carbon footprint and helping to enable our customers and hometowns to reduce their climate impacts. Rooted in the triple bottom line, this means working towards a clean energy future in partnership with others—and in a way that grows California's economy, while keeping energy service safe and affordable for customers.

We're excited about the opportunities to engage in broad-based climate actions to decarbonize California's economy—from deploying clean energy technologies, to shaping the future natural gas delivery system, to actively supporting the state's goals for distributed energy resources, zero emission vehicles, and battery storage.

All of this work will be done in the context of the "new normal" of climate impacts projected for California, necessitating broad steps to ensure an energy system that is increasingly resilient to the physical impacts of a changing climate.

Throughout this report, when we refer to "PG&E," we are discussing all of PG&E Corporation and its subsidiaries, including Pacific Gas and Electric Company. When we refer to the "Utility," we are discussing Pacific Gas and Electric Company.

This Climate Strategy Report contains forward-looking statements that do not relate strictly to historical or current facts. These forward-looking statements relate to, among other matters, our plans, goals, and strategies with respect to sustainability and environmental matters, improvements in operating procedures and technology, and potential benefits to us therefrom; our efforts to enable our customers to achieve their own ESG goals; demand for our services; competition; government regulation; and other matters. These statements are also identified by words such as "assume," "expect," "intend," "forecast," "plan," "project," "believe," "estimate," "predict," "anticipate," "may," "should," "would," "could," "potential" and similar expressions, or by discussions of our guidance, priorities, strategy, goals, vision, mission, opportunities, projections, intentions, or expectations.

These statements reflect management's judgment and opinions that are based on current estimates, expectations, and projections about future events and assumptions regarding these events, and management's knowledge of facts as of the date of this report. These statements are based on current expectations and assumptions, which management believes are reasonable, but are necessarily subject to various risks and uncertainties, the realization or resolution of which may be outside of management's control. Actual results could differ materially from those expressed or implied in the forward-looking statements, or from historical results. PG&E Corporation and the Utility are not able to predict all the factors that may affect future results. For a discussion of some of the factors that could cause actual results to differ materially, please see PG&E Corporation and the Utility's reports filed with the Securities and Exchange Commission (SEC), including their joint annual report on Form 10-K for the year ended December 31, 2021, their joint quarterly report on Form 10-Q for the period ended March 31, 2022, and their subsequent reports filed with the SEC, which are available on PG&E Corporation's website at www.pgecorp.com and on the SEC website at www.sec.gov. Unless otherwise noted, statements in this report are made as of June 8, 2022. PG&E Corporation and the Utility undertake no obligation to publicly update or revise any forward-looking statements, whether due to new information, future events, or otherwise, except to the extent required by law.

CAP
CENTRAL ARIZONA PROJECT

CLIMATE ADAPTATION PLAN | **2018**

EXECUTIVE SUMMARY

www.CentralArizonaProject.com

1. Introduction

The Central Arizona Project (CAP) provides a renewable water supply to central and southern Arizona, where about 80 percent of the population of Arizona resides. This water supply comes from the Colorado River Basin and is subject to priority administration during drought. Recent drought, as well as studies on the potential impacts of climate change, have put a fine point on the need for CAP to be prepared for changing conditions. A prolonged shortage in the Colorado River Basin due to persistent drought could cause CAP to suffer a reduction in water diversions from the river. In addition, drier and warmer conditions may have broader effects on water demand, the economy, and CAP's financial security. It follows that climate change could have far-reaching effects throughout the CAP organization. The purpose of the climate adaptation project described herein is to investigate the potential effects of climate change across CAP departments, and to develop a plan to increase CAP's resiliency.

2. Primary Climate Change Concerns for CAP

The Colorado River Basin generates CAP's water supply, so warmer and drier conditions caused by prolonged climate change-induced drought in the watershed, with reduced snowpack and streamflow, is a major challenge that requires active management. Increased warming in the CAP service area also results in inflated water demand from customers, and extreme weather events such as flooding negatively impact CAP's water infrastructure.

Drought in the Upper Colorado River Basin

Prolonged drought conditions in the Colorado River Basin can impact the annual water supply available for the basin's water users. Reliability of Colorado River water supply is strongly influenced by hydrologic conditions in the Upper Colorado River Basin. As such, annual Colorado River flow is dependent on winter precipitation, snowpack accumulation, and spring runoff that occurs in the Upper Basin.

Drier and hotter conditions associated with drought may reduce the accumulation of snow during the winter season due to fewer precipitation events and increased sublimation and melting of the existing snowpack. In addition, excessively warm winter temperatures coupled with winter precipitation may cause rain instead of snow to fall on the snowpack. This has the effect of reducing the size of the winter snowpack. This reduction in snowpack can impact spring runoff, when snow accumulation shifts to snow melt. The volume of snowmelt generated from spring runoff is critical in determining inflow into Lake Powell and subsequently the active storage of the Colorado River system.

Water stored in Lake Powell and Lake Mead constitutes the large majority of the Colorado River Basin's system storage. The elevation and volume of the water stored in Lake Powell and Lake Mead factor into how much water is delivered to downstream users in the Lower Colorado River Basin. If the Lower Basin is under shortage conditions due to Lake Mead storage falling below 1075 feet elevation, Arizona suffers a reduction to its 2.8 MAF annual allocation of Colorado River.

Furthermore, CAP is a junior Colorado River priority holder in Arizona, and due to the nature of its Colorado River entitlement will be expected to absorb reductions to Arizona's Colorado River allocation due to shortage. This reduction propagates down to CAP's customers in central Arizona, which include cities, farms, and Indian communities. Therefore, a primary effect of sustained drought due to climate change on the Colorado River Basin is reductions to precipitation, snowpack accumulation, and snow melt. When these outcomes are coupled with the operating framework of the Colorado River system and cascaded downstream, Arizona, and more specifically CAP, bears the largest brunt of vulnerability in terms of cuts to its Colorado River water supply.

Increased Warming in the Lower Colorado River Basin

Rising regional temperatures associated with increased warming due to drought and climate change produce several effects relevant to CAP and its operations. Higher temperatures in the southwest translate to greater potential evaporation. For water stored in Lake Mead, this could mean an accelerated timetable toward Lower Basin shortage and reductions to Arizona and CAP's annual Colorado River diversion. Higher evaporation rates can also impact the volume of CAP water stored in Lake Pleasant, reducing CAP's flexibility in utilizing that stored water to meet CAP customer demands in central Arizona.

Higher temperatures tend to cause water use to inflate, especially for agricultural customers and particularly during the summer months. An inflation of water use for Arizona's Colorado River water users, reduces the volume of Colorado River water that CAP can divert and deliver to its customers in central Arizona. A similar effect can occur within CAP's framework of customer priority, such that higher priority users may utilize more CAP water, leaving less water available to lower priority contract holders.

In terms of CAP's infrastructure, an increase of monthly temperatures can accelerate the degradation and lifespan of CAP's physical assets (e.g. CAP canal, pumping plants, and mechanical parts). Higher temperatures may also encourage algae growth and proliferation of aquatic nuisance species in the waters of the CAP canal, necessitating an increase in maintenance activities. In addition to the physical operations that experience high vulnerability due to increased warming, extreme temperatures also generate health risks and dangers to CAP's workforce, especially to CAP employees who work in the field and are exposed to these conditions on a daily basis.

Finally, a potential cost component driven by increased temperatures relates to power costs during peak temperature periods. As the largest consumer of energy in Arizona, the CAP system may endure higher energy costs during the summer months due to inflated costs associated with the peak energy demand portion of the year. Since CAP's operations generally cannot be scaled back to mitigate higher energy costs in the summer, CAP will have to factor for these power costs in the summer when water and energy demand are both high.

Extreme Weather Events in the CAP Service Area

The primary concern for CAP when it comes to extreme weather events is directly related to the durability of its infrastructure and the safety of its employees. Central Arizona continues to experience extreme weather events such as dust storms, heavy thunderstorms, flash flooding, and high winds with some periodic regularity. All of these extreme events can stress CAP's existing infrastructure, shortening the lifespan of physical assets and increasing the risk of system failures. When coupled with accelerated degradation of infrastructure due to warming, extreme events can cause significant damage to CAP infrastructure and require higher and more frequent levels of maintenance. The frequency and intensity of these extreme weather events also poses a safety risk to CAP employees, particularly for those who primarily work out in the field.

3. Scenario Planning Approach

The impact of climate change on CAP is dependent on future conditions, which are by definition uncertain. To help shape policies that will ensure the resiliency of CAP and its ability to divert and deliver Colorado River water, a scenario planning approach was developed, that considers a range of future conditions. Considering a range of future conditions allows CAP to be prepared for a variety of circumstances, mitigating uncertainty.

The scenario planning process used for this study was centered on workshops attended by CAP subject matter experts. A summary of the process is described as follows:

- **Develop focal questions and assemble the CAP team**. Prior to the workshops, the focal questions were developed, and CAP experts were selected to participate in the workshops. To select the CAP team, CAP's functions that are sensitive to climate change and that would likely be involved in adaptation efforts were identified. Functions represent key areas of the organization that carry out actions in support of CAP's operations and goals. Functions may include specific departments, pairs of departments, or entire groups. Experts were selected from CAP's functions, identified as having the greatest sensitivity to climate change impacts and potential adaptation efforts.
- **Develop drivers and scenarios**. The CAP team identified potential drivers, or forces external to CAP that impact CAP operations or future conditions. The drivers were condensed into a set of "key drivers" deemed to have the most potential impact and whose outcomes were the most uncertain. Three scenarios were then developed, defined by a specific "state" of each key driver, representing plausible future conditions.
- **Develop implications**. For each scenario, the CAP team identified potential implications across all CAP climate-sensitive functions. Implications are the potential effects of climate change on CAP.
- **Develop adaptation strategies**. For each scenario, the CAP team identified potential specific actions that could be taken to adapt to each implication of climate change.
- **Develop robust solutions**. The CAP team selected preferred adaptation strategies that could be implemented and organized them into several strategy portfolios.

Key to development of this adaptation plan was active participation of the CAP team, representing CAP's climate-sensitive functions. All drivers, implications, strategies, and robust solutions were developed by the CAP team, in a collaborative fashion. In all workshops, the CAP team was split into three to four groups for brainstorming sessions. The result was that the components of the CAP Climate Adaptation Plan were developed entirely by experts from within CAP. The CAP functions represented are as follows:

- Central Arizona Groundwater Replenishment District (CAGRD)
- Colorado River Programs
- Communications
- Engineering
- Environmental, Health and Safety
- Financial Planning and Analysis
- Human Resources
- Information Technology
- Legal Services
- Maintenance
- Operational Technology
- Protective Services
- Public Affairs (including the CAWCD Board of Directors)
- Resource Planning and Analysis

- Risk and Liability Management
- Water Operations and Power Programs

4. Drivers and Scenarios

In the first workshop, drivers were identified, and scenarios were developed based on the drivers. Drivers are forces external to CAP that impact CAP operations or future conditions. For this study, CAP focused on drivers related to climate change. Primary drivers include the physical components of climate change: temperature, precipitation, and streamflow. Secondary drivers flow from these and may affect what CAP does more directly. For example, temperature change (primary driver) could cause reduced population (secondary driver) in Phoenix, which could affect human resources by limiting CAP's employee recruitment pool.

A group of "key drivers" was selected from the larger list of drivers. Key drivers are the most important and the most uncertain and may be either primary or secondary drivers. The CAP team then "bracketed" the key drivers with a qualitative range of potential future conditions.

Scenarios represent possible futures and are described by a defined "state" (high bracket or low bracket) for each of the key drivers. To facilitate a robust adaptation plan, it is useful to define several plausible scenarios that together capture a range of potential future conditions. For this study, three scenarios were developed that capture a range of plausible futures (Table 1). Key elements of the scenarios are as follows:

- Scenario 1: Low water supply, high demand for water, with a strong economy.
- Scenario 2: High water supply, low demand for water, with a weak economy.
- Scenario 3: Low water supply, high demand for water, with a weak economy.

Table 1: Key Drivers and Scenarios

Key Driver	Scenario 1	Scenario 2	Scenario 3
Colorado River supply	Frequent deep shortages	Normal CAP supply, with some infrequent excess supply above historical amount	Frequent deep shortages
Temperature	Significantly warmer	Warmer overall, but potentially seasonally cooler	Warmer overall, but potentially seasonally cooler
Local precipitation	More extreme events (drought or rain)	Historical	More extreme events (drought or rain)
Demand changes	Full contract demand (full CAP use)	Low contract demand (full CAP use)	Full contract demand (full CAP use)
Population of Central Arizona	High growth	Low growth	Low growth
Regulatory/legal/policy	Restrictive	Flexible	Restrictive
Interagency coordination/collaboration	Competitive/combative	Collaborative	Collaborative
Economic health	Strong economic growth	Weak economic growth	Weak economic growth

Key Driver	Scenario 1	Scenario 2	Scenario 3
Technology	Rapid technological advances; mainstreaming; higher capacity of utilization	Status quo. Current level of technology and capacity for technological improvements	Status quo. Current level of technology and capacity for technological improvements

5. Climate Change Implications

Implications are the potential effects of the climate change scenarios on CAP. Implications may be challenges, opportunities, or both. A total of 61 unique climate change implications were identified by the CAP team. A summary of each scenario, based on both key drivers and implications, is provided as follows:

Scenario 1 centers around a low supply on the Colorado River and high demand. Challenges result from higher temperatures and lower Colorado River supply causing issues ranging from reduced deliveries to low priority users and biological (i.e. algal) growth in water to increased health and safety issues for CAP employees. Opportunities, stemming from a higher regional population, include a larger tax base for capital improvements and increased technological advances to combat shortages and offset warmer temperatures.

Scenario 2 focuses on a high supply on the Colorado River and low demand. Decreased regional population means difficulty recruiting and maintaining staff along with decreased tax revenue for capital improvements. Excess supply causes the need for new recharge locations while bolstering state-wide groundwater storage. A flexible regulatory environment increases opportunities for collaboration with other agencies and the ability to pursue regulatory changes that benefit CAP.

Like scenario 1, scenario 3 centers on low Colorado River supply and high demand. Extreme weather in scenario 3 presents challenges in the form of infrastructure issues (such as canal resiliency and risk insurance) and a change in seasonal supply and demand patterns. Low population growth limits CAP's ability to recruit and maintain talent. However, this scenario presents opportunities for more collaboration and technological advances among lower basin states, as well as increased water conservation.

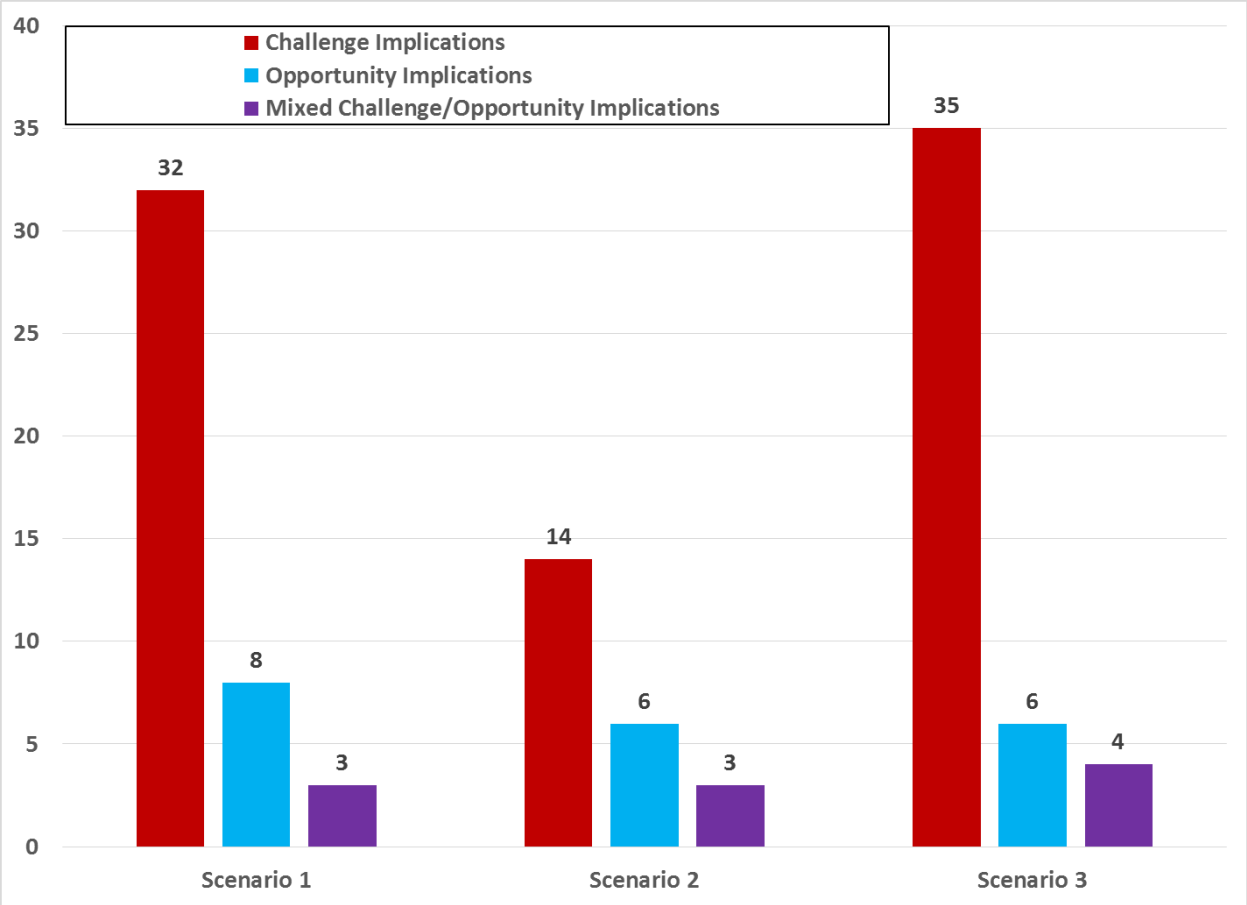


Figure 1: Number of implications per scenario

The relative influence of key drivers on scenario implications was estimated based on the number of challenges or opportunities associated with each key driver state. Colorado River supply (frequent shortages) and demand changes (full contract demand) are the two most influential key drivers in terms of challenges, and technology (higher capacity of utilization) is the most influential key driver in terms of opportunities. Two key driver states did not primarily influence any of the climate change implications generated by the CAP team: strong economic growth and historical precipitation.

Per Figure 1, Scenarios 1 and 3 are the most challenging to CAP in terms of the number of implications, in large part due to low Colorado River supply and full CAP contract demand. Scenario 3 is more challenging than Scenario 1 due to weak economic growth and less technological advancement. Scenario 2, which has normal CAP supply and low contract demand, has less than half as many challenge implications as Scenario 1 or 3.

Different CAP functions had varying levels of sensitivity to climate change, as approximated by the number of implications for each function. *Water Operations and Power Programs* and *Maintenance* are the two most sensitive CAP functions, while *Protective Services* and *Information Technology* are the two least sensitive CAP functions. Figure 2 illustrates the number and types of implications affecting each CAP function.

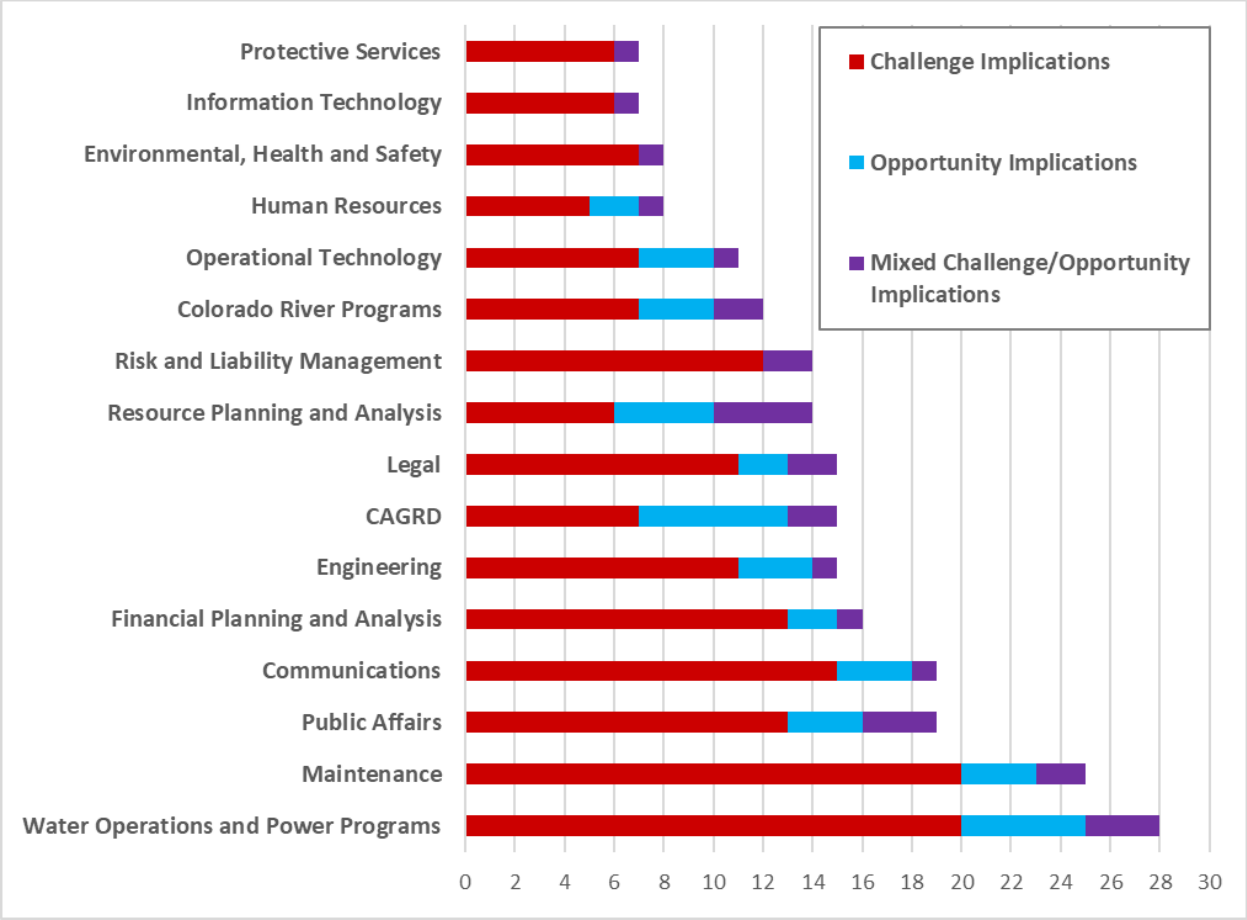


Figure 2: The number and types of implications affecting each CAP function

6. Climate Change Adaptation Strategies

One hundred and thirty one adaptation strategies were developed by the CAP team in response to the implications that were generated. Each adaptation strategy is an action meant to mitigate a challenge or capitalize on an opportunity. Adaptation strategies were assigned an ease of implementation (easy/medium/difficult) that corresponds with how easy or difficult it is to implement a strategy in a given scenario. Having a strategy that can be implemented in more than one scenario also makes it possible for that strategy to have different levels of ease of implementation in the different scenarios (e.g. a strategy can be easy to implement in one scenario but difficult to implement in another scenario).

In addition to the suite of adaptation strategies, the CAP team also identified an additional strategy that was applicable for almost any implication, regardless of the scenario. This strategy is described as “Do Nothing”. The “Do Nothing” strategy in itself is not an adaptation strategy because it requires no adaptive action. Rather, this strategy implies that by doing nothing in the face of an implication, CAP is willing to pay fines and penalties as needed, suffer the full consequences of a challenging implication, or not capitalize on an opportunity. The “Do Nothing” strategy also recognizes there may be implications so dire or extreme that it may be more palatable for CAP to not invest resources to adapt to them.

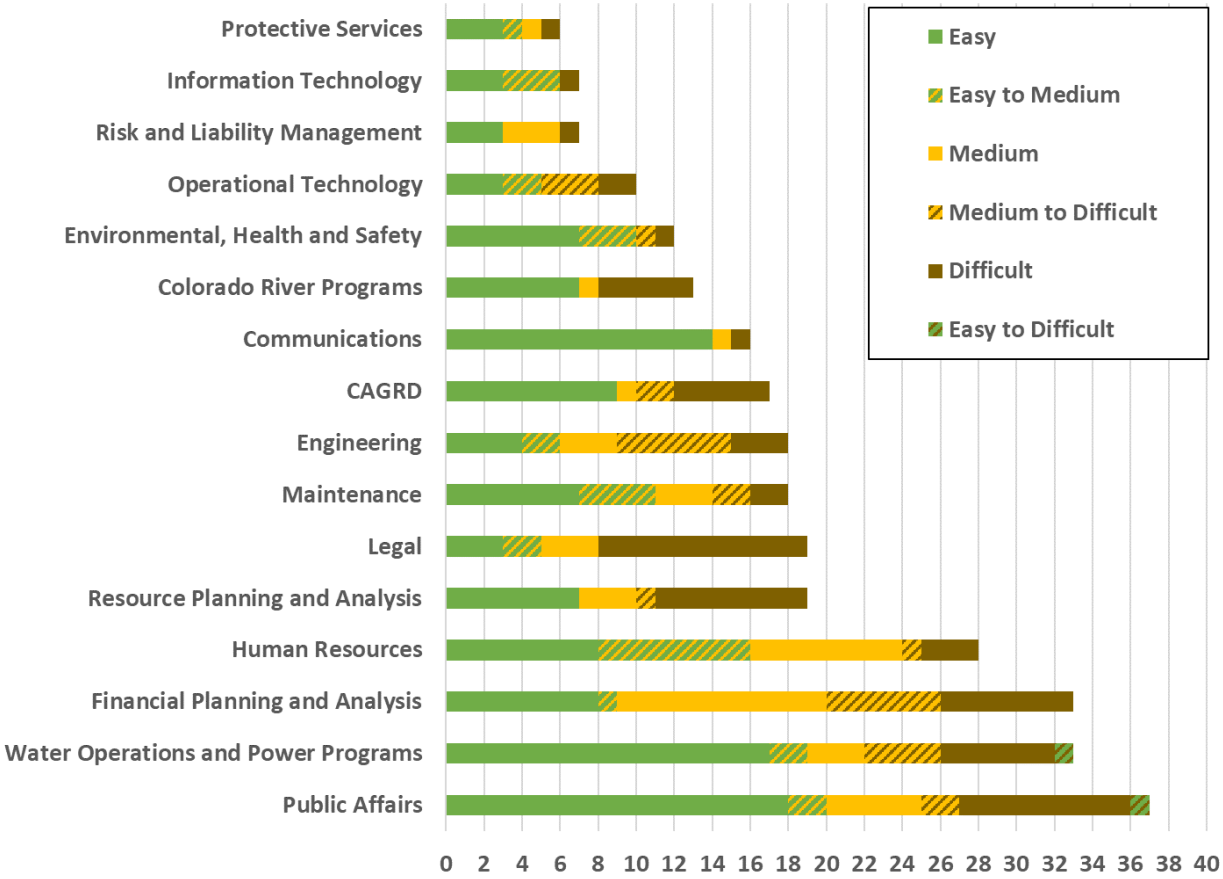


Figure 3: The number and types of strategies involving each CAP function

A function's ability to respond to climate change can be approximated by the number of strategies that involve that function (Figure 3). *Public Affairs* is the most responsive function, while *Protective Services* is the least responsive function. Most strategies (more than 70 percent) involve one or two functions; only two strategies involve more than five functions (Figure 4). For strategies requiring multiple functions to implement, there are certain combinations of functions that frequently share both implications and strategies. These combinations could result in the formation of multi-function teams (two to three functions) to implement strategies. For example, there are 14 strategies associated with both *Legal* and *Public Affairs*, suggesting these two functions could work closely together in climate adaptation. Another potential multi-function team could include *Resource Planning and Analysis*, *Colorado River Programs*, and *CAGRD*; each of these pair combinations has at least eight shared strategies.

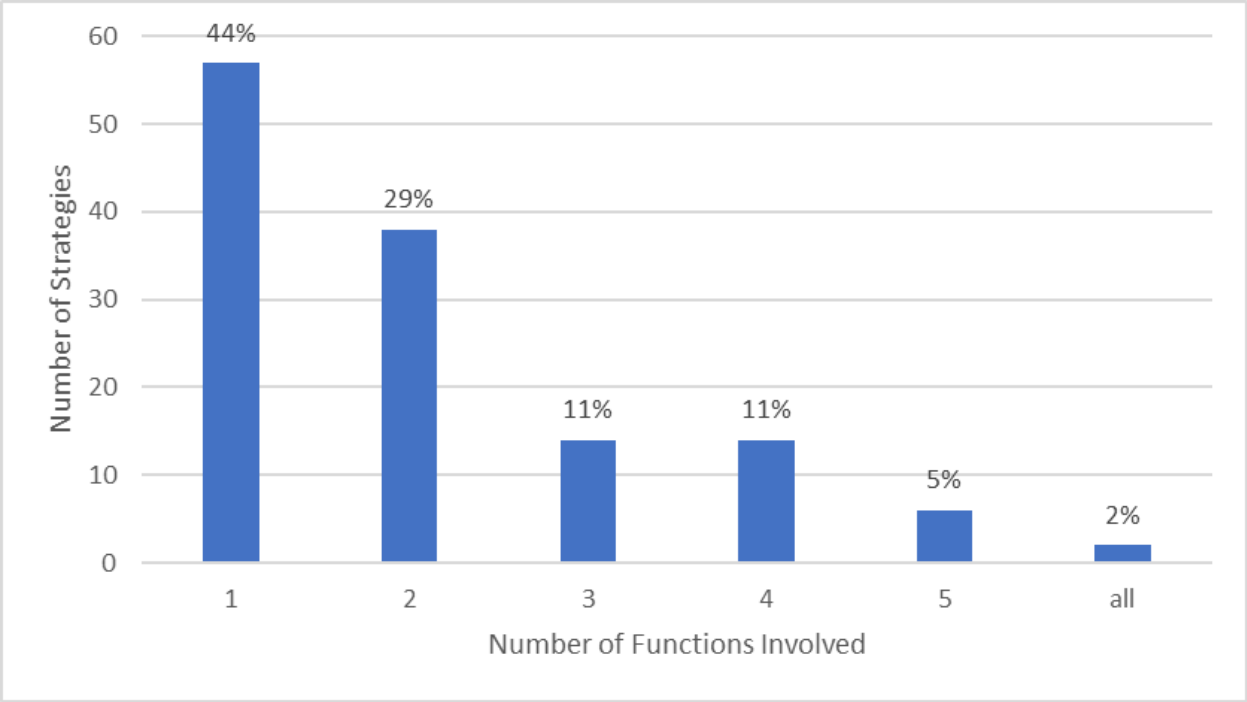


Figure 4: Adaptation strategies summarized by number of functions involved

7. Portfolios

A portfolio is defined as a collection of strategies. Portfolios are used to help understand how individual strategies perform under different conditions. The CAP team developed several portfolios that generally mitigate implications affecting all CAP climate-sensitive functions, but not all functions were involved with implementing each portfolios' strategies. The CAP team assigned one of the following categories to each portfolio strategy:

1. **No Regrets** strategies are easy to implement, and provide a net benefit whether or not the specific implication it targets comes to pass. As such, there is no risk of overinvestment with No Regrets strategies. No regrets strategies are those that CAP would generally adopt, and are very likely to adopt in the near-term; for example: mandatory safety equipment for all employees.
2. **Low Regrets** strategies are generally easy to implement, and generally provide a net benefit whether or not the specific implication it targets comes to pass. However, the benefit to the organization is higher when the specific implication occurs. There is little risk for overinvestment with Low Regrets strategies, but there could be significant risks if there is underinvestment in these types of strategies. An example of a low regrets strategy is to increase water conservation programs. While there is some cost to conservation programs, the risk of overinvestment is small.
3. **Conditional** strategies are those that would be implemented under very specific conditions. They tend to be difficult to implement, and typically only provide a benefit for a particular implication. If that implication does not transpire, the strategy should not be implemented. However, there may be an associated "option to preserve" – in which some action would need to be taken in the short term to "preserve" the ability to implement the conditional strategy should it be needed in the future. Conditional strategies have a high risk of overinvestment and generally address large scale and high-risk implications with extremely detrimental effects. An example of a Conditional

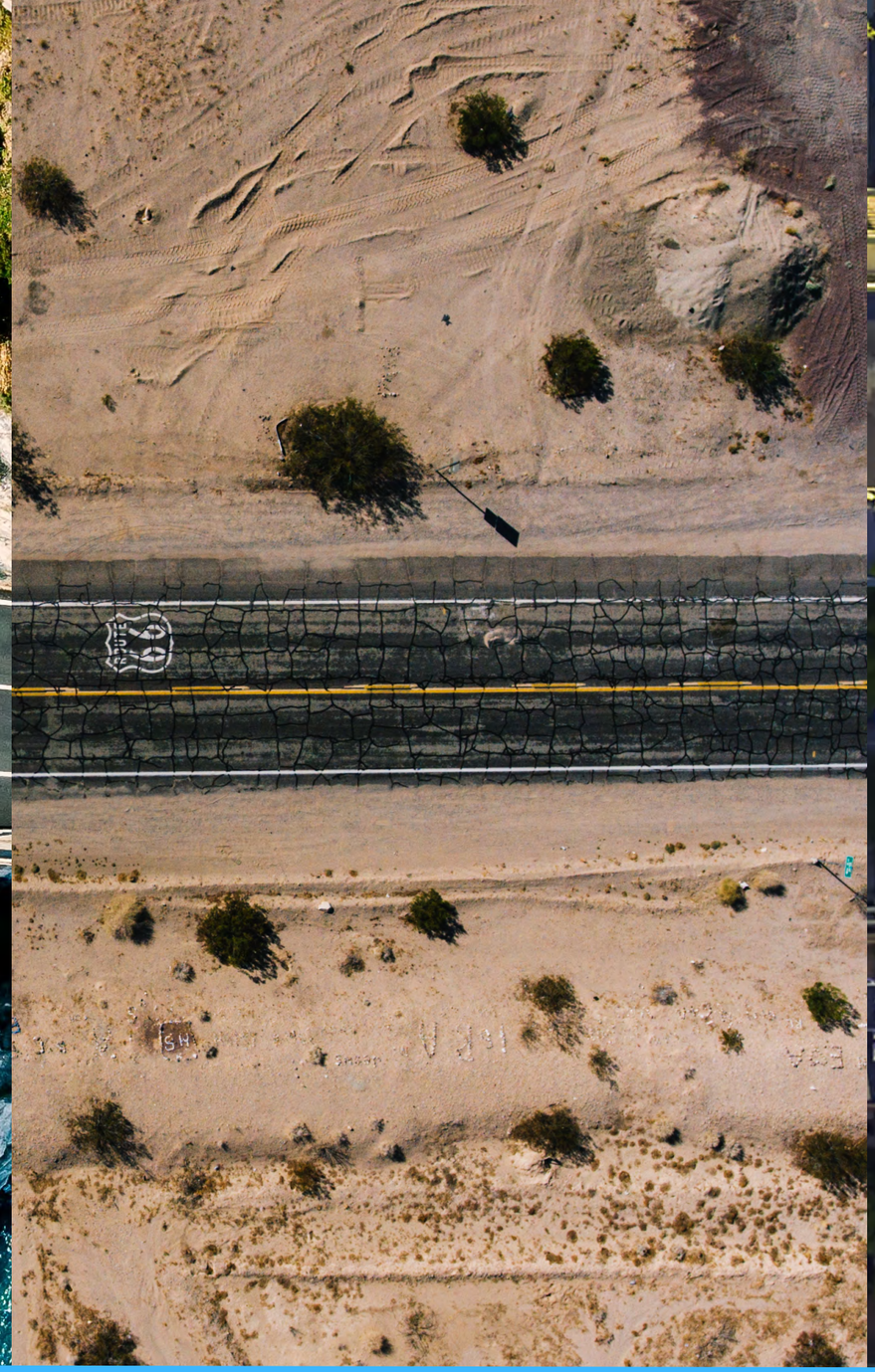
strategy is the construction of a desalination plant, which is a very costly and lengthy process to provide water augmentation against severe drought conditions.

8. Next Steps

Additional in-depth analysis of implications and strategies with respect to CAP functions is recommended to identify and prioritize the most important adaptation strategies. This analysis could be used to support an implementation plan that highlights what strategies should be implemented and how to implement them, along with a process for monitoring conditions to inform additional future action.

The following is an example list of actions that could be included in the implementation plan:

- Identify and implement no regrets strategies and select low regrets strategies.
- Identify options to preserve based on important conditional strategies, develop conditions of implementation, and implement as appropriate.
- Develop procedures and processes for implementing strategies, including identification of functions and teams of functions that will implement strategies and an approach for identifying timing and sequencing of strategy implementation.
- Develop key conditions to monitor, based on the most influential drivers, to support subsequent implementation plan updates. Monitoring is intended to support triggering of strategies, either through identifying conditions that change strategies from conditional to low regrets or no regrets, or otherwise supporting sequencing of strategy implementation.
- Develop a timeline for revisiting and updating the analysis. Generally, the implementation plan should be revisited frequently enough that if changing conditions result in the need to implement a conditional strategy (that is, it becomes no regrets or low regrets), there is sufficient time to implement that strategy.



May 2022

EDISON INTERNATIONAL®

ADAPTING FOR TOMORROW

POWERING A RESILIENT FUTURE

SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead®

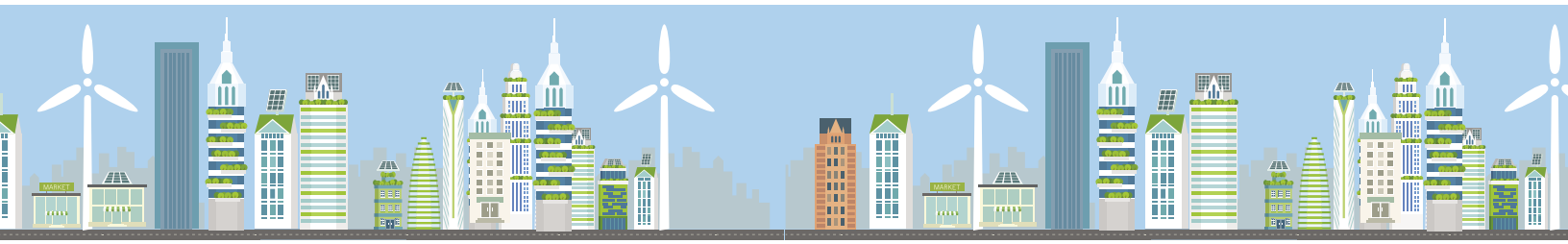
SOUTHERN CALIFORNIA EDISON FACTS

Who We Are

- An Edison International company
- One of the nation's largest electric-only utilities (no natural gas distribution), SCE is an investor-owned utility, a private company owned by shareholders/investors and regulated by the California Public Utilities Commission and Federal Energy Regulatory Commission
- Headquarters in Rosemead, California
- 135 years of history

Who We Serve

- 50,000 square miles of SCE service area across Central, Coastal and Southern California
- 184 cities, 15 counties and 13 Native American tribes
- 15 million residents
- 5 million customer accounts



Operations and Revenue

- 118,000 circuit miles of distribution and bulk transmission lines
- 1.4 million power poles
- SCE's profits are not tied to the amount of electricity we deliver. The CPUC allows SCE the opportunity to earn a fixed profit on our capital investments — the infrastructure you see every day in your communities, such as poles, wires, substations, power plants and more
- More than 80% of the electricity delivered to SCE customers is generated by independent power producers
- To continue powering California's growing population and economy, SCE plans to invest $15 to 16 billion over the next three years expanding and strengthening its electric system infrastructure. (2021)
- SCE maintained the lowest system average rate among California's investor-owned utilities and its rates have grown less than Los Angeles area inflation over the past 30 years

Clean Energy

- Forty-three percent (42.6%) of the electricity that SCE delivers to customers comes from carbon-free resources, including solar and wind (2020)
- SCE has no coal generation or contracts in its portfolio
- More than 4,000 rooftop solar installations connected on average per month (2020)
- With more than 2,000 MW of energy storage installed or contracted, SCE has one of the largest energy-storage portfolios in the nation. (2020)
- SCE's Charge Ready program is the largest light-duty EV charging program run by an investor-owned utility
- By the end of 2020, SCE had installed infrastructure to support 2,700 charge ports and in the next few years will add infrastructure to support 38,000 more.

Priorities

- Accelerating clean power and electrification, including clean energy initiatives to achieve California's climate change and air quality goals: 100% carbon-free electricity by 2045, energy storage and transportation and building electrification
- Strengthening and modernizing the grid, including safety and system reliability
- Mitigating climate change-related risks, including wildfires
- Achieving operational and service excellence

Communities

- Of Edison International's $22 million in annual philanthropic funding in 2020, $19 million went directly to organizations and initiatives focused on diverse and underserved communities
- $5.5M donated to environmental causes; 134 environmental grants provided (2020)
- $8.8M donated to education causes; 276 education grants provided and 70 higher education institutions supported (2020)
- $4M in STEM scholarships awarded; 82% of STEM funding went to diverse recipients and 69% went to low-income recipients (2020)
- 51,140+ hours volunteered by Edison International and SCE team members and retirees (2020)

For more information, visit sce.com

Updated: 06/29/2021

"... by 2050, wildfires could take out full corridors of transmission ... critical substations in flood plains could become inundated ... and the grid will have up to 20% reduced capacity in some areas due to increased extreme temperatures."

EXECUTIVE SUMMARY

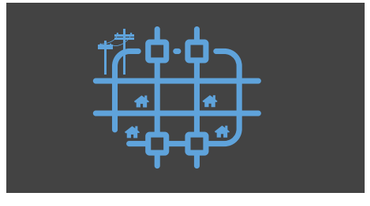
Climate change is a societal issue, and the failure to adapt poses severe consequences to public health, safety and finances.[1] The recently released Sixth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2022: Impacts, Adaptation and Vulnerability*, found that increases in the frequency and intensity of climate and weather extremes around the world already have had widespread, pervasive impacts on ecosystems, people, settlements and infrastructure.[2] The cost of inaction is greater than the cost of action. If we do not rapidly decrease GHG emissions by midcentury, large parts of our planet will become uninhabitable and 10% of total economic value will be lost.[3,4]

The electrical grid is critical infrastructure that powers our communities. It is imperative in California and around the world to have a grid that adapts and responds to climate change, both to provide resiliency and reliability, and to achieve the carbon neutrality that will help slow the rate of climate change.

Southern California Edison recently completed a detailed climate adaptation vulnerability assessment (CAVA) on assets, operations and services throughout our 50,000-square-mile service area.[i] The chief conclusions are that, by 2050, wildfires could take out full corridors of transmission, leaving large swaths of customers without service for long periods; critical substations in flood plains could become inundated due to more extreme precipitation events; and the grid could have up to 20% reduced capacity in some areas due to increased extreme temperatures. To meet this new reality, infrastructure must be designed to withstand more intense storm surges and flooding, and new transmission lines must be constructed to bolster regional reliability under more severe wildfire conditions.

i. The SCE climate adaptation vulnerability assessment was filed with the California Public Utilities Commission on May 13, 2022 and is available at https://www.sce.com/about-us/environment/climate-adaptation.

KEY FINDINGS DEMAND URGENT ACTION:



PLANNING: Today, electric grid design standards and planning practices used at SCE and throughout the industry are based on historical climate data, underestimating future conditions and associated risks. Future climate states must be incorporated into planning processes to appropriately address chronic and acute climate risks, especially those related to long-lived assets and systems. Additionally, utility planning horizons should be extended from the typical timeframe of 10 years or less to at least 20 years, so investments in the near term can help address climate change risks in the long term.

INVESTMENT: Climate adaptation investments are needed now. No-regrets foundational measures need to be developed and funded in the near term with the understanding that more significant investments will be required in the next 10 to 20 years. The cost to invest now is far less than the cost of inaction and will help hedge against the uncertainty society faces in the future.

PARTNERSHIPS: Significant collaboration among communities, local and regional planning authorities, and governments is required to address the interdependencies of critical infrastructures; perform cross-sector resiliency planning to take care of disadvantaged, climate-vulnerable communities; and minimize societal adaptation costs.

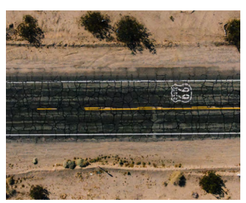
At Edison International, we are committed to doing our part to safely meet the energy resiliency needs of customers and communities and, as we laid out in Pathway 2045, to lead the way to a cleaner and carbon-free California and U.S. We call on all our public, industry and community partners to join us now in the work of adapting to the changing climate.

2050 CLIMATE EXPOSURE TRENDS AND POTENTIAL IMPACTS ON THE ELECTRICAL SYSTEM

AVERAGE TEMPERATURE

5°F projected increase relative to historical averages

AVERAGE TEMPERATURE IMPACTS
- Existing infrastructure will become less efficient, especially inland, resulting in reduced capacity on lines and higher losses in transformers
- Useful life of assets will decrease due to increased exposure and usage



EXTREME HEAT

7X more likely, on average, for SCE service area to experience temperatures as hot as or hotter than the historical 99th percentile temperature

EXTREME HEAT IMPACTS
- Worker safety standards will need to account for heat
- Peak load could increase significantly
- Equipment will not cool overnight during intense heat waves, reducing capacity and useful life of some equipment

PRECIPITATION

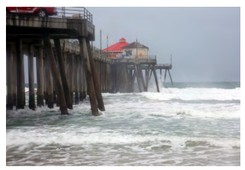
40% projected decline in snowpack and more variable year-to-year precipitation with more intense drought and fewer, more intense precipitation events

PRECIPITATION IMPACTS
- Infrastructure will need to be designed to withstand more intense storm surges and flooding
- Hydroelectric generation could become less reliable if the current drought continues or in the event of future prolonged droughts

WILDFIRE

23% more land projected to burn during summer fuel-driven wildfires and wildfire season is expected to become longer

WILDFIRE IMPACTS
- Conditions will be more conducive to wildfire ignition and spread
- Impacted service centers may not be able to operate or perform key functions during wildfires or droughts



SEA LEVEL

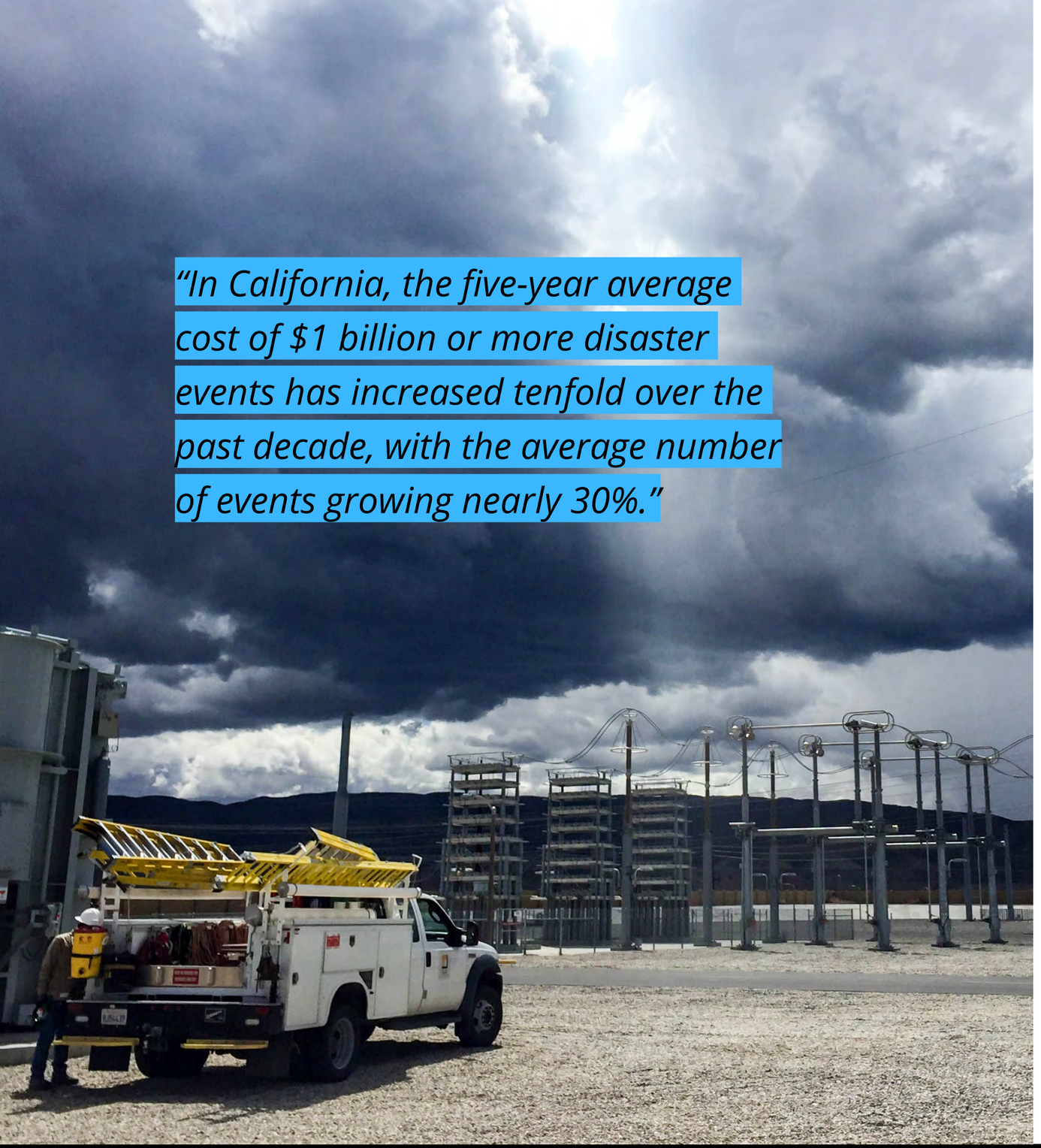
2.6 feet projected sea level rise relative to the year 2000

SEA LEVEL IMPACTS
- Infrastructure and communities in some coastal areas will be at higher risk of flooding

CASCADING EVENTS

A range of high-impact, low-probability events can occur from the interaction between exposure variables such as post-fire mudslides (debris flow) and rain-on-snow events

CASCADING EVENTS IMPACTS
- Communities in or near high fire risk areas could be exposed to increased landslide risk
- Hydroelectric planners need to account for early snowmelt and extreme runoff



"In California, the five-year average cost of $1 billion or more disaster events has increased tenfold over the past decade, with the average number of events growing nearly 30%."

OVERVIEW

Identifying and mitigating climate vulnerabilities across communities is increasingly urgent. The impacts of climate-related events are alarming, and the costs are increasing. For example, more than one-third of costs related to billion-dollar-plus disaster events over the previous 42 years were incurred in the last five years[ii], and 2021 was the seventh consecutive year in which 10 or more billion-dollar weather and climate disaster events have affected the U.S.[5] Potentially even more alarming, in 2021 from a human and community perspective, more than 40% of Americans lived in counties impacted by a climate-related disaster.[6]

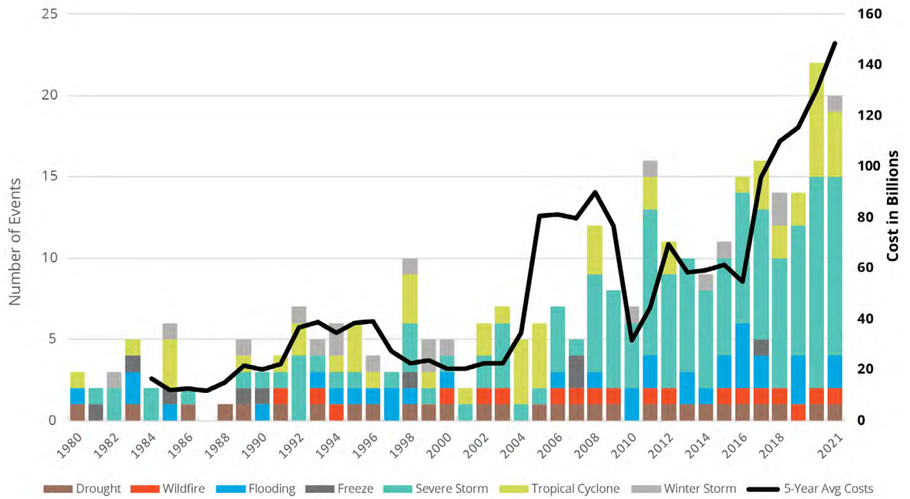


Figure 1: U.S. Billion-Dollar Disaster Events 1980-2021 (CPI Adjusted)

Studies have investigated the intensity of recent extreme weather events to determine the impact human-caused climate change has had on damages. For example, $8 billion of the $60 billion of damages from Superstorm Sandy from Florida to Maine was linked to climate-related sea level rise.[8] In addition, the Pacific Northwest 2021 heat wave was determined to be almost impossible without the influence of human-caused climate change.[9]

Looking into the future, a first-of-its-kind analysis released recently by the White House's Office of Management and Budget estimated that, under current policy pathways, climate change could reduce U.S. GDP by 3% to 10% by the end of this century with an annual federal revenue loss of 7.1%[iii] at the upper end of the range.[10] Specific to the electric sector, a recent McKinsey study projects costs for 10 large power utilities in seven states where hurricanes are common. Their conservative analysis projects the cost of damages and lost revenues would rise by 23%, or $300 million, in economic damage for each utility by 2050 due to climate change.[11]

In California, the five-year average cost of $1 billion or more disaster events has increased tenfold over the past decade, with the average number of events growing nearly 30%.[12] In addition, California's Fourth Climate Change Assessment shows statewide costs associated with direct climate impacts by 2050 in the order of tens of billions of dollars, with these direct costs likely multiplying as the rate of climate change accelerates.[13]

ii. NOAA's U.S. Billion-Dollar Weather and Climate Disasters cost data shows total costs of $742 billion for years 2017-2021.
iii. In today's dollars, this equals $2 trillion per year.

Over the past decade, climate adaptation has emerged as a critical topic at the federal level,[14, iv] in California's state government[15] and in some regional and local jurisdictions.[16] However, due primarily to knowledge gaps and lack of funding, many communities are lagging in identifying climate vulnerabilities and taking appropriate adaptive measures. Although mandated, 40% of counties (six out of 15) and only 25% of cities (52 out of 206) in SCE's service area have integrated climate adaptation plans into their general safety plans or developed a standalone resilience plan that includes climate adaptation.[17] Climate change is a societal issue, and the failure to adapt poses severe consequences to public health, safety and finances.[18]

The electric grid not only makes modern society function, but is a critical enabler for civilization to reach carbon neutrality by midcentury through decarbonization of the power supply and electrification of other sectors. With electricity becoming increasingly important, climate adaptation of the electric grid is required to provide reliability and resilience to better serve and power our communities in a changing climate. Moreover, if society does not move fast enough to decarbonize or the speed of onset of climate hazards is faster than expected, the need for more significant adaptations will increase. Making adaptation investment decisions now will help hedge against the uncertainty society faces in the future.

Coordinated adaptation among local and regional governments, communities and infrastructure providers is essential to minimize societal costs to reliably and resiliently meet society's decarbonization goals and adapt to the imminent impacts of climate change. Timeliness of action and alignment between public and private stakeholders on adaptation goals will help to minimize redundancy and prioritize areas of focus in promoting affordability and equity across communities.

iv. In 2015 and 2016, the U.S. Department of Energy (DOE) established the Partnership for Energy Sector Climate Resilience. Seventeen electric utilities, including SCE, serving approximately 25% of electricity customers in the U.S., conducted high-level climate vulnerability assessments to help advance resilience planning and adaptation across the industry.

EDISON INTERNATIONAL AND SCE: INVESTING TODAY IN A RESILIENT FUTURE

Since 2018, SCE has been adapting to climate change through system hardening to reduce wildfire risk. Today, SCE invests over $5 billion annually to maintain, upgrade and harden its system. By the end of 2021, SCE reduced present-day catastrophic wildfire risk by 65%-70% compared to pre-2018 estimates, and by the end of 2022, SCE will have hardened about 40% of its overhead distribution infrastructure in high fire risk areas.

Edison International is investing in climate resiliency through community engagement and partnerships. Our Corporate Philanthropy program has supported Climate Resolve's Ready for Tomorrow Program since 2018. In addition, SCE was a founding member of the California Resilience Challenge, which awards grants to local governments, tribes and community-based organizations in underserved communities for climate adaptation projects that address wildfire, high heat, drought and flooding.

"Making adaptation investment decisions now will help hedge against the uncertainty society faces in the future."

METHODOLOGY

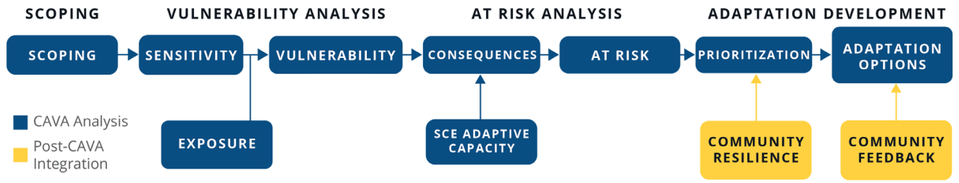


Figure 2: Climate Adaptation Vulnerability Assessment Flow Chart

In 2019, the CPUC issued a decision in the Climate Adaptation Order Instituting Rulemaking (OIR) requiring investor-owned utilities to identify expected climatic impacts through 2070 on assets, operations and services based on California's Fourth Climate Change Assessment. Pursuant to this, SCE filed its Climate Adaptation Vulnerability Assessment on May 13, 2022.

Figure 2 gives a high-level overview of the process used to identify vulnerabilities and possible adaptations for SCE's assets, operations and services for future climate conditions.

SCE used a phased approach to determine which projected climate events were most impactful. First, SCE considered future projections for temperature, wildfire, precipitation, sea level rise and cascading events such as debris flow, in 2030, 2050 and 2070 timeframes. All exposure projections reflect climate change under a "high emissions" scenario, or Representative Concentration Pathway (RCP), commonly referred to as RCP 8.5. The primary models used were the 10 Global Climate Models (GCMs) identified by California's Fourth Climate Change Assessment as best representing the state's climate. Figure 3 shows several key methodological components used to help develop SCE's CAVA.

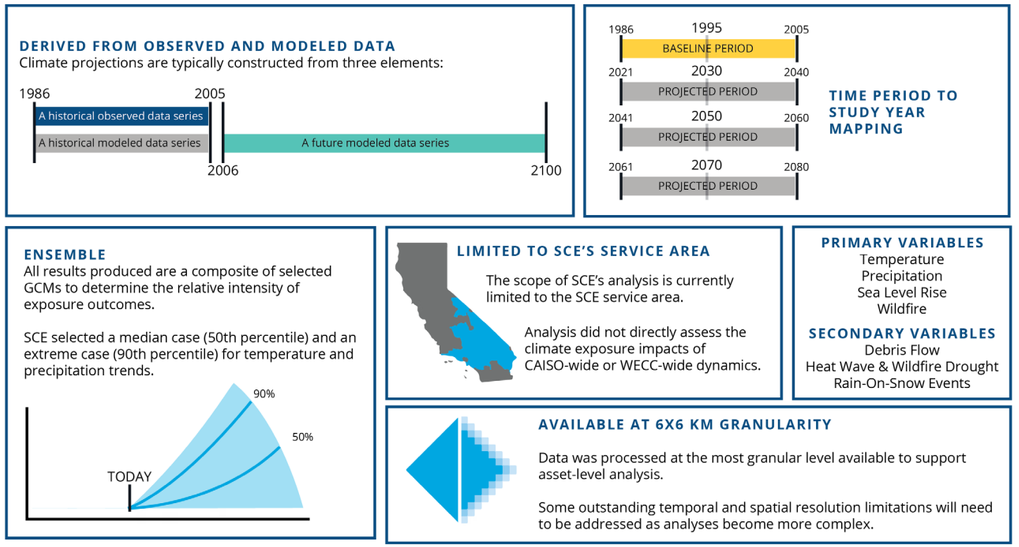


Figure 3: Key Methodological Components

Second, SCE considered vulnerabilities. Any asset, operation or service determined to be exposed to extreme conditions and sensitive to those conditions was deemed "vulnerable" and was considered for further analysis.

Third, SCE determined whether a given asset, operation or service was at risk based on potential consequence and adaptive capacity. Consequences were evaluated based on the safety, reliability and financial impacts of a given vulnerability. The adaptive capacity analysis considered whether existing or planned measures are sufficient to reduce the consequences to an acceptably low level or minimize the likelihood of the potential consequences occurring.

Finally, SCE considered potential adaptation strategies. The analysis identified investments that may be needed by 2030 and 2050 to address climate risks for at-risk assets, operations and services with low adaptive capacity.

CLIMATE HAZARDS EXPOSURE, VULNERABILITIES AND ADAPTATIONS

The CAVA focused primarily on the ways in which changes in exposure to temperature, precipitation, wildfire and sea level rise could impact SCE's assets, operations and services, consequently affecting power availability. Impacts to SCE's infrastructure were assessed by defining climate hazard exposure to assets, analyzing the degree to which assets can withstand climate impact, and identifying adaptations to the climate-induced impact, e.g., restoration activities, resiliency investments and design changes.

TEMPERATURE

Exposure

Climate projections show increases in average temperatures and heat waves. The average maximum temperature is projected to rise approximately 5 degrees F from 1995 temperatures by 2050, with slightly wider swings from summer to winter. Extreme temperature events such as heat waves are expected to become more frequent, more prolonged and more intense, particularly in inland regions of the SCE service area where the population is growing.

Without mitigations, extreme heat may put at risk our ability to meet electricity demand due to reduced generation, transmission and distribution capacity, and increased temperature-driven asset failures. Simultaneously, electricity demand will likely increase and concentrate due to cooling needs. SCE and other utilities will need to plan for more intense and more frequent heat waves over a broader geographical extent in the future. Additionally, the increase in exposure is expected to impact worker safety and the general public. On average, extreme exposure days, defined under OSHA standards, are projected to more than double from 29 days per year to 61 days per year across SCE's service area. Consequently, heat illness will become a much more significant concern, and more frequent extreme heat indices could alter SCE work schedules to protect worker safety.

Vulnerabilities

By 2050, SCE found that 24% of transmission circuits and subtransmission circuits will be exposed and sensitive to heightened levels of extreme temperature; the increased temperature is expected to decrease line capacity by 10% to 20%. In addition, 4% of SCE's distribution substation transformers are projected to be vulnerable to four-day heat waves by 2030. Key generators may be less available during critical periods due to exceeding design standard operating temperatures more often. The projected increase in the heat index in inland districts will impact field operations; for example, this could result in rescheduling nonessential work on extreme heat days.

Adaptations

Adaptation options for transmission and subtransmission vulnerabilities include reconductoring of lines or constructing new lines to compensate for the deratings and additional customer demand. Based on CAVA results, SCE is working to incorporate climate change-informed temperature projections and accompanying system reliability impacts into infrastructure replacement programs for distribution assets. For example, projected generation derates or outages should be incorporated into regulatory planning processes to ensure adequate resources are procured to meet reliability standards. In addition, deployment of lightweight personal protective equipment and portable air-conditioned breakrooms in districts projected to be exposed to extreme temperatures can ensure employee safety during these harsh working conditions.

PRECIPITATION

Exposure

Precipitation patterns in California are projected to become increasingly variable from year to year, which will likely contribute to increased flooding risks and longer droughts. Although average aggregate precipitation is projected to remain relatively constant, precipitation is expected to fall in fewer, high-intensity events. Increased frequency of whiplash between wet and dry periods may also trigger asset damage and landslides.

Atmospheric river events are responsible for most extreme precipitation events in California and are projected to increase in strength and intensity under climate change.[19] In Southern California, the frequency of these events is projected to double, and the intensity is projected to increase nearly 40% by the end of the century under RCP 8.5.[20] Concurrently, the peak season for atmospheric river events may also lengthen, extending California's flood-hazard season.[21]

Flood

SCE used FEMA maps of flood plains, which identify present-day risks and areas already considered to be exposed, to identify current and potential future at-risk areas for flooding due to changes in storm intensity and seasonal runoff. FEMA flood maps reflect present-day risks and indicate which areas are already considered to be exposed.

While the CAVA did not quantify potential flood plain changes, SCE evaluated regional precipitation projections to supplement the existing flood maps. Twenty-four-hour and 72-hour precipitation projections suggest FEMA flood plains may flood more often or with higher intensity due to climate change. SCE found that 100-year extreme precipitation events are projected to become on average 8% more intense by 2050. However, further analysis of storm sequencing and ground conditions prior to flood events needs to be conducted to determine how risks could compound.

Drought

California may continue to experience drought conditions with increasing severity due to climate change. A future 20-year drought (megadrought) or continuation of the current, worst regional drought in history could result in SCE's hydroelectric generation from Big Creek being nearly 24% lower than historical averages. Furthermore, future droughts may be even more severe than historical droughts, resulting in lower average hydroelectric production than historical drought years. This would reduce the predictability of generation capacity, increase power procurement needs and cause greater maintenance and operational requirements.

Drought may have cascading impacts beyond generation. Sustained droughts may weaken the flood resistance of soil and vegetation, resulting in worsened subsequent floods or landslides. During drought periods, wildfires may worsen because of decreased fuel moisture and increased dead fuel loading.

Vulnerabilities

Flood

Using FEMA flood maps, 23% of transmission substations are vulnerable to 100-year flood inundation exposure or sea level rise. In addition, SCE's assessment found that a subset of transmission substations that may be exposed to severe inland flooding put the transmission system at heightened risk of widespread cascading outages. SCE found that 22% of distribution substations are potentially exposed to 100-year inundation.

Drought

Although SCE's electric transmission and distribution assets do not face significant risks due to drought alone, drought presents potentially significant system-level vulnerabilities. For example, widespread protracted drought conditions can limit available hydroelectric resources and strain the water supply throughout the West. SCE currently relies on approximately 1,000 MW of hydroelectric generation from the Sierra Nevada. In addition, Southern California imports 60%-70% of its water from the Sierras and from the Colorado River Basin, which further underscores the importance of coordinated climate adaptation.[22] Droughts also have a secondary effect of potentially increasing wildfire exposure risks.

Adaptations

Substation hardening, which may include building floodwalls around substations within FEMA 100-year flood plains, is critical to managing increased flood risks. Longer-term redundancy investments such as developing new paths for power flow to lessen the impact of these critical substations' failure may also be needed. For vulnerable padmount asset types, waterproofing or raising the equipment above the flood levels would lessen the impact of flood events. Adaptation measures related to droughts include system-level planning, such as incorporating projected generation derates or outages into the integrated planning process to ensure adequate resources are procured to meet reliability standards. Additional adaptations related to the secondary impact of drought contributing to increased wildfire conditions are discussed in the Wildfire section below.

WILDFIRE

Exposure

Projected changes in fire weather suggest that peak fire seasons are likely to continue becoming longer and more intense. Increasing temperatures will lead to drier vegetation during summer and fall, contributing to increased wildfire volatility. More precipitation variability could also facilitate higher tree mortality and vegetation stress. Fire exposure is projected to increase in and around high fire risk areas (HFRAs), which already have an elevated risk of wildfires (Figure 4). Summer fuel-driven wildfires are projected to become more intense, particularly in mountain regions. However, most areas in the SCE service area outside of HFRAs are projected to experience similar area burned as in historical data.

It is also important to note that current wildfire projections do not include wind-driven fire weather, which typically occurs later in the year and presents the greatest risk to SCE assets and operations. Santa Ana winds are a particular concern. Historically, the strongest Santa Ana winds appear after the onset of winter precipitation when fuels are less flammable. Under a changing climate, precipitation may be reduced and delayed in fall and winter, causing drier vegetation and creating a longer window of time when Santa Ana winds can occur in the presence of dry fuels, which poses significant risks for fire growth and intensity. Wildfire projections, therefore, likely underestimate fire risk.

Vulnerabilities

Historically, transmission corridors impacted by wildfire have taken four days, on average, to resume operation from the initial time of de-energization. By 2050, wildfire seasons are expected to become longer and could affect regional reliability. Among SCE's transmission circuits, 23% are sensitive to projected potential wildfire exposure. SCE grouped the exposed assets into 33 common transmission corridors. If all lines in a corridor are impacted during a wildfire event, outages in five of the 33 corridors would result in system reliability concerns for these extreme simulations, potentially impacting upward of 2 million customers. Four of the five corridor outages require mitigations to ensure the system remains stable. On SCE's sub-transmission system, 28% of circuits are determined to be sensitive to potential wildfire exposure. Approximately 1,000 MW of generation in the SCE service area are vulnerable to wildfire.

Adaptations

In the near term, adaptation options for hydro generation facilities exposed to wildfire risk include deploying redundant communication and power equipment to key areas so critical water valves can be operated remotely during and after wildfires. In addition, no-regrets adaptations for the grid include increasing inspection and tower footing clearing frequency for transmission towers, prioritizing fire wrapping of sub-transmission poles, pole brushing and creating new circuit ties for high-risk areas for transmission and sub-transmission lines. Longer-term mitigation options for regional reliability, transmission and sub-transmission vulnerabilities include constructing new lines to add system redundancy, adding customer-sited generation and storage or shedding load to maintain system stability.[v]

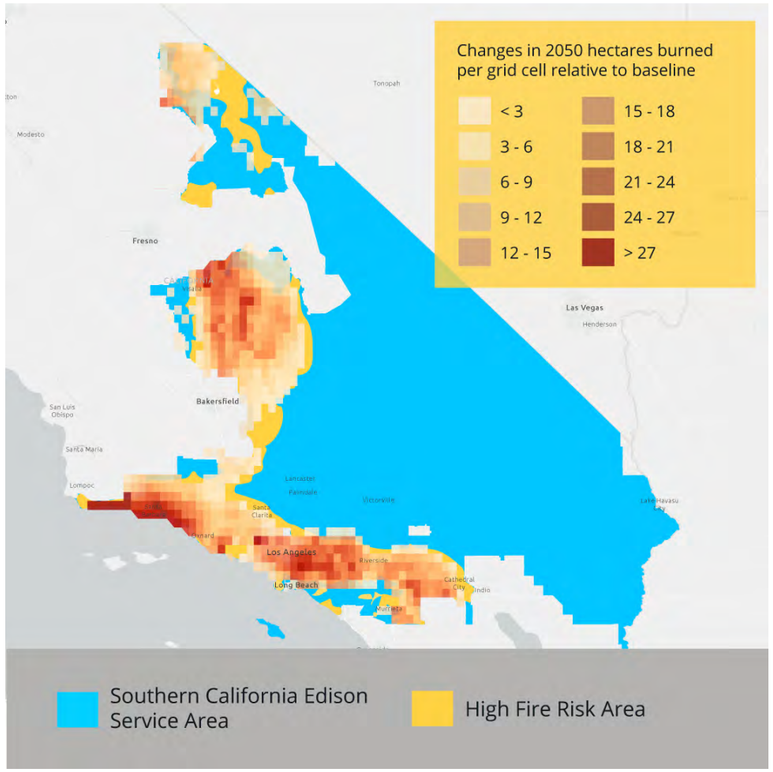


Figure 4: Overlay of Changes in Area Burned with HFRA Boundaries

BOOTLEG FIRE TRANSMISSION IMPACTS

As the Bootleg Fire in southwest Oregon grew to over 240,000 acres, the 500 kV lines that comprise the AC Intertie north of the Oregon-California border tripped in and out of service on July 9, 2021 due to smoke particles from the fire. The AC Intertie was reduced to less than 10% of its capacity, 428 MW. Additionally, the Oregon-California DC path that feeds Southern California was derated 50%, to 1,500 MW, for reliability issues. From July 9-13, 2021, California, at times, could not access about 5,500 MW from the northwest. Despite the combined heat wave and wildfire threat, the grid was able to avoid rolling blackouts due to an emergency proclamation issued by Gov. Newsom and electricity conservation by customers. These types of extreme events will occur more frequently in the future if climate adaptations are not implemented.

v. Some near term and long lead time adaptation strategies directly overlap with SCE's Wildfire Mitigation Plan. Though most of these programs have been implemented to decrease utility-caused ignition, they can also reduce the probability of a wildfire causing damage to equipment. In the future, as SCE continues to deploy wildfire mitigation, SCE will consider climate hazard data to determine overall scope in a given area.

SEA LEVEL RISE

Exposure

With sea level rise, more assets will be exposed to coastal flooding during storms. SCE evaluated sea level rise through average conditions, king tide[vi] conditions, 100-year storm conditions and 100-year storm conditions coinciding with king tide conditions. SCE followed California's sea level rise guidance recommendations for critical infrastructure to plan for approximately 1 foot of sea level rise by 2030 relative to 2000 and 2.6 feet by 2050.[23] Sea levels are projected to continue rising throughout the century and impact coastal communities across SCE's service area. This has the potential to drive permanent inundation of coastal assets in low-lying areas and require asset relocation.

Vulnerabilities

By 2050, 24 distribution substations (4%) are projected to be within the 100-year storm inundation area. From a distribution perspective, 530 distribution service transformers would be vulnerable to flooding. Catalina Island is particularly exposed to sea level rise and vulnerable during major storm surges. Catalina storm surges are associated with Southeast tropical swells and Northeast Santa Ana winds, which differ from the mainland king tide analysis.

Adaptations

Potential adaptation options to address sea level rise include installing distribution tie lines to increase operational flexibility and replacing padmounted transformers, switches and capacitors with waterproof padmount equivalents. In addition, installing additional tie lines would increase SCE's ability to support the load in neighboring circuits in the event of substation failure.

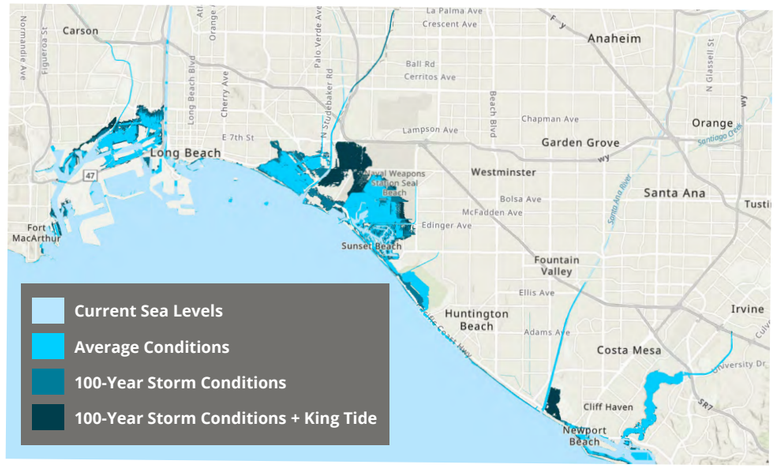
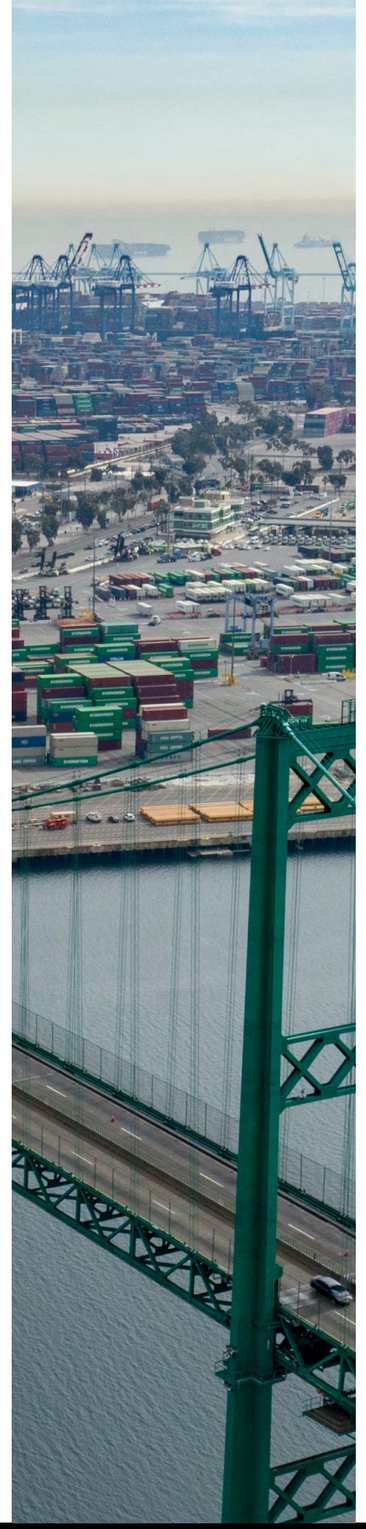


Figure 5: Coastal Inundation, 2050

vi. King tides are the highest and lowest tides of the year and typically occur seasonally during the summer and winter solstices.



KEY LEARNINGS

Climate adaptation investments are needed now and will grow over the next 20 to 30 years. Therefore, no-regrets foundational measures need to be developed and funded in the near term with the understanding that more significant investments will be required in the next 10 to 20 years. While these actions may require substantial funding, the cost of inaction would be even greater, not only in financial terms but also in terms of safety and health impacts on our population.

Utilities must incorporate future climatic conditions into planning and design processes, including load forecasts, resource planning, distribution and transmission planning, and asset and technology selection. Though there are inherent uncertainties in any climate change vulnerability assessment, utilities and their regulators must work together to proactively plan necessary remediations. Regulatory processes will need to review and approve investments in the near term to avoid costlier, just-in-time responses and more severe societal impacts if solutions cannot be implemented in time.

Significant collaboration among communities, local and regional planning authorities, and state agencies and governments is needed. While many asset-specific risks will require engineering solutions, a broader resource planning mandate remains unaddressed and requires significant coordination among stakeholders. The climate risks SCE assessed carry interrelated challenges outside a single electric utility's locus of control. Due to the grid's interconnectedness, major heat waves and wildfires require multilateral and regional adaptation plans to adapt to climate change effectively. For example, significant Western Interconnection interagency collaboration is needed to integrate climate change impacts into resource and infrastructure planning proceedings.

CLIMATE RESILIENCE LEADERSHIP GROUP

SCE established the Climate Resilience Leadership Group (CRLG) in September 2021 and convened the group over a dozen times through March 2022 to improve engagement with Disadvantaged Vulnerable Communities (DVCs) on utility climate adaptation efforts. SCE proactively formed the CLRG as a critical step to better learn from SCE's communities. From this work, SCE learned that increased resources and collaboration with community-based organizations are necessary to collect DVC feedback; deeper education and awareness is critical on all related climate adaptation topics; and, customized strategies are essential to identify and meet specific groups' needs.

Additionally, adapting to climate vulnerabilities may be more cost-effective across jurisdictions than singular industry action. For example, urban flooding may require community action to cost-effectively mitigate the vulnerability instead of deployment of adaptations to singular assets like substations. A flood wall could be built to protect an entire community. Closer collaboration between governments and infrastructure providers across sectors is needed, guided by a common blueprint, targets and objectives set at the state level. Moreover, funding needs to be available to cities and counties for climate adaptation plan development. Less than half of counties and only one quarter of cities in SCE's service area have climate adaptation and resilience plans.[24]

Further advances in climate projections are needed to better understand the expected frequency and spatial extent of more extreme outlying events. The success of specific adaptation measures is dependent on preparing appropriately for these more extreme events. SCE's vulnerability assessment using climate projection data identified climate vulnerabilities and associated adaptations. The process also identified climate data gaps, including the need for wind speed and direction projections; forward-looking flood extent and depth maps under extreme precipitation events; and landslide maps that account for the probability of landslides due to heavy precipitation events.

CALL TO ACTION

In October 2021, the Biden administration released more than 20 federal agency climate adaptation and resilience plans outlining the steps each agency will take to ensure its facilities and operations adapt to, and are increasingly resilient to, climate change.[25] In the same month, California released its Draft 2021 Climate Adaptation Strategy (Draft 2021 Strategy), defining the state's key climate resilience priorities and serving as a framework for action across sectors and regions in California.[26,vii] While progress is being made nationally and at the state level, there is a lack of common language among stakeholders and clear frameworks to apply climate projections locally across regions, sectors and hazards. Given the enormity of future costs associated with climate change, progress is not occurring at the required scale when assessed against future risk levels.

One of the Draft 2021 Strategy's key priorities is to collaborate to leverage resources, with supporting goals of building climate resilience across sectors and scales and developing public awareness of climate adaptation issues.[27] These goals should be a priority for the state of California and all levels of government, businesses and industry, including the electric sector, and communities.

Government/Regulatory planning: Many of the California Draft 2021 Strategy's priorities and goals resonate with SCE's climate adaptation work findings. For example, a key priority is to bolster public health and safety in light of increasing climate risks, with goals to consider future climate impacts in planning and investment decisions and build infrastructure resilience to protect public health and safety.[28]

These goals are consistent with SCE's finding that relevant climate projections should be consistently incorporated across all key long-term energy planning processes:

- The federal and state governments should fund local and regional adaptation planning and solutions that holistically address specific climate change risks in optimized ways.
- The California Energy Commission's Integrated Energy Policy Report (CEC IEPR) Load Forecast should reflect chosen RCP temperature projections through 2045, including the impact these future temperatures will have on cooling loads across different climate zones. These loads need to be integrated with the climate mitigation load of electrification through 2045. Given the use of the CEC IEPR load forecasts across agencies in planning proceedings, this incorporation is foundational.
- The CPUC's Integrated Resource Plan (IRP) should incorporate projected hourly capacity derates and lost energy production from increased temperature impacts. In addition, any associated reliability analysis should include climate change futures stochastically to produce a climate change-informed reliable resource buildout.

Industry/Electric sector planning: The electric sector has a history of mutual assistance, benchmarking and collaboration among utilities. Planning for climate change is no exception. Since Superstorm Sandy in 2012, Consolidated Edison Company of New York (ConEd) has been a leader in framing how to adapt to climate vulnerabilities.[29] In addition, the Electric Power Research Institute (EPRI) recently created the Climate READi Initiative, which focuses on developing a framework to enhance the planning, design and operation of a resilient power system in the context of climate change.[30]

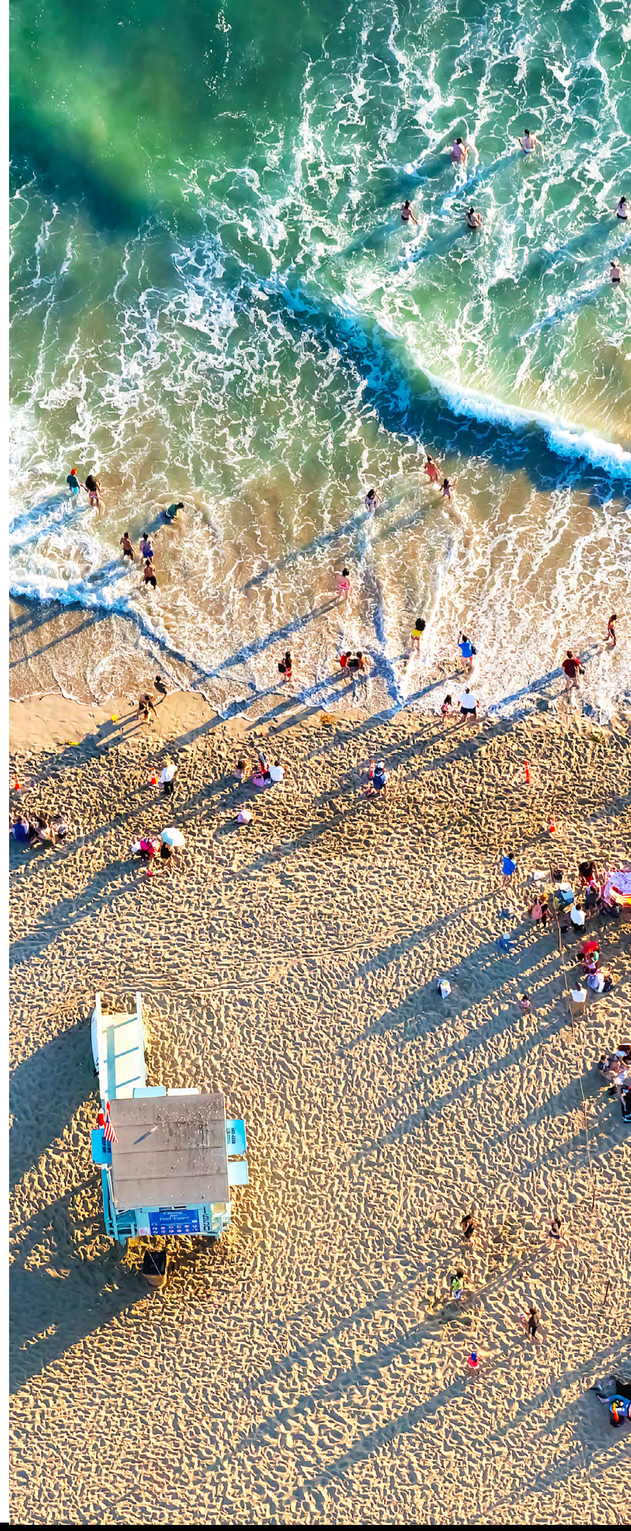
SCE identified the following insights that apply across the electric industry during discussions with industry partners and in developing the CAVA:

- Severe climate change impacts emerge over longer planning horizons than 10 years, while many utility planning process timeframes are 10 years or less. Therefore, extending planning horizons to 20+ years will help guide shorter-term infrastructure investments that also address longer-term climate change risks.
- The more the industry can incorporate scenario-based planning to allow for an ensemble of climate change futures, the better utilities will be able to arrive at least-regrets solutions that address many plausible outcomes. Appropriate resiliency design criteria need to be developed across the electric industry. Depending on the level of resiliency desired, more adaptations may be required. The industry has not yet defined these design criteria beyond the regular N-1-type contingency or loss-of-load expectation (LOLE) analysis. These current approaches may be insufficient to justify investment at the levels that may be needed to meet future desired resiliency levels.

Community Collaboration: A key insight from SCE's community engagement related to the CAVA is that a common understanding of climate change risks is needed among communities, local jurisdictions, state agencies and the federal government. This understanding will facilitate meaningful, collaborative discussions on climate adaptation measures to optimize the public good and perform cross-sector resiliency planning to address the interplay and dependencies of critical infrastructures such as water, wastewater, fuel supplies, transportation corridors, etc.

- Local jurisdictions and communities must be appropriately resourced to conduct their own climate change vulnerability assessments and identify specific risks before moving into productive adaptation development collaboration. Identifying common climate change risks is the starting point for any successful public/private partnership.
- State agencies need to provide local jurisdictions with climate adaptation vulnerability assessment guidelines and technical support services. This support will enable local jurisdictions to produce robust climate adaptation vulnerability assessments.
- DVCs need extra support to ensure a just transition. Federal, state and local governments should provide focused funding and technical assistance to DVCs to help with climate vulnerability assessments, climate mitigation and climate adaptation.

Society no longer has the luxury to wait and see what climate change will bring; the potential costs are too great. The time for action is now. While climate adaptation can help hedge against impacts from climate mitigation delays and vice versa, we cannot do one over the other. Instead, we must simultaneously decarbonize our energy systems and adapt to a changing climate. Efficient and effective adaptation requires assessing vulnerabilities across infrastructure, ecosystems and communities; investing in adaptations today with an eye toward solving tomorrow's issues; planning for tomorrow's needs; and partnering among communities, governments and industry to achieve the best outcomes for society.



vii. The Draft 2021 Climate Adaptation Strategy priorities have subsequently been included in California's updated Climate Adaptation Strategy interactive website released on April 4, 2022. https://www.climateresilience.ca.gov/

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