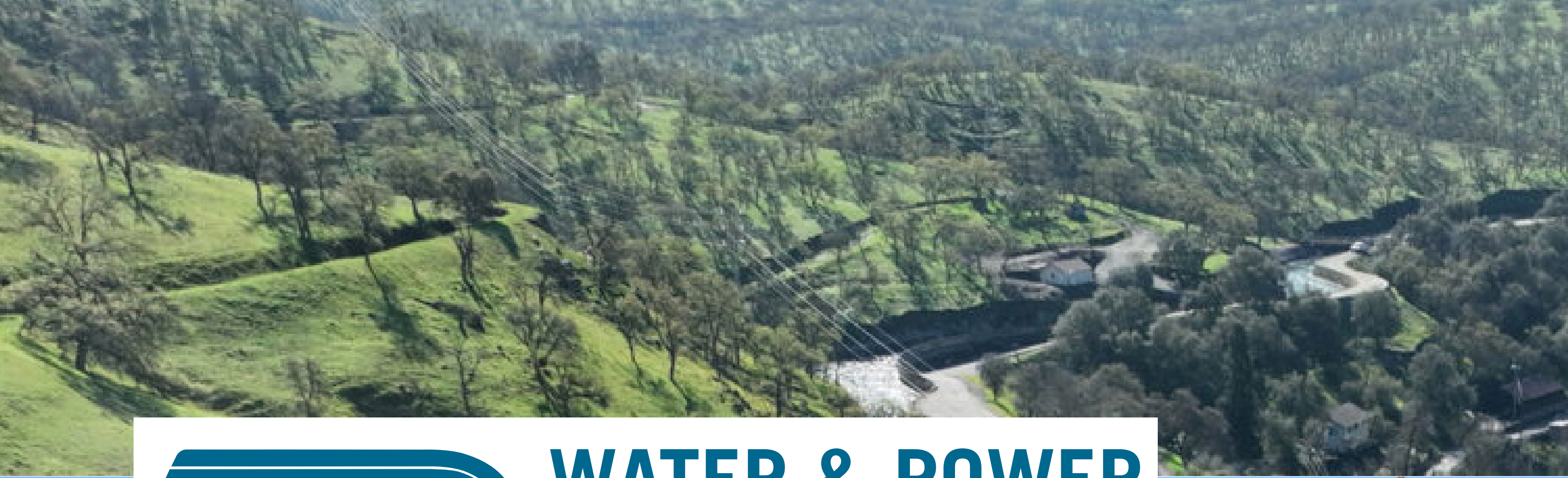

TID

WATER & POWER

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2023 Integrated Resource Plan

Preface

The Turlock Irrigation District (TID) 2023 Integrated Resource Plan (IRP) serves as the foundational planning strategy to deliver safe, reliable electricity service to our customers while maintaining stable, just, reasonable, and affordable rates and meeting all pertinent local, state, and federal requirements. This IRP aims for TID to develop and maintain a diverse and flexible resource portfolio by employing current energy technologies, thus minimizing our risk exposure, while enabling us to capitalize on well-grounded emerging technologies should those opportunities arise.

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1. Executive Summary

The TID 2023 IRP outlines a strategy for continuing to meet a diverse set of goals. Implementing this IRP would allow TID to meet the current and forecasted energy requirements of our customers, maintain and expand a diversified resource portfolio to provide reliable and safe electric service, and ensure TID meets regulatory and statutory environmental requirements while maintaining stable, just, reasonable, and affordable rates.

The Results of Integrated Resource Planning

Through extensive modeling and analysis, the IRP process developed a preferred resource portfolio that meets the California Energy Commission's (CEC) resource planning requirements and a plan for integrating the selected resources into TID's resource mix.

Our IRP sets forth a plan for acquiring sufficient resource generation that includes a 15 percent planning reserve margin (PRM) as required by TID's Board to comply with California statutory requirements. Our IRP:

- Reduces greenhouse gas (GHG) emissions to reach the target for TID established by the California Air Resources Board (CARB) in support of the 40 percent reduction of emissions from 1990 levels by 2030 as required by Senate Bill (SB) 350, and sets a path for reducing GHG emissions to 85 percent of 1990 levels by 2045 as required by Assembly Bill (AB) 1279.
- Achieves a 60 percent Renewable Portfolio Standard (RPS) by 2030 by procuring adequate renewable generation, also required by SB 350 and updated by SB 100. Our IRP also meets the interim RPS goals of 44 percent by the end of 2024 and 52 percent by the end of 2027 as required by SB 100.
- Progresses toward serving 90 percent of our retail load with a portfolio of clean, zero-carbon generation by 2035, 95 percent zero-carbon generation by 2040, then 100 percent zero-carbon generation by 2045, as first mandated by SB 100 and updated by SB 1020.

The IRP also addresses energy efficiency and demand response (DR) initiatives; facilitates the permitting of customer-sited distributed energy resources (DERs) mainly from rooftop solar photovoltaic (PV) installations; integrates battery energy storage systems (BESS) to improve system flexibility and support ancillary services; addresses transportation and building electrification forecasted load; fosters economic, social, and electric rate benefits for low-income residents and disadvantaged communities (DACs); and manages cost-of-service investments to ensure stable, competitive rates.

Capacity Expansion Buildout

A requirement of the IRP is to ensure that 60 percent of TID's retail sales are supplied by RPS-eligible resources by 2030. The plan must also show progress towards complying with the requirement that eligible renewable energy and zero-carbon resources supply 90 percent of all retail sales by 2035, 95 percent by 2040, and 100 percent by 2045. In addition, the IRP considered the load reducing generation from DERs and energy efficiency measures as well as the added load from electric vehicle (EV) adoption (and the accompanying charging demand) and from building electrification.

The IRP's capacity expansion plan meets these priorities. The capacity expansion buildout adds solar, wind, and geothermal renewable resources combined with BESS. After an initial buildout of a solar plus BESS project, the capacity expansion plan adds geothermal, more solar, and wind over the course of the 2023–2030 planning period.

Figure 1 shows the cumulative nameplate capacity of the selected portfolio for the planning period.

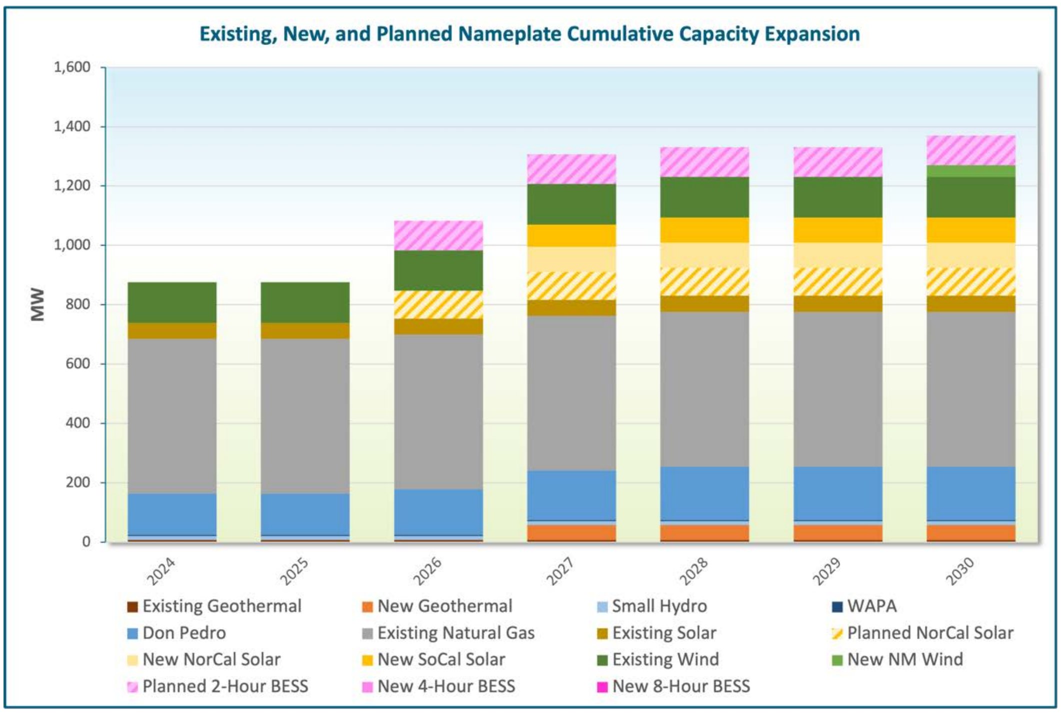

Figure 1. Existing, New, and Planned Nameplate Cumulative Capacity Expansion

Resource Capacity Action Plan

The core aspect of the IRP's action plan calls for implementing the capacity expansion buildout. The first priority is to ensure that the 94 MW of planned solar and storage is added to the TID portfolio in 2026. Next, the IRP modeling process selected 210 MW of renewable generation to be added in 2027: 85 MW of additional northern California solar, 75 MW of new southern California solar, and 50 MW of new geothermal energy. The model selected 10 MW of new southern California solar in 2028 and 40 MW of New Mexico wind in 2030.

Figure 2 depicts these resource additions during the planning period.

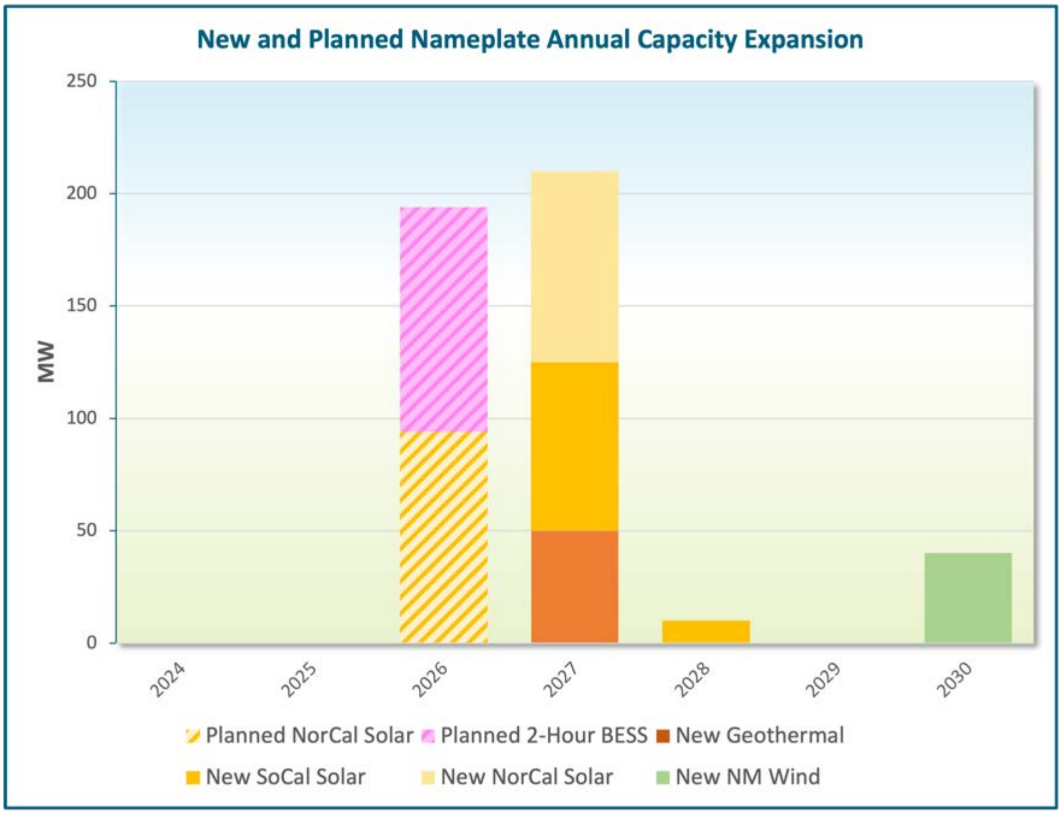

Figure 2. New and Planned Nameplate Annual Capacity Expansion

To meet the CARB 2030 carbon emissions target range, TID's natural gas-fired power plants will operate at lower capacity factors. New renewables, energy storage, and market power purchases will fill in the gap left by reduced natural gas generation. These thermal units, however, are not retired in the planning period so that their capacity remains available to maintain reliability of the TID system when needed. Adding firm geothermal capacity will further improve TID's system reliability and the ability to provide the necessary ancillary services.

Cost and Rate Impacts

The IRP optimally minimizes the cost of serving load over the planning period. These costs, aggregated across resources and the planning period, include thermal generation resource costs, renewable resource costs, BESS costs, and sales and purchases from TID's trading hubs. TID will undergo a separate process from this IRP filing to determine power supply costs more accurately, subject to constraints that were unable to be modeled in this IRP.

Conclusion

TID will continue to monitor aspects discussed in this IRP, including the impacts of energy efficiency and DR programs, transmission and distribution assessments, electric vehicle (EV) charging station growth, building electrification impacts, DER generation increases, and DAC considerations.

This IRP was based on proven, commercially available generation technologies. TID plans to monitor developments in emerging energy technologies, especially green hydrogen fuel production and transportation, small modular reactor (SMR) advancements and installations, long-duration energy storage (LDES) innovations, pumped-storage hydroelectricity (PSH) possibilities, and carbon capture and sequestration (CCS) technology. As these technologies become viable, TID will consider incorporating them into our resource portfolio to meet our RPS and zero-carbon requirements, so long as they are cost-effective additions to our resource portfolio and help us maintain our high level of reliable service with rates that are both affordable and stable.

2. Resource Planning Principles and Inputs

This Integrated Resource Plan (IRP) process has enabled Turlock Irrigation District (TID) to evaluate our electrical generation resources and map a future course for a resource portfolio mix that prepares for growth while meeting regulatory and statutory goals, especially toward reducing anthropogenic greenhouse gas (GHG) emissions. The IRP summarizes the technical and financial feasibility for developing additional clean resources, and details how TID plans to meet the numerous environmentally oriented requirements in addition to minimizing risks and costs, all while operating and maintaining a safe and reliable electric power grid.

This chapter discusses several topics that form the foundation for developing this IRP. These topics start with the IRP goals and objectives cast against TID as a utility and our core operating values. Additional topics include a statewide perspective on GHG emission reductions, RPS and clean energy goals, regulatory and technological considerations, energy efficiency standards, transportation electrification and building electrification impacts, and the evolving nature of the western power markets.

Integrated Resource Planning Process and Goals

California has set the standard in the United States for addressing climate change issues. Since 2006, California legislation and regulations have substantially altered how electric utilities operate across the state. These statutes are regulated, monitored, and enforced by various state agencies including the California Energy Commission (CEC), the California Air Resources Board (CARB), and the California Public Utilities Commission (CPUC).

Core Values

TID's mission is to provide reliable and competitively priced electric and water service, while being good stewards of our resources and providing a high level of customer satisfaction. We operate under several values.

Reliability, by planning, building, and maintaining our electric and water systems to reliably serve customers.

Affordability, by providing stable, competitive rates for our customers.

Stewardship, by providing leadership who sustainably manage the resources entrusted to us.

Safety, by ensuring a safe and secure environment for employees and customers.

Quality Workforce, by attracting and retaining highly-skilled and experienced management and staff.

Customer Focus, by building strong and lasting relationships with our customers and community through engagement, transparency, accountability, and trust.

Local Control, by enabling local people to make decisions that address local needs, which are essential to TID's continued success.

Visionary, by proactively balancing near-term decisions with the long-term well-being of customers.

IRP Objectives

All Load-Serving Entities (LSEs), including Investor-Owned Utilities (IOUs), Community Choice Aggregators (CCAs), Electric Service Providers (ESPs), and Publicly-Owned Utilities (POUs), of a certain size, file an IRP at least once every five years.

Those IRPs must meet these overarching goals:

- Provide reliable and safe electricity service.
- Maintain stable, just, reasonable, and affordable rates.
- Cost-effectively meet applicable local, regional, state, and federal policies, mandates, rules, and regulations.
- Develop and maintain a diversified and flexible electric supply portfolio while minimizing risk exposure.
- Enable opportunities to capitalize on evolving and emerging generation technologies.
- Promote the standard of living within the service area by supporting the state's climate goals.

TID's 2023 IRP presents a strategy for the remainder of the decade to meet all of these goals. More specifically, our IRP sets forth a plan that:

- Reduces greenhouse gas (GHG) emissions by 40 percent from 1990 levels by 2030 as required by Senate Bill (SB) 350 and sets a path for reducing GHG emissions to 85 percent of 1990 levels by 2045 as required by Assembly Bill (AB) 1279.
- Achieves a 60 percent Renewable Portfolio Standard (RPS) by 2030 by procuring adequate renewable generation, also required by SB 350 and updated by SB 100. Our IRP also meets the interim RPS goals of 44 percent by the end of 2024 and 52 percent by the end of 2027 as required by SB 100.
- Progresses toward serving 90 percent of our retail load with renewables and clean, zero-carbon generation by 2035, 95 percent by 2040, then 100 percent by 2045, as mandated by SB 100 and updated by SB 1020.
- Acquires sufficient resources to meet RPS and zero-carbon energy goals while considering an adequate planning resource margin (PRM).
- Maintains system reliability through adequate dispatchable baseload local generation.
- Outlines a strategic plan for increasing savings from energy efficiency and demand-side management (DSM) initiatives, and adopts our first-ever demand response (DR) program.
- Facilitates the permitting of customer-sited distributed energy resources (DERs) mainly from rooftop solar photovoltaic (PV) installations.
- Integrates battery energy storage systems (BESS) to improve system flexibility and support the provision of ancillary services.
- Ensures adequate generation to support the transition to transportation and building electrification.
- Fosters economic, social, and electric rate benefits for low-income residents and disadvantaged communities (DACs).
- Manages cost-of-service investments to ensure stable, just, reasonable, and affordable rates.

Our IRP favors transitioning to mature, currently available generation resources over emerging, yet unproven technologies. As such, our IRP charts an acquisition strategy that favors procuring reliable, affordable, renewable, and zero-carbon energy generation to meet forecasted growth by balancing supply with demand. The IRP considered geothermal, solar PV, wind, and BESS. The IRP's resource acquisition strategy also considered increasing transportation and building electrification demands, energy efficiency and demand-side management initiatives, and DERs mainly from customer-sited rooftop solar PV.

Generation from variable renewable energy resources—such as wind and solar—heavily depends on weather. In general, the generation profiles for wind and solar are somewhat complementary. Wind generation tends to occur in the early morning hours (before dawn), then late afternoon and evening. Solar generation, on the other hand, begins at dawn, peaks around noon, and diminishes throughout the afternoon. Increasing amounts of variable renewable energy presents an increasingly important challenge for TID in our ability to provide adequate dispatchable baseload and load-following generation to keep the electric grid in balance.

The IRP process examined the amount, timing, and type of sustainable resources that can meet energy and demand forecasts at the lowest reasonable cost while meeting sustainability and reliability requirements. From that resource plan, we developed an action plan to implement the results of the IRP.

In 2029, TID will file another IRP that assesses the interim five years, considers developments in the energy industry's evolving landscape, and charts an updated course for meeting current and future requirements.

Planning Period

The IRP considered a planning period that ranged from 2024 through 2030 in its modeling and analysis. The IRP focused on developing a plan to meet forecasted demand and energy requirements through increasing amounts of renewable and zero-carbon generation while considering the load increasing impacts of transportation and building electrification; the load decreasing impacts of DERs, energy efficiencies, and DR; and the adaptation of our system to effectively incorporate variable renewable generation.

The result, as always, is a plan that meets statutory and regulatory requirements while operating a safe and reliable electric grid.

About Turlock Irrigation District

The Turlock Irrigation District, established in 1887 under the Wright Act[1], is the first publicly-owned irrigation district in California. As one of only four irrigation districts in the state, TID provides electric retail energy directly to homes, farms, and businesses. TID operates under the provisions of the California Water Code as a special district and is governed by a five-member, locally elected Board of Directors.

TID owns and operates an integrated and diverse electric generation, transmission, and distribution system that provides power to a population of roughly 240,000 within a 662 square-mile service area (Figure 3) that includes portions of Stanislaus, Merced, and Tuolumne counties in central California. TID is one of eight California Balancing Authorities (BAs), operating independently within the western United States power grid. As a BA, TID is fully responsible for generating, securing, scheduling, and delivering electricity to customers.

TID also delivers irrigation water to 4,500 farms in our service area through 250 miles of a gravity-fed canal system that irrigates approximately 150,000 acres of farmland. Crops grown in the area include almonds, corn, oats, and alfalfa.

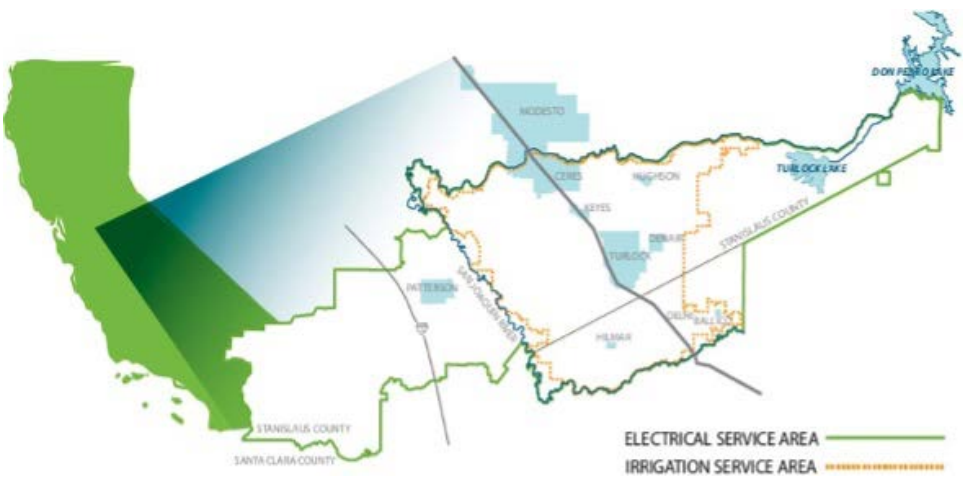

Figure 3. TID Service Area

1 Passed by the California legislature on March 7, 1887, the Wright Act allowed farming regions to form and bond irrigation districts enabling small farm owners to band together, pool resources, and get water to where it was needed.

Customer Base and Energy Usage

Figure 4 shows TID's customer accounts, while Figure 5 shows the energy consumed by each customer category. All amounts are from year-end 2022.

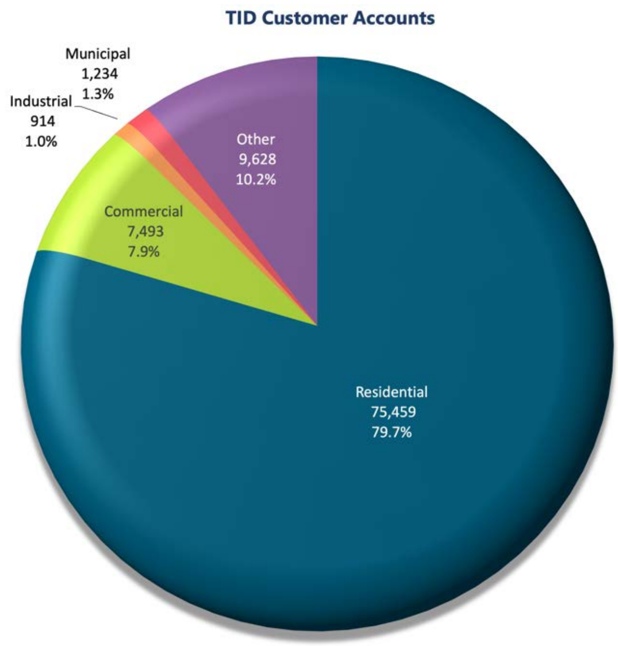

Figure 4. TID Customer Count

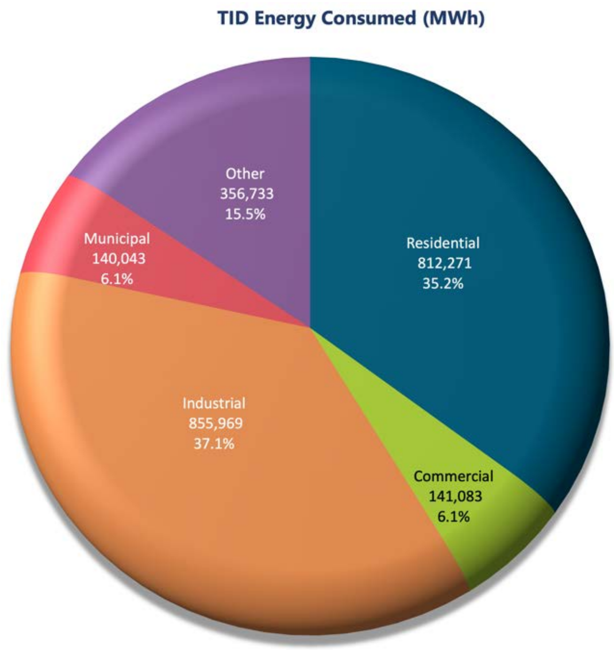

Figure 5. TID Energy Consumed

Greenhouse Gas Emission Reductions

Dramatically reducing GHG emissions in the state of California drives all other energy-related environmental goals. Several statutes set the requirements for meeting their goals.

In 2006, AB 32 started the state on developing its environmental goals by requiring that GHG emissions be reduced to the levels measured in 1990 by 2020. In 2015, SB 350—the Clean Energy and Pollution Reduction Act of 2015—set precise levels of GHG emission reductions: 40 percent of 1990 levels by 2030 and 80 percent of 1990 levels by 2050. SB 350 also established more aggressive standards for meeting RPS targets. SB 350 took effect in 2020.

AB 197—the California Global Warming Solutions Act of 2016: Direct Emissions—required CARB to adopt regulations to maximize GHG emission reductions in a cost-effective manner and to prioritize direct emission reductions from large, stationary, and mobile sources. AB 1279—The California Climate Crisis Act of 2022—furthered GHG emission reduction goals by requiring an 85 percent reduction of 1990 levels no later than 2045 and to continue that reduction into the future.

Achieving these goals requires a transformation in how energy is generated and distributed. These requirements started the transition away from thermal toward renewable and zero-carbon resources with energy storage, the advancement of energy efficiency and demand response initiatives, the growth of DERs mainly from customer-sited rooftop solar PV generation, the transition away from internal combustion engine vehicles toward EVs through transportation electrification, and away from gas-powered appliances to electric-powered appliances through building electrification.

This transformation profoundly affects TID's operations, today and into the future. The requirements present many opportunities and risks for TID which have been factored into the development of this IRP. We have already embarked on meeting these GHG reduction requirements. TID's emissions between now and 2030 are expected to fall due to significant increases in renewable procurements.

Renewable Portfolio Standard and Clean Energy Goals

As one of the first states to implement an RPS, California is a leader among US states in renewable and clean energy growth.

California Renewable Portfolio Standard Statutes

Three statutes created the current RPS and clean energy landscape.

Senate Bill 350: Clean Energy and Pollution Reduction Act of 2015. SB 350 called for a new set of objectives to improve air quality and public health, reduce GHG emissions to address the impacts of climate change, and expand other clean energy policies. The bill was signed into law in 2015 and took effect in 2020.

The bill set three additional RPS targets culminating with a 50 percent requirement in 2030 that must be maintained into the future. (See "Compliance Period Requirements" on page 2-9 for details.) The bill includes an interim goal of 40 percent RPS by 2024 and 45 percent RPS by 2027. Starting in 2021, at least 65 percent of RPS procurement must be derived from long-term contracts of 10 years or more.

The bill defined the renewable energy and zero-carbon sources that support the RPS goals. Renewable energy includes generation from solar, wind, geothermal, small hydroelectric, municipal solid waste, biofuels (biodiesel, biomass, and biomethane), fuel cells using renewable fuel, and hydrokinetic energy (ocean thermal energy conversion, ocean wave, and tidal current). Zero-carbon generation that does not emit climate-altering GHGs include large hydroelectric and nuclear technologies.

Senate Bill 100: The 100 Percent Clean Energy Act of 2018. Passed in 2018, SB 100 accelerated the state's RPS set in SB 350 to ensure that, by 2030, at least 60 percent of California's electricity is renewable. This percentage of renewable generation must be maintained at or above 60 percent from 2030 onward. In addition, SB 100 required that renewable energy generation and zero-carbon resources power 100 percent of retail electricity sold in California by the year 2045.

While not specified in SB 100, combustion resources fueled by biofuels or hydrogen derived from renewable energy resources are defined as zero-carbon resources. In addition, while all retail electricity sales in California must come from renewable and zero-carbon resources by 2045, the transmission and distribution line power losses (due to heat) can still be served by fossil fuel generation.

Finally, SB 100 required the CEC, the CPUC, and CARB to employ programs under existing laws to achieve 100 percent clean electricity and issue a joint policy report on SB 100 by 2021 and every four years thereafter. In May 2023, progress toward the state's goal was highlighted in the Governor's Clean Energy Transition Plan.

Senate Bill 1020: The Clean Energy, Jobs, and Affordability Act of 2022. In September 2022, SB 1020 added interim goals and the clean energy mandates established in SB 100. SB 1020 requires that eligible renewable energy and zero-carbon resources supply 90 percent of all retail electricity sales to California end-use customers by December 31, 2035, and supply 95 percent of all retail electricity sales by December 31, 2040. In addition, all electricity delivered to California state agencies must be supplied by renewable and zero-carbon energy resources by the end of 2035.

TID currently generates 27 percent of retail sales from RPS-eligible resources and 44 percent from zero-carbon resources, fulfilling the remaining target with REC purchases or banked RECs. The IRP lays out a plan to procure additional RPS-eligible and zero-carbon resources to more than meet the 2030 targets.

Compliance Period Requirements

Current legislation breaks down meeting RPS requirements into six compliance periods (CPs) with corresponding RPS targets. Starting in 2010, the RPS percentages are for increasingly progressive renewable energy targets for local POUs to increase their procurement of eligible renewable energy resources.

Figure 6 depicts the RPS percent procurement requirements by CP, breaking the CPs into interim goals by year.

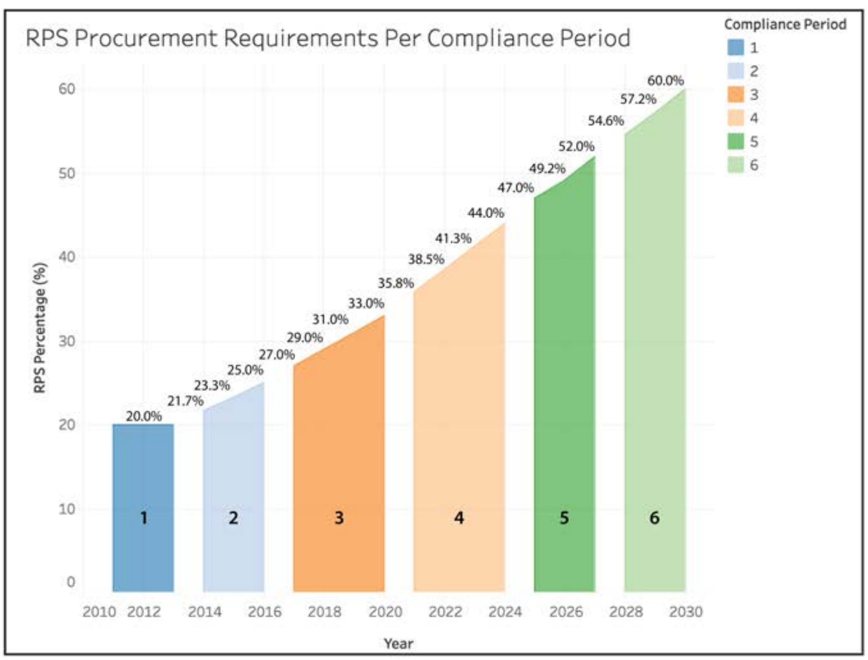

Figure 6. RPS Percent Procurement Requirements by Compliance Periods[2]

2 https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/rps/rps-compliance-rules-and-process/60-percent-rps-procurement-rules

RPS procurement requirements are categorized by Product Content Category (PCC): renewable energy credits (RECs) characterized by the bundling of renewable attributes with delivered power. RECs are tradable commodities that represent proof that one MWh of electricity was generated from an eligible renewable source. There are three main PCC groups.

PCC-1: A renewable resource located within the state of California or a renewable resource that is directly delivered to California without energy substitution from another resource that came online after June 1, 2010. A PCC-0 is a resource that was already online before this date.

PCC-2: A renewable resource that is out-of-state and delivered to California where the RECs are paired with a substitute energy resource imported into the state.

PCC-3: A REC from a resource delivered without the energy component. This is commonly called an "unbundled" REC.

Starting in CP 3, the renewable portfolio mix of all retail electric providers that serve electric load in California must be made up of 75 percent or more of PCC-0 and PCC-1 resources, 15 percent or less of PCC-2 resources, and 10 percent or less of PCC-3 resources. In addition, starting with CP 4 (2021–2024), 65 percent or more of an entity's RPS procurement must come from owned resources or PPA contracts that extend 10 years or more. Both requirements must be maintained starting in CP 4 and beyond. The annual RPS compliance report is due to the CPUC on July 1.

Regulatory and Technological Considerations

To evaluate the resources and assets necessary to achieve California's environmental goals, the IRP considered numerous assumptions in forecasting future energy needs, and to make the best use of its current resources and assets—including repurposing them and adding to them—to prepare for the sustainable growth necessary to meet the state's clean energy objectives.

CARB Scoping Plan

The 2022 CARB Scoping Plan for Achieving Carbon Neutrality, issued on November 22, 2022, lays out a sector-by-sector roadmap for California to achieve carbon neutrality by 2045 or earlier, by reducing anthropogenic GHG emissions by 85 percent below 1990 levels (as directed by AB 1279).

The actions and outcomes in the plan will achieve:

- Significant reductions in fossil fuel combustion by deploying clean technologies and fuels.
- Further reductions in short-lived climate pollutants.
- Support for sustainable development.
- Increased action on natural and working lands to reduce emissions and sequester carbon, and the capture and storage of carbon.

Under this Scoping Plan, the role of electricity in powering the economy will grow in almost every sector. A clean, affordable, and reliable electricity grid will serve as a backbone to support deep decarbonization across California's economy. Decarbonizing the electricity sector is a crucial pillar of this Scoping Plan. It depends on both using energy more efficiently and replacing fossil-fueled generation with renewable and zero-carbon resources, including solar, wind, energy storage, geothermal, biomass, and hydroelectric power.

The Scoping Plan incorporates SB 350's energy efficiency doubling goal, aligns with the CPUC's IRP 2030 GHG target and latest GHG emissions benchmarks through 2035, the governor's 20 gigawatt (GW) offshore wind and no new gas generation goals, and SB 100's 2030 RPS and 2045 zero-carbon retail sales targets. The goal is to reduce dependence on fossil fuels in the electricity sector by transitioning substantial energy demand to renewable and zero-carbon resources.

CEC Integrated Energy Policy Report Forecast

The CEC prepares the IEPR every two years (updated every other year) as required by SB 1389. The IEPR outlines a cohesive approach to best manage California's energy transition from oil and natural gas to renewable energy resources and away from internal combustion engine vehicles to ZEVs for transportation.

The report assesses and forecasts energy-related trends, and, using that information, develops "energy policies that conserve resources, protect the environment, ensure energy reliability, enhance the state's economy, and protect public health and safety."[3]

The IEPR includes the California Energy Demand Update (CEDU) for 2022. The CEDU includes updates to historical data, economic and demographic projections, electricity rates, and the hourly forecast (to consider the September 2022 heat event), as well as incorporating a new approach to assessing the transportation sector given the rapid advancements in transportation electrification.

The CEC revised its forecasting framework to create a more transparent process to better describe scenario assumptions. The revised framework includes a baseline forecast, a planning forecast, and a local reliability scenario. To better evaluate electricity forecasts, the planning forecast contains sensitivity scenarios (Scenario 3) for additional achievable energy efficiency (AAEE), additional achievable fuel substitution (AAFS), and additional achievable transportation electrification (AATE). The local reliability scenario also contains sensitivity scenarios for AAEE (Scenario 2), AAFS (Scenario 4), and AATE (Scenario 3).

3 Pub. Res. Code § 25301(a)

The Final 2022 IEPR Update[4] (filed February 28, 2023) assesses several trends: economic and demographic, climate, behind-the-meter photovoltaic (PV) solar and storage, and transportation as well as consider state policies and goals. Using these trends, the IEPR includes forecasts for the 2023–2035 timeframe for:

- Annual electricity consumption
- Electricity sales
- Managed sales, including AAEE, AAFS, and AATE electricity impacts
- Peak demand (load)

The IRP considered the IEPR forecasts and used them, along with other data sources, to inform certain aspects of the modeling.

In-State Gas Transportation Cost General Rate Case

General Rate Cases (GRC) are proceedings before the CPUC used to address the costs of operating and maintaining the utility system and allocating those costs among customer classes. A utility's revenue requirement must be allocated among the different customer classes—residential, commercial, agricultural, and street lighting—based on the costs incurred when serving that class. A utility then proposes rates for collecting that revenue.

In its GRC Phase II application, the utility proposes its calculations for marginal costs and revenue allocation, and then proposes rates based on these calculations together with background documentation and arguments for adoption. Following a public review process, the CPUC approves or denies the rates.

TID pays Pacific Gas and Electric (PG&E) under a CPUC-approved Gas Transportation Rate to deliver natural gas to TID's natural gas-fired power plants. In 2016, the Gas Transportation Rate increased to more than $1.00 per MMBtu, more than doubling previous rates.

PG&E's recently approved 2023 GRC application (A.21-06-021) adjusts 2023 all-volumetric gas transportation rates to entities like TID to almost $4.00 per MMBtu, which is close to the current cost of the natural gas.

TID expects the Gas Transport Rate to continue to rise and put upward pressure on TID's generation cost.

4 *Final 2022 Integrated Energy Policy Report Update with Errata*, California Energy Commission; Docket Number 22-IEPR-01, TN # 248998, February 28, 2023 (CEC-100-2022-001-CMF), pp 57–67, found on https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update

Energy Efficiency Standards

Federal and California energy efficiency standards aim to reduce electric consumption. Among the various provisions set forth by SB 350, a key requirement directed state agencies to double the energy savings in electricity and natural gas end uses through energy efficiency and conservation by 2030.

Assembly Bill 2021 required POUs to establish specific annual energy efficiency goals as a percent of total annual retail electric consumption and establish 10-year targets every three years (modified to four years by AB 2227), starting 2007. Before investing in new carbon-based resources, utilities must exhaust savings from all available energy efficiency and demand reduction resources that are cost-effective, reliable, and feasible. The cost of implementing this program was funded through a 2.85 percent surcharge on customer bills. The statute also required the CEC to quantify all achievable energy efficiency savings to establish realistic attainment levels.

The 2019 California Energy Efficiency Strategic Plan[5] states three overarching goals:

1. Doubling energy efficiency goals by 2030
2. Expending energy efficiency in low-income and disadvantaged communities
3. Building decarbonization

These standards, policies, and goals will lead to reduced energy use and potentially alter the TID's system load shape.

Transportation Electrification

Transportation currently accounts for more than 50 percent of California's GHG emissions. Thus, a significant element of the transformation to a clean energy future is transportation electrification—replacing gas-powered internal combustion engine vehicles with zero-emission cars, buses, and trucks. This transition is vital to reducing California's GHG emissions.

Transportation Impacts and Targets

In 2012, Governor Brown issued Executive Order B-16-2012 to electrify the transportation sector, calling on the CEC and other state agencies to achieve 1.5 million ZEVs by 2025. In 2018, Governor Brown issued Executive Order B-48-18 that increased that goal to 5 million ZEVs by 2030. As a result, several California statutes and regulations require a shift toward ZEVs. California considers hydrogen fuel cell electric vehicles (FCEVs or HFCEVs), plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs) to be ZEVs.

5 https://www.energy.ca.gov/filebrowser/download/1900

Senate Bill 350, the Clean Energy and Pollution Reduction Act of 2015, required utilities to propose multiyear programs and investments to accelerate widespread transportation electrification that reduce dependence on petroleum, meet air quality standards, achieve EV charging station goals, and reduce GHG emissions. The CPUC, in consultation with CARB and the CEC, approves these programs and their investments.

SB 1000 required the CEC to assess whether EV charging infrastructure, especially DCFC stations, is disproportionately deployed by population density, geographical area, or by low-, middle-, and high-income levels and whether access to these charging stations is disproportionately available. Three other statutes (AB 1236, AB 2127, and AB 970) streamlined the EV charging station permitting process.

In August 2022, CARB established an annualized roadmap to phase out the sale of internal combustion passenger vehicles by issuing measures: the Advanced Clean Cars II (ACC II), Advanced Clean Trucks (ACT), and Advanced Clean Fleets (ACF) rules. The ACC II rule codified Governor Newsom's Executive Order N-79-20. The rule requires that 35 percent of all new cars and light trucks sold in 2026 be ZEVs and PHEVs, and that figure to increase to 100 percent in 2035. The related Advanced Clean Fleet program helps electrify heavy-duty vehicles.

Figure 7 shows the annual requirements for complying with ACC II.

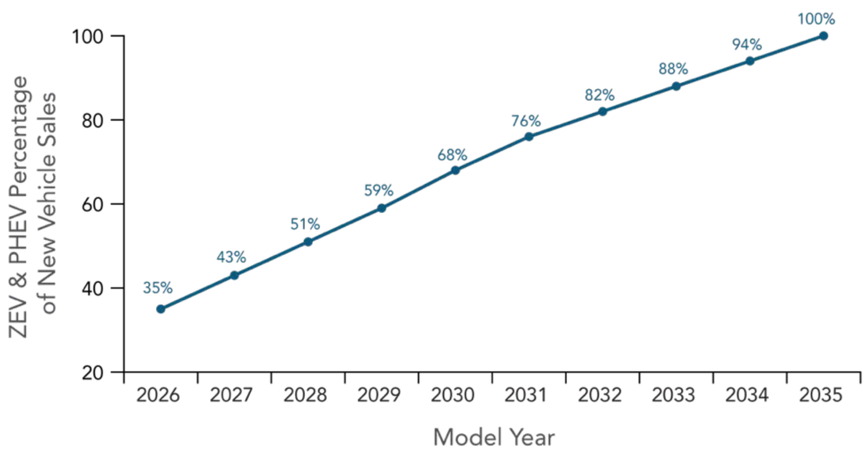

Figure 7. Annual Zero-Emission Vehicles Sales Targets for the Advanced Clean Cars II Rule[6]

By 2037, the rule will reduce smog-causing pollution from light-duty vehicles by 25 percent to meet federal air quality standards. In 2040, GHG emissions from cars, pickups, and sport utility vehicles (SUVs) will decrease by 50 percent from today's levels. By 2040, the regulation will cut climate warming pollution from those vehicles a cumulative total of 395 MMT.

The rule delivers multiple benefits to sell more ZEVs that continue to grow year after year. By 2030, 2.9 million fewer new gas-powered vehicles will be sold in California, rising to 9.5 million fewer conventional vehicles by 2035. This potentially results in over 12 million additional EVs within the next 13 years.

6 https://ww2.arb.ca.gov/news/california-moves-accelerate-100-new-zero-emission-vehicle-sales-2035

Zero-Emission Vehicle Adoption and Energy Impacts

The ACC II rule propelled the energy required for increased transportation electrification into prominence. The CEC forecasts as many as 15 million additional ZEVs on California's road in the next twelve years requiring almost 25,500 GWh of energy. Transportation electrification forecasts are included in our peak demand and energy forecasts. The CEC's IEPR forecast additional capacity required by the increasing volume of various ZEV purchases over the planning period.

The IEPR, through an additional achievable transportation electrification (AATE) framework, forecasts the adoption rate and energy impacts from three ZEV sectors—light-duty, medium-duty, and heavy-duty—by modeling three scenarios:

Baseline Scenario: Economic and demographic inputs; vehicle attributes such as price, range, refueling time, acceleration, and model availability; federal tax credits, state rebates and rewards, and high-occupancy vehicle access incentives; incentives resulting from the 2022 Inflation Reduction Act; consumer model preference; and CARB's Innovative Clean Transmit regulation.

AATE Scenario 2: Direct, post-process alignment of light-duty ZEV sales that capture delayed compliance or some exemptions with CARB's policies, in particular the ACC II rule; lower prices for medium-duty battery-electric trucks to capture increased electrification.

Scenario 3: Full compliance with all regulations (including the Advanced Clean Fleets rule) with a postprocess alignment of new vehicle sales with state light-duty and proposed medium- and heavy-duty regulations.

The forecasts from these three scenarios can be compared to TID's EV forecasts to determine how the transition within TID's service area compares to that of the entire state. Refer to "Transportation Electrification and Electric Vehicle Forecast" (page 4-18) for details on TID's EV forecast.

Building Electrification Impacts

On August 11, 2021, the CEC adopted Building Energy Efficiency Standards (also known as Title 24 or the Energy Code) that apply to residential, nonresidential, high-rise residential, and hotel and motel buildings. The California Building Standards Commission unanimously approved the standards on December 14, 2021, which then became effective January 1, 2023.

The standards result in more efficient use of energy and water for new residential and new nonresidential buildings, and energy and water conservation design standards. The standards encourage electric heat pump technology for space and water heating, sets a solar requirement, and adopts electric-ready requirements for single-family homes. (These solar requirements were factored into our DER forecast, which can be found in Distributed Generation Forecast on page 4-5.) These building electrification standards refer to the electrification of appliances and equipment in buildings, such as electric heat pump replacing gas heating, electric water heaters replacing gas water heaters, and electric cooktops replacing gas cooktops.

Energy use in buildings causes one quarter of California's climate pollution and emits seven times more toxic nitrogen oxide (NOx) air pollution than all the state's power plants. Switching from fossil fuels to clean, efficient electric heat pump space and water heating offers a pathway to zero-emission buildings. An efficient heat pump saves at least 75 percent of GHG emissions over its lifetime.[7]

The CEC has established the Technology and Equipment for Clean Heating (TECH) program and the Buildings Initiative for Low-Emissions Development (BUILD) program to offering incentives for all-electric new construction in low-income communities. BUILD is a residential building decarbonization program that provides incentives and technical assistance to support the adoption of advanced building design and all-electric technologies in new, low-income all-electric homes and multifamily buildings. BUILD provides financial assistance for a statewide direct-install building retrofit programs for low-income households to replace fossil fuel appliances with electric appliances.[8]

On September 22, 2022, CARB issued the 2022 State Strategy for the State Implementation Plan (SIP). This 2022 State SIP Strategy includes the requirement that all space and water heaters sold in California for either new or existing residential and commercial buildings must comply with a statewide zero-emission GHG standard by 2030. The 2022 SIP includes a strategy to limit oxides of nitrogen emissions from space and water heaters, which would effectively limit new sales of gas space and water heaters.

The Final 2022 IEPR Update included building electrification projections in its energy and electricity consumption forecasts. The forecast is projected to be 2.5 percent annually, and as high as 3 percent as buildings transition from gas to electricity. TID takes usage per customer into account for how electrified each customer is, which in turn informs our load forecast that also includes building electrification.

Western Power Markets Initiatives

Dependable dispatchable resources are becoming increasingly necessary to reliably meet minute-to-minute load shapes as variable renewable resources become a larger percent of the overall resource mix. Over the previous decade, California has legislated several measures to address this issue, including flexible capacity resource requirements, policies, and mandates to promote energy storage, and flexible capacity resource requirements as well as promoting a multi-state real-time energy imbalance market and regional grid.

7 https://www.nrdc.org/bio/pierre-delforge/california-forging-ahead-zero-emission-buildings

8 https://www.energy.ca.gov/programs-and-topics/programs/building-initiative-low-emissions-development-program

Western Energy Imbalance Market

In response to these issues, CAISO established the Western Energy Imbalance Market (WEIM) in 2014 as a real-time energy market. WEIM's advanced market system conducts economic dispatch based on available supply and demand, and finds the lowest cost dispatch to serve consumer demand across the West. Currently, 22 utilities, irrigation districts (including TID), and BAs across 11 states participate in WEIM.[9]

WEIM covers 79 percent of the load in the Western Interconnection. WEIM allows participants to buy and sell power close to the time electricity is consumed and gives system operators real-time visibility across neighboring grids. The WEIM platform balances fluctuations in supply and demand by automatically finding the lowest-cost resources to meet real-time power needs. WEIM manages congestion on transmission lines to maintain grid reliability and supports integrating renewable resources. In addition, the market makes excess renewable energy available to participating utilities at low cost rather than turning those generating units off. By operating over a large geographic area, WEIM allows supply and demand to be balanced on a sub-hourly basis, which results in lower power supply costs, improved integration of variable renewable resources, and less curtailments.

More specifically, regional coordination in generating and delivering energy produces significant benefits in four main areas:

- Improved efficiency of the regional transmission system.
- Reduced carbon emissions and more efficient use and integration of renewable energy. For instance, when one utility area has excess hydroelectric, solar, or wind power, CAISO can deliver it to customers in California or to another participant. Likewise, when CAISO has excess solar energy, it can help meet demand outside of California that otherwise would be met by more expensive, and less clean, energy resources. Since its inception, WEIM has reduced renewable energy curtailment by more than 1.8 million MWh and reduced CO_2 emissions by 800,000 MT.[10]
- Enhanced reliability by increasing operational visibility across electricity grids and improving the ability to manage transmission line congestion across the region's high-voltage transmission system.

This IRP only modeled hourly power markets; it did not model sub-hourly markets associated with our participation in WEIM.

9 WEIM participants are Arizona Public Service, Avangrid, Avista, Balancing Authority of Northern California (BANC), Bonneville Power Administration, CAISO, El Paso Electric, Idaho Power Company, Los Angeles Department of Water & Power, NorthWestern Energy, NV Energy, PacifiCorp, Portland General Electric, Powerex, Public Service Company of New Mexico, Puget Sound, Salt River Project, Seattle City Light, Tacoma Power, Tucson Electric Power, Turlock Irrigation District, and the Western Area Power Administration (WAPA) Desert Southwest Region. Berkshire Hathaway Energy (BHE) Montana plans to join in 2026.

10 https://www.ucsusa.org/resources/transforming-western-power-grid#read-online-content

3. Generation Resources

TID's resource portfolio, comprised of thermal, renewable, and zero-carbon resources, continues to evolve to meet state generation requirements for reducing GHG emissions.

Existing Power Supply Resources

TID's generation portfolio consists of local and remote resources owned by TID and acquired through PPAs as well as market purchases to meet retail load.

Table 1 summarizes our resource portfolio.

Resource	Capacity (MW)	Owner	Term	Fuel	Type
Thermal					
Walnut	49.6	TID	Life of Project	Natural Gas	Peaker
Almond	48.3	TID	Life of Project	Natural Gas	Intermediate
Almond II	174.0	TID	Life of Project	Natural Gas	Peaker
Walnut Energy Center	250.0	TID	Life of Project	Natural Gas	Baseload
Renewable					
NCPA Geothermal	7.0	TID	Life of Project	Geothermal	Baseload
Tuolumne Wind Project	136.6	TID	Life of Project	Wind	Variable
Rosamond West Solar 2	54.0	PPA	2037	Solar	Variable
Dawson	5.5	TID	Life of Project	Hydro	Run of Canal
Hickman	1.1	TID	Life of Project	Hydro	Run of Canal
La Grange	5.3	TID	Life of Project	Hydro	Run of River
Turlock Lake	3.3	TID	Life of Project	Hydro	Run of Canal
Solar PV *(pending)*	94.0	tbd	tbd	Solar	Variable
Zero-Carbon					
Don Pedro	139.0	TID	Life of Project	Hydro	Limited Dispatchable
WAPA	4.0	PPA	2024	Hydro	Limited Dispatchable
Battery Energy Storage System					
BESS *(pending)*	100.0	tbd	tbd	n/a	Storage

Table 1. Generation Resource Portfolio

TID, acting as our own balancing authority (BA), relies on several efficient and flexible resources—a mix of baseload, intermediate, and peaking resources—to balance supply with demand. This reduces TID's exposure to commodity price volatility. These resources play a key role in integrating renewable resources, including distributed energy resources (DERs) such as customer-sited solar photovoltaic (PV) plus energy storage, to aid in a transition to a renewable and zero-carbon portfolio.

Don Pedro and all natural gas-fueled and run-of-canal hydroelectric facilities are sited within TID's BA area, which helps increase system reliability. In addition, TID is currently negotiating a PPA for an RPS-eligible solar PV plus BESS resource, which is expected to come online in 2026.

TID supplements the above resources with purchases from other regional utilities and the CAISO market. Power purchases occur when the purchase cost is less than generating power from one of our natural gas power plants, which lowers overall power supply costs.

Energy Resources Mix

The energy projected to be generated from TID's diverse resource portfolio to meet forecasted load and wholesale sales in 2024 is depicted in Figure 8. Renewable and zero-carbon energy generation currently comprise approximately 36 percent of TID's total energy generation. By 2030, the energy from the renewable portion of TID's portfolio will increase to at least 60 percent of total retail sales to comply with the state's RPS requirement.

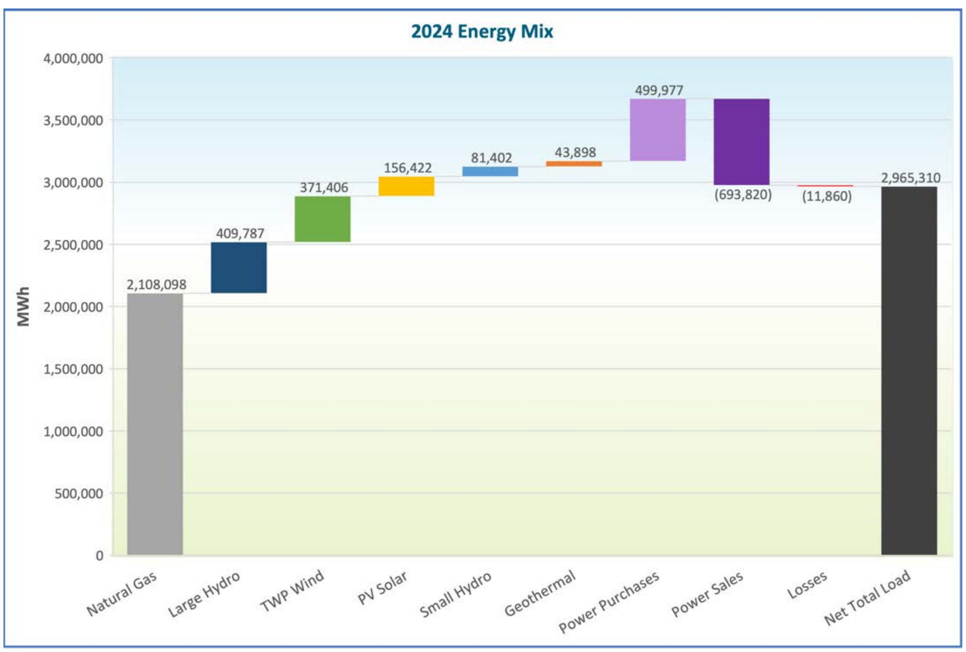

Figure 8. 2024 Energy Mix

Natural Gas Resources

Almond Power Plant

The Almond Power Plant (Figure 9) is a steam-injected combustion turbine (CT) generating unit. Initially brought online in 1996, it was repowered in 2003 with a new LM 6000 turbine generator, improving fuel efficiency and increasing capacity to 48.3 MW. The unit, owned by TID, is sited in Ceres. In 2023, the unit generated approximately 60,276 MWh of energy.

Figure 9. Almond Power Plant

Almond II Power Plant

The Almond II Power Plant (A2PP, Figure 10) came online in July 2012. The unit, owned by TID, is sited on a 4.6-acre parcel adjacent to the Almond Power Plant. In 2023, the unit generated approximately 128,096 MWh of energy. A2PP consists of three 58-MW General Electric LM 6000PG gas turbines for a total capacity of 174 MW. The three turbines are equipped with a water injection system that reduces NOx emissions and a selective catalytic reduction system that further controls NOx emissions. A2PP receives recycled water from the Ceres Wastewater Treatment Plant for equipment cooling and service water for domestic use provided by an existing onsite water well.

Figure 10. Almond II Power Plant

A2PP contributes towards system reliability, operating reserves, and flexible capacity for TID. The unit assists TID in meeting reliability obligations with firm, local capacity that provides flexibility to our electrical system and improves our ability to integrate variable renewable resources.

Walnut Power Plant

The Walnut Power Plant consists of two CT generating units each with a capacity of 24.8 MW, for a total capacity of 49.6 MW. The units, which came online in 1987, are sited in Turlock and owned by TID. The units mainly provide non-spinning reserves but occasionally, when market prices are high, generate power during peak periods to reduce power purchases.

Figure 11. Walnut Power Plant

Walnut Energy Center

WEC (Figure 12) consists of two 85 MW CTs and one steam turbine (ST) generator rated at 100 MW with a net capacity of 250 MW. WEC is a highly efficient, environmentally responsible source of economical and reliable energy. The power plant uses reclaimed, recycled water from the City of Turlock's wastewater treatment plant. WEC is among the cleanest power generating facilities of comparable size in the nation. By utilizing the best available emissions control technology, its NOx emissions are as much as 85 percent lower than those of older generating facilities currently operating in California.

Figure 12. Walnut Energy Center

WEC provides a large portion of TID's energy needs, operating reserves, and flexible capacity. WEC became operational in 2006, is owned by TID, and is sited in Turlock. In 2023, the unit generated approximately 1,566,073 MWh.

Renewable Resources

The Geysers Geothermal Plant

Figure 13. Geysers Geothermal Power Plant

The Geysers Geothermal plant (Figure 13) consists of three currently operating 55 MW ST generators for a total capacity of 165 MW. Each unit can operate independently from the other units. The geothermal facility consists of steam wells, a steam gathering system and reinjection wells of the steam supplier, a power plant, and transmission line. Each ST has its own condensing system, cooling tower and electrical substation to step-up the voltage for transmission. The plant is located on federal land approximately 60 miles northwest of Sacramento, in an unincorporated area of Sonoma County near the town of Anderson Springs.

The Northern California Power Agency (NCPA) owns the bulk of the facility. TID owns 6.33 percent of the facility. TID's generation from the facility has averaged about 43,000 MWh annually for the past few years. This resource has been a steady source of renewable GHG free power for TID.

Tuolumne Wind Project Power Plant

Figure 14. Tuolumne Wind Project Power Plant

The Tuolumne Wind Project (TWP, Figure 14) power plant consists of 62 wind turbines: 42 Siemens Model SWT 2.3 MW turbines and 20 Senvion REPower MM93 2.0 MW turbines, for a total capacity of 136.6 MW. TWP, the first wind facility owned by TID, came online in May 2009 and is located near Goldendale, Klickitat County, Washington, along the Columbia River. The wind facility is currently TID's largest source of renewable power, generating approximately 375,000 MWh of GHG-free energy annually.

Rosamond West Solar 2

TID owns a 20-year PPA with SunPower for 54 MW of clean, renewable solar power from the Rosamond West Solar 2 project. The solar facility utilizes SunPower's proprietary robotic solar panel cleaning system that uses 75 percent less water, which improves system performance by up to 15 percent. The facility is located near Edwards Air Force Base in Kern County and TID receives approximately 155,000 MWh per year under the PPA. This PPA expires in 2037.

Figure 15. Rosamond West Solar 2 Facility

Small Hydroelectric: Dawson, Hickman, La Grange, and Turlock Lake

TID owns and operates four small hydroelectric plants. These facilities generate electricity on its irrigation canal system as well as surrounding irrigation district's canals. Each of these renewable energy plants utilizes the power of irrigation water flowing—called run-of-canal—through the gravity-fed canal system to create electricity. These hydroelectric plants became operational between 1924 and 1983. These hydro plants provide TID with a combined total capacity of 15.2 MW of renewable, GHG-free energy.

Mini Hydro

TID owns or is entitled to energy from four small hydroelectric plants: Fairfield, Parker, Frankenheimer, and Woodward. These are units located in Merced and South San Joaquin Irrigation districts in the CAISO BA. Energy from these units is sold directly into the CAISO system.

Zero-Carbon Resources

Don Pedro Hydroelectric Project

In 1971, Turlock and Modesto Irrigation Districts jointly replaced the original Don Pedro dam with a much larger one. The dam now holds enough water to accommodate irrigation needs for multiple years. Don Pedro consists of a dam, a reservoir, and a powerhouse on the Tuolumne River 3.5 miles upstream of La Grange Dam. The hydroelectric facility consists of four generators that have a combined capacity of 203 MW.

Figure 16. Don Pedro Hydroelectric Power Plant

TID owns a 68.46 percent share of Don Pedro, equaling approximately 139 MW of capacity. TID generates approximately 400,000 MWh per year of clean, GHG free energy from Don Pedro. Don Pedro also provides TID with significant operating reserves and flexible capacity.

The turbines at the Don Pedro hydroelectric facility will undergo a generator life extension and upgrade over the period of 2025 through 2028. This repowering will increase the total capacity of Units 1–3 to 74.9 MW, meaning TID's share will increase from approximately 37.7 MW to approximately 51.3 MW for each unit. Unit 4 capacity will not change. These generator upgrades will also improve the efficiency of the units. The resultant incremental increase in generation qualifies as RPS-compliant renewable energy.

Table 2 details the phased upgrade timetable and associated unit outage for the facility's repowering.

Equipment & Project	Outage Start	Outage Stop
Unit 1 Turbine & Generator Life Extension	1-Jun-2027	15-Feb-2028
Unit 2 Turbine & Generator Life Extension	1-Jun-2025	15-Mar 2026
Unit 3 Turbine & Generator Life Extension	1-Jun-2026	15-Feb-2027
Unit 4 Turbine & Generator Life Extension	1-Jun-2028	15-Dec-2028

Table 2. Don Pedro Hydroelectric Turbine and Generator Life Extension Timeline

Central Valley Project Hydroelectric

The Western Area Power Administration (WAPA) markets and transmits wholesale electric power generated by power plants owned and operated by the Bureau of Reclamation from the California Central Valley Project (CVP). The CVP consists of 18 dams that create reservoirs to store up to 13 million acre-feet of water. The project's 615 miles of canals irrigate an area 400 miles long and 45 miles wide—almost one-third of California. Power plants at the dams have an installed capacity of 2,113 MW.

TID, through a 20-year PPA with WAPA, currently contracts for a 0.34088 percent share of the CVP, which provides an average of 10,000 MWh of energy annually to TID. When the current contract terminates at the end of 2024, it will be replaced with a 30-year contract wherein TID receives a 0.66362 percent share of CVP, providing approximately 20,000 MWh of energy annually.

Short-Term Market Purchases

TID's electric system is directly interconnected with several entities in California (listed in the "Bulk Transmission System" section on page 5-1). These interconnections enable TID to procure power from these entities as well as other markets (such as CAISO). TID also has partial ownership in the California-Oregon Transmission Project (COTP) that enables 237 MW of transmission rights to the California-Oregon Border (COB) for access to the power markets in the northwestern states. These transmission interconnections allow TID to optimize market purchases based on a larger footprint with more geographic diversity. TID procures market power for to maintain system reliability, reduce costs, and to better meet RA, PRM, and GHG emission targets.

Energy Requirements

TID, due to our diverse power supply and transmission resources, is able to adapt our power supply mix to react to load and market conditions to benefit customers. Besides serving customers, TID also delivers power to the Merced Irrigation District (MeID) according to a power sales agreement (PSA) between the two entities signed in 2016. Although the PSA ends in April 2028, this IRP assumes that TID will continue to provide power to MeID throughout the planning period.

TID plans to leverage the wholesale power markets to minimize our power supply costs when possible, particularly when these prices are negative due to over generation from variable renewable resources.

Resource Planning Reserve Requirements

Resource Adequacy Planning Reserve Margin

TID's Board has approved an RA policy that requires sufficient electric resources to be acquired to meet 105% of forecasted peak demand for May through September of the following year by June first of the current year, and 115% of forecasted peak demand for a month at least 60 days before the beginning of such month. Thus, the analysis for this plan is based on a 15 percent PRM. This policy ensures that TID will have sufficient resources to serve customer demand and provide operating reserves to meet applicable Western Electric Coordination Council (WECC) requirements.

Table 3 lists the forecasted peak load that meets TID's RA requirements over the planning period.

Year	Peak Load (MW)	Peak Load + 15% PRM (MW)
2023	597	687
2024	602	692
2025	604	695
2026	607	698
2027	610	702
2028	614	706
2029	618	711
2030	623	717

Table 3. Resource Adequacy Peak Load Plus Planning Reserve Margin

Contingency Reserves Requirements

WECC sets reliability standards that TID, as a BA, must meet. One such standard, the WECC Contingency Reserve standard, requires that a BA must maintain sufficient excess generation capacity capable of being dispatched within ten minutes to ensure reliable system operation in both normal and abnormal conditions. To better meet this standard, TID participates in the Northwest Power Pool (NWPP) Reserve Sharing Group. Participating in this group has reduced our costs and enabled access to other member's resources to respond to contingency reserve situations.

The 2023 IRP modeling demonstrates that TID can adequately respond to contingency reserve requirements using existing resources during the planning period.

Renewable Generation Requirements

For over 100 years, TID has generated energy from clean resources. Our current renewable portfolio includes geothermal, wind, solar, small hydroelectric facilities, and biomass. A PPA for solar PV plus BESS is anticipated in 2026. Over the planning period, by implementing the action plan of this IRP, we plan to add more solar, wind, and geothermal to our resource portfolio as well as BESS.

TID currently generates 25.6 percent of our energy for retail sales from renewable resources (based on TID's 2022 Power Content Label). To comply with RPS requirements, TID must supply at least 44 percent of our retail sales by December 31, 2024, 52 percent by December 31, 2027, and 60 percent by December 31, 2030 and thereafter through a combination of renewable generation and purchases of renewable energy certificate (RECs).

Greenhouse Gas Emissions and California Carbon Allowances

The transition to a clean energy future for California is driven by state requirements to reduce anthropogenic GHG emissions from 1990 levels by 40 percent by 2030 and by 85 percent by 2045. To meet these requirements, TID has been methodically adding renewable and zero-carbon resources.

TID also participates in the CARB allowance auctions to purchase volumes of allowances necessary to meet compliance requirements for thermal generation and other market purchases. Cap and Trade regulations require that one California Carbon Allowance (CCA) be surrendered for each metric ton (MT) of GHG emitted by thermal resources. CCAs can be acquired at quarterly CARB auctions at an auction settlement price or from third parties in the secondary markets at a bilateral price. CARB implements a minimum price for CCA purchases which increases annually. The increasing floor price and tighter emission requirements mean future CCA prices are expected to increase.

The modeling and analysis of this IRP for selecting additional resources considered GHG emission levels and the cost of CCAs.

4. Planning Forecasts

The integrated resource planning process relies, in large part, on a series of inputs that serve as the foundation for modeling a reliable resource portfolio mix that meets state goals. Effective forecasts of these many inputs are key variables in this process. These inputs begin with TID's energy (MWh) and peak demand (MW) forecasts which indicate the growth in retail energy sales. Other inputs include forecasts for distributed generation, energy efficiency savings, power and natural gas prices, candidate resource costs, transmission costs, carbon costs, and transportation and building electrification forecasts.

Taken together, these planning forecasts drive decisions on the type, timing, and quantity of resource procurements for TID's resource mix.

Load Forecasts

Long-Term Forecasting Methodology

TID developed our energy and peak demand load forecast using an econometric model that forecasts energy consumption, and peak demand for each rate class. For each rate class, TID fit historical load data to a linear regression model. Separate models were employed for energy and peak demand.

The following historical data inputs were used in fitting the model.

- Historical number of customers and energy consumption by rate class for the last twenty years.
- Historical load and coincidence factors by rate class for the last five years.
- Historical distribution losses for the last seven years.
- Historical temperature data from 1950 until the present.
- Historical and projected employment, income, and population for Stanislaus County, obtained from Woods & Poole Economics—a firm that specializes in long-term county economic and demographic data projections.
- Historical consumer price index for all urban consumers—a city average obtained from the United States Department of Labor's Bureau of Labor Statistics.
- Historical delivered natural gas prices to commercial and electric power consumers, obtained from the United States Energy Information Administration (EIA).

- Historical number of customer solar installations, capacity, and generation by customer class.
- Historical hourly customer solar generation profile by customer group.

Once the models were fit, future energy and peak demand projects used projections from various sources including:

- Projected California natural gas prices obtained from S&P Global (a provider of research and data on global markets, economy, and credit) and from several broker data reports.
- Customer solar growth forecasts from the EIA, the most recent CEC Integrated Energy Policy Report (IEPR) 2021–2035 Mid Demand Case forecast, and S&P Global.
- Projected cumulative energy efficiency savings and demand reduction from the proprietary energy efficiency model from GDS Associates, created for California Municipal Utilities Association (CMUA) members and used in setting the latest TID Board-adopted energy efficiency targets.
- Projected number of electric vehicles (EVs) and associated energy consumption for the TID service area based, in part, on the latest the CEC's forecast for the sales and energy consumption of zero-emission vehicles (ZEVs), medium-duty and heavy-duty EV load growth forecast from Guidehouse consultancy, as well as existing numbers of EVs within TID service area
- ZEV hourly charging profile from S&P Global.

The econometric model forecast is based on three scenarios—base, high growth, and low growth—to reflect various economic and demographic growth expectations. The model also forecasts three temperature scenarios: peak demand under a 1-in-5, 1-in-10, and 1-in-100 (extreme case). The forecast reflects the effects of future distributed generation additions, projected EV growth, load reductions from energy efficiency programs, and the effects of implementing California's building electrification standards (which include the requirement for solar generation in new homes). The forecast also considers potential large load customers expected to be online within a few years.

Monthly Energy Forecasts

TID anticipates energy load to grow approximately 4.3 percent, from 2,399 GWh to 2,502 GWh from 2023 through 2030. This anticipated growth is larger than historical growth rates and can be largely attributed to the growth of transportation electrification.

Figure 17 depicts the monthly energy load for the planning period. TID's total load varies by approximately 65 percent between winter months and summer months. By 2030, we project our monthly load to approach 280,000 MWh during the summer months compared to about 160,000 MWh during the winter months.

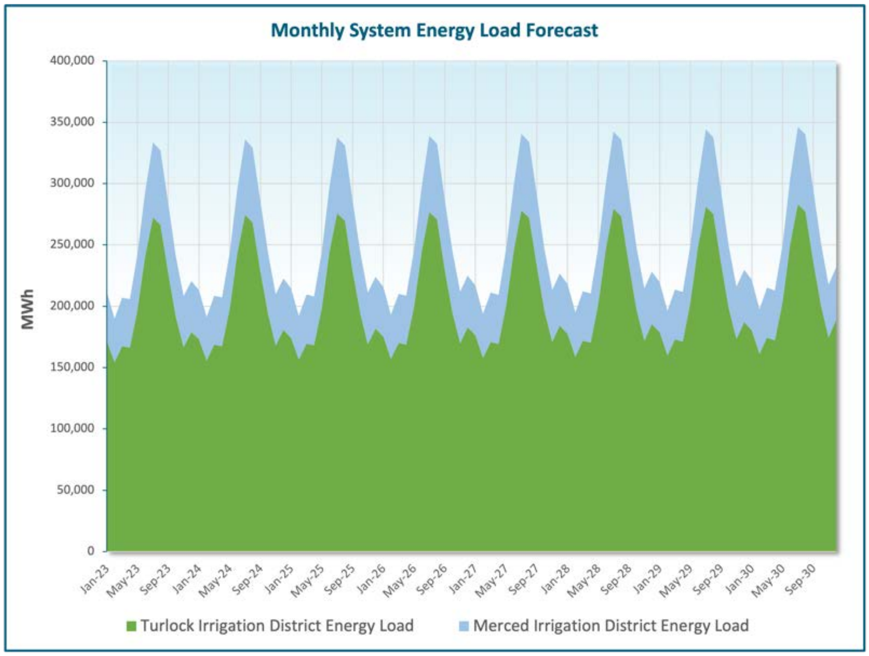

Figure 17. System-Wide Monthly Energy Forecasts

Peak Demand Forecast

The largest amount of power that customers use at one time determines peak demand. Meeting customer demand and avoiding blackouts requires sufficient available resources during peak hours. TID's peak demand is largely driven by heat waves during the summer months. Due to these factors, peak demand is much higher in the summer compared to other seasons.

Based on the forecast from the econometric model calculations, TID anticipates peak demand to grow approximately 4.3 percent, from 597 MW to 623 MW from 2023 through 2030. This anticipated growth can be attributed to the concurrent growth of transportation electrification and overall customer growth.

Figure 18 depicts the monthly peak demand for the planning period. TID's total peak demand roughly doubles between winter months and summer months.

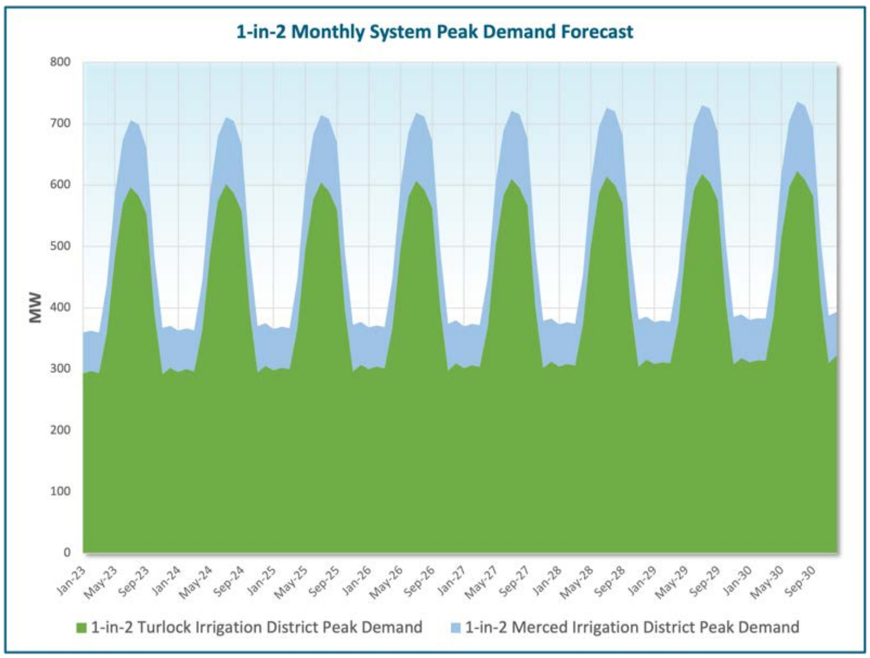

Figure 18. System-Wide Monthly Peak Demand Forecast

Distributed Generation Forecast

Current customer installations generate approximately 75 percent more MWh than in 2018 (the time of our last IRP). TID projects more than 93 MW of total installed distributed energy resource (DER) capacity by 2030, an increase of approximately 69 percent from currently installed capacity. In 2030, customer solar PVs are expected to generate close to 120,000 MWh, which is about 4.8 percent of total forecasted energy load.

This growth was estimated based on historical trends, the recently adopted California building standards, and industry projections of solar PV. Customer solar PV growth reduces overall load growth and changes the shape of the load served by TID resources.

Figure 19 depicts the growth in capacity and energy generation of customer solar PV installations.

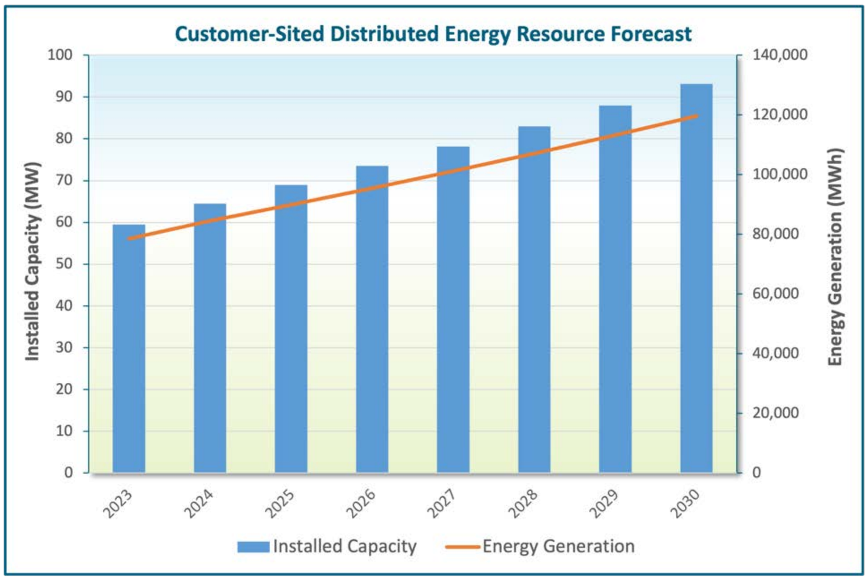

Figure 19. Customer-Sited Distributed Energy Resource Forecast

Figure 20 depicts the forecasted DER solar generation for a typical summer and winter day in 2030.

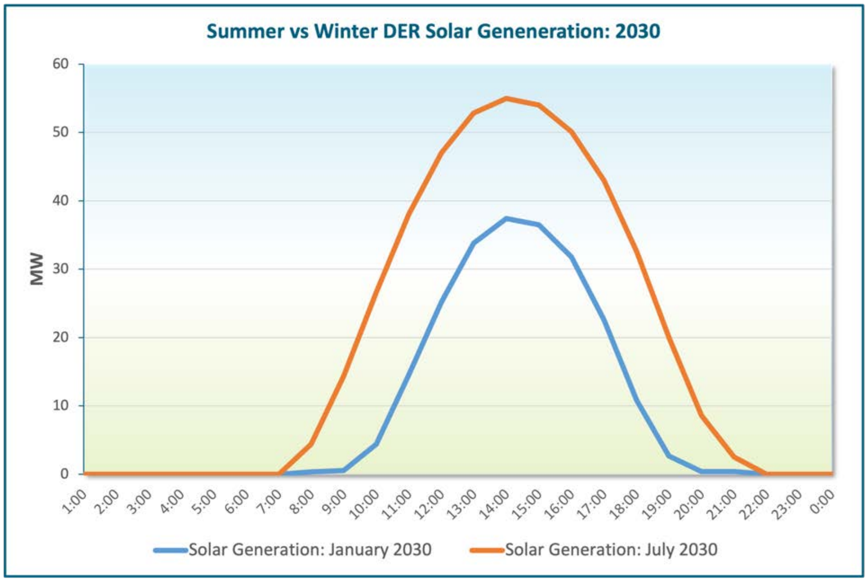

Figure 20. Summer versus Winter DER Solar Generation: 2030

Customer solar will likely push daily peak demand from its current time of 6:00 pm to about 7:00 pm by 2030, especially during the summer months. Given our current generation mix, TID will be able to reliably meet peak demand despite this anticipated evolution in ramp rates and peak hour.

Energy Efficiency and Demand Response

Energy Efficiency

TID continues to develop robust, cost-effective energy efficiency programs with measurable and verifiable goals. TID strives to meet the electric needs of our customers using the lowest cost resources feasible. We are committed to providing our customers with cost-effective energy efficiency solutions and programs. Energy efficiency programs not only reduce energy consumption but also result in lower emissions and reduce the need for distribution infrastructure.

TID offers several energy efficiency programs, most of which have been in place for several years. Since 2001, TID has spent approximately $25.6 million on these energy efficiency programs resulting in reduced energy consumption and emissions.

Here are but three of our energy efficiency programs.

Non-Residential Lighting Program: Offers incentives to replace fluorescent, metal halide, high induction density lighting with light-emitted diodes (LED). This program allows customers to tailor their lighting efficiency upgrades to better meet their needs and attain greater energy savings. TID has sustained a high participation rate with this program.

Commercial Direct Install (CDI) Program: Available to qualifying businesses whose average monthly electrical demand is 100 kilowatts (kW) or less. TID replaces inefficient lighting with LEDs for customers participating in this program for little to no installation cost.

Home Energy Analysis Program: Provides customers with information regarding their monthly usage compared to similar homes in our community or compared to their prior year’s usage. Customers also have access to a web portal where they can customize their home energy use using the energy audit tool, and access helpful energy saving tips.

In addition, TID offers tune-up rebate to promote the efficiency of HVAC equipment.

The TID Board adopts ten-year energy efficiency goals, currently updated every four years (Table 4). TID's based these energy efficiency goals on a study performed together with most of the California's POUs. This study[11] identified all potentially achievable, cost-effective electricity efficiency savings for each participating utility using well established industry accepted data and methodologies.

Year	MWh	MW
2022	11,275	1.5
2023	11,139	1.4
2024	11,078	1.4
2025	10,359	1.3
2026	10,055	1.3
2027	9,728	1.2
2028	9,697	1.2
2029	9,779	1.2
2030	9,700	1.2
2031	9,447	1.2

Table 4. TID Board Adopted Annual Energy Efficiency Goals 2022–2031

Based on the results of this joint-POU study, TID expects to achieve a cumulative incremental savings of 87,000 MWh in 2030 from our energy efficiency programs from a 2021 baseline—as depicted in Figure 21.

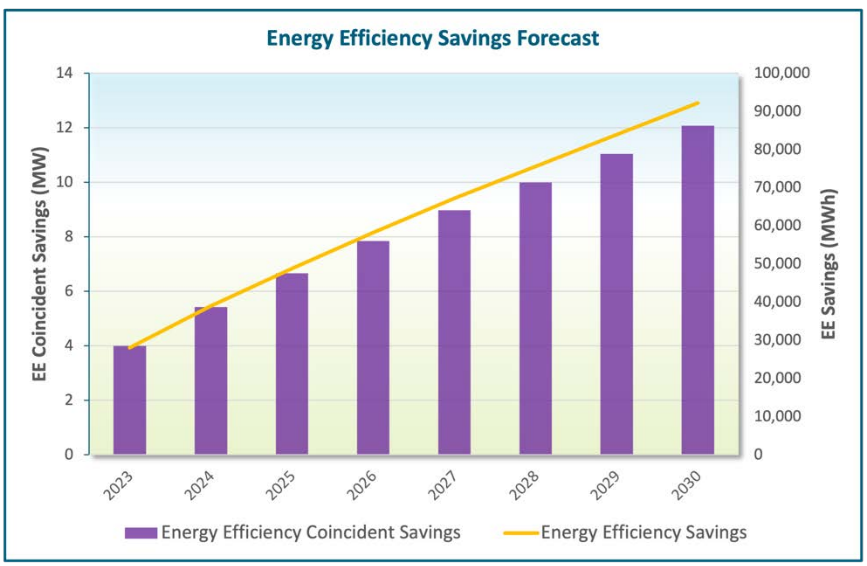

Figure 21. Annual Energy Efficiency Savings from TID Programs

11 See "Energy Efficiency in California's Public Power Sector" submitted to the CEC in 2021 for details on the study: https://www.energy.ca.gov/programs-and-topics/topics/energy-assessment/energy-efficiency-public-power-sector. Although the energy efficiency goals were only adopted through 2031, the study estimated savings through 2041.

TID also supports developing appliance and building codes and standards; those savings, which represent about 1.6 percent of forecasted energy load in 2030, are not reflected in these goals.

Demand Response

TID has begun the process of developing our first demand response (DR) program. From an RFP process, TID will select an industry expert to assess our system and design one or more DR programs. TID aims to implement a plan in late 2024 and to have at least one DR service available to our customers by summer 2025. Our consultant, through their design process, will determine the size and type of DR program offered.

TID expects that this DR program will facilitate more optimal electric system operation and reduce power costs. We anticipate the program to curtail or shift load during supply shortages and offset RA procurement with DR capacity—benefits that can enhance system reliability. Depending on the type of program implemented, TID may also be able to reduce costly energy purchases through DR deployment.

Starting in 2001, TID has offered TOU rates to all non-residential customers, which encourages shifting load to times when demand is low. In 2022, 46 percent of our retail load was billed on TOU rates. In 2008, TID began deploying smart meters and has currently reached a majority of customers, allowing many TID customers to opt for TOU rates. Today, all TID customers have smart meters. In addition, residential customer can track their electric usage in hourly intervals; non-residential customers can track their electric usage in 15 minute intervals.

As part of our Strategic Plan, TID started installing a new Customer Information System (CIS) with Meter Data Management Software (MDMS). The smart meters and CIS create a foundation for future programs to meet changing technology and customer needs, including DR. Based on this new technological foundation, TID will continue to research and analyze prospective customer programs that could benefit our customers.

Power and Natural Gas Price Forecasts

As the demand for renewable and clean energy increases, the power markets will likely see higher volatility in power supply availability and price uncertainty. This volatility is due mainly to the variable nature of wind and solar—the two major renewable resources in California.

CAISO NP-15 and Mid-Columbia Power Price Forecasts

California currently mandates a 100 percent shift to zero-carbon energy resources by 2045. This shift to clean energy's continued growth has led to increasing curtailment probability, lower average power prices, and increasing price volatility. The heavy solar generation during the day in California is forecasted to push on-peak power prices in CAISO below off-peak power prices in the near-term. In the long-term, power prices are expected to remain flat, and slowly drop, even as natural gas prices and carbon costs increase.

Figure 22 depicts how the on-peak and off- peak CAISO NP-15 power prices are expected to slowly drop over the planning period.

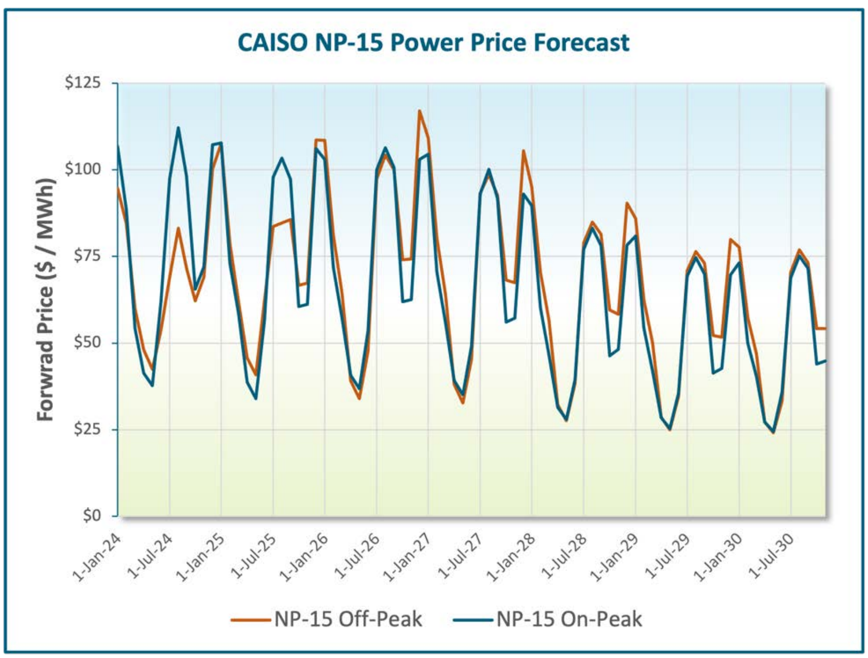

Figure 22. CAISO NP-15 Power Price Forecasts

Figure 22 depicts how the on-peak and off- peak Mid-Columbia power prices are expected to slowly drop over the planning period. By 2030, both the CAISO NP-15 and Mid-Columbia power prices are forecast to be approximately the same.

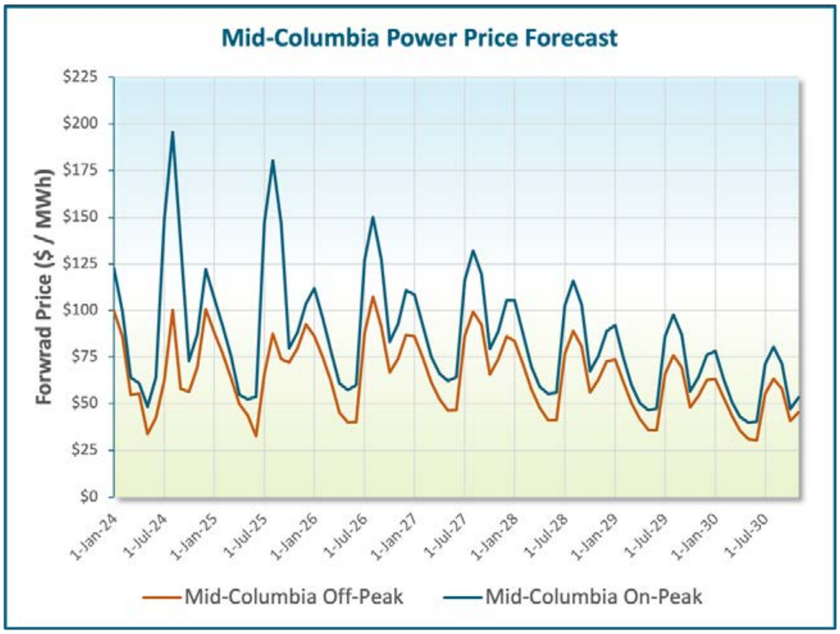

Figure 23. Mid-Columbia Power Price Forecasts

Natural Gas Price Forecast

Figure 24 depicts the monthly PG&E Citygate natural gas price forecast over the planning period.

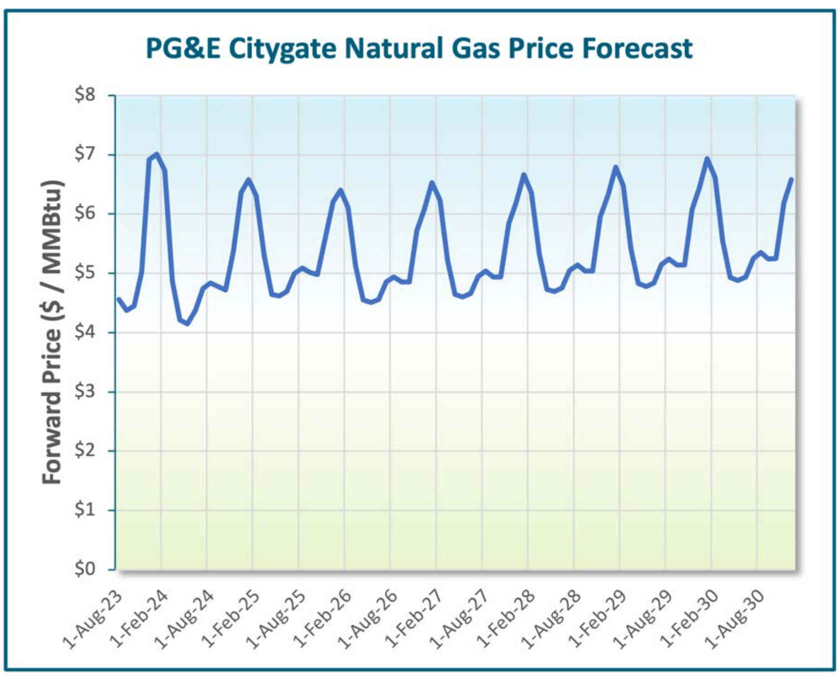

Figure 24. PG&E Citygate Natural Gas Price Forecast

Daily Power Price Profiles

The changing supply mix in California also affects the daily power price profiles. Figure 25, Figure 26, and Figure 27 depict the monthly price shapes for expected daily power prices. The charts show a graph of average power prices over the course of a day.

These three figures demonstrate the daily price profiles for three indicative months throughout the year over the planning period. They show how prices remain low in the middle of the day due to the high level of solar generation. However, energy storage reduces the power price difference between midday and evening hours since storage shifts more of the midday generation to the evening peaks.

Figure 25 depicts the projected price shapes for April.

Figure 25. Projected April Daily Price Shapes

Figure 26 depicts the projected price shapes for August.

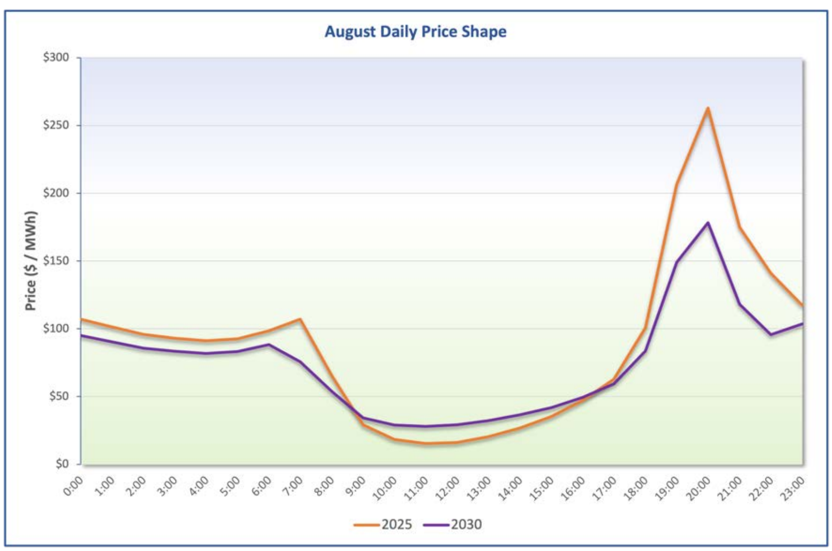

Figure 26. Projected August Daily Price Shapes

Figure 27 depicts the projected price shapes for December.

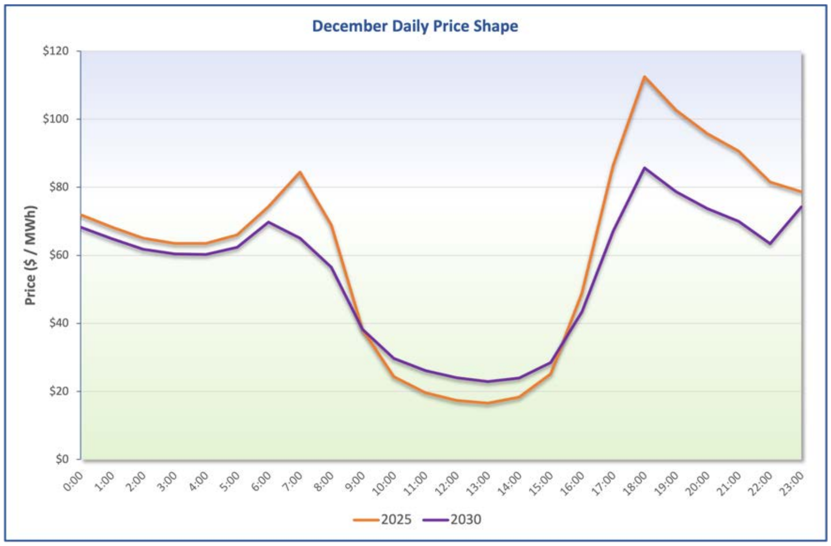

Figure 27. Projected December Daily Price Shapes

California Carbon Price Forecast

Adding to the pressure on natural gas resources, the cost of carbon emissions is expected to continue to rise and accelerate over the planning period. Some causes for the increase in carbon prices is the rising auction floor prices administratively set by CARB, current supply and demand needs in Cap-and-Trade, and the decline in the number of allowances offered into the market over time. Figure 28 depicts how the price for carbon emissions is forecast to almost double by 2030.

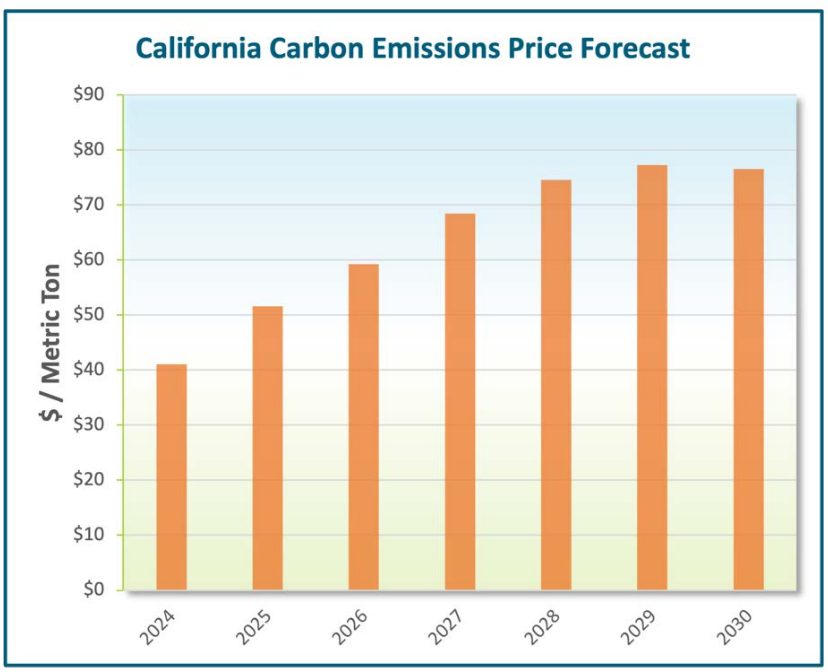

Figure 28. California Carbon Price Forecast

Candidate Resource Costs and Capacity Factors

A fundamental component of the capacity expansion analysis involves identifying the set of "candidate resources", which are generic versions of each candidate technology type considered in capacity expansion optimization modeling. The IRP considered several options to increase TID's renewable share to meet our RPS requirements. These candidate technologies include Northern and Southern California photovoltaic solar, Wyoming-based wind, New Mexico-based wind, geothermal, and four-hour and eight-hour lithium-ion BESS.

Wind and solar provide energy and RECs with low capacity value to meet RA requirements. Geothermal provides both energy and capacity value at a higher cost compared to wind and solar. Energy storage provides no energy or RECs, but can support variable resources like wind and solar to provide needed capacity value for RA. Cost assumptions are but one factor when evaluating the portfolios, and include financial assumptions, tax credits, depreciation, and the cost of capital.

Generation data for each of the candidate solar or wind technologies from representative locations with similar weather conditions are based on data from National Renewable Energy Laboratory's (NREL) System Advisor Model (SAM). SAM facilitates decision-making for renewable energy integration. The stochastic modeling approach employed by PowerSIMM relies on historical generation (acquired from SAM) and weather data to create realistic simulations of wind and solar.

The following provides a brief overview of the candidate resources.

Solar. New candidate solar PV resources are assumed to be single-axis tracking. The northern California solar candidate has a capacity factor of 32 percent; the southern California candidate has a capacity factor of 34 percent. TID is expected to have abundant opportunity to contract for more solar in their portfolio over the next few years.

Wind. As a low risk and mature technology, wind provides carbon free energy that can also be counted in fulfilling the RPS requirements. Several sourcing options are available to TID when it comes to wind resources. Local wind resources in the area are attractive due to annual generation profiles that more closely align with TID's load shape. However, the availability of resources having both a commercially attractive capacity factor and environmentally-compliant siting may be limited. This IRP also includes alternate scenarios that consider wind resources from a wider scope, such as out-of-state wind in places like western New Mexico. Out-of-state wind is both plentiful, high-quality (greater than 40 percent capacity factor), and the potential for lower-cost. It is not without its downsides, though. One challenge with wind is overgeneration outside of peak times (on the hourly or monthly scale). Wind generation tends to peak in nighttime hours, outside TID's net peak load hours just after sunset. In addition, especially in the case of New Mexico-sourced wind, the annual generation profile may not align well with the months of highest energy demand. Wind capacity factors in the New Mexico region peak in the winter and are lowest in months where TID demand is highest (July and August).

Two candidate wind resource locations were considered: Wyoming and New Mexico (both out-of-state). SAM was used to generate simulated historical hourly generation for the years 2011–2014, which was then used to establish the relationship in PowerSIMM between hourly generation behavior and the historical hourly weather data for representative weather stations within these two locations. Monthly generation profiles for these resources are presented below. No degradation of the wind resources is assumed over the forecast period, analogous to a PPA contracted at a fixed capacity and expected capacity factor.

Geothermal. Geothermal provides reliable clean power around the clock. Generation from geothermal sourced power is firm and dependable since it does not rely on weather. California is the national leader in geothermal energy with more than 5 percent of total generation coming from geothermal resources.

Storage. BESS storage durations of 4-hour and 8-hour durations were considered. The model assumes that space and transmission capacity is adequate to install a battery in Turlock. The BESS candidate resource costs are based on lithium-ion chemistry, daily BESS cycling (up to 365 cycle per year), and capacity augmentation throughout the resource lifecycle. Battery technology will likely evolve over the next twenty years with iron-air and flow batteries showing promise for the next generation of energy storage. For this IRP, however, TID relied solely on mature, commercially available storage technologies.

Figure 29 depicts the PPA cost trends for the renewable candidate resources included in the modeling for this IRP. Notice that the costs for wind and solar are projected to decrease over the planning period while geothermal costs are expected to rise. Tax credits from the Inflation Reduction Act of 2022 (IRA) are included in the price forecasts.

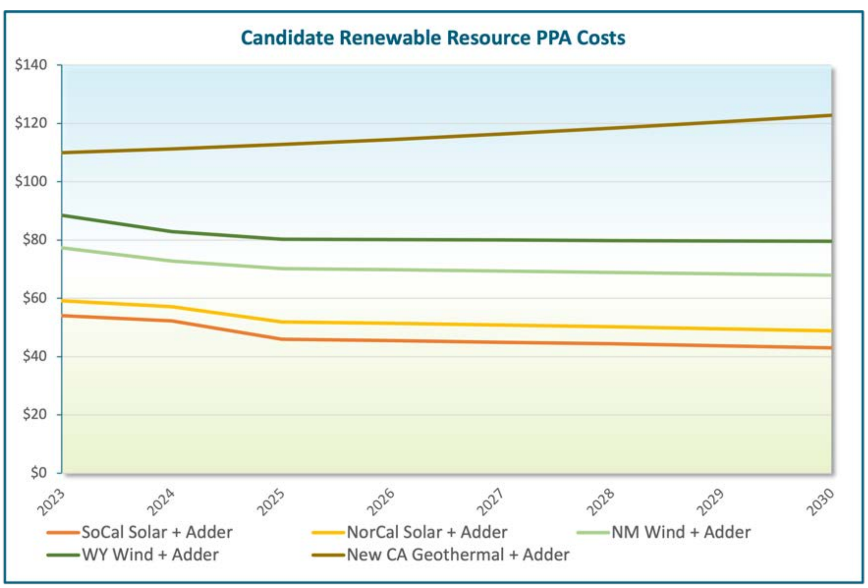

Figure 29. Assumed PPA Costs for Candidate Renewable Resources

A transmission cost per MWh adder was included in the cost of these candidate PPA resources to account for the expected increased expense for securing out-of-state transmission.

Table 5 summarizes the average cost (in dollars per MWh) of potential renewable resources and energy storage for the capacity expansion models to consider when selecting the preferred resource portfolio. The analysis shows that the lowest cost resources are southern California solar, New Mexico wind, and 4-hour Li-Ion BESS. The capacity factor is an average for the entire year.

Resource Technology	2027 $/MWh	2030 $/MWh	Capacity Factor	Earliest Allowed Build Year
Southern California Solar	$44.92	$43.03	34%	2027
Northern California Solar	$50.82	$48.80	32%	2027
New Mexico Wind	$69.36	$67.93	43%	2030
Wyoming Wind	$79.97	$79.51	44%	2030
Geothermal	$116.38	$122.84	n/a	2027
4-hour Battery	$12.62	$12.00	n/a	2027
8-hour Battery	$22.49	$21.05	n/a	2030

Table 5. Candidate Renewable Resource Cost Assumptions

Capacity factors play an important planning role when choosing resources for capacity expansion. Figure 30 shows the varying capacity factors for the candidates solar and wind resources. Solar resource capacity factors are higher in the summer; wind resource capacity factors are higher in the winter.

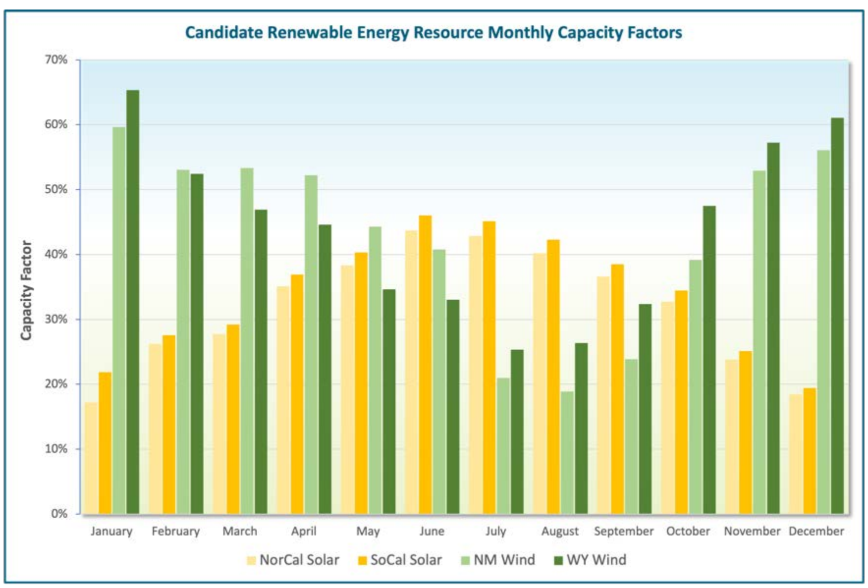

Figure 30. Candidate Renewable Resource Monthly Capacity Factors

Energy Storage Cost Forecast

Integrating increasing amounts of variable wind and solar resources requires a complementary increasing amount of energy storage so that generated energy can be dispatched during high demand—especially since wind and solar tend to generate energy during periods of low demand. As such, the IRP considered 4-hour and 8-hour duration BESS as candidate resources—the two most commonly seen and commercially available BESS options on the market today.

The IRP analysis assumed a round trip efficiency of 85 percent for both battery durations, along with an equivalent forced outage rate (EFOR) of 5 percent with a mean outage of time of one day and a 365-cycle limit per year. The analysis further assumed that 4-hour BESS are built earlier in the capacity expansion process. When the dispatch capacity of those batteries begins to diminish, 8-hour BESS can be chosen after 2030, which allows for a realistic timeframe for procuring and installing these resources.

The cost of energy storage has declined significantly over the past decade—and is expected to continue to decline—making this resource a viable option for our capacity expansion plan. Energy storage in TID's portfolio will be beneficial and necessary as variable renewable resources comprise a larger part of our generation mix. Adding dispatchable generation from BESS to our resource mix is important in fulfilling our role as a BA. A solar plus BESS installation could also defer transmission and distribution upgrades, and better optimize our existing resources which would further reduce GHG emissions.

Figure 31 depicts the decreasing cost trends for both 4-hour and 8-hour BESS candidate resources.

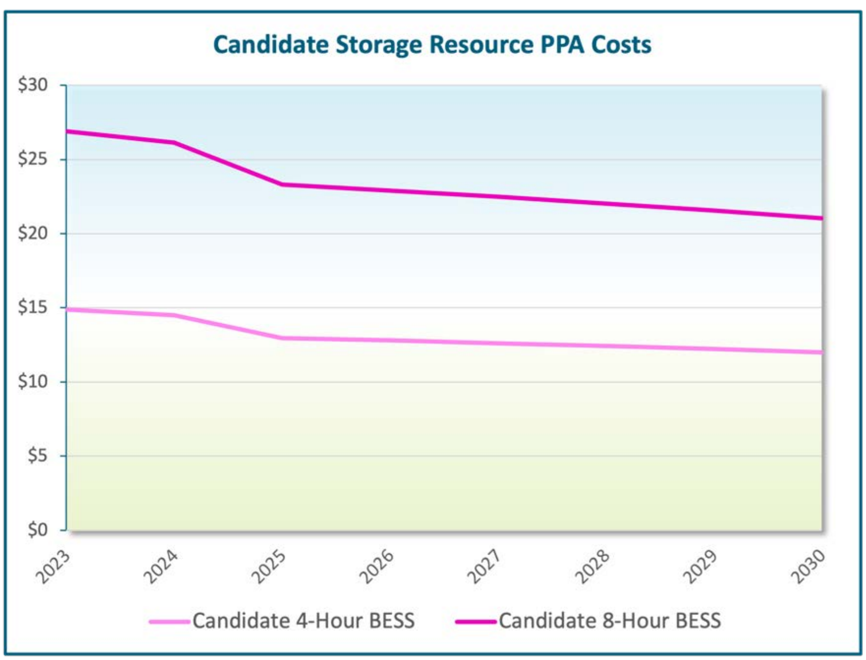

Figure 31. Battery Energy Storage System Cost Forecast

Transportation Electrification and Electric Vehicle Forecast

Electrifying the transportation sector, which is a major source of GHG emissions, is fundamental in meeting California's goal of reducing GHG emissions. The transition to transportation electrification has been spurred by SB 350 and three CARB measures: the Advanced Clean Cars II (ACC II), Advanced Clean Trucks (ACT), and Advanced Clean Fleets (ACF) rules. TID expects that California policies and regulations will continue to promote the growth of ZEVs in California.

Technological advances have increased the efficiency of ZEVs. Improved fuel economy, a longer driving range, vehicle travel model improvements, and price declines. All such factors point towards higher ZEV adoption rates.

The CEC's most recent IEPR forecasts transportation electrification adoption rates and energy demand for three ZEV sectors—light-duty, medium-duty, and heavy-duty. The IEPR forecasts the number of light-duty ZEVs (essentially passenger cars) in California to reach a population of about 6 million vehicles by 2030, and for the combined number of medium-duty and heavy-duty ZEVs to attain a population of about 200,000 by 2030. The resultant energy consumption from all three categories of ZEVs is forecasted to increase by 30,000 GWh by 2030.

To support California's goal to decarbonize the transportation sector, TID designed an EV Program, which aims to promote EV adoption in our service area. The EV Program has an annual budget of approximately $500,000. TID participates in the Low Carbon Fuel Standard (LCFS) program managed by CARB to fund our EV Programs.

Our EV Program is composed of five major components.

Customer Incentives. This program component offers rebates for purchasing new and used EVs as well as residential and non-residential Level 2 (L2) EV chargers. Rebates are higher for low-income customers to encourage a higher participation from DACs within our service area. Rebates are also available to non-residential customers for electrifying their vehicle fleets and for installing Level 3 (L3) DCFC, while allowing TID to keep the LCFS credits. A one-time infrastructure rebate of up to $15,000 is available to non-residential customers who install L2 chargers. All customers can use our online rebate portal to apply for these rebates.

Community and Government Partnerships. The EV Program partners with local government, school districts, delivery companies, and other customers interested in electrifying their fleet or installing EV charging stations to assist them in this transition. In January 2022, TID's board adopted our EV Charging Station Program, which describes how TID will install, operate, and maintain ten EV chargers in publicly accessible locations throughout our service area.

TID Fleet. Our current fleet includes several hybrid pool vehicles. We consider transitioning to hybrids or EVs whenever we need to replace or expand any vehicle in our entire fleet, including pool vehicles, line trucks, and forklifts. We are pursuing grants to further our transition to hybrid or EVs. To minimize emissions, we monitor and reduce idle time from our current gas vehicle fleet.

TID Employee Charging. To promote ZEV purchases by our employees, TID provides Level 1 (L1) charging stations are various locations throughout our service area. A fair number of our employees currently own ZEV; we anticipate this number to grow as charging stations proliferate.

Special EV Rate. In April 2022, TID adopted a special EV rate to promote off-peak EV charging. We have developed a ZEV charging profile based on third-party studies. We used these studies to develop the hourly ZEV load forecast used in this IRP.

TID developed an EV load forecast that follows California's ambitious goal of expanding the ZEVs throughout the state. TID projects ZEVs in our service area to grow from approximately 2,600 as of year-end 2022 to more than 5,200 by 2030 adding close to 47,000 MWh of additional load (Figure 32). This EV load represents approximately 2 percent of our overall forecasted energy load for 2030.

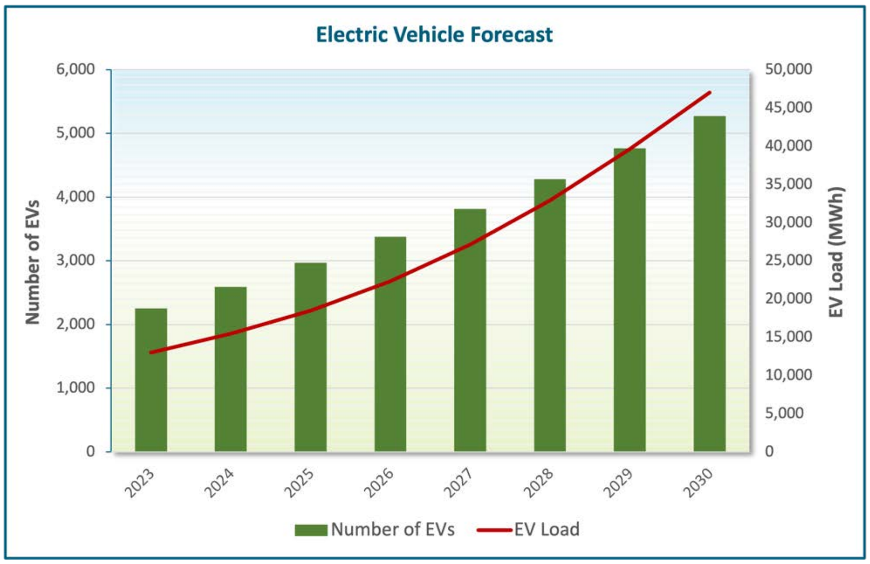

Figure 32. Electric Vehicle Forecast

The Geysers Geothermal Generation Forecasts

Northern California Power Agency (NCPA) operates the Geysers Geothermal power plant as a baseload facility. The facility comprises two plants, each with two units TID owns 6.33 percent of the facility.

Water injection is necessary to operate the plant. Water injection continues to be essential in maintaining reservoir pressure and mitigating steam production decline rates. This water is composed of wastewater from the Southeast Geysers Effluent Pipeline (SEGEP) and steam condensate from the power plants. Drought conditions have caused the amount of injected wastewater to be intentionally reduced over the last few years.

NCPA expects the Geysers Geothermal Project to operate on reduced water injection amounts since California is still experiencing drought conditions, 2023 conditions notwithstanding. 2021 showed that steam production from reduced water injections has moderated and is expected to continue an annual 0.8 percent decline. As such, capacity and energy rates are forecast to decline over the planning period.

Figure 33 shows the historical and forecast net capacity generation for the Geysers power plant.

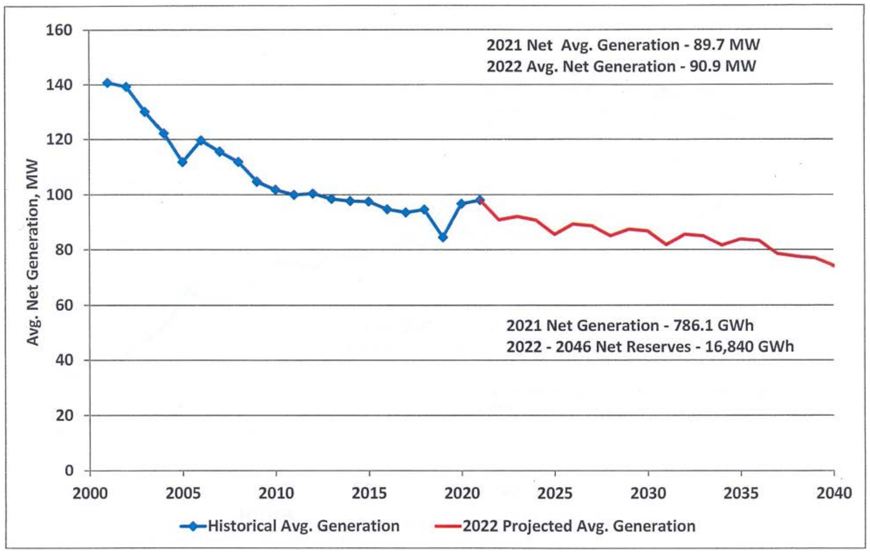

Figure 33. Geysers Geothermal Historical and Forecast Average Net Capacity Generation[12]

Figure 34 shows the historical and forecast net energy generation from the Geysers power plant.

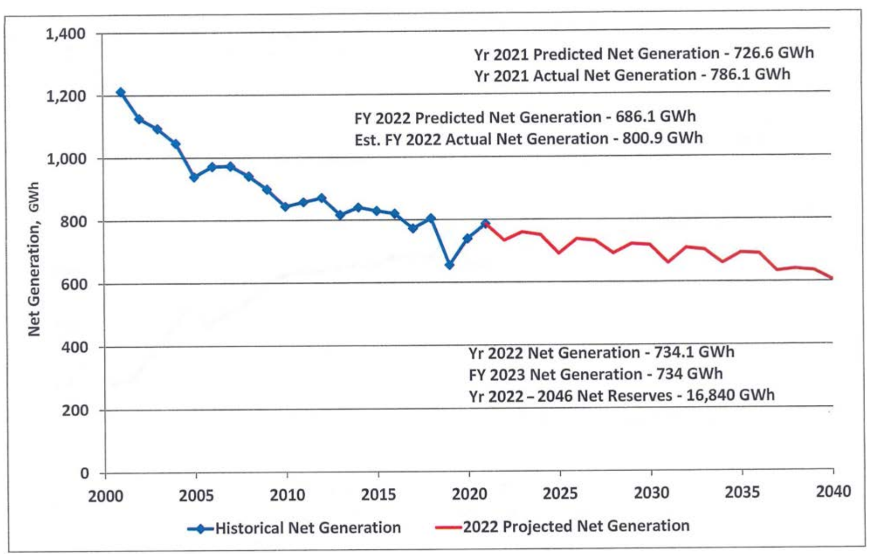

Figure 34. Geysers Geothermal Historical and Forecast Net Energy Generation[13]

12 *NCPA Steam Field Operations & Forecast Report—April 2022*; Figure 14, p. 23.

13 *Ibid.*; Figure 15, p. 24.

The Central Valley Project Forecast

TID contracts with WAPA's CVP for non-dispatchable hydroelectric generation. WAPA publishes a CVP Power Resources Report, which describes the functions that WAPA fulfills. Forecasts for resources from CVP are based on actual generation from 2012–2022 and cycled through at random, with associated low hydroelectric years during higher market prices cycled approximately 70 percent of the time. Thus, CVP hydroelectric power forecasts are conservative and represent an amount that can be delivered with a high degree of certainty.

The IRP forecasts CVP generation in 2023 to be similar to that of 2017, and forecasts 2024 to be an average year. Starting in 2025, the CVP forecast annually decreases capacity (in MW) by one half percent per year until 2045. Capacity values are taken from the long-term averages published in the Power Resources Report, which has been decremented by 30 percent starting in 2025.

Monthly base resource CVP data is divided into on-peak and off-peak energy based on daily data. For long-term power modeling, April, May, and August are split into sub-periods to more accurately model significant changes in energy pumping and San Luis generation (on one of CVP's reservoirs) that generally occurs in those months.

Figure 35 depicts the average of base resource on-peak and off-peak energy of all water years for each month and split-month.

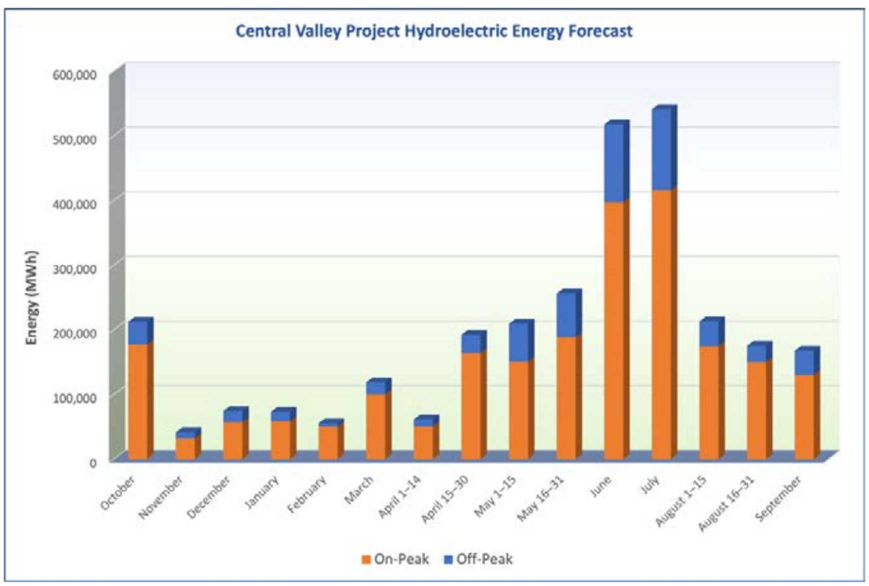

Figure 35. CVP Average Base Resource Energy for All Water Years[14]

14 *Central Valley Project Power Resources Report ("Green Book 2004")*, WAPA; Figure 4-4 – CVP Base Resource (Energy), Average All Years, p. 40.

Emerging Technologies

TID considered commercially available resources and mature storage technologies for this IRP. In future IRPs, however, TID plans to consider emerging technologies, including but not limited to green hydrogen fuel, small modular reactors (SMRs), long-duration energy storage (LDES), pumped-storage hydroelectricity (PSH), and carbon capture and sequestration (CCS).

Green Hydrogen Technology

Green hydrogen can provide clean, dispatchable power. The process of converting renewable energy to hydrogen followed by the hydrogen combustion to produce electricity provides a method to dispatch clean energy when needed to match load. Therefore, green hydrogen is often categorized as energy storage.

Green hydrogen technology is still an emerging resource option with projects in development that are expected to use a blend of green hydrogen and natural gas to generate electricity. Technological advances are underway to create turbines capable of running on pure hydrogen. Currently, there are no contracts or projects in place for generation from 100 percent green hydrogen. Technology to run green hydrogen will likely be commercially available in the near future, but the timing is uncertain.

Green hydrogen is produced via electrolysis from renewable electricity. Hydrogen generation requires combustion turbines engineered to burn pure hydrogen, pipelines to transport the hydrogen, and a means to store hydrogen on-site. The added infrastructure requirements coupled with energy losses (including storage leakage and boil off) from hydrogen production from wind or solar power currently make green hydrogen an expensive option. Tax-reduction incentives in the IRA, however, provide for a tax credit of up to $3.00 per kilogram for green hydrogen.

This uncertainty and potential high costs lead TID to forgo including green hydrogen as a candidate resource in the capacity expansion models for this IRP. As the technology is commercialized and adopted by utilities, costs may come down.

TID will continue to follow developments in green hydrogen for potentially including this technology in a future resource plan.

Small Modular Reactors

Nuclear technology is evolving towards smaller, flexible generators known as small modular reactors (SMRs) that can be assembled in a modular fashion for easy future expansion. SMRs are advanced nuclear fission reactors capable of generating up to 300 MW that can be built in one location, then shipped, commissioned, and operated at a separate site. SMRs are, by design, small when compared to traditional reactors and they provide carbon-free, fully dispatchable energy. Costs, however, currently are higher than green hydrogen, with forecasts of approximately $155 per MWh of energy.

To date, no SMRs have been installed in the United States as of yet, but multiple companies are working to develop this emerging technology. There are potential SMR projects in the planning stages.

Long-Duration Energy Storage

California's move to decarbonize its energy sector is requiring vast increases in variable renewable generation, mainly from solar and wind. Integrating these variable resources strains the existing power generation, transmission, and distribution infrastructure, creating new flows of electricity and potential imbalances in supply and demand, changes in transmission flow patterns, and creating the potential for greater system instability.

One solution being explored is long-duration energy storage (LDES)—enabling variable renewable resources to be stored when generated, then dispatched for days or even weeks to manage the balance between supply and demand. LDES technology is not being planned to use the same Lithium-Ion technology employed in 4-hour and 8-hour BESS. LDES, instead, encompasses mechanical, thermal, electrochemical, and chemical storage technologies that can be deployed to store energy for prolonged periods and scaled up economically to sustain energy needs.

A medium-duration 12-hour Iron Flow battery is currently being developed. While commercially available, it is in the pilot stage and not yet widely installed. A 100-hour Iron-Air battery is another LDES currently being developed with plans for small pilots with multiple utilities. Neither is expected to be available until at least 2030.

The United States Department of Energy (DOE) is conducting an LDES Demonstration program funded with $505 million from the Bipartisan Infrastructure Law. The program's goal is to "advance LDES systems toward widespread commercial deployment by providing an opportunity for nascent LDES technologies to overcome the technical and institutional barriers that exist for full-scale deployment with a focus on a range of different technology types for a diverse set of regions."[15] The DOE defines LDES as a storage system capable of delivering electricity for 10 or more hours in duration.

15 https://www.energy.gov/oced/long-duration-energy-storage-demonstrations-0#moreinfo

Pumped-Storage Hydroelectricity

Pumped-storage hydroelectricity (PSH) is a type of hydroelectric energy that includes energy storage. It is a mature technology that has been successfully implemented around the world in grid applications.

PSH facilities use reversible turbine-generators to pump water from a lower reservoir into one at a higher elevation, thus storing potential energy. The distance between these two reservoirs—be they natural bodies of water or artificial reservoirs—must be high enough to generate power.

Water would typically be pumped during off-peak periods when the cost is low, or during periods of excess energy generation from variable renewable resources. Water in the upper reservoir can be stored indefinitely as potential gravitational energy. During periods of high net demand, water stored in the upper reservoir is subsequently released through the turbine-generators to produce electricity. Thus, PSH can provide peaking capacity and load shifting capabilities.

While PSH has a relatively high capital cost, its useful life is 50 years or more. Pumped energy storage is very efficient, with round trip efficiencies approaching 80 percent. An adjustable speed pump turbine offers more precise control, thus providing operating flexibility. This, in turn, allows PSH to provide a number of ancillary services (such as frequency regulation, voltage support (dynamic reactive power), spinning and non-spinning reserve, load following, and black start) as well as energy services such as peak shaving and energy arbitrage. This can increase operating efficiencies, improve dynamic behavior, and lower operating costs.

In the past, TID has performed scoping exercises for a large-scale pumped hydroelectric project. For future IRPs, we plan to revisit PSH as a generation and energy storage option.

Carbon Capture and Sequestration

Carbon capture and sequestration (CCS) is the process of capturing, securing, treating, transporting, and storing CO_2 in a long-term storage location. The idea is to stabilize carbon in solid and dissolved forms to reduce GHG emissions. CCS can greatly reduce CO_2 emissions from coal-fired and natural gas-fired power plants as well as from large industrial sources.

There are two main types of carbon sequestration: biological and geological. Biological carbon sequestration is the process of storing CO_2 in vegetation (such as grasslands or forests) as well as in soils and oceans. Geological carbon sequestration is the process of storing CO_2 in underground geologic formations, or rocks. The captured CO_2 is injected into deep underground rock formations. These formations are often a mile or more beneath the surface and consist of porous rock that holds the CO_2. Overlying these formations are impermeable, non-porous layers of rock that trap the CO_2 and prevent it from migrating upward.

In June 2023, on a 65-acre site in Ector county, Texas, a $1 Billion project called Stratos began construction with funding from the DOE. The project, currently the largest in the world, aims to remove 500,000 tons of CO_2 from the atmosphere every year when the facility is fully operational in 2025.[16] In August, the DOE announced that two facilities, one in Texas and one in Louisiana, were awarded $1.2 Billion to act as hubs to help drive the carbon-removal industry in the United States. These two facilities aim to purge more than 2 million tons of COs from the atmosphere.[17]

While CCS shows promise for reducing the human carbon footprint, there are skeptics as to its effectiveness especially when compared to its costs. TID plans to monitor CCS for its potential inclusion in a future resource portfolio.

16 https://www.theguardian.com/environment/2023/sep/12/carbon-capture-texas-worlds-biggest-will-it-work

17 https://www.energy.gov/articles/biden-harris-administration-announces-12-billion-nations-first-direct-air-capture

5. Transmission and Distribution

Bulk Transmission System

TID owns 379 miles of transmission lines. The TID electric system is directly interconnected to several bulk transmission systems:

- Hetch Hetchy Water and Power (CAISO BA) at Oakdale 115kV Switchyard
- Pacific Gas and Electric (CAISO BA) at Oakdale 115kV Switchyard
- Modesto Irrigation District (Balancing Authority of Northern California (BANC) BA) at Walnut 230kV Switchyard and Westley 230kV Switchyard
- WAPA (BANC BA) at Westley 230kV Switchyard
- Merced Irrigation District (TID BA) at August 115kV Substation and Tuolumne 115kV Switchyard

TID owns a portion of the California-Oregon Transmission Project (COTP) that provides 237 MW of transmission rights to the California-Oregon Border (COB). TID also is a partial owner of the Pacific Northwest AC Intertie providing access from the northwest for delivery at COB.

The combination of these transmission assets increases the market footprint that TID can participate in and allows TID to participate in the NWPP Reserve Sharing Group.

Distribution System

TID owns approximately 2,200 miles of distribution lines and 29 substations. To maintain the reliability of our electric system, we invested approximately $5.9 million in new distribution facilities and line upgrades in 2022.

TID regards the reliability of our distribution infrastructure carefully and regularly plans, constructs, operates, and maintains a variety of projects and activities dedicated to preserving a high standard of reliability for every TID ratepayer. Over the planning period, distribution system upgrades can include work dedicated to replacing equipment that has reached its useful end-of-life, system voltage control improvements, system capacity improvements, system load balancing improvements, new construction, and more.

TID employs industry standard reliability measures to monitor service quality. We undertake several programs to reduce the number and duration of distribution system outages. These programs include:

- Trimming trees to clear paths for distribution lines.
- Replacing underground cables based upon failure trends.
- Prioritizing preventative equipment inspections according to reliability impact.
- Refining data categorization to better maintain reliability.

2022 recorded an average of less than one outage per customer, which meant that the average customer was without power for approximately 68 minutes. TID continues to use these statistics to help identify opportunities to improve our distribution system.

During normal operations, TID has no load-constrained areas within our electric system—areas that can only be reliably served with sufficient, local, dispatchable generation capable of providing operating reserves and the associated energy when loads are high. However, as load increases throughout the day, TID dispatches must-run generation to manage power flow patterns.

TID regularly analyzes our electric system to identify the need for potential system upgrades. TID currently anticipates future transmission and distribution projects to support projected load growth, the expansion of DERs, as well as transportation and building electrification loads. Nonetheless, we expect that our current internal local generating capacity has the capability to serve anticipated load growth over the planning period. After that, we anticipate adding capacity to address transmission constraints, distribution constraints, expected load growth, distributed generation growth, and EV load growth.

Currently, about 55 MW of customer-installed solar PV is connected to the TID system, which is forecasted to reach about 93 MW by 2030. (See Distributed Generation Forecast on page 4-5.) Most customer-installed solar PV systems are quite small and not concentrated in any specific local area. Over 90 percent are residential systems with an average size of 0.006 MW. Less than 2 percent of our customer-installed solar PV systems have capacities greater than 0.25 MW. As such, these installations have not caused major issues on the TID transmission and distribution systems despite their occasional unpredictability.

According to NREL and their published solar insolation data, the TID service area is less favorable to solar generation, particularly when compared with the southern parts of California. Still, TID continues to receive inquiries for interconnecting larger solar PV facilities, several of which are actively exploring interconnecting to the TID service area. No large solar PV facilities have as yet interconnected to TID, and none are a certainty in the immediate future. TID will continue to monitor the growth of customer-installed solar PV and the potential for larger solar PV facilities interconnecting to our service area and carefully evaluate the reliability impacts to our electric system.

EVs continue to proliferate. By the end of 2022, there were over 2,600 EVs geographically dispersed throughout our service area, a rapid rise from a few hundred vehicles only five years before. While EVs have yet to make a substantive impact on our electric system, we forecast the number of EVs in our service area to more than double during the planning period. We recently launched an EV Program designed to promote EV adoption. (See Transportation Electrification and Electric Vehicle Forecast on page 4-18.)

TID forecasts that the growth in the customer-installed PV systems and EV adoption will remain dispersed throughout our service area. As such, we currently have no planned upgrades or enhancements to our transmission and distribution system dedicated to their impact. TID will continue to monitor their impact on our electric system and respond as necessary to incorporate their load to maintain reliable service.

6. Local Air Quality

Impacts on Local Air Quality

To best understand TID's impact on local air quality, we will provide some historical perspective on TID's electric operations.

1887. TID was the first irrigation district established in the State of California.

1923. Construction of the Old Don Pedro Dam and powerhouse completed, TID began serving local retail power. As our service territory was developed and the demand for power increased over the subsequent four plus decades, TID expanded our portfolio of electric generating resources to serve our mission of providing low cost, reliable power to customers.

1971. The Don Pedro Dam was expanded, ensuring an adequate supply of water and power for generations to come. The Don Pedro reservoir, dam, and powerhouse also provide numerous recreational and environmental benefits to the region, and is a GHG-free generating resource.

1979. TID began constructing the first of eight small scale hydroelectric power plants at strategic points on our canal system—in other words, at locations where water flows were sufficient to spin a turbine. In addition, TID constructed several small hydroelectric plants on the canal systems of surrounding irrigation districts.

1986. TID began building the Walnut Power Plant. The unit came online the following year.

1995. TID began building the Almond Power Plant, which came online in 1996.

1996. The California State Legislature passed AB 1890, paving the way for deregulating California's wholesale power market.

2001. The California energy crisis occurred. Many in the state were without power for extended periods of time. When power was available, the majority of Californians paid exorbitant power prices. TID, due to an interconnection with the newly created CAISO, was subject to rolling brownouts. As a result, TID decided to become our own BA, ensuring that TID customers would have access to reliable power.

2005. TID built the Walnut Energy Center (WEC), a state-of-the-art combined-cycle natural gas-fired plant. WEC provided the necessary power, voltage support, and reserves for TID to become a BA, ensuring that the lights stayed on in the TID service area.

2006. The California Legislature passed two energy-related bills. AB 32 required GHG emissions to be reduced to 1990 levels by 2020. SB 1 required utilities to adopt and implement a process for developing customer solar PV rooftop installations.

2009. TID built TWP, a 136.6 MW wind power plant—two years ahead of state renewable energy requirements and eight years ahead of TID's Board adopting a goal of 20 percent renewable energy by 2017. TWP remains a staple of our renewable generation portfolio.

2011. The California Legislature passed SB X1-2 establishing, for the first time, tiered renewable energy portfolio requirements that culminated in a 33 percent penetration by 2020 on POUs.

2012. TID completed construction of A2PP, which provides the needed flexibility to serve demand reliably.

2014. Driven by market conditions and potential expiration of tax credits on certain renewable resources, TID issued an RFP for renewable projects. TID considered all technologies, ownership arrangements, term lengths, and siting locations. After a lengthy and rigorous evaluation process, TID signed the Golden Fields Solar I PPA for the Rosamond West Solar 2 resource. The Rosamond West Solar 2 resource generates enough energy to power approximately 20,000 homes every year and helps TID meet our 60 percent RPS requirement by 2030.TID began to receive power from the Rosamond West Solar 2 resource in early 2017.

TID continues to monitor the renewables market and is poised to add another layer to our portfolio to continue to meet renewable energy goals and benefit our customers.

Environmental Sustainability

One of the objectives when building and operating a generation plant is to minimize environmental and air quality impacts. To achieve this, TID conducts extensive air quality impact analyses to show that any impact on ambient air quality is going to be mitigated to the satisfaction of several agencies. These agencies include the United States Environmental Protection Agency (EPA), CEC, CARB, and the San Joaquin Valley Air Pollution Control District (which holds regional jurisdiction over TID's natural gas-fired generating plants).

TID prepares these air quality impact analyses in accordance with SJVAPCD-approved modeling protocols. The analyses use dispersion models and techniques that have been accepted by the CEC for other similar sites. We conduct ambient air impact assessments using EPA-approved air quality dispersion models.

The CEC requires natural gas thermal units to undergo a permitting process that entails a thorough and extensive 12-month evaluation certified under the California Environmental Quality Act (CEQA). The CEC permitting process provides many opportunities for public participation to assure compliance with federal, state, and local laws and regulations. For any project under CEQA's jurisdiction, the agency, such as TID, sponsoring the project must identify mitigation measures and alternatives by preparing an Environmental Impact Report (EIR). The agency—TID—must also approve projects with feasible mitigation measures and the environmentally superior alternative.

CEQA guidelines list 18 areas for identifying mitigation measures and environmental impacts for units submitted to the permitting process. These areas are:

Aesthetics	Biological Resources	GHG Emissions
Land Use	Housing	Traffic and Transportation
Cultural Resources	Hazardous Materials	Agriculture and Forestry Resources
Mineral Resources	Public Services	Utility Systems
Air Quality	Geology and Soils	Water Quality
Noise	Recreation	Mandatory Finding of Significance

The SJVAPCD is the local agency that issues the Authority to Construct permits and Permits to Operate. The SJVACPD ensures that all power plant projects are constructed and operated according to federal and state regulations as well as SJVAPCD rules. TID has identified the environmental impacts and described mitigation measures for all units submitted through the permitting process. The CEC permitted WEC and A2PP; Almond and Walnut are non-CEC permitted units.

Every TID natural gas plant has gone through the rigorous SJVAPCD permitting process that includes the New Source Review process, which requires the plant to implement Best Available Control Technology to control emissions and adequate amounts of emissions offsets to ensure the plant will not deteriorate the ambient air quality. The permitting process also includes a Risk Management Analysis that determines the concentration of identified pollutants near local residents and worksites, compares the projected concentration of each identified pollutant to national and state standards, then analyzes them for the potential health risks.

After undergoing this rigorous permitting process, the submitting agency, TID is obligated to construct and operate the project according to all the federal and state regulations and the SJVAPCD rules outlined in its permit. The CEC permitting process adds another compliance layer for all the areas described in the CEQA process: the project must maintain a compliance program.

The emissions from Almond, A2PP, and WEC are monitored by a Continuous Emissions Monitoring System (CEMS) to satisfy federal regulations. The CEMS requires its own maintenance program to ensure quality data, when it is measured, complies with all emission limits. The CEMS is subjected to daily calibrations and quarterly quality assurance tests using EPA-certified calibration gas cylinders to ensure quality data. In addition, an Annual Source Emissions Testing and a Relative Accuracy Test Audit are performed to test the CEMS equipment against a third-party CEMS to ensure that the gas turbine units are within their permitted emission limits.

In addition to CEC and SJVAPCD compliance, WEC, A2PP, and Almond are subject to annual federal and state GHG reporting. TID actively monitors carbon monoxide and nitrogen oxides (NOx) at these three power plants and reports those values to the SJVAPCD and EPA. These three power plants plus Walnut are also subject to California's Air Toxics "Hot Spots" Information and Assessment Act (AB 2588).

For all four power plants, TID reports permitted values for total organic gases, reactive organic gases, volatile organic compounds, oxides of sulfur, and two types of particulate matter: PM2.5 and PM10. WEC, A2PP, and Almond are all located near a major freeway and agriculture land which are major sources of particulate matter, leaving TID limited abatement opportunities.

7. Disadvantaged Communities Issues

TID offers several programs for low-income customers and disadvantaged communities—some of which have been in place since the 1990s. Here are the program details.

- Through the TID CARES Program, low-income customers receive payment assistance. Eligible customers receive an $11 discount on the residential customer charge and a 15 percent discount on the first 800 kWh of monthly energy use.
- Customers who depend on medical equipment, or if their medical condition requires special heating or air conditioning, receive rate assistance. Eligible customers receive a 50 percent discount on the first 500 kWh of monthly energy use.
- Residential customers can take advantage of a “Budget Billing” option to eliminate the bill shock associated with months of high energy use. TID simply divides a customer annual electric bill into equal monthly payments, so the customer has the same bill every month.
- Low-income customers can participate in TID’s Weatherization Program, a direct install program. TID contracts a third-party vendor who installs a wide variety of energy efficiency measures in customer homes free of charge.

TID endeavors to gain a deeper understanding of our customers: their demographics, interest levels in our products and services, and opportunities to improve service. Toward that end, we commissioned a comprehensive research project by surveying over 1,000 of our customers in 2018. In 2021, we commissioned an updated study to gain further insight. The primary goal of the research project was to assess the effectiveness of TID’s ability to serve customers in areas of our service territory classified by the California Legislature as either “disadvantaged communities” (as determined by Senate Bill 535) or a “low-income community” (as determined by Assembly Bill 1550). A majority of the TID service territory is classified as either disadvantaged or low income. The surveys provided us with a wealth of information about our customer base. We will strongly consider those insights in our future policy discussions and program design.

The CEC report, *SB 350 Low-Income Barriers Study, Part A – Commission Final Report*, promulgated 12 recommendations to promote a coherent vision for low-income clean energy programs, explore innovative solutions to expanding access, and ensure that economic benefits of public investments are realized by low-income customers and disadvantaged communities. TID is familiar with the recommendations. A core tenet of TID’s mission is to keep energy rates low for all customers, and to continue serving our customers with low cost, reliable power.

Figure 36 compares TID's rates in various classes[18] from 2023 with three other California utilities: Modesto Irrigation District (MID), Sacramento Municipal Utility District (SMUD), and MeID. In every rate class, TID's rates are lower than the average for the four POUs. In seven of the eleven rates classes, TID's rates are the lowest.

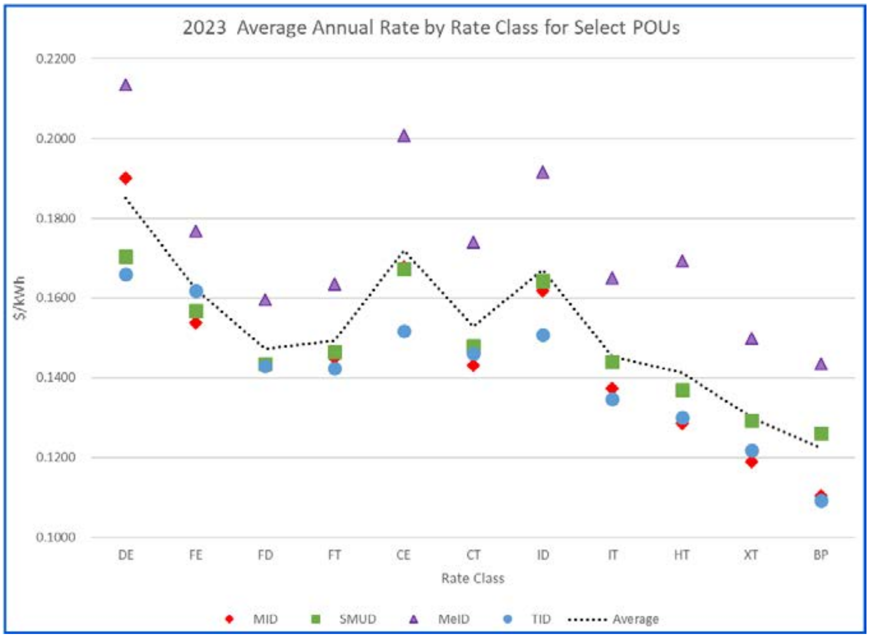

Figure 36. 2023 Average Annual Rate Comparison for Selected POUs

Due to prudent planning, TID offers some of the lowest energy rates in California, keeping costs down for residential customers and making our service territory attractive for commercial and industrial expansion. TID is already enacting some of the report's 12 recommendations: our commissioned surveys, our Weatherization Program and our energy efficiency program. This program offers no-cost, direct installation of energy efficiency measures such as LED lighting, weather stripping, and caulking for customers in multi-family complexes located in disadvantaged communities and low-income areas.

TID recently implemented a rebate for purchasing an EV and installing an EV charger, with extra incentives for low-income customers. (See Transportation Electrification and Electric Vehicle Forecast on page 4-18.) We have also considered and evaluated the merits of a community solar program and will pursue it further if deemed in the best interest of our ratepayers.

18 DE: Domestic Service (residential); FE: Farm Service (energy rate); FD: Farm Service (demand rate); FT: Farm Service (time-of-use); CE: Commercial Service (under 35 kW); CT: Commercial Service (time-of-use under 35 kW); ID- Small Industrial Service (demand 35–499 kW); IT: Small Industrial Service (time-of-use 35–499 kW); HT: Large Industrial (demand 500–2,999 kW); XT: Very Large Industrial; BP: Bulk Power Industrial

8. Rate and Cost of Service Impacts

One of TID's core values has focused on bringing value to the communities that we serve. Toward that end, TID developed a Strategic Plan in 2020. In it, we included our mission statement:

> TID will provide reliable and competitively priced water and electric service, while being good stewards of our resources and providing a high level of customer satisfaction.

In keeping with our mission statement, TID's aim to keep retail electric rates low resonates throughout all TID departments. Due to prudent planning, TID has some of the lowest energy rates in California, making our service territory attractive for commercial and industrial expansion, as well as keeping costs down for our residential sector.

Our locally-elected, five-member Board of Directors, in a transparent process, sets our retail rates.

To set our rates, TID annually evaluates revenue requirements to ensure strong financial standing. We align customer rates with the costs of service to keep rates competitive and stable. The TID Board ensures that electric rates are sufficient to pay for operating and maintaining the TID electric system as well as sustain adequate financial reserves to service debt, cover the capital costs of new facilities and improvements to existing facilities, and meet the costs incurred from implementing various laws and mandates.

In 2020, TID completed our Advanced Metering Infrastructure (AMI) and implemented a new Customer Information System. Both systems enable us to gather and process large amounts of data that are critical for us to tailor programs and evaluate rate incentives that align with grid and supply conditions—all of which benefit our customers as well as our overall distribution system.

In keeping with the state's initiative on transportation electrification, TID adopted an EV charging rate option for customers who own a plug-in electric vehicle in 2022.

9. Planning Analysis and Results

The fundamental purpose of integrated resource planning is to ensure adequate capacity to generate energy for current and forecasted demand, while maintaining reliability, ensuring competitive and stable rates, and meeting state regulatory requirements.

The future TID system must continue to be reliable, sustainable, and affordable. Ascend used three different models to test various ways that TID's portfolio can meet these needs.

Resource Adequacy Model. Determine the reliability of the portfolio to meet the specified load forecast by determining the loss-of-load probability (LOLP) for the planning period.

Capacity Expansion Model. Determine the cost-optimal procurement type, quantity, and timing for new energy and capacity resources to meet future capacity and energy (including clean energy) targets. Ascend's capacity expansion model is known as Automated Resource Selection (ARS).

Production Cost Model. Simulate the load-limited economic dispatch of the portfolio (as informed by the capacity expansion modeling) over the planning horizon. This modeling helps to confirm that TID is meeting the specified RPS, zero-carbon, and carbon emissions targets.

Planning Methodology

Resource planning is used to determine a path from the current energy supply portfolio to the future capacity and energy needs of the utility. Planning for the future requires a clear understanding of what the energy supply is today. The key benchmark metrics for the current portfolio are reliability and energy mix. Modeling the system's reliability allows the planning process to make inferences about what capacity resources are necessary to serve load in a reliable manner in the future. Modeling the energy mix helps chart a path toward meeting clean energy and emissions goals and requirements in the future.

The first phase of modeling for the IRP is to establish TID's capacity needs and the value of incremental generation to the system. The current capacity position is modeled using resource adequacy models. The outcome of this initial phase of modeling determines the inputs used in the capacity expansion model to ensure adequate new capacity is built to maintain a reliable system. The second outcome of the initial reliability modeling is to determine effective load carrying capacity (ELCC) for variable generation and storage resources. ELCC is a metric that estimates the equivalent firm capacity a resource can contribute toward meeting a reliability metric, such as the common

1-in-10 standard. The 1-in-10 standard as used in this analysis refers to one day of unserved energy in ten years.

After using initial resource adequacy modeling to establish TID's capacity needs, the modeling process turns to the capacity expansion phase to determine the least-cost buildout that meets both capacity and energy needs. In capacity expansion modeling, the energy needs for TID are determined by customer load, RPS requirements, and clean energy requirements set by SB 350, SB 100, and SB 1020. These laws collectively have established the following key clean energy targets:

- At least 60 percent of retail sales from 2030 onward must be from RPS resources[19]
- At least 90 percent of retail sales from 2035 onward must be from zero-carbon resources[20]
- At least 95 percent of retail sales from 2040 onward must be from zero-carbon resources
- 100 percent of retail sales from 2045 onward must be from zero-carbon resources

To meet the RPS and zero-carbon requirements, TID must add new resources to existing supply resources in the portfolio. The "Candidate Resource Costs and Capacity Factors" section (page 4-14) describes the candidate resources available to the capacity expansion model to select the lowest-cost, new resource buildout subject to the RPS and clean energy constraints.

The portfolios selected in capacity expansion are required to meet constraints on an annual basis. A second phase of resource adequacy modeling ensures that all selected portfolios maintain reliability throughout the planning period. If any portfolio does not meet the reliability standards, a second iteration of capacity expansion and reliability analysis is performed.

The final phase of modeling for the IRP is production cost modeling. Production cost modeling provides a view into the hour-by-hour operations of the TID system. Production cost modeling seeks to provide insight into the energy mix of the portfolio, emissions, and variable costs. This final phase of modeling demonstrates the portfolio's compliance with RPS, clean energy, and emissions requirements as well as rates and total system costs.

19 RPS-eligible resources relevant to the TID portfolio include solar, wind, geothermal, biomass, and small-scale hydroelectric (less than or equal to 30 MW nameplate capacity).

20 Zero-carbon resources relevant to the TID portfolio include solar, wind, geothermal, biomass, and both large-scale and small-scale hydroelectric. Current generation from Don Pedro Hydroelectric Project counts as a zero-carbon resource; the planned incremental upgrade to the existing large-scale turbine capacity at Don Pedro will count as an RPS-eligible resource. Nuclear generation counts as a zero-carbon, but not an RPS-eligible, resource.

Modeling and Analysis Framework

Input Assumptions and Portfolio Modeling

TID licensed PowerSIMM, developed by Ascend Analytics, for the modeling work in this analysis. PowerSIMM provides capacity expansion, resource adequacy, and production cost modeling. The modeling in this IRP relied on stochastic models for capacity expansion and production cost. The modeling team configured PowerSIMM to capture variability and uncertainty in load, renewables, and prices while maintaining structural parameters among the variables.

PowerSIMM simulations combine future expectations for load, markets, and renewables, with historical data to create realistic future simulations of the power system. Simulations are scaled to future expectations based on monthly forecasts for renewable generation, load, and prices including price volatility and daily price shapes. The result is a set of simulations covering a useful and accurate range of potential future paths.

ARS selects the least-cost resource procurements or retirements that satisfy the model constraints. The models begin with a dispatch of existing and candidate resources to determine variable costs, energy generation, carbon emissions, and renewable generation over the long-term planning period. The modeling employed four constraints.

Planning Reserve Margin. Requires the portfolio to meet projected annual peak demand plus a 15 percent PRM.

Emissions. Reduces generation from existing natural gas assets to ensure the resultant portfolio complies with the TID-specific emissions targets set by CARB as required by SB 350.

IRP Electricity Sector GHG Planning Targets: 2023 Update. TID's portfolio must account for less than 239,000 MTs of carbon dioxide (CO_2) emissions on a net basis.

RPS and Zero-Carbon Levels. Requires adequate renewable generation to ensure the resultant portfolio complies with the RPS requirements of SB 350, SB 100, and SB 1020.

Outputs from ARS provide the timing and quantity of resources to procure over the long-term planning period that satisfies these four constraint categories at the lowest cost. The model considers full resource costs including capital costs, fixed costs, and variable costs (such as start-up costs, fuel, and variable operation and maintenance (VOM) costs). Market sales revenue is treated as a negative cost in the model.

Risk Analysis

The future can only be predicted through research and forecasts. Modeling the future and planning based on the results comes with risk. Every effort is made to minimize this risk, which must be considered when devising and implementing any plan. The stochastic nature of PowerSIMM resource planning helps to better understand future uncertainty.

Risks inherent in resource planning include:

- Higher than expected environmental compliance costs
- Higher than expected carbon prices
- Higher than expected resource generation costs
- Higher than expected transmission and distribution costs
- Direct and indirect environmental costs
- Transportation costs

Additional risks include increased demand and energy requirements, regulatory energy policy changes, and financial liquidity risks. Resource planning attempts to mitigate these risks as much as possible so that resultant actions remain viable for the foreseeable future.

TID included risk from generation costs, load, renewable generation, and market prices by simulating the system multiple times in our models to capture a wide range of values for all variables contributing to uncertainty in the outputs. This uncertainty was directly considered in the resource selection algorithms of ARS.

Resource Adequacy Modeling

A critical component of the IRP process involves understanding how well TID's current portfolio can handle peak system load, both today and in the future. Reliability metrics such as loss-of-load hours (LOLH) and expected unserved energy (EUE) can be used to quantify the degree to which the system can adequately meet demand throughout the planning period. Forecasts of energy demand and peak load for 2023–2045 were discussed in the Load forecast section. Once an understanding of the current portfolio's resource adequacy has been established, the incremental reliability benefit of adding new resources can be established through ELCC for each technology type.

Loss of Load Hours and Expected Unserved Energy

LOLH refers to the number of hours over a given period (typically annual) in which generation is insufficient to meet load. Every LOLH is treated the same regardless of the depth of the shortfall; the metric simply reflects a count of how many times this occurs.

EUE is a related, but slightly different metric. EUE is measured in MWh and is the sum of the unserved energy across all LOLHs that occur in a given year. Figure 37 illustrates these related concepts over a single day.

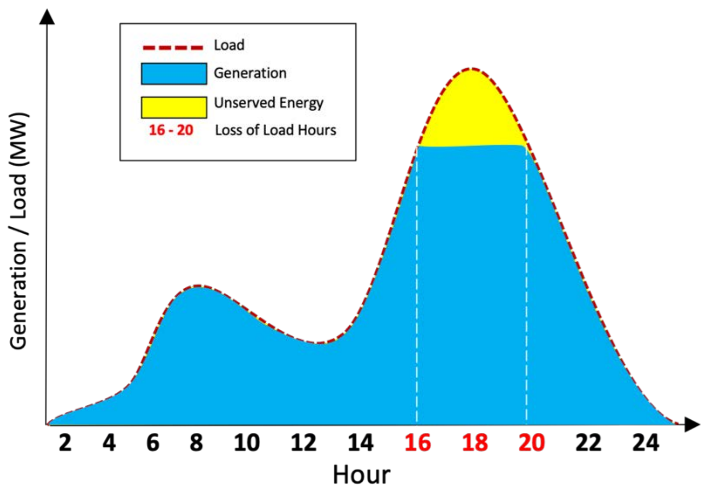

Figure 37. Simplified Loss-of-Load Hour (LOLH) and Expected Unserved Energy (EUE) Depiction

On this example day, the LOLHs are the four-hour range indicated by the red numbers on the horizontal axis, while the EUE would be the area of the yellow shaded region during these same hours.

As a starting point for the resource adequacy modeling for this IRP, PowerSIMM modeled the current TID portfolio of existing and planned generation and storage assets (as of July 2023) together with the assumed future load forecasts. An LOLP analysis was conducted on this portfolio for the year 2027, the first year that resources are allowed to be selected by the ARS capacity expansion model.

The common reliability metric of one day of load loss in 10 years (2.4 LOLH per year) was used as a calibration or target metric. By determining the amount of additional 'perfect' capacity (that is, dispatchable capacity with a forced outage rate of 0 percent) required in each year for the portfolio to reach the target reliability metric, a baseline capacity short position estimate was established. The results of this analysis indicated that TID's capacity short would be approximately 24 MW in 2027. Thus, TID's current portfolio would maintain the 1-in-10 target reliability in 2027 with resource additions equivalent to 24 MW of firm capacity in that year.

Effective Load Carrying Capability

ELCC analysis serves as an essential tool for determining the contributions that can be expected from non-dispatchable assets in reaching reliability targets. Energy output from variable generation sources such as wind and solar may not (and often does not) coincide with the peak energy demands of the system. This contrasts with a dispatchable asset such as a natural gas-fired power plant which can be called on to serve load at specific times of day when demand is greatest. Simulating how including a new variable generation resource affects overall system reliability targets allows TID to effectively calculate the equivalent amount of firm (dispatchable) capacity that would need to be added to the system to achieve that same level of reliability. The ratio between this firm capacity and the nameplate capacity of the variable generation resource added to the portfolio is the ELCC for that resource, typically expressed as a percentage.

$$ELCC\ (\%) = \frac{Firm\ capacity\ equivalent\ (MW)}{Nameplate\ capacity\ of\ resource\ (MW)} * 100\%$$

Standard practice involves assessing ELCC values within a portfolio that has been calibrated to the reliability target of interest (in this case, 2.4 LOLH per year). When there is a portfolio capacity shortfall—when LOLP analysis concludes that the reliability metric for the current portfolio was greater than 2.4 LOLH per year—'perfect' capacity must be added to the portfolio to calibrate it.

For each candidate resource type (excluding geothermal units, which were assumed to have 100 percent ELCC values when they were modeled), incremental 100 MW blocks of capacity were successively added to the portfolio. At each increment, an LOLP analysis was run to assess the EUE at various additional 'perfect' capacity increments. The equivalent amount of firm capacity that yielded the same reduction in EUE in the previous iteration's portfolio (that is, the baseline portfolio for that iteration) could be determined, which then yielded the marginal ELCC for that resource amount.

That incremental portfolio then became the baseline portfolio for each subsequent iteration. The process repeats for five iterations, adding up to 500 MW of capacity for each candidate resource type. The five marginal ELCC values obtained from a downward sloping curve, which is the expected behavior as additional increments of the same resource type, are added to the portfolio.

Table 6 and Figure 38 depict the marginal ELCC values for various capacity increments for 4-hour and 8-hour storage variable candidate resources.

Candidate Resource	0–100 MW	100–200 MW	200–300 MW	300–400 MW	400–500+ MW
Northern California Solar	14.6%	0.6%	0.0%	0.0%	0.0%
Southern California Solar	18.6%	1.0%	0.0%	0.0%	0.0%
Wyoming Wind	15.6%	3.5%	1.6%	1.0%	0.6%
New Mexico Wind	10.6%	2.4%	1.0%	0.5%	0.3%

Table 6. Marginal ELCC for Candidate RPS-Eligible Variable Candidate Resource Percent Data

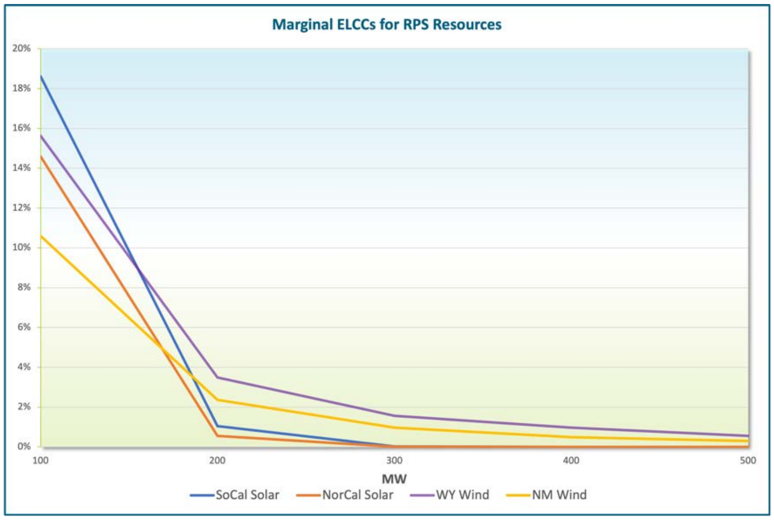

Figure 38. Marginal ELCC for Candidate RPS-Eligible Variable Candidate Resources

Table 7 lists the marginal ELCC values for various capacity increments for 4-hour and 8-hour storage variable candidate resources. Figure 39 depicts the marginal ELCC values of these same resources for the various capacity increments.

Candidate Resource	0–40 MW	40–80 MW	80–120 MW	120–160 MW	160–200+ MW
4-hour Battery	61.4%	46.5%	41.4%	30.7%	28.2%
8-hour Battery	89.3%	68.9%	68.0%	33.8%	16.0%

Table 7. Marginal ELCC for Storage Candidate Resources Percent Data

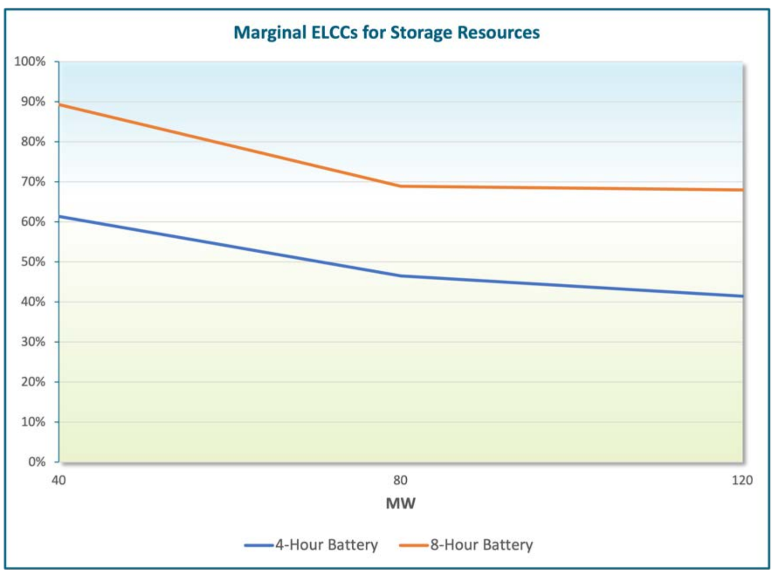

Figure 39. Marginal ELCC for Storage Candidate Resources

Given the increasing peak load forecast, additional capacity resources may be needed in future years beyond 2027 to maintain reliability and TID's planning reserve margin.

Capacity Expansion Results

Resource Adequacy Requirements

TID has a Board-approved Resource Adequacy Policy that requires that we procure sufficient resources to meet 115 percent of forecasted peak demand for a month at least one month before the beginning of such month. This policy ensures that TID has sufficient resources to serve customer demand and provide operating reserves to meet applicable WECC requirements. Due to this policy, the PRM for this analysis was set at 15 percent above forecast peak load for the planning period.

Analysis results show that TID meets the RA requirement through the entire planning period. Satisfying the RA requirements allows TID to continue to provide reliable service to customers. The actual capacity values for all resources are determined by CAISO in its annual study (for resources interconnected into CAISO). Therefore, the RA values shown in the Capacity Resource Accounting Table (CRAT) are based on capacity accreditation projections from Ascend that might be different than the values experienced over time.

Preferred Portfolio Selection

ARS selected a cost-minimizing portfolio that meets three sets of constraints:

- RA-established annual capacity targets (PRM) to achieve 1-in-10 reliability.
- RPS energy and zero-carbon energy targets established collectively by SB 350, SB 100, and SB 1020.
- TID's BA-specific carbon emissions target range established by CARB.

The selected capacity expansion buildout proceeds as follow. After the initial planned builds of a hybrid solar plus storage project with a planned commercial operation date (COD) in 2026, the main resource additions chosen by ARS are 50 MW of geothermal capacity and 160 MW of solar capacity in 2027. The initial builds of solar, storage, and geothermal from 2026 through 2028 improve reliability metrics and enable TID to meet its RPS targets by 2030. They also enable the portfolio to rely less on natural gas generation over the planning period, helping TID meet its 2030 carbon emissions target.

In the later portion of the planning period, the diversity of the RPS portfolio is improved with the addition of 40 MW of wind power sourced from New Mexico. This additional clean energy capacity also sets the trajectory for eventual achievement of the zero-carbon targets starting in 2035.

Figure 40 shows the cumulative nameplate capacity of the selected capacity expansion portfolio for the planning period.

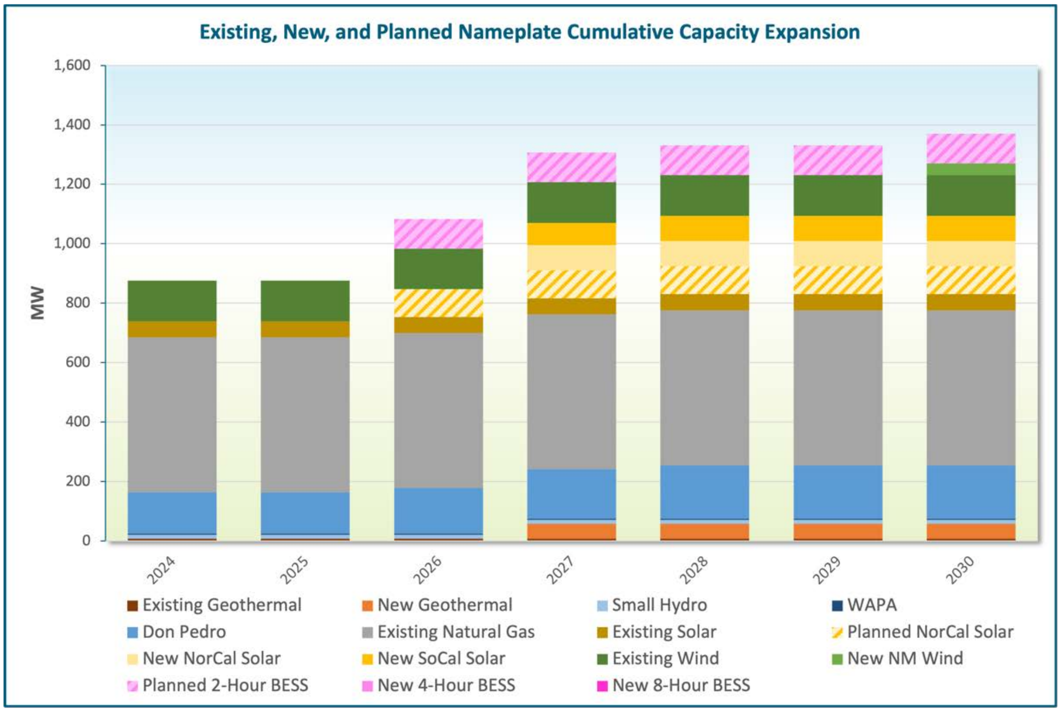

Figure 40. Existing, New, and Planned Nameplate Cumulative Capacity Expansion

Figure 49 (page 10-2) shows the incremental annual nameplate capacity of the selected capacity expansion portfolio for the planning period.

Figure 41 depicts the annual capacity contribution by resources (including market capacity purchases), which shows TID's BA capacity balance during the planning period. The capacities shown in this figure are ELCC-adjusted to indicate the equivalent firm capacity provided by the variable generation and storage resources. In the near term (2024–2025), any capacity needed to meet the PRM target will come from RA purchases.

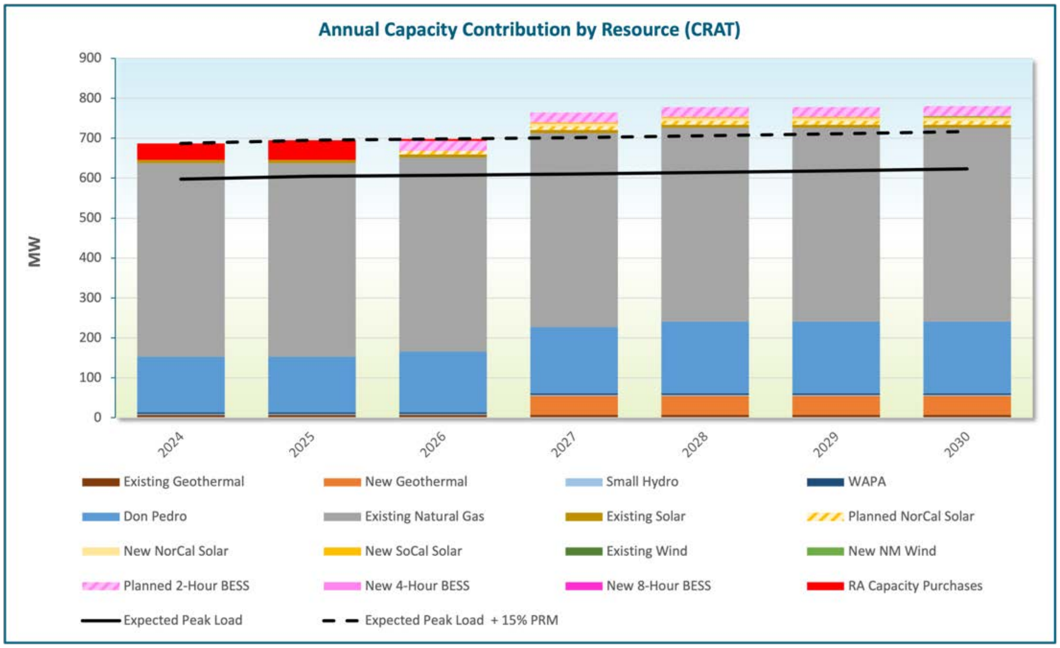

Figure 41. Annual Capacity Requirements and Capacity Contribution by Resource (CRAT)

Figure 41 shows that TID will meet or exceed the required PRM through our existing and planned resources, and through market purchases throughout the planning period.

Production Cost Modeling

Production cost analysis simulates hourly dispatch of the capacity expansion portfolio for the forecast period. A stochastic model of ten simulations for future price, load, and variable generation instances was used to simulate economic load dispatch of the thermal and storage units as well as Don Pedro Hydroelectric Project. Ten simulations were chosen to reflect ten potential future inflows for Don Pedro to better understand how high or low water years affect dispatch. Unless otherwise noted, the results presented from the production cost analysis reflect the mean outputs across these ten simulations. Production cost modeling enables an assessment of overall portfolio costs to serve load, expected capacity factors, carbon emissions, battery cycling patterns, as well as individual unit revenues, costs, and any curtailment of renewables.

Figure 42 shows how TID plans to serve our retail and wholesale power obligations as a BA during the planning period. As carbon costs and natural gas rates increase, generation from TID's thermal resources are projected to decline.

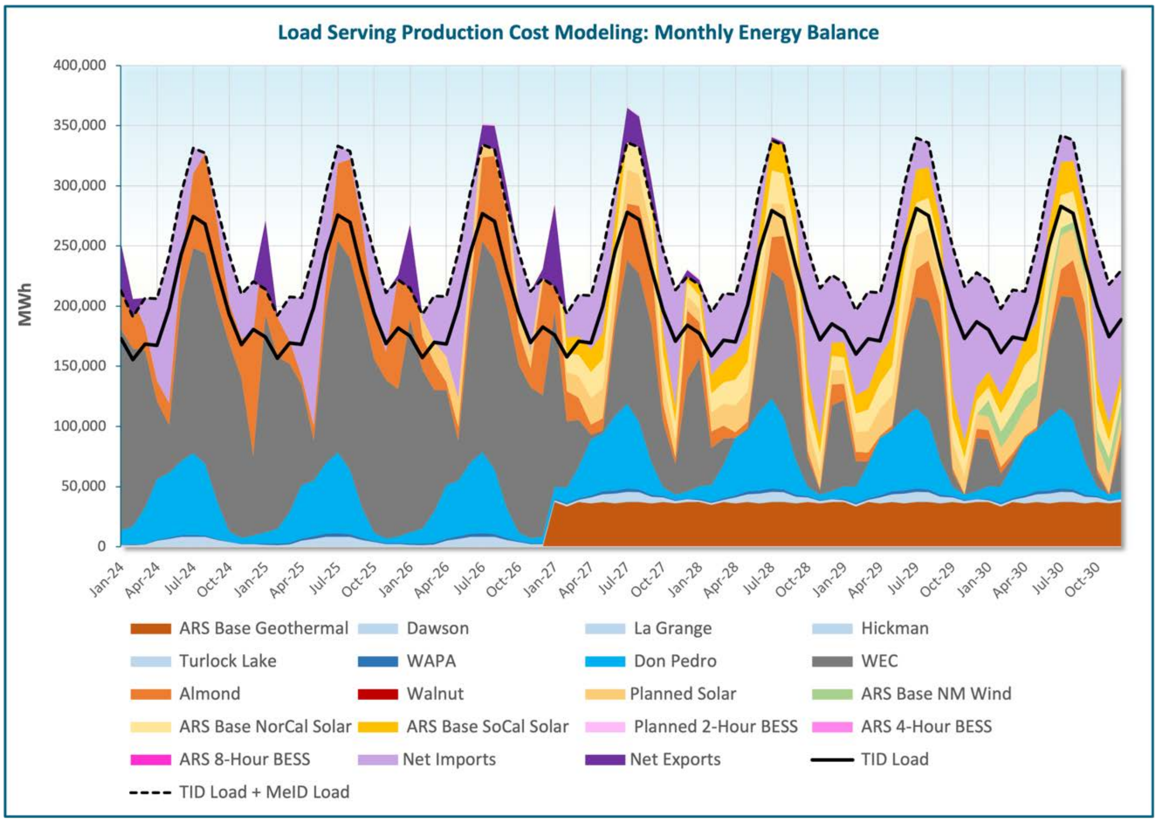

Figure 42. TID Balancing Authority Area Load Serving Monthly Energy Balance

As Figure 43 shows, TID's diverse set of resources enable us to optimize our power supply mix through the planning period to minimize cost and ensure a reliable system. The graph depicts operations of all resources, including sales from resources into the power markets. New resources come online starting in 2027 to meet future energy needs.

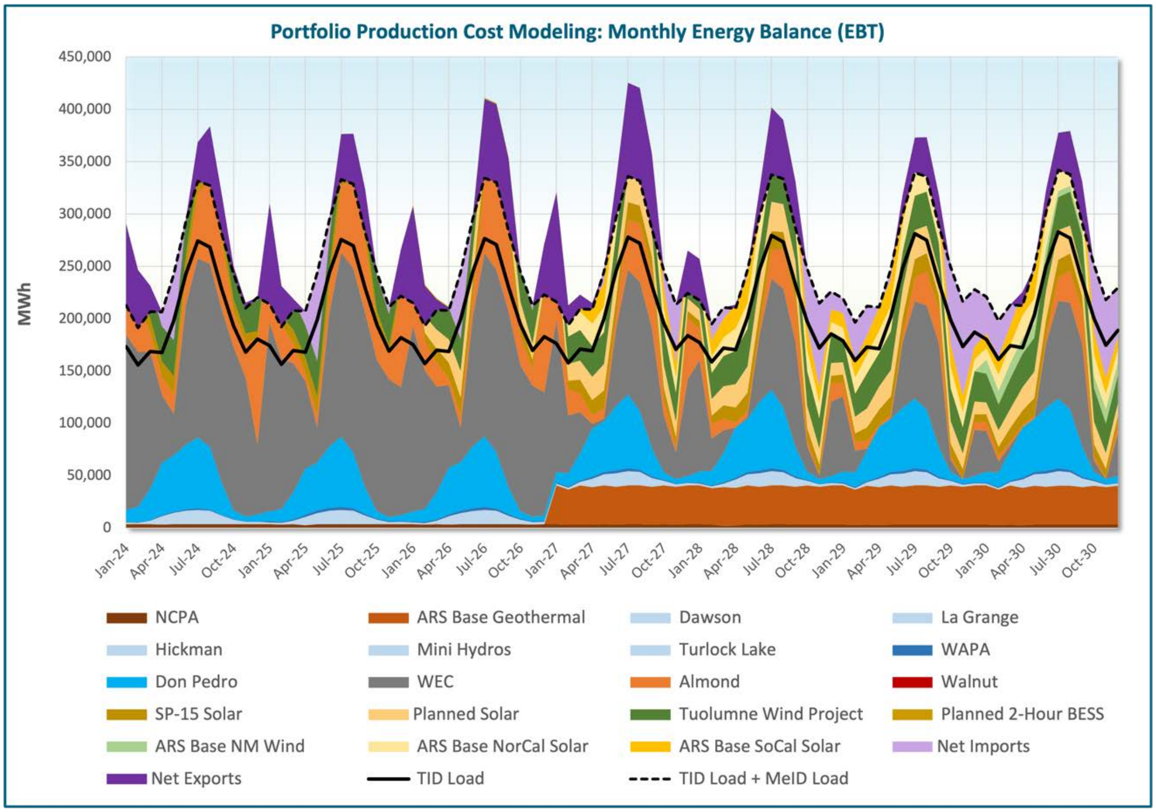

Figure 43. TID Balancing Authority Area Portfolio Monthly Energy Balance (EBT)

Figure 45 depicts the shorter-term compliance period for RPS targets established by SB 100—40 percent by December 31, 2024; 52 percent by December 31, 2027; and 60 percent by December 31, 2030—are met by a combination of existing RPS-eligible generation and future procurements of RPS-eligible resources. Some resources in TID's portfolio that are not RPS-eligible do count for zero-carbon generation, namely the WAPA large-scale hydroelectric projects and the Don Pedro Hydroelectric Project. These resources will contribute toward meeting the zero-carbon targets established by SB 100 and SB 1020.

Implementing the results of this 2023 IRP will add approximately 1.25 million MWh annually from solar, wind, and geothermal, by 2030 to fully comply with the RPS requirements. The cost effectiveness of a renewable resource is affected, among many things, by location and actual financial terms. Before adding new renewable resources, TID plans to issue an RFP, evaluate the received proposals, and select the best available option.

The added renewables create a need for flexible resources to provide ramping capability, especially during the hours when variable renewable generation is waning and load is rapidly increasing. Figure 44 depicts the forecasted average hourly net load (load minus wind and solar) for a typical peak day in July 2030. During the hours of 5 PM and 6 PM, net load increases by 124 MW at the same time that solar generation is decreasing. TID's resources must be able to ramp up quickly to meet that rapidly increasing net load to maintain reliability.

The production cost dispatch simulations demonstrate that TID's flexible natural gas generation, hydroelectric generation, and energy storage will be sufficient to follow the net load ramps during these peak periods and throughout the year.

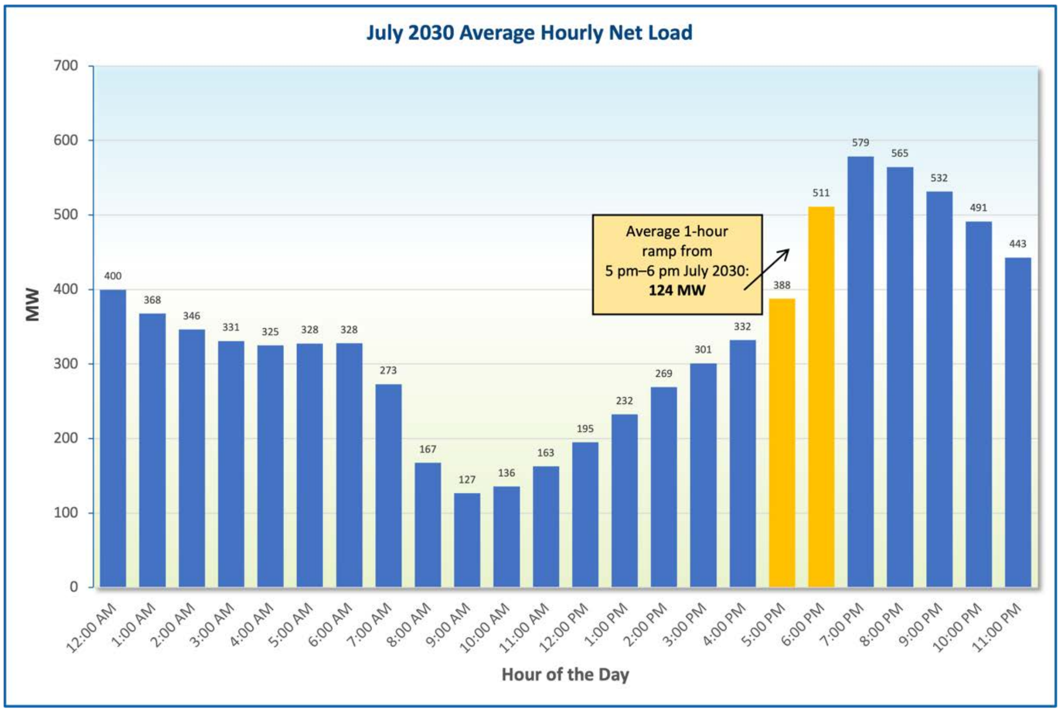

Figure 44. Average Hourly Net Load: July 2030

Figure 45 shows TID's projected renewable resource balance with the assumed additions through 2030 to fully comply with RPS requirements. The actual timing, amount, and type of additional renewable resources might differ depending on future market conditions, changing regulatory requirements, and other factors.

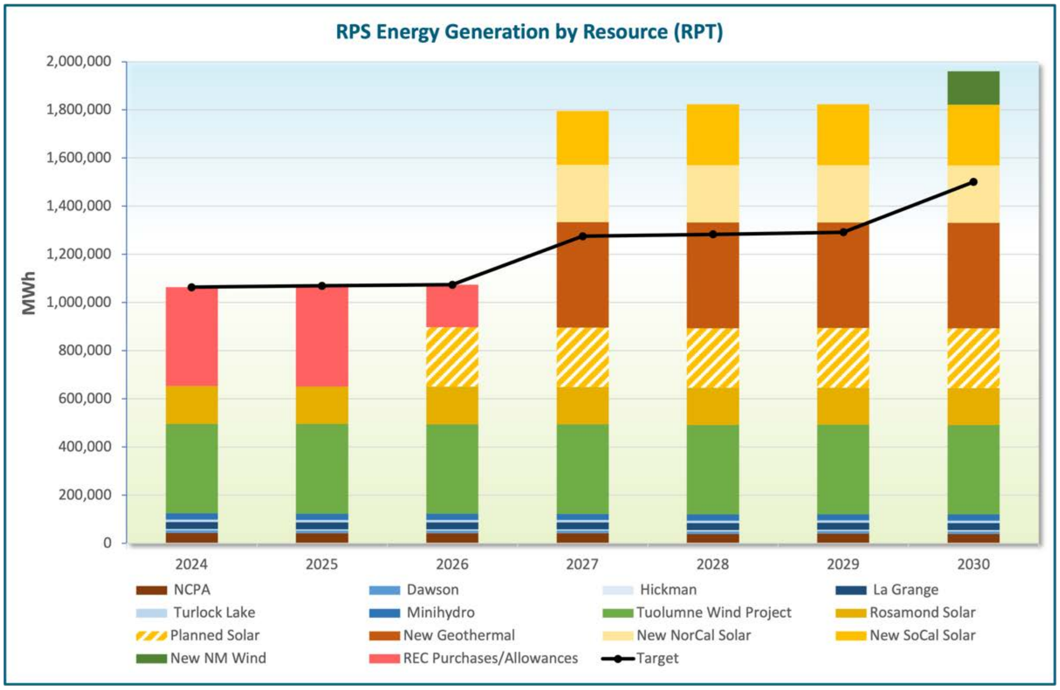

Figure 45. Current and Projected RPS Energy Generation by Resource (RPT)

SB 350 required CARB to establish 2030 GHG planning targets for POUs and LSEs. In September 2023, CARB released an update to the SB 350 Electricity GHG Planning Targets. The 2030 electricity sector GHG planning target range in the 2023 Update is 30–38 MMT CO_2-e. The upper limit of this range has a more aggressive target than the 2020 update (which set the 2030 upper limit of the target range at 53 MMT). TID's commensurate proportion of this updated target range is 0.629 percent, which equates to between 189,000 and 239,000 MT. The production cost modeling also confirms these portfolio-wide carbon emissions reductions and ensures that they meet the established CARB target ranges for TID.

Figure 46 depicts this CO_2 emissions accounting. GHG emissions drop significantly in 2027 as generation from Almond and WEC is reduced by approximately 30 percent due to increased renewable generation. TID's GHG emissions attributed to load is forecasted to be approximately 100,000 MTs by 2030—well within our target range established by CARB.

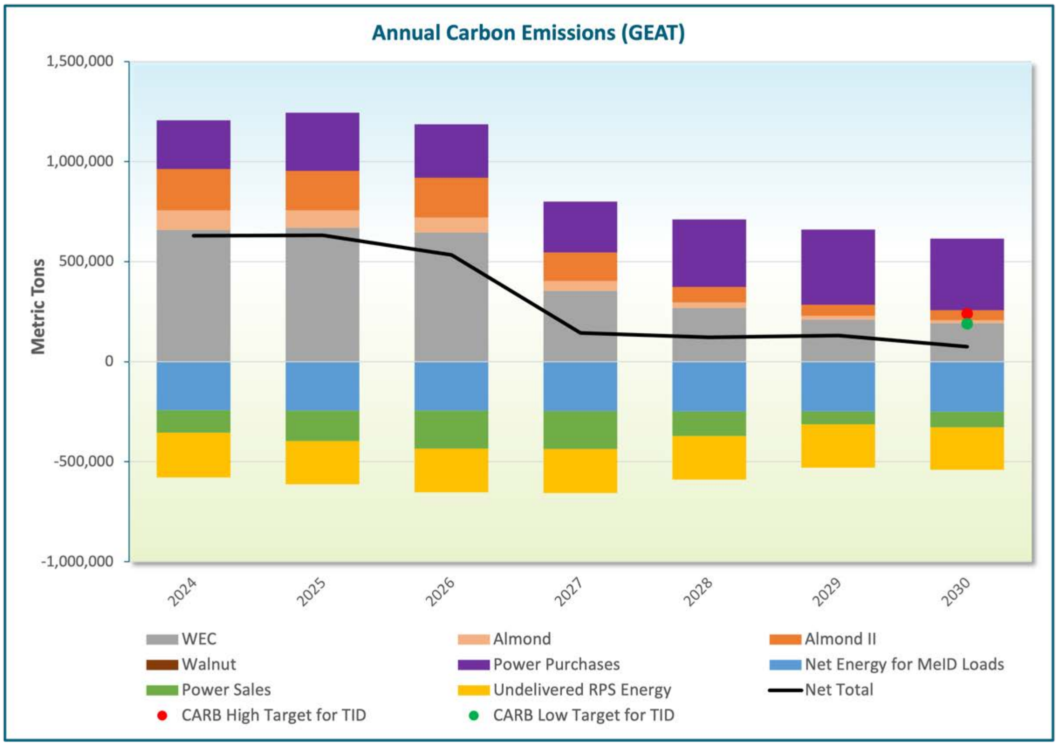

Figure 46. Annual Carbon Emissions (GEAT)

The metric tons of GHG offset are calculated by using the unspecified emission value of 0.428 MT per MWh, which is the same calculation used for energy export credits.

Portfolio Cost Considerations

As its name suggests, a primary aim of production cost modeling involves optimally minimizing the cost of serving load over the planning period, while meeting other modeled constraints such as reserve requirements. PowerSIMM outputs include several categories of costs within the optimized economic load dispatch results suite, and these can then be aggregated across resources and timescales to summarize the overall costs expected for the portfolio. Unless otherwise noted, all costs in the IRP are in nominal dollars.

TID will undergo a process separate from this IRP development and filing that will focus on how to meet the RPS, GHG, and reliability targets through 2045. Part of this process will consist of a deeper dive into various sensitivities and scenarios to gauge cost impacts in meeting the targets. To avoid potentially conflicting cost impacts, we instead focused on the diversity of portfolio costs considered for this IRP. Our separate process will provide far more detail and discussion on cost impacts than would apply to this IRP.

Each of these cost components are described below.

Thermal generation resource costs include:

- Fuel costs (natural gas cost).
- Variable O&M cost for each unit including gas transportation costs.
- Any startup costs, including startup fuel costs.
- Cost associated with obtaining carbon allowances for the emissions of the unit in any given year, pursuant to California's cap-and-trade program. In PowerSIMM, this is modeled as a carbon price attributed to each unit of carbon emitted when the plant is operating.

Renewable resource costs include the PPA cost per MWh of generation, a common method of pricing for renewables. For future resource procurements, a PPA price forecast provided by Ascend's Market Intelligence team is assumed. Maintaining the capital expense (that is, TID ownership) cost accounting approach for new builds becomes more complicated due to the required additional assumptions on long-term service agreement O&M costs. These are assumed to be priced into the PPA, which are otherwise closely tied to the assumed capital expenditures for each resource type in the capacity expansion phase of the analysis. The PPA cost approach also makes more sense given the likely nature of acquiring the new renewable generation through a Request for Offer (RFO) process.

Storage costs are also modeled on a full-toll PPA basis rather than a capital expense basis, analogous to renewable resources given that storage too would most likely be procured via an RFO. The assumed storage price projections in $/kW-month were provided by Ascend's Market Intelligence team and reflect the current (as of mid-2023) market environment for such resources.

Sales and purchases of power are assumed to occur in the spot market, abstracting away the realities and complexities of bilateral energy contracts that may be negotiated far in advance. Thus, sales and purchases in a given hour reflect the quantity bought or sold multiplied by the modeled trading hub spot price for power in that hour. The model is configured with the current transmission constraints into and out of TID's main trading hubs: CAISO and COB.

Geothermal generation is assumed to be much more expensive than 4-hour storage and solar in the future. These costs are a function of the expected resource costs ten to fifteen years from now, which include a significant amount of uncertainty and risk.

Selected Portfolio Reliability Modeling

As a final check on the selected capacity expansion resource portfolio, a reliability analysis was conducted to understand the improvement in reliability exhibited by the proposed portfolio with additional capacity and energy resources. As in the reliability modeling conducted prior to the capacity expansion analysis, the year 2027 was modeled as a comparison point. TID's existing portfolio has a firm capacity short position estimated at approximately 24 MW. With the new resource additions selected for 2027, that position drops to –42 MW, indicating a slightly long capacity position. Thus, the selected capacity expansion portfolio would still be able to achieve the 1-in-10 reliability target even if it had 42 MW less firm capacity in 2027.

Capacity Expansion Resource Mix

Figure 47 depicts TID's forecasted RPS-eligible resource mix in 2030; Figure 48 depicts TID's forecasted zero-carbon resource mix in 2030. The main difference is the addition of large hydroelectric generation from Don Pedro and the WAPA projects which are not RPS-eligible but count as zero-carbon resources.

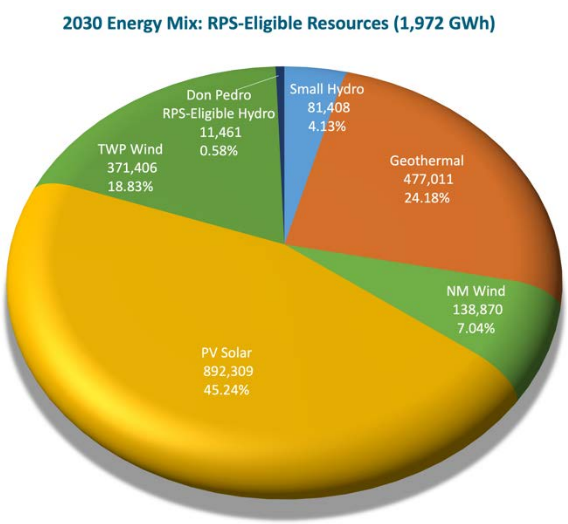

Figure 47. 2030 RPS-Eligible Resource Mix

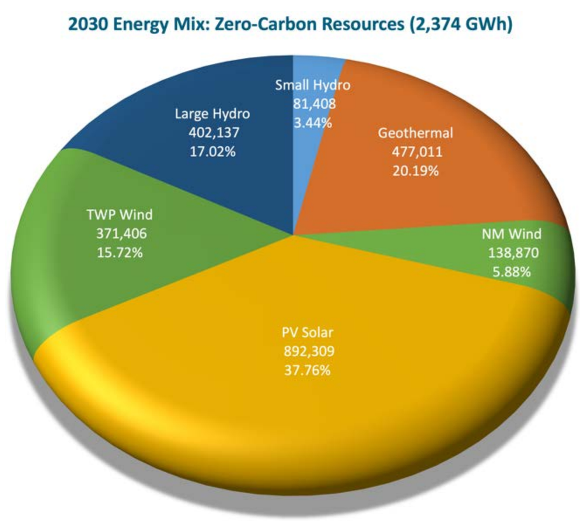

Figure 48. 2030 Zero-Carbon Resource Mix

10. Action Plans

In keeping with TID's mission and goals, our IRP action plans focus on improving reliability, reducing costs, meeting environmental goals, and improving the lives of our customers. Our action plans outline the steps necessary to expand capacity to meet growing demand and transition to a renewable and zero-carbon generation resource portfolio. This is a prudent approach that relies on proven generation technologies while keeping the door open to incorporating emerging technologies as they become viable.

Capacity Expansion Plan

Our current resource portfolio is diverse, incorporating various fuel sources, owned resources, PPA terms, resource types, and siting locations. Supplementing this portfolio with short-term power purchases will be sufficient to serve current and forecasted load and reserve requirements for the duration of the planning period.

A priority of the IRP is to ensure that 60 percent of TID's retail sales are served by RPS-eligible resources by 2030. In addition, the plan must strengthen the transition of TID's portfolio to comply with the requirement that eligible renewable energy and zero-carbon resources supply 90 percent of all retail sales by 2035, 95 percent by 2040, and 100 percent by 2045.

The action plan's first priority is to ensure that the 94 MW of planned solar and 100 MW of 2-hour BESS is added to the TID portfolio in 2026. The capacity expansion model selected 201 MW of renewable generation in 2027: 85 MW of additional northern California solar, 75 MW of new southern California solar, and 50 MW of new geothermal energy. The model also chose to add 10 MW of new southern California solar in 2028 and 40 MW of New Mexico wind in 2030.

Figure 49 depicts these resource additions during the planning period.

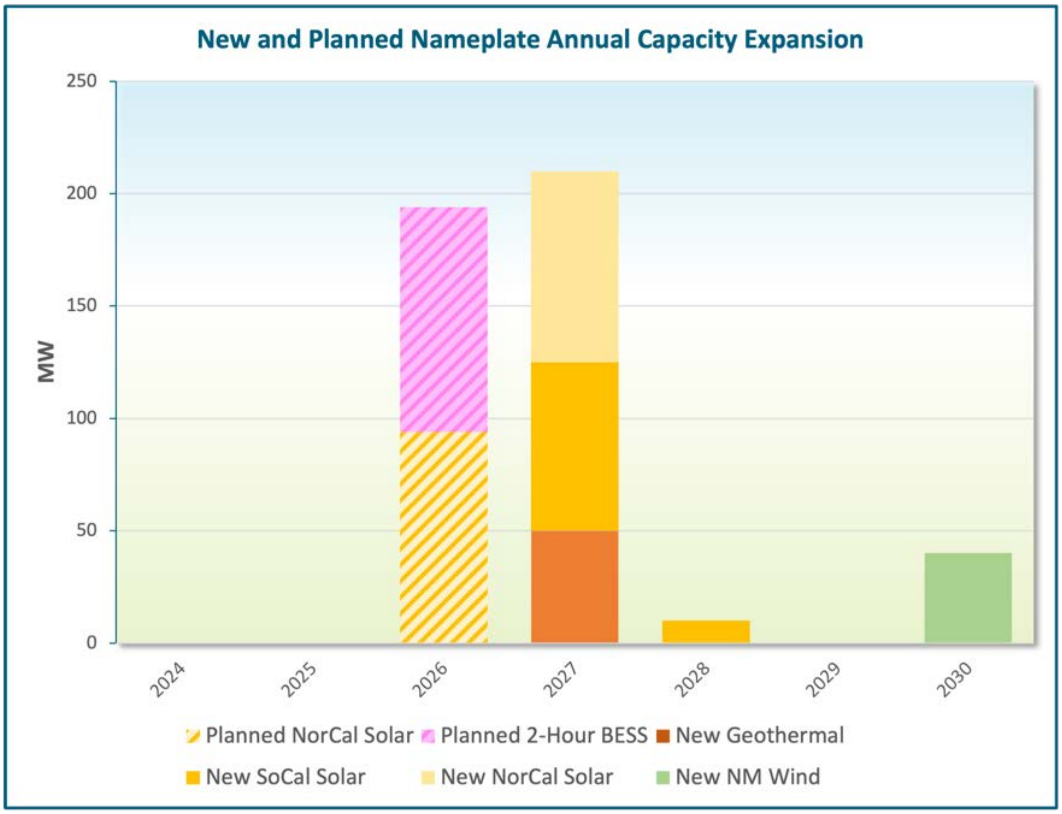

Figure 49. New and Planned Nameplate Annual Capacity Expansion

Increasing GHG emissions costs and natural gas transportation costs during the planning period result in lower use of TID's natural gas-fired power plants. These thermal units, however, are not retired in the planning period so that their capacity can maintain reliability of the TID system when needed. Adding firm geothermal capacity and storage assets will further improve TID's system reliability and provide additional ancillary services.

RPS-eligible resources will be procured through an RFO process, wherein TID would solicit bids for eligible resources to integrate into the existing renewable portfolio. TID recognizes that given the volatile and rapidly-evolving nature of the renewable energy market, the availability and offered pricing for these resources contained in an RFO may differ from those assumed in the capacity expansion plan outlined in this IRP. Thus, the resulting procurement outcomes may differ from those suggested in this IRP based on the actual availability and pricing of these resources. Nonetheless, the goal is to ensure that cost-effective and sufficient cumulative RPS energy is procured by the established target dates.

Customer-Focused Action Plans

TID plans to undertake a number of action items to enhance our commitment to our customers, and to provide a high level of customer satisfaction.

Transportation Electrification

As discussed in Chapter 4, TID's EV Program is a comprehensive and multifaceted initiative that supports California's goal to decarbonize the transportation sector by encouraging and facilitating the adoption of EVs among our customers, partners, and employees. The program offers various incentives, such as rebates for purchasing new and used EVs, residential and non-residential L2 chargers, and L3 DCFCs, with higher rebates for low-income customers and disadvantaged communities. The program also partners with local government, school districts, delivery companies, and other customers interested in electrifying their vehicle fleets or installing EV charging stations and assists them in this transition.

In January 2022, TID's board adopted our EV Charging Station Program, which describes how TID will install, operate, and maintain ten EV chargers in publicly accessible locations throughout our service area. TID has adopted an optional EV rate to promote off-peak EV charging.

Transmission and Distribution

As discussed in Chapter 5, TID regularly analyzes our electric system to identify the need for potential system upgrades. TID currently anticipates future transmission and distribution projects to support projected load growth that includes large amounts of DERs as well as transportation and building electrification loads. Nonetheless, we expect that our current internal local generating capacity can serve anticipated load growth over the planning period. After that, we anticipate adding capacity to address transmission constraints, distribution constraints, expected load growth, distributed generation growth, and EV load growth.

Emerging Technologies

TID plans to continue to monitor developments in emerging energy technologies, especially green hydrogen fuel production and transportation, SMR advancements and installations, LDES innovations, PSH, and CCS technology. As these technologies become viable, TID will consider incorporating them into our resource portfolio to meet our RPS and zero-carbon requirements so long as we can maintain our high level of reliable service.

A. IRP Guidelines Cross-Reference

In August 2022, the CEC published its *Publicly Owned Utility Integrated Resource Plan Submission and Review Guidelines, Revised Third Edition*. Chapter Two of these guidelines dictate the contents of all IRPs submitted to the CEC. This appendix contains a cross-reference between the sections specified in Chapter Two and the relevant sections of the TID 2023 IRP.

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A	Planning Horizon	Planning Period	2-4
B	Scenarios and Sensitivity Analysis	Integrated Resource Planning Process and Goals Modeling and Analysis Framework	2-1 9-3
C	Standardized Tables	No response required.	—
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C2	Energy Balance Table (EBT)	Western Power Markets Initiatives Figure 43: TID Balancing Authority Area Portfolio Monthly Energy Balance (EBT)	2-16 9-12
C3	RPS Procurement Table (RPT)	Figure 45: Current and Projected RPS Energy Generation by Resource (RPT)	9-14
C4	GHG Emissions Accounting Table (GEAT)	Figure 46: Annual Carbon Emissions (GEAT)	9-15
D	Supporting Information	No response required.	—
D1	Analyses, Studies, Data, Work Papers, or Others	Refer to filed supplemental material	—
D2	Additional Information	Refer to filed supplemental material	—
E	Additional Supporting Information	No response required.	—
E1	Analyses, Studies, Data, Work Papers, or Others	Refer to filed supplemental material	—
E2	Additional Information	Refer to filed supplemental material	—
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F2.2	Demand Forecast Methodology and Assumptions	Long-Term Forecasting Methodology	4-1
F3.3	Demand Forecast—Other Regions	This requirement does not apply to TID as it does not forecast regions outside our jurisdiction.	—

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G2.2b	Renewable Procurement	Renewable Generation Requirements Production Cost Modeling Selected Portfolio Reliability Modeling	3-10 9-11 9-17
G2.2c	RPS Procurement Plan	Emerging Technologies Capacity Expansion Plan	4-22 10-1
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G3.3	Energy Efficiency, Fuel Substitution, and Demand Response Resources	IRP Objectives Energy Efficiency Standards	2-2 2-13
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Table 8. CEC IRP Guidelines Cross-Reference

B. Glossary and Definitions

Additional Achievable Energy Efficiency (AAEE)

Defined by the CEC as incremental savings from the future market potential identified in utility potential studies not included in the baseline demand forecast, but reasonably expected to occur, including future updates of building codes, appliance regulations, and new or expanded investor-owned utility or publicly owned utility efficiency programs.

Additional Achievable Fuel Substitution (AAFS)

Defined by the CEC as a load modifier to the baseline demand forecast achieved by substituting an end-use fuel type with another, such as changing out gas appliances in buildings for cleaner more efficient electric end uses.

Additional Achievable Transportation Electrification (AATE)

Defined by the CEC as the estimated incremental transition to electric vehicles over the baseline transportation electrification forecasts.

Advanced Clean Cars II (ACC II)

The rule that requires all car sales in California to be 100 percent zero emission by 2035

Advanced Clean Fleets (ACF)

The requirement for medium-duty and heavy-duty fleets to purchase an increasing percentage of zero-emission trucks.

Advanced Clean Trucks (ACT)

The regulation requiring manufacturers to sell ZEV trucks and school buses.

Advanced Metering Infrastructure (AMI)

A primary component of a modern grid that provides two-way communications between the customer premises and the utility. An AMI is a necessary prerequisite to the interactions with advanced inverters, customer sited storage, demand response through direct load control, and EVs.

Almond II Power Plant (A2PP)

A TID-owned natural gas power plant that consists of three gas turbines for a total capacity of 174 MW.

Ancillary Services

Those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the electric system in accordance with good utility practice.

Assembly Bill (AB)

Legislation that originates or is modified by the entire California State Assembly.

Automated Resource Selection (ARS)

A component of Ascend's PowerSIMM modeling software that chooses resources for a least-cost portfolio expansion plan.

Balancing Authority (BA)
The responsible entity that integrates resource plans ahead of time, balances supply with demand, and supports interconnection frequency in real time.

Balancing Authority of Northern California (BANC)
A regional balancing authority in central California.

Baseload
The minimum electric or thermal load that is supplied continuously over a period of time.

Battery Electric Vehicle (BEV)
A type of electric vehicle that exclusively uses chemical energy stored in rechargeable battery packs with no secondary source of propulsion.

Battery Energy Storage System (BESS)
Rechargeable batteries that store energy that can be discharged when needed. Types include lithium-ion, lead-acid, flow batteries, and flywheels. Common capacities include 4-hour, 8-hour, and 10-hour batteries, designating the length of time the battery can discharge energy.

British Thermal Unit (Btu)
A unit of energy equal to about 1,055 joules that describes the energy content of fuels. A Btu is the amount of heat required to raise the temperature of one pound of water by 1°F at a constant atmospheric pressure. When measuring electricity, the proper unit would be Btu per hour (or Btu/h) although this is generally abbreviated to just Btu.

Buildings Initiative for Low-Emissions Development (BUILD)
A CEC program designed to provide technical assistance and incentives for new all-electric low-income residential buildings that reduce GHG emissions.

California Air Resources Board (CARB)
Responsible for promoting and protecting public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on California's economy.

California Carbon Allowance (CCA)
An allowance equal to the total amount of permissible emissions (that is, the "cap") delivered to CARB's Cap-and-Trade Program market, which is designed to reduce GHG emissions. One allowance equals one metric ton of carbon dioxide equivalent emissions. Each year, fewer allowances are created and the annual cap declines.

California Energy Commission (CEC)
California's primary energy policy and energy planning agency. Responsible for ensuring publicly owned utilities' compliance with the state's Renewables Portfolio Standard and Title 20 data reporting requirements.

California Energy Demand Update (CEDU)
The biennial update to various statewide energy-related forecasts, included in the CEC IEPR.

California Environmental Quality Act (CEQA)
A California policy that requires state and local agencies (including utilities) to disclose and evaluate the significant environmental impacts of proposed projects and adopt all feasible mitigation measures to reduce or eliminate those impacts.

California Independent System Operator (CAISO)
A nonprofit independent system operator that oversees the operation of the bulk electric power system, transmission lines, and electricity generated and transmitted by its participants. CAISO is the largest balancing authority in California.

California Municipal Utilities Association (CMUA)
An association incorporated in 1933 to represent the interests of California's publicly owned electric utilities before the California Legislature and other regulatory bodies.

California-Oregon Border (COB)
One of TID's main trading hubs for buying and selling electricity through the Northwest power markets

California-Oregon Transmission Project (COTP)
A corridor of 340 miles of three roughly parallel 500 kV alternating current power lines with a combined power transmission capacity of 4,800 MW connecting the electric grids of southern Oregon and central California. Also identified as Path 66.

California Public Utilities Commission (CPUC)
Regulates California's investor-owned electric utilities, telecommunications, natural gas, water, and passenger transportation companies, in addition to household goods movers and the safety of rail transit.

Capacity
The MW rating of the unit.

Capacity Factor
The percentage of time a resource generates electricity compared to its maximum generation output. The capacity factor of a variable renewable resource can vary widely.

Capacity Resource Accounting Table (CRAT)
Defined by the CEC as the annual peak capacity demand in each year and the contribution of each energy resource (capacity) in a POU's portfolio to meet that demand.

Carbon Capture and Sequestration (CCS)
A process that captures, separates, and treats CO_2 emissions from a power plant, then transports it for long-term storage so that it doesn't enter the atmosphere.

Carbon Dioxide (CO_2)
A colorless, odorless gas found in the atmosphere that is associated with global warming. It is released into the atmosphere through the burning of fossil fuels such as coal, oil, and natural gas.

Carbon Dioxide Equivalent (CO_2-e)
The standard measurement that expresses the impact of different greenhouse gases as an equivalent of the amount of CO_2 that would create the same amount of warming.

Central Valley Project (CVP)
A complex, multi-purpose network of dams, reservoirs, canals, hydroelectric power plants, and other facilities extending 400 miles through central California, that reduces flood risk and supplies domestic and industrial water for the Central Valley.

Combustion Turbine (CT)
Any of several types of high-speed generators using principles and designs of jet engines to produce low cost, high efficiency power; also commonly referred to as a gas turbine.

Commercial Direct Install (CDI)
A TID energy efficiency program that replaces inefficient lighting with LEDs for participating customers.

Commercial Operation Date (COD)
The date when a capacity resource begins to generate power that can be sold.

Community Choice Aggregator (CCA)
Communities formerly served by the IOUs that have formed a separate organization to aggregate the buying power to procure energy.

Compliance Period (CP)
There are six compliance periods for attaining Renewables Portfolio Standard goals as defined in Public Utilities Code section 399.30 (c):

Compliance Period 1:
January 1, 2011 to December 31, 2013.

Compliance Period 2:
January 1, 2014 to December 31, 2016.

Compliance Period 3:
January 1, 2017 to December 31, 2020.

Compliance Period 4:
January 1, 2021 to December 31, 2024.

Compliance Period 5:
January 1, 2025 to December 31, 2027.

Compliance Period 6:
January 1, 2028 to December 31, 2030.

Continuous Emissions Monitoring System (CEMS)
An integrated system to measure flow, dust, and the concentration of air pollutants (such NOx and CO_2) resulting from combustion in industrial processes, such as electric generation, as a means to comply with EPA regulations.

Cost of Service
A study performed by utilities to forecast the cost to provide services to retail customers.

Customer Information System (CIS)
A software package that addresses metering and billing processes, customer services (such as call centers), social media interactions, and information gathering.

Demand
The rate at which electricity is used at any one given time (or averaged over any designated interval of time). Demand differs from energy use, which reflects the total amount of electricity consumed over a period of time. Demand is measured in kilowatts (kW) or megawatts (MW). Load is considered synonymous with demand. (See also Load on page A-7.)

Demand Response (DR)
An electricity tariff or program established to motivate changes in electric use by end-use customers, designed to induce lower electricity use typically at times of high market prices or when grid reliability is jeopardized.

Demand-Side Management (DSM)
The planning, implementing, and monitoring programs that encourage consumers to manage their electricity usage patterns to shift or reduce demand.

Department of Energy (DOE)
An executive department of the United States government that is concerned with the United States' policies regarding energy, environmental, and nuclear challenges.

Direct Current Fast Charger (DCFC)
Fastest available EV chargers, designed to fill a battery to 80 percent in 20–40 minutes, and 100 percent in 60–90 minutes.

Disadvantaged Community (DAC)
Disadvantaged communities are designated by California Environmental Protection Agency pursuant to Senate Bill 535 using the California Communities Environmental Health Screening Tool; identified by census tract, they score at or above the 75th percentile.

Dispatchable Generation

A generation source that is controlled by a system operator or dispatcher who can increase or decrease the amount of power from that source as the system requirements change.

Distributed Energy Resource (DER)

Any resource (such as solar and wind power, energy efficiency, demand response, fuel cells, energy storage, electric vehicles, and building electrification) on the distribution system that produces electricity.

Effective Load Carrying Capacity (ELCC)

The ability to effectively increase the generating capacity available to a utility without increasing the utility's loss of load risk, quantified as the amount of new load that can be added to a system after capacity is added by a generator without increasing the loss of load probability or expectation.

Electric Service Provider (ESP)

A non-utility entity that offers electric service to customers within the service territory of an electric utility.

Electric Vehicle (EV)

A vehicle that uses one or more electric motors for propulsion.

Energy

The amount of electricity a generation resource produces, or an end user consumes, in any given period of time, measured in kWh, MWh, or GWh. Energy is computed as capacity or demand multiplied by time (hours). A one MW power plant running at full output for one hour produces one megawatt-hour (1 MWh) of electrical energy.

Energy Balance Table (EBT)

Defined by the CEC as the annual total energy demand and annual estimates for energy supply from various resources.

Energy Efficiency

Practices or programs designed to reduce the amount of energy required to provide the same level and quality of output.

Energy Information Administration (EIA)

A principal agency of the United States Federal Statistical System (within the U.S. Department of Energy) responsible for collecting, analyzing, and disseminating energy information. One of its major roles is to provide publicly available fuel price projections for the power generation industry.

Environmental Impact Report (EIR)

A CEC report that evaluates the potential environmental impact and identified mitigation methods for a proposed generating unit.

Environmental Protection Agency (EPA)

A United States agency that protects the country's geography by developing, implementing, and enforcing environmental laws that regulate air, water and soil quality, pesticide use, and waste recycling and reduction.

Equivalent Forced Outage Rate (EFOR)

The number of hours a generating is on forced outage over the total number of hours the unit was needed to serve load.

Expected Unserved Energy (EUE)

The amount of end-customer demand (measured in MWh) that cannot be supplied (in other words, forced load shedding) within a NEM region due to a deficiency of generation or interconnector capacity.

Federal Energy Regulatory Commission (FERC)

A United States federal agency that regulates the transmission and wholesale sale of electricity and natural gas in interstate commerce, regulates the transportation of oil by pipeline in interstate commerce, and licenses non-federal hydropower projects. FERC also reviews proposals to build interstate natural gas pipelines, storage projects, and terminals.

Fossil Fuel

Any naturally occurring fuel formed from the decomposition of buried organic matter, essentially coal, petroleum (oil), and natural gas. Fossil fuels take millions of years to form, and thus are non-renewable resources. Because of their high percentages of carbon, burning fossil fuels produces about twice as much carbon dioxide (a greenhouse gas) as can be absorbed by natural processes.

Fuel Cell Electric Vehicle (FCEV)

An electric vehicle that uses a fuel cell, sometimes in combination with a small battery or supercapacitor, to power its onboard electric motor. Also referred to as a hydrogen fuel cell electric vehicle (HFCEV).

General Rate Cases (GRC)

Proceedings before the CPUC used to address the costs of operating and maintaining the utility system and allocating those costs among customer classes.

Generation (Electricity)

The process of producing electrical energy from other forms of energy; also, the amount of electric energy produced, usually expressed in kilowatt-hours (kWh) or megawatt hours (MWh).

Nameplate Generation (Gross Generation): The electrical output at the terminals of the generator, usually expressed in megawatts (MW).

Net Generation: Gross generation minus station service or unit service power requirements, usually expressed in megawatts (MW). The energy required for pumping at a pumped storage plant is regarded as plant use and must be deducted from the gross generation.

GHG Emissions Accounting Table (GEAT)

Defined by the CEC as the annual GHG emissions associated with each resource in a POU's portfolio to demonstrate compliance with the GHG emissions reduction targets established by the CARB.

Gigawatt (GW)

A unit of power, capacity, or demand equal to one billion watts, one million kilowatts, or one thousand megawatts.

Gigawatt-Hour (GWh)

A unit of electric energy equal to one billion watt-hours, one million kilowatt-hours, or one thousand megawatt-hours.

Greenhouse Gas (GHG)

A gas that contributes to the greenhouse effect by absorbing infrared radiation, including carbon dioxide, methane, and fluorocarbons.

Heavy-Duty Vehicle

A vehicle with a gross weight greater than five tons, including the vehicle, fuel, occupants, and cargo (such as large transit buses, common tractor-trailer trucks, and refuse trucks).

Hydrogen Fuel Cell Electric Vehicle (HFCEV)

An electric vehicle that uses a fuel cell, sometimes in combination with a small battery or supercapacitor, to power its onboard electric motor. Also referred to simply as FCEV

Inflation Reduction Act of 2022 (IRA)

A federal statute that, among many other provisions, offers funding, programs, and incentives to accelerate the transition to a clean energy economy.

Integrated Energy Policy Report (IEPR)

A report adopted by the California Energy Commission and transmitted to the Governor and Legislature every two years. It includes trends and issues concerning electricity and natural gas, transportation, energy efficiency, renewables, and public interest energy research.

Integrated Resource Plan (IRP)

A long-term comprehensive plan that balances the mix of demand and supply resources over a long-term planning horizon to meet specified policy goals.

Investor-Owned Utility (IOU)

A for-profit utility owned by either public or private shareholders that serve 72 percent of United States electricity customers.

Kilowatt (kW)

A unit of power, capacity, or demand equal to one thousand watts. The demand of an individual electric customer or the capacity of a distributed generator is often expressed in kilowatts.

Kilowatt-hour (kWh)

A unit of electric energy equal to one thousand watt-hours. The standard billing unit for electric energy sold to retail consumers is the kilowatt-hour.

Level 1 (L1)

A private, residential EV battery charger with a power rating of up to 2.4 kW.

Level 2 (L2)

A public EV battery charger with a power rating of up to 12 kW.

Level 3 (L3)

A public EV battery charger (also known as a DCFC), the fastest EV charger available, uses a 480-volt direct current capable of a charging rate of up to 500 kW.

Levelized Cost of Energy (LCOE)

The price per kilowatt-hour for an energy project to break even; it does not include risk or return on investment.

Light-Duty Vehicle

A vehicle with a gross weight less than five tons including the vehicle, fuel, occupants, and cargo (such as passenger cars and light-duty and medium-sized pickup trucks).

Load, Electric

The moment-to-moment measurement of power that an end-use device or an end-use customer consumes. The total of this consumption plus planning margins and operating reserves is the entire system load. Load is often used synonymously with demand. (See also Demand on page A-4.)

Baseload: The constant generation of electric power load to meet demand.

Connected Load: The sum of the capacities or ratings of the electric power consuming apparatus connected to a supplying system, or any part of the system under consideration.

Load-Serving Entity (LSE)

An energy-related company that serves end users and has been granted authority by California to sell electric energy to the same.

Long-Duration Energy Storage (LDES)

A battery energy storage system that holds energy for at least ten hours, but generally for days or weeks.

Loss of Load Expectation (LOLE)

The total duration of increments when the loss of load is expected to occur, specified in days using the peak value for the entire day.

Loss of Load Hour (LOLH)

The total duration of increments when the loss of load is expected to occur, specified in hours using the peak value for each hour.

Loss-of-Load Probability (LOLP)

The probability that a generation shortfall (loss of load) would occur. This probability can be used as a consideration in generation adequacy requirements.

Low Carbon Fuel Standard Credit (LCFS Credit)

A CARB program that aims to reduce emissions in the transportation sector by providing incentives to install EV charging equipment.

Medium-Duty Vehicle

A vehicle with a gross weight greater than five tons, including the vehicle, fuel, occupants, and cargo (such as moving trucks, large step vans, and some heavy-duty pickups).

Megawatt (MW)

A unit of power, capacity, or demand equal to one million watts or one thousand kilowatts. Generating capacities of power plants and system demand are typically expressed in megawatts.

Megawatt-Hour (MWh)

A unit of electric energy equal to one million watt-hours or one thousand kilowatt-hours, used to specify the amount of energy consumed by customers over time.

Merced Irrigation District (MeID)

One of four California irrigation districts located in the Central Valley to the southeast of TID's service area.

Meter Data Management Software (MDMS)

Software that performs long-term data storage and management for the vast quantities of data delivered by a smart metering system.

Metric Ton (MT)

A weight measurement used to determine the quantity of greenhouse gases emitted into the atmosphere.

Million Metric Ton (MMT)

A weight measurement used to determine the quantity of greenhouse gases emitted into the atmosphere.

National Renewable Energy Laboratory (NREL)

The Federal laboratory dedicated to researching, developing, commercializing, and using renewable energy and energy efficiency technologies relied on by utilities across the country for integrated resource planning.

Net Energy Metering (NEM)

A billing arrangement that credits a customer with an eligible renewable distributed generator (mostly for solar photovoltaic rooftop systems) for electricity added to the grid. The customer only pays for the net amount of electricity taken from the grid.

Net Load

The remaining load after non-dispatchable resources (such as renewable energy) have been accounted for.

Nitrogen Oxide (NOx)

A pollutant and strong greenhouse gas emitted by combusting fuels.

Nominal Dollars

At its most basic, nominal dollars are based on a measure of money over a period of time that has not been adjusted for inflation. Nominal value represents a cost usually in the current year. As such, nominal dollars can also be referred to as current dollars; in other words, what it costs to buy something today. Nominal dollars are often contrasted with real dollars.

Northwest Power Pool (NWPP)

A Portland-based corporation that helps member electric utilities and BAs sell power throughout the Northwestern states and Western Canada.

Ocean Thermal Energy Conversion (OTEC)

A process that produces electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters.

One Million British Thermal Unit (MMBtu)

One million of the units of energy equal to about 1,055 joules that describes the energy content of fuels.

Operations and Maintenance (O&M)

The recurring costs of operating, supporting, and maintaining authorized programs, including costs for labor, fuel, materials, supplies, and other current expenses.

Outage

The period during which a generating unit, transmission line, or other facility is out of service. The following are types of outages or outage-related terms.

Forced Outage: The removal from service availability of a generating unit, transmission line, or other facility for emergency reasons or a condition in which the equipment is unavailable due to unanticipated failure.

Planned (or Scheduled Maintenance) Outage: The removal or shutdown of a generating unit, transmission line, equipment, or other facility for inspection or maintenance according to an advance schedule.

Pacific Gas & Electric (PG&E)

An investor-owned utility that provides natural gas and electric services to northern and central California.

Particulate Matter (PM)

A complex mixture of extremely small particles and liquid droplets made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

Peak Demand

The maximum amount of power necessary to supply customers; in other words, the highest electric requirement occurring in a given period (for example, an hour, day, month, season, or year). For an electric system, it is equal to the sum of the metered net outputs of all generators within a system and the metered line flows into the system, less the metered line flows out of the system. From a customer's perspective, peak demand is the maximum power used during a specific period of time.

Photovoltaic (PV)

The technology that converts light into electricity using semiconducting materials that exhibit the photovoltaic effect by absorbing photons and then emitting electrons.

Planning Reserve Margin (PRM)

The percent of unused available capability above projected annual peak demand to meet expected demand and maintain adequacy of supply. Planning reserve margin is designed to measure the amount of generation capacity available to meet expected demand in a planning horizon.

Plug-In Hybrid Electric Vehicle (PHEV)

A vehicle that operates using a battery recharged by plugging it into an external source of electric power or by using an on-board gas engine.

Portfolio Content Category (PCC)

A category of electricity products procured from an eligible renewable energy resource (as specified by the CEC) for meeting RPS requirements.

PCC-0: A renewable resource that meets the criteria of PCC-1 but was signed or went online before June 1, 2010.

PCC-1: A renewable resource located within the state of California or, a renewable resource that is directly delivered to California without energy substitution from another resource.

PCC-2: A renewable resource that is out-of-state and delivering to California, where the RECs are paired with a substitute energy resource imported into the state.

PCC-3: A tradable or unbundled REC from a resource, delivered without the energy component.

Power Purchase Agreement (PPA)

A contract to purchase energy and or capacity from a commercial source at a predetermined price or on pre-determined pricing formulas.

Power Sales Agreement (PSA)

A legally binding agreement between an independent power producer and a regulated electric utility that establishes the terms and conditions for the sale of power from the facility to the utility.

Publicly-Owned Utility (POU)

Not-for-profit utilities owned by customers and subject to local public control and regulation.

Pumped-Storage Hydroelectricity (PSH, also PHES)

Uses off-peak electricity to pump water from a lower reservoir into one at a higher elevation, storing potential energy to be released to pass through hydraulic turbines to generate electricity. A modern pumped-storage facility can provide a number of ancillary services, such as frequency regulation, voltage support (dynamic reactive power), spinning and non-spinning reserve, load following, and black start as well as energy services such as peak shaving and energy arbitrage.

Real Dollars

At its most basic, real dollars are a measure of money over a period of time that has been adjusted for inflation. Real dollars represent the true cost of goods and services sold because the effects of inflation are stripped out of the cost. Over time, real dollars are a measure of purchasing power. As such, real dollars can also be referred to as constant dollars; in other words, if the price of something goes up over time at the same rate as inflation, the cost is the same in real dollars. Real dollars are often contrasted with nominal dollars.

Reliability
The degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired. Reliability can be measured by the frequency, duration, and magnitude of adverse effects on the electric supply.

Renewable Energy Credit (REC)
Tradable commodities that represent proof that 1 MWh of electricity was generated from an eligible renewable source.

Renewable Energy Resource
An energy resource that is naturally replenished and is virtually inexhaustible, but might be limited in their constant availability. Unlike fossil fuel generation plants (which can be sited where most convenient because the fuel is transported to the plant), most renewable energy generation plants must be sited where the energy is available.

Renewable Portfolio Standard (RPS)
The program that, by law, requires all California-sanctioned electric utilities to increase the production and procurement of energy from renewable energy resources.

Request for Offer (RFO)
A document that contains a detailed scope or business requirements for a proposed utility project used to gather and compare information from prospective vendors.

Request for Proposal (RFP)
A competitive solicitation for suppliers to submit a proposal on a specific commodity or service, often through a bidding process.

Resource Adequacy (RA)
The CAISO requirements that ensure sufficient capacity exists for grid-wide reliability (up to a specified loss-of-load probability), including system, local, and flexible capacity requirements.

RPS Procurement Table (RPT)
Defined by the CEC as a detailed summary of a POU's resource plan to meet the RPS requirements.

San Joaquin Valley Air Pollution Control District (SJVAPCD)
A public agency that regulates air quality in the Central Valley and offers incentives for residents and businesses to reduce emissions. It holds regional jurisdiction over TID's natural gas-fired generating plants.

Senate Bill (SB)
Legislation that is either proposed or modified in the California State Senate.

Small Modular Reactor (SMR)
Advanced nuclear fission reactors capable of generating up to 300 MW that can be built in one location, then shipped, commissioned, and operated at a separate site.

Southeast Geysers Effluent Pipeline (SEGEP)
A 40-mile pipeline that delivers approximately 9 million gallons per day of secondary treated wastewater from Lake County and communities in the Clear Lake area for injection into The Geysers reservoir.

Spinning Reserve
Available generating capacity that is synchronously connected to the electric grid and capable of automatically responding to frequency deviations on the system.

State Implementation Plan (SIP)
A CARB document that governs the implementation of building electrification initiatives.

Steam Turbine (ST)
A turbine that extracts thermal energy from pressurized steam and uses it to rotate an output shaft.

Stochastic Modeling
Modeling analysis using as input a random collection of variables that represent the uncertainties associated with those variables (as opposed to deterministic modeling that analyzes a single state). Stochastic modeling analyzes multiple states and the range of their uncertainty, then captures the probabilities of those uncertainties.

Substation
A small building or fenced in yard that contains switches, transformers, and other equipment that steps down voltages for customer use, switches and monitors transmission and distribution circuits, and performs other service functions.

System Advisor Model (SAM)
A performance and financial model, developed by NREL, designed to estimate the cost of energy for grid-connected power projects based on installation and operating costs and system design to facilitate decision making for people involved in the renewable energy industry.

Technology and Equipment for Clean Heating (TECH)
A CEC program that aims to reduce a building's greenhouse gas emissions by installing and using clean space and water heating technology such as electric heat pumps. For single family houses.

Time-of-Use (TOU)
A rate structure for on-peak, off-peak, and mid-day times designed to encourage customers to shift energy use to lower rate periods.

Transmission and Distribution (T&D)
Transmission lines are used for the bulk transfer of electric power across the power system, typically from generators to load centers. Distribution lines are used for transfer of electric power from the bulk power level to end-users and from distributed generators into the bulk power system.

Tuolumne Wind Project (TWP)
A TID-owned wind power plant that consists of 62 wind turbines for a total capacity of 136.6 MW.

Variable Operation & Maintenance (VOM)
A function of the hours of operation of a power plant, and include yearly maintenance and overhaul, repairs, consumables, water supply, and environmental costs.

Walnut Energy Center (WEC)
A TID-owned natural gas power plant that consists of two combustion turbines and one steam turbine for a total net capacity of 250 MW.

Western Area Power Administration (WAPA)
One of four power marketing administrations, it markets wholesale hydropower generated at 57 hydroelectric federal dams operated by the Bureau of Reclamation, United States Army Corps of Engineers, and the International Boundary and Water Commission.

Western Electric Coordination Council (WECC)
Ensures bulk electric system reliability for the entire Western Interconnection.

Western Energy Imbalance Market (WEIM)

An energy market that automatically finds low-cost energy to serve demand close to the time the electricity is consumed, improving the balance of supply and demand.

Zero-Emission Vehicle (ZEV)

A vehicle that emits no exhaust gas from its source of power, such as plug-in electric vehicles and hydrogen electric vehicles.

C. PowerSIMM Planner

PowerSIMM Overview

PowerSIMM is Ascend's proprietary software program used for simulating the performance of an electric power system with high spatial and temporal granularity. This section provides an overview of the key features and capabilities of this simulation software. In the IRP analysis, PowerSIMM was used for the following applications:

Production Cost Modeling: Simulates power system operations, inclusive of transmission constraints, on an hourly or sub-hourly timestep for use in decision making for portfolio management or resource planning.

Capacity Expansion Optimization: Provides a roadmap of future resource procurements to meet policy or reliability needs at the lowest cost.

Resource Adequacy Analysis: Determines how well a portfolio of resources can serve customer load over a defined period of time on an hourly basis.

All applications start with simulations of weather, load, renewables, forced outages, and market prices. The only exception is in resource adequacy models where prices are not used.

Simulations in PowerSIMM

PowerSIMM simulations start with weather as the fundamental driver of load, renewable generation, and market prices. Weather simulations consist of daily maximum and minimum temperatures. PowerSIMM uses historical temperatures to construct future simulations of weather with a time-series model that includes seasonal inputs.

Renewable items require hourly historical generation data coupled with weather data from a nearby station to determine the structural relationship between daily min and max temperatures and renewable generation. PowerSIMM constructs a model for each renewable item using inputs that include daily min and max temperatures, month, and hour. Future simulations are generated with the model using weather simulations as an input. Generation output is scaled to meet future expectations for monthly energy generation and capacity limits.

For load, PowerSIMM creates a structural model using hourly load data, daily min and max temperatures, hour, day of the week, and month. Load simulations are based on weather simulations and scaled to match load forecasts for monthly energy and peak demand.

The simulation of market prices follows a similar construct, but there are more structural variables observed in both historic and forecast values. There are also more parameters used as inputs. For market price simulations, PowerSIMM adheres to market expectations (that is, forward prices and option quotes for volatility in prices) by scaling simulations such that the average price exactly meets the forward curves for monthly average prices for natural gas, on-peak power, off-peak power, and carbon. The stochastic price ranges hold to future expectations of price volatility, correlations across time and commodities, and daily price shapes.

Dispatch in PowerSIMM

Simulations of weather, load, renewables, and spot prices roll into the dispatch module. PowerSIMM models dispatch by optimizing supply resource options in a “dispatch to load” or “dispatch to price” model. In a dispatch to load model, PowerSIMM calculates dispatch decisions to serve load at the least cost, while accounting for transmission system congestion. Market purchases are generally, but not always, included as an option for serving load. The dispatch to price model calculates dispatch decisions to maximize market revenue from generation.

Dispatch calculations rely on inputs to define the physical and economic characteristics of supply resources, including thermal resources, energy storage, hydro resources, or demand-side options. Users can also define transmission lines to represent constraints, such as import or export limits, or line losses. Ancillary services can be included in dispatch models where PowerSIMM will co-optimize supply resources to serve load and fulfill ancillary requirements. PowerSIMM ancillary product dispatch can include regulation up, regulation down, spinning reserves, and non-spinning reserves. PowerSIMM can also perform multiphase dispatch.

PowerSIMM uses a mix-integer linear programming algorithm in the dispatch calculations. The objective function in the algorithm is the minimization of cost to supply energy and ancillary requirements. Included in the total cost are startup costs, variable operations and maintenance (VOM) costs, fixed O&M costs, fuel costs and fuel delivery costs, electric power purchases and power sales. Power sales are treated as negative costs.

The decision variables for the dispatch algorithm include the online state of dispatchable generators, the generation setting for all dispatchable generators, the assignment of ancillary services for units capable of providing ancillary services, the charge or discharge state of energy storage resources, and the amount of market purchases. PowerSIMM iterates over a range of possible values to settle on the decision variables that provide the lowest possible cost within the model constraints.

Dispatch constraints are set for all units in the model such as economic max generation, economic min generation, ramp rates, must run requirements, minimum generation, etc. There are also constraints attributable to transmission limits and the requirement to meet load.

Variable generation from wind, solar and geothermal items are not considered dispatchable, but PowerSIMM may elect to curtail variable resources if system conditions require it. For example, wind generation may be curtailed due to transmission limits.

Resource Planning Modeling

PowerSIMM was used to run a variety of models for this resource plan. This section describes the types of models used for the plan.

Production Cost Modeling

The most common application of PowerSIMM in resource planning is as a production cost model, which shows many detailed aspects of system operations over a future time period. Production cost models can run with dispatch modeled across a range of simulated future conditions.

Outputs from production cost models include generation costs, fuel consumption, renewable generation, carbon emissions, and a long list of additional variables used to make investment and operational decisions. Example uses for PowerSIMM include analyzing options to hedge fuel price risk, evaluating new generation resource options, or conducting a study to determine renewable additions for RPS mandates.

Production cost model outputs allow users to understand how the system will operate with the assumed inputs. Figure 50 shows hourly dispatch outputs over a three-day period from a production cost model plotted against load. Comparing outputs from two or more production cost models allows a user to understand how changes in resource mix, price forecast, operational constraints, or other aspects of the system will affect future outcomes.

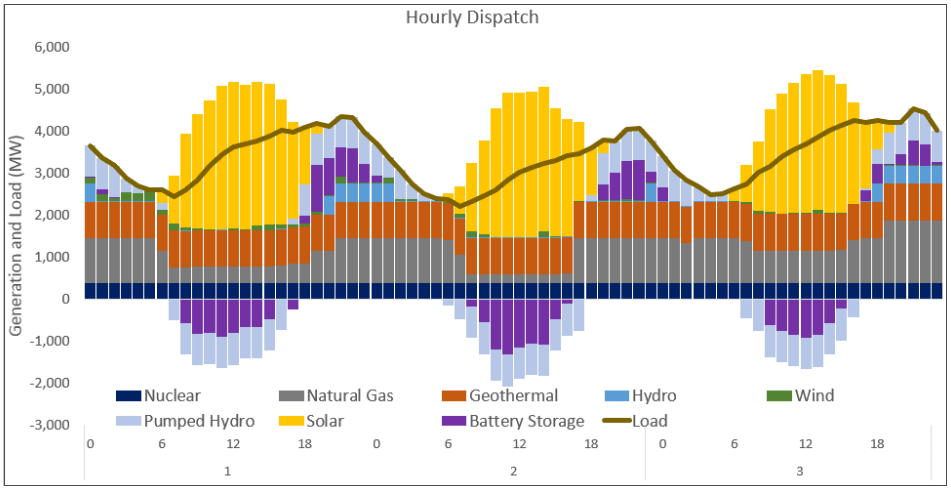

Figure 50. Three-Day Dispatch Outputs Plotted against Load

Key inputs for production cost models include the simulated system conditions[21] and supply resource operating parameters. The operating parameters of dispatchable generation assets in the portfolio—such as ramp rates or start-up times for thermal assets, leakage rates and round-trip efficiencies for battery storage, or spill requirements for hydro—guide dispatch optimization to ensure the model adheres to the actual physical capabilities and attributes of the resources in the portfolio.

Capacity Expansion Optimization

A second common application of PowerSIMM in resource planning is for capacity expansion optimization, which provides the least-cost selection of future resources over time, subject to user-specified constraints. Such constraints may include resource adequacy requirements, annual energy positions, renewable portfolio standards, or carbon emission limits. The Automatic Resource Selection (ARS) module contains the PowerSIMM capacity expansion model. ARS evaluates the performance of a portfolio of existing resources and candidate resources across a range of future operating conditions to assess their likely revenues, costs, and other characteristics (for example, carbon emissions). Based on the user inputs and constraints, the model determines the optimal resource additions (or retirements) for minimizing total costs while ensuring the generation portfolio can serve load without violating loss-of-load standards or emissions constraints.

21 Weather, load, renewables, and market prices for fuel and power, when not a dispatch to load without intertie purchases.

Figure 51 illustrates an ARS model that adds candidate resources to a portfolio to serve load at the lowest cost. The portfolio of existing resources and customer load are evaluated with candidate resources across a range of future conditions to select the optimal portfolio composition under input constraints.

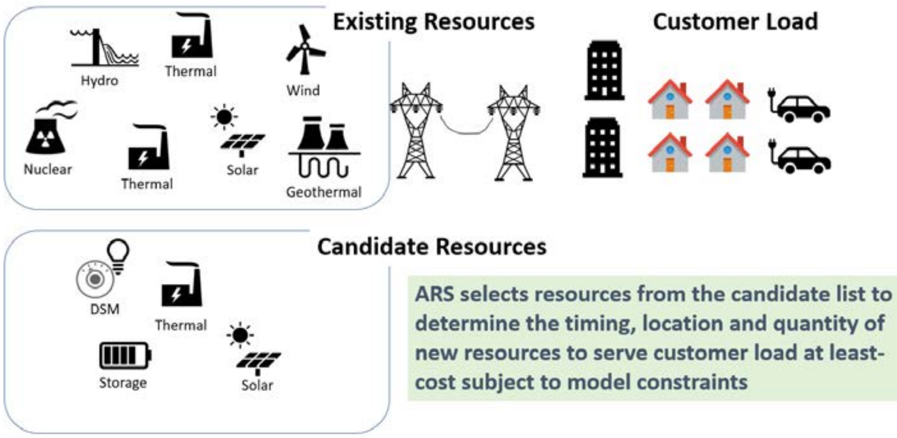

Figure 51. ARS Schematic of Candidate Resource Expansion

The input data requirements for ARS are generally the same as for production cost modeling except for additional project cost information (for example, new candidate resources), accredited capacity (for example, existing and new resources), and project specific constraints such as annual build limits for new resources. Users must also define model constraints to apply in the resource selection process, such as requirements for capacity, energy, or renewable generation.

Resource Adequacy Analysis

The third main application of PowerSIMM in resource planning is for resource adequacy analysis, which is used to assess the probability that a system will have adequate generation resources to meet load over a wide range of conditions. Common metrics for this assessment include loss-of-load probabilities (LOLP), expected unserved energy, and capacity deficit (the amount of additional capacity needed to meet reliability targets), among others. PowerSIMM's resource adequacy module can also be used to assess the capacity contribution from specific resources or technology types, which is typically measured with the effective load-carrying capability (ELCC) metric.

As shown in Figure 52, PowerSIMM's simulation engine provides simulations of load, renewables, and forced outages used to analyze the ability of a portfolio of resources to serve load. Resource adequacy models may also include transmission constraints.

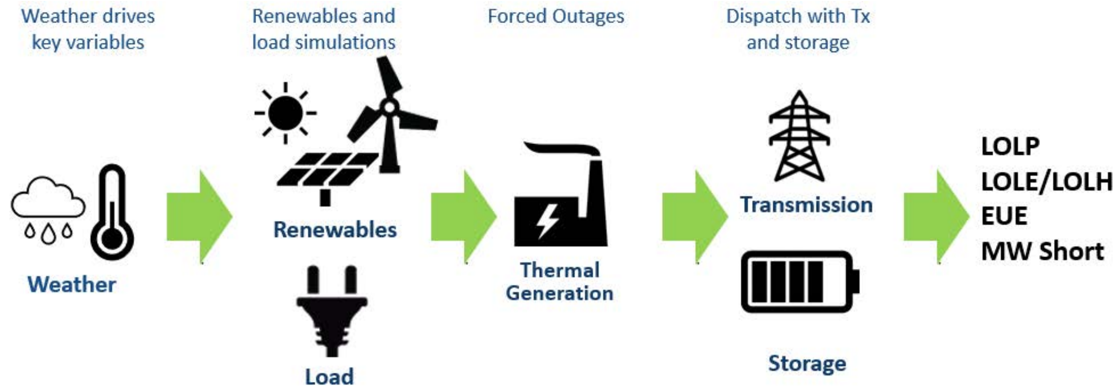

Figure 52. PowerSIMM Simulation Engine

The PowerSIMM resource adequacy model considers weather variability as a key driver to renewable and load simulation. These simulations are coupled with stochastically imposed forced outage in the dispatch module to measure common metrics, including LOLP, loss-of-load expectations (LOLE), or loss-of-load hours (LOLH), expected unserved energy, and capacity deficit (MW short).

The dispatch algorithm in a resource adequacy model differs from that used in production cost or capacity expansion models. Resource adequacy models evaluate systems based on how well they can meet system needs, so the ability to import power is typically eliminated (or significantly restricted). The model dispatches resources to minimize load shedding without regard to dispatch cost. Market prices also have no bearing on the dispatch decision in a resource adequacy model. Instead, the important inputs driving resource adequacy results include forced outage rates, correlation between load and renewables, and operational constraints. In each simulated hour of a resource adequacy study, the model calculates hourly load requirements and compares this to the sum of total renewable generation, available thermal capacity (that is, not on forced or scheduled outage), and available energy in storage (which is charged with excess energy when it is available). The model then dispatches thermal and energy storage resources chronologically (hour-by-hour) to determine how much (if any) load cannot be met in each hour.

Resource adequacy models provide metrics to evaluate the reliability of a system. Additionally, resource adequacy models provide a useful means of determining the capacity contribution of a specific resource, known as the ELCC. The standard approach for an ELCC analysis involves three model runs. The reliability contribution of the ELCC resource is compared to the reliability contribution from a "perfect" generator to determine the capacity value of the ELCC resource.