27-28 Transmission Planning Process RESOLVE Modeling Results

R.25-06-019 Integrated Resource Planning

Attachment to Administrative Law Judge's Ruling

Energy Division Staff

California Public Utilities Commission

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Overview of 27-28 TPP Recommended Portfolios Analysis

Overview of the CAISO's Transmission Planning Process

- Every year Commission staff develop a recommended set of portfolios for the California Independent System Operator (CAISO) to use in its annual Transmission Planning Process (TPP).
- CAISO intends to modify its Transmission Planning Process to include Order 1920 "Long-Term Transmission Planning" requirements and proposed cadence adjustment to the current cycle.[1] The 2027-2028 TPP cycle (with CAISO Board approval expected in 2028) will be the last one under current structure before transitioning to the new process.
- Generally, in each TPP cycle, the CAISO evaluates a reliability and/or policy-driven base case portfolio.
  - Under the CAISO tariff adopted by the Federal Energy Regulatory Commission (FERC), if the results of the base case analysis show the need for additional transmission development, the transmission projects are brought to the CAISO Board for approval in the spring of the second year of the TPP.
  - If approved by the CAISO Board, under the FERC tariff, the project would receive cost recovery through the transmission access charge.
- Along with the base case analysis that generally leads directly to transmission project approval, in each TPP cycle the CAISO can typically analyze one or more sensitivity portfolios.
  - The purpose of the sensitivity portfolio analysis is not to lead directly to transmission development immediately, but rather to assist in future planning by identifying relevant transmission needs and potential costs.
- The Commission adopted the 26-27 TPP portfolio in Decision (D.) 26-02-057. This Decision included both a base case and a sensitivity portfolio that the CAISO is in the process of analyzing for the 26-27 TPP cycle.
  - The base case portfolio was based on the scenario that achieves a 25 million metric ton (MMT) greenhouse gas (GHG) emissions target in 2035, including 4.5 gigawatts (GW) of offshore wind (OSW) from CPUC jurisdictional LSEs' IRPs submitted in November 2022, with an extension of online dates for some OSW resources by up to six years, and up to a two-year extension to the in-service dates for the transmission to support North Coast offshore wind.
  - The sensitivity portfolio tested a low-wind development scenario to identify additional transmission development that could be needed given a slowdown in out-of-state, offshore, and in-state wind development.

1 dec-9-2025-tariff-amendment-order-no-1920-compliance-filing-er26-704.pdf

Overview of 27-28 TPP Analysis

- Staff has conducted analysis to support the development of portfolios for consideration for study in CAISO's 27-28 TPP
  - The analysis builds off the 26-27 TPP portfolio that the Commission adopted in D.26-02-057
- This deck includes analysis of three portfolios under consideration for TPP transmittal:
  - A recommended 27-28 TPP Base Case with 0 GW of offshore wind and 38MMT by 2030, 30 MMT by 2035 GHG target
  - A potential 27-28 TPP Sensitivity Portfolio based on the 2025 IEPR load forecast
  - A recommended 27-28 TPP Sensitivity Portfolio with limited out-of-state resources
- This deck also includes analysis for two additional portfolios not being recommended for TPP transmittal that are included to support and enhance discussion around the recommended Base Case:
  - An alternate 27-28 TPP Base Case with 4.5 GW OSW, 30 MMT GHG target by 2030, 25 MMT GHG target by 2035
  - An alternate 27-28 TPP Base Case with 4.5 GW OSW, 38 MMT GHG target by 2030, 30 MMT GHG target by 2035
- The Commission will transmit a single base case portfolio and can consider transmitting a sensitivity portfolio to the CAISO for the 27-28 TPP
- CAISO's study of these portfolios focused on model years that are 10 and 15 years in the future:
  - 2037 — 10-year projection
  - 2042 — 15-year projection
- Comments are sought on the Administrative Law Judge's Ruling Seeking Comments on Electricity Portfolios for the 2027-2028 Transmission Planning Process and Potential for Geographically-Targeted Procurement.

27-28 TPP Case Matrix

Case Name	Minimum Builds	Load Forecast	Out-of-State Resources	Offshore Wind	Diablo Canyon	GHG Targets
Recommended Base Case	LSE Contracts Reliability Procurement Orders[1] Partial AB1373[2]	2024 IEPR Planning Scenario[4]	Default (updated for 27-28 TPP)	None forced-in	Offline 2025[3]	38MMT by 2030, 30 MMT by 2035
38 MMT + OSW	LSE Contracts Reliability Procurement Orders[1] Partial AB1373[2]	2024 IEPR Planning Scenario[4]	Default	2.9 GW Morro Bay (2037) 1.6 GW Humboldt (2042)	Offline 2025[3]	38MMT by 2030, 30 MMT by 2035
30 MMT + OSW	LSE Contracts Reliability Procurement Orders[1] Partial AB1373[2]	2024 IEPR Planning Scenario[4]	Default	2.9 GW Morro Bay (2037) 1.6 GW Humboldt (2042)	Offline 2025[3]	30 MMT by 2030, 25 MMT by 2035
2025 IEPR	LSE Contracts Reliability Procurement Orders[1] Partial AB1373[2]	2025 IEPR Planning Scenario	Default	None forced-in	Offline 2025[3]	38MMT by 2030, 30 MMT by 2035
Recommended Sensitivity Case (Limited Out-of-State Resources)	LSE Contracts Reliability Procurement Orders[1] Partial AB1373[2]	2024 IEPR Planning Scenario[4]	No generic transmission potential	None forced-in	Offline 2025[3]	38MMT by 2030, 30 MMT by 2035

1 15.5 GW NQC cumulative from MTR orders (2023-28) and 6 GW of proposed procurement (2029-32)
2 Half of the maximum non-OSW amounts (0.5 GW geothermal, 0.5 GW 12-hr LDES, 0.5 GW multi-day LDES)
3 As required by SB 846
4 Single Forecast Set Agreement: https://efiling.energy.ca.gov/GetDocument.aspx?tn=269506&DocumentContentId=106596

Executive Summary

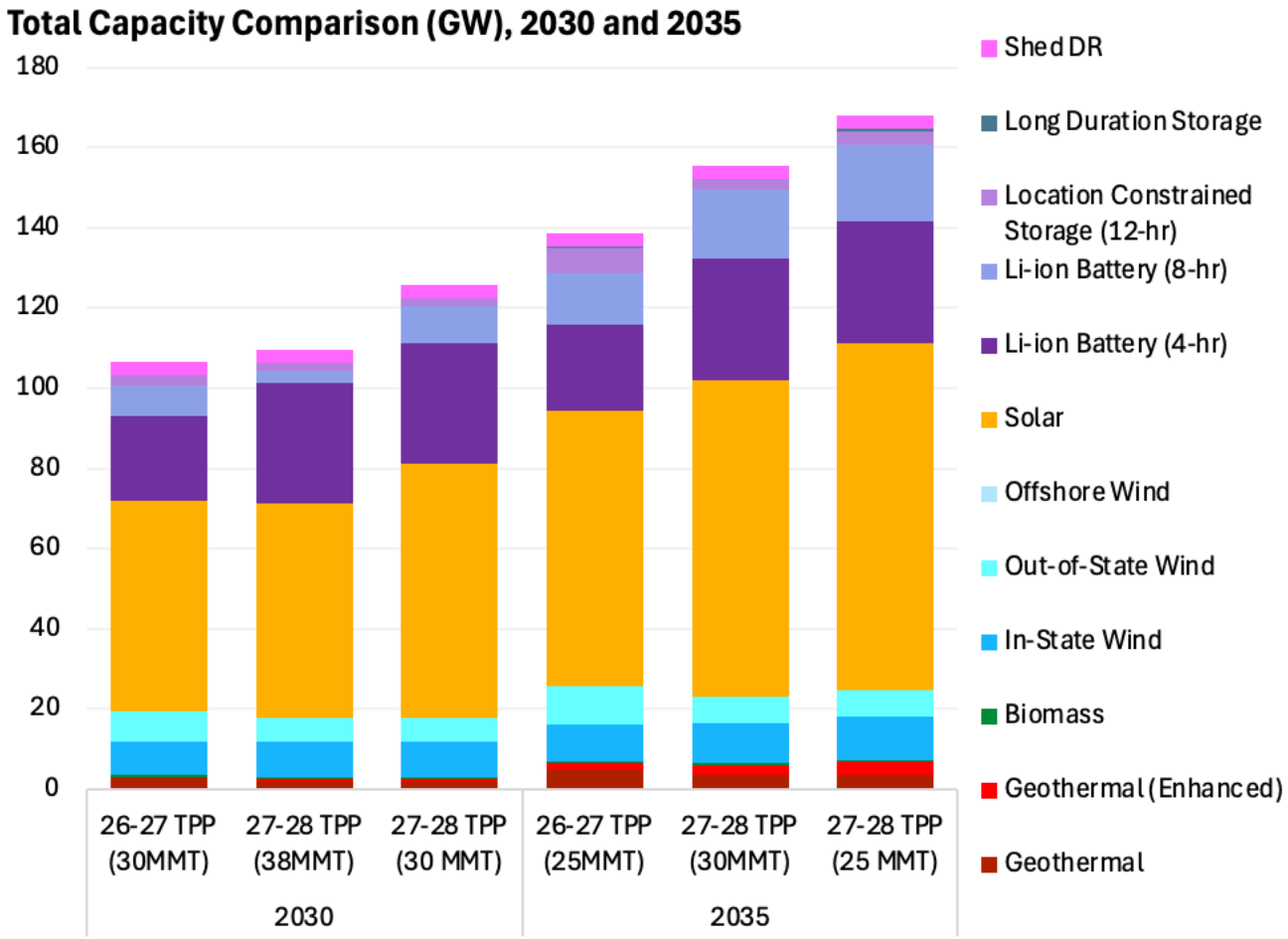
Key Drivers of Modeling Results

- The 27-28 TPP Recommended Base Case results include **higher near-term build rates** (primarily solar and storage), along with **increased transmission needs and GHG abatement costs**, compared to the previously transmitted TPP base case. These results are driven by binding 2030 and 2035 GHG constraints in combination with **the following inputs**:
  1. The **2024 IEPR load forecast** (+105 TWh sales and +14 GW peak by 2035) includes significant growth in building and vehicle electrification and data centers.
  2. The **GHG target set by the CPUC** requires rapid increases in near-term build rates. The target modeled for the 26-27 TPP (30 MMT statewide by 2030, 25 MMT statewide by 2035) results in likely infeasible near-term build rates now; a modified target (38MMT statewide by 2030, 30MMT statewide by 2035) partially mitigates the need for aggressive near-term builds and **saves $2 billion in portfolio resource costs**.
  3. Continued **omission of Diablo Canyon (DCPP) from IRP planning**, per SB 846, creates a large GHG gap that must be solved by new generation and transmission**.**
  4. **(New to 27-28 TPP) The first available years for generic wind and geothermal**[1] have been updated to **reflect increased development lead-times**.
     - 2034 for in-state wind and geothermal, 2037/2042 for out-of-state wind and geothermal

1 These are resources not identified in generator interconnection queues or deliverable by in-development or proposed transmission projects

Near-Term Solar and Storage Builds for the 27-28 TPP are More Aggressive than the 26-27 TPP

- Delayed availability of geothermal and wind in the near-term, compared to the 26-27 TPP, drives additional solar and storage builds to meet the GHG target of 30 MMT by 2030 (and 25 MMT by 2035)
  - ~2 GW (2030) and ~3 GW (2035) less geothermal and wind selected, compared to the 26-27 TPP
  - Solar and storage builds increase significantly to fill this gap[1]:
    - 2030: +11 GW solar, 10 GW storage
    - 2035: +18 GW solar, 12 GW storage
- Meeting a modified 38 MMT by 2030 (and 30 MMT by 2035) target still requires additional solar and storage compared to the 26-27 TPP, though the differences are smaller



1 Other RESOLVE updates (updated solar profiles, representation of forced outage rates in RESOLVE) account for roughly 4-6 GW of these incremental solar and storage builds

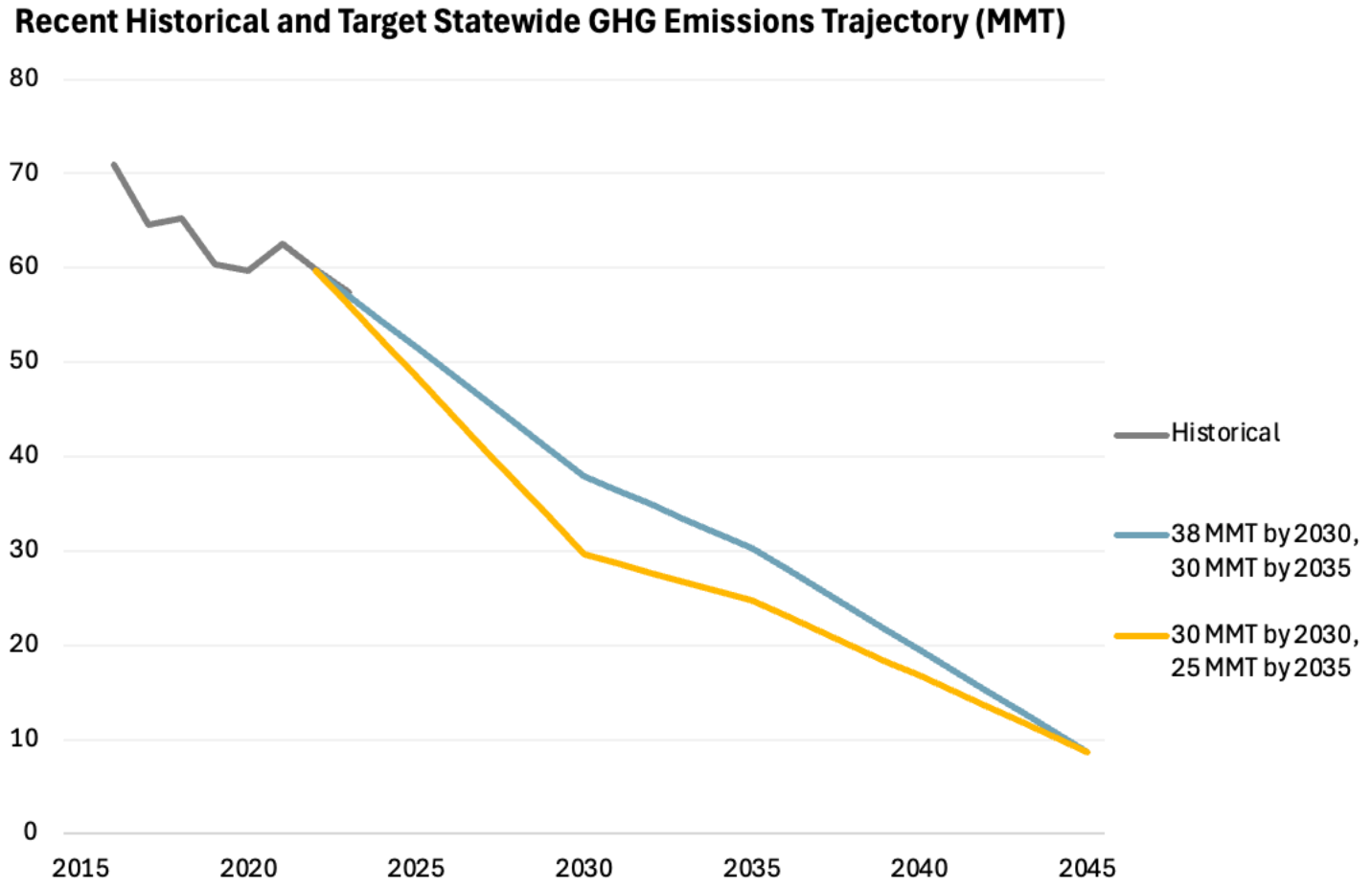
Note: 26-27 TPP results interpolated between model years where necessary

Recommended Policy Changes in the Recommended Base Case

- The 27-28 TPP Recommended Base Case portfolio includes two key updated policy assumptions compared to the previous TPP:
  1. **The electric sector GHG target is modified**(38 MMT statewide by 2030, 30 MMT statewide by 2035) due to likely infeasible near-term builds and very high abatement costs under the previous target (30 MMT statewide by 2030, 25 MMT statewide by 2035)
  2. **No offshore wind is forced in** (and RESOLVE does not optimally select it) due to high cost impacts and the impact of recent federal policy developments
- Regarding the other drivers of high near-term builds and costs, the CPUC cannot unilaterally change assumptions around the IEPR load forecast vintage (due to commitments within the MOU between state agencies) nor DCPP (due to statutory requirements from SB 846)

Historical GHG Emissions and Near-Term Targets

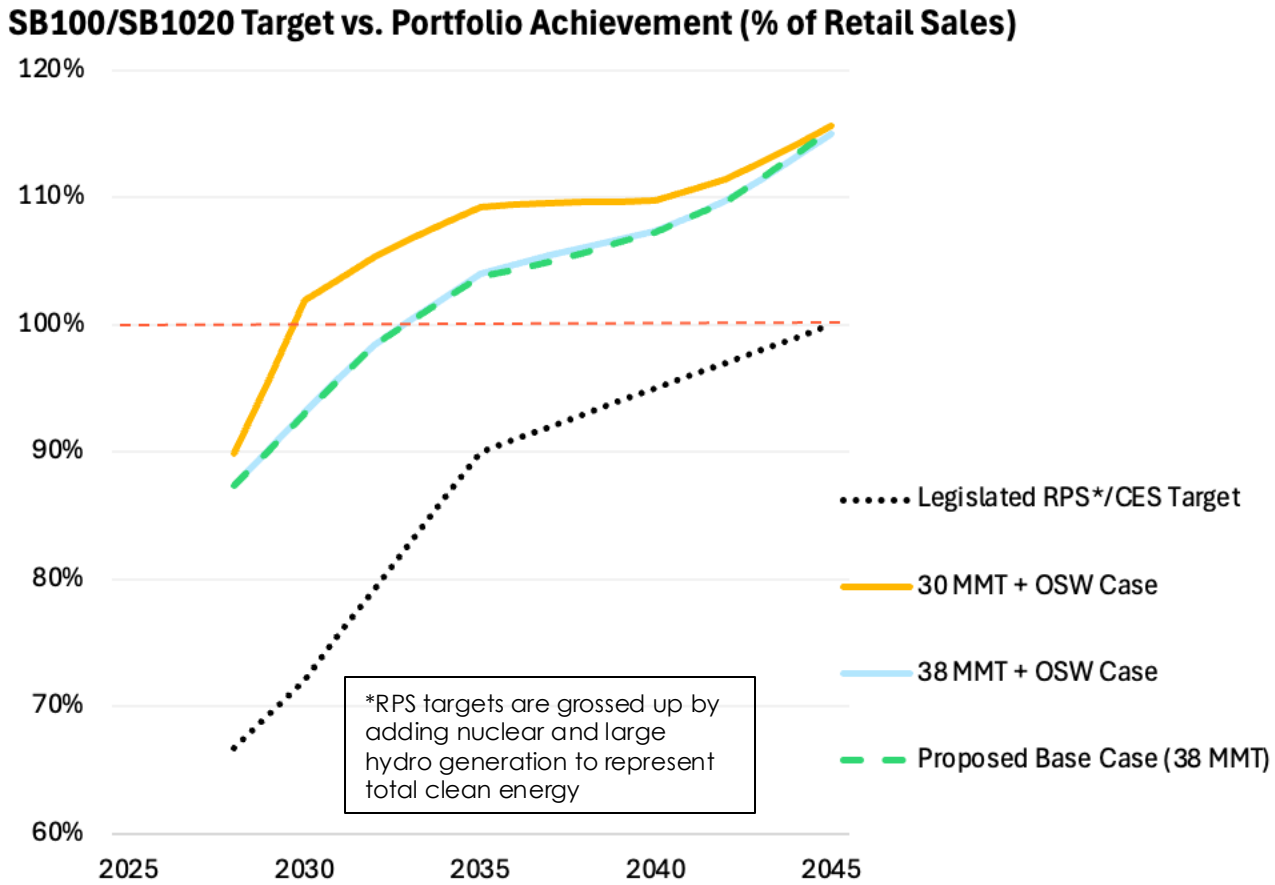
- **The lower GHG target (30 MMT by 2030) was adopted in the 2023 Preferred System Plan (PSP) under a more favorable policy environment (including Inflation Reduction Act (IRA) tax credits for solar and wind and fewer tariffs) and lower 2030-2035 load forecasts**
- Achieving 30 MMT emissions reflects a ~50% reduction from recent levels (2019-23) amidst very high near-term load growth
- The higher GHG target (38 MMT by 2030) still makes significant near-term reductions
- Both GHG targets converge at the same end point (~8 MMT by 2045)



Note: CAISO emissions are ~81% of statewide emissions
Note 2: California statewide emissions in 2000 were approximately 461 MMT, including approximately 105 MMT from the electric sector.

GHG Targets Exceed Legislated Clean Energy Targets

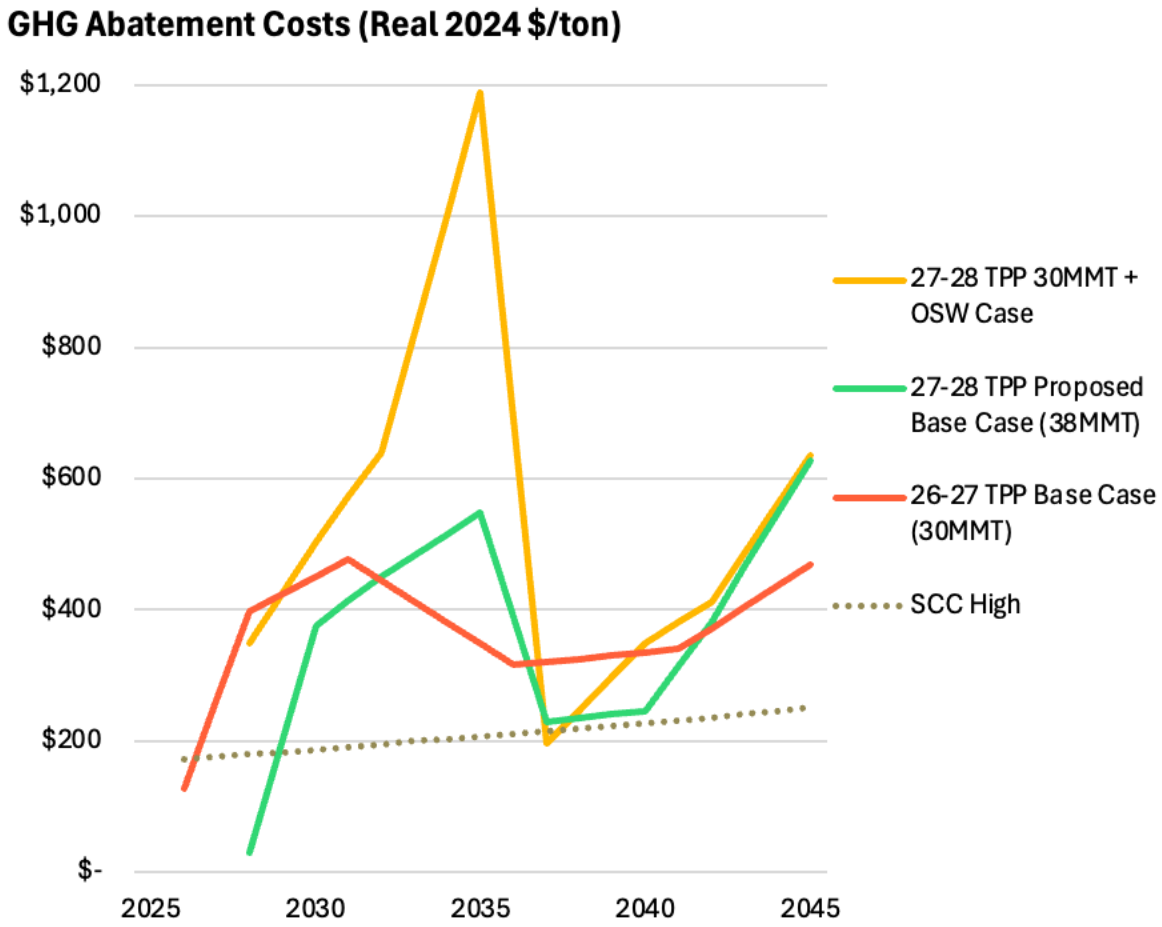
- Renewable Portfolio Standard (RPS) and Clean Energy Standard (CES) targets are based on a percentage of retail sales
- Mass-based GHG targets cause the achieved RPS/CES to exceed legislated requirements[1]
- **Both the 30 MMT and 38 MMT portfolios significantly exceed the legislated RPS/CES**, exceeding 100% retail sales by 2030 (30 MMT) or 2035 (38 MMT)
    - **Including DCPP output increases achieved CES by another ~7% in 2030**, leading to ~100% achieved CES (38 MMT) and ~110% achieved CES (30 MMT)



1 RPS/CES accounting counts exported Renewable Energy Credits (RECs) earned by renewable sources and Zero-Emission Credits (ZECs) earned by non-renewable zero-emission sources of energy. In contrast, GHG emissions accounting assigns no credit to exported clean energy while RPS/CES retail sales definitions do not include T&D losses, hence how portfolios with remaining emissions can exceed 100% CES.

Electric GHG Marginal Abatement Costs Have Increased vs. the 26-27 TPP

- After recent federal policy changes, GHG marginal abatement costs in the 26-27 TPP were already higher than the CPUC's High Social Cost of Carbon (SCC) value in all years; marginal abatement costs increase further in the 27-28 TPP analysis
- **Moving to a 38 MMT target in 2030 leads to a substantial reduction in marginal abatement costs through 2035**, indicating the challenge of scaling clean energy in the near-term



Marginal Abatement Costs = GHG Shadow Price + CARB Floor Carbon Price (described in further detail in the appendix)

Aggressive Near-Term Targets Increase System Costs Amidst Limited Resource Diversity Options

- With federal policy shifts, tariffs, and other ongoing cost drivers, resource costs have increased since the CPUC set the 30 MMT by 2030 GHG target in the 2023 PSP
  - **Planning for a 38 MMT by 2030 (and 30 MMT by 2035) target reduces costs by ~$1.4 Billion in 2030 and ~$2 Billion and 2035, with long-term savings persisting through 2045**
  - If offshore wind is not forced into the portfolio, additional savings of ~$2 Billion/yr are realized in the long-term

RESOLVE-Optimized Costs ($MM in 2024$)

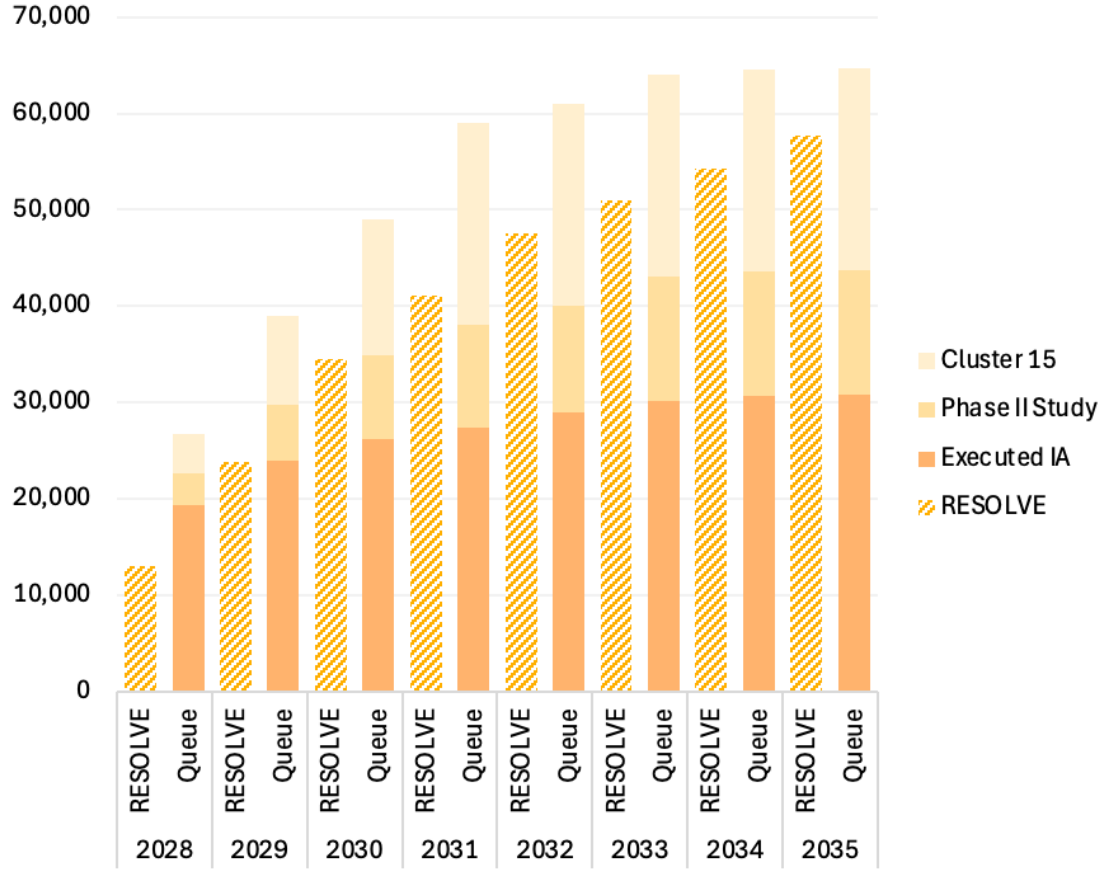
Case	2028	2030	2032	2035	2037	2040	2042	2045	NPV
Recommended Base Case	$13,316	$16,667	$20,080	$25,190	$27,746	$30,420	$32,378	$40,287	*$421,454*
38 MMT + OSW *(cost increase if OSW included)*	$13,329 +13 (0.1%)	$16,659 -8 (0.1%)	$20,107 +27 (0.1%)	$25,281 +92 (0.4%)	$29,338 +1,592 (5.7%)	$31,867 +1,447 (4.8%)	$34,481 +2,103 (6.5%)	$42,561 +2,274 (5.6%)	*$439,108 +17,654 (4.2%)*
30 MMT + OSW *(cost increase of lower GHG target)*	$13,578 +249 (1.9%)	$18,031 +1,371 (8.3%)	$21,860 +1,753 (8.8%)	$27,335 +2,054 (8.1%)	$30,685 +1,347 (4.6%)	$33,005 +1,138 (3.6%)	$35,493 +1,012 (2.9%)	$43,437 +876 (2.0%)	*$456,005 +16,898 (3.8%)*

RESOLVE-optimized costs account for ~15-30% of total system costs (increasing over time); non-optimized baseline generation, transmission, and distribution make up the rest of the total revenue requirement

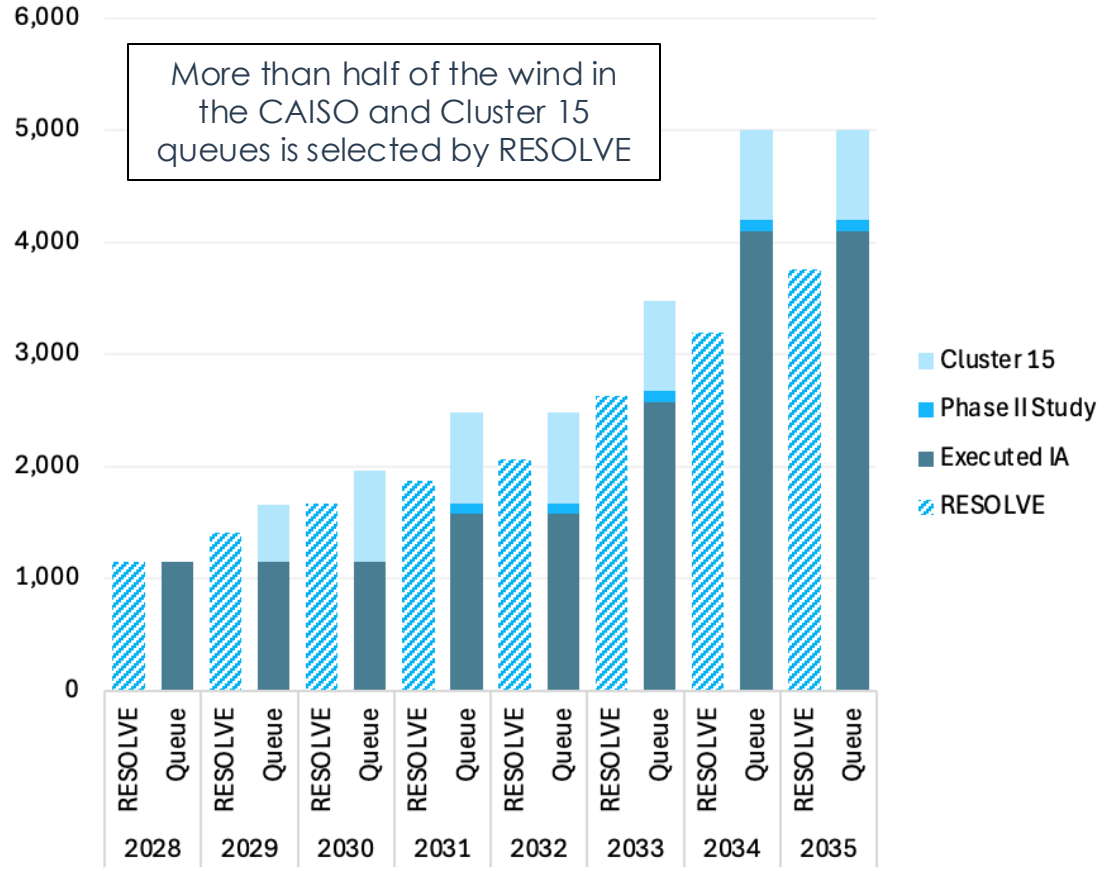
Solar and Wind RESOLVE Build vs. Queue – 30 MMT by 2030, 25 MMT by 2035

- **To meet the 30 MMT GHG target under 2024 IEPR, nearly all solar in the queue is selected**
  - Tightness in the PPA market due to limited supply could result in elevated PPA prices

RESOLVE Solar Build vs. IX Queue (MW)



RESOLVE In-State Wind Build vs. IX Queue (MW)

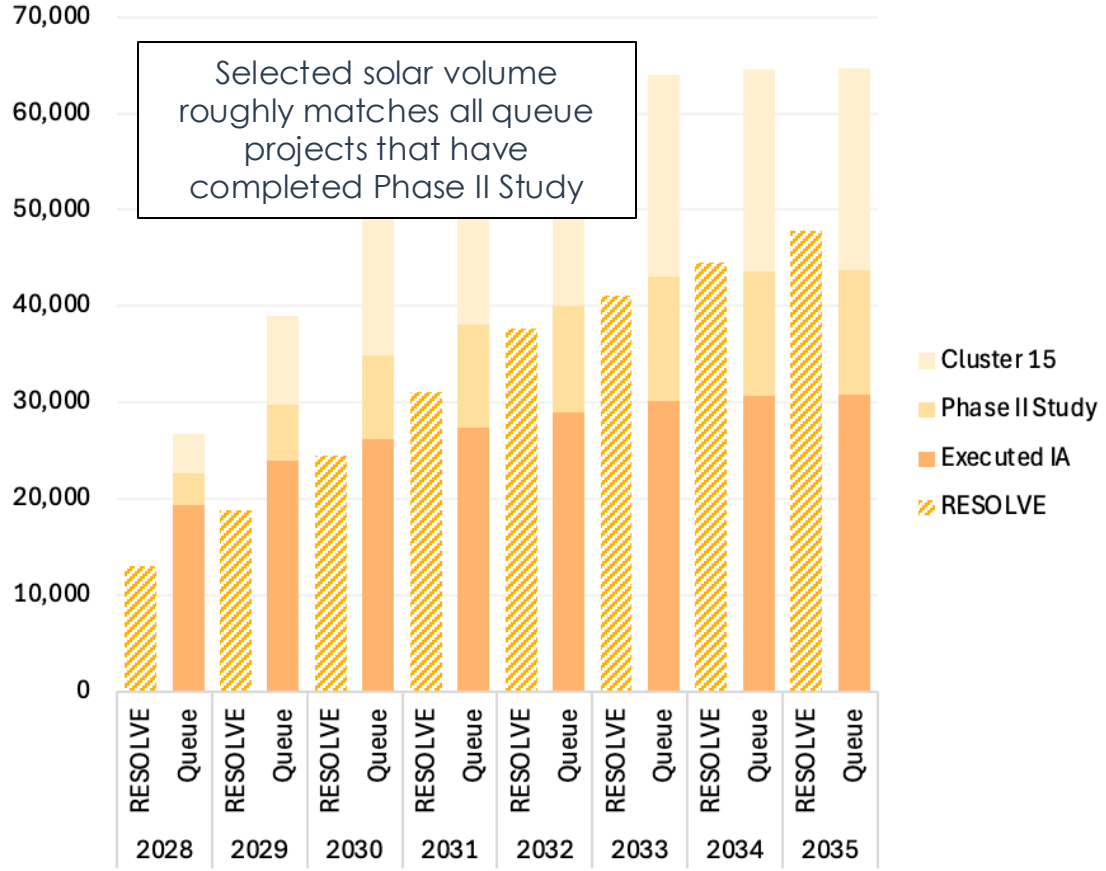


CAISO Queue and Cluster 15 data accessed 5/5/2026

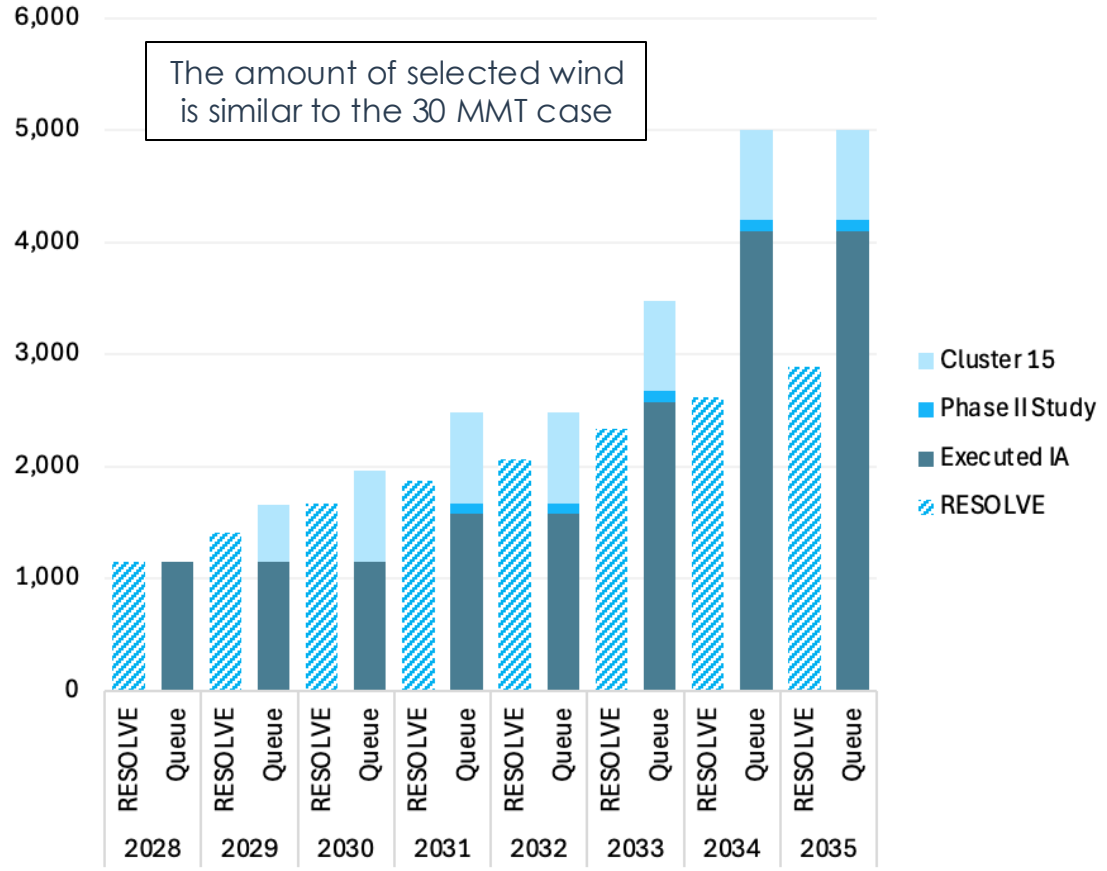
Solar and Wind RESOLVE Build vs. Queue – 38 MMT by 2030, 30 MMT by 2035

- With a modified GHG target, near-term solar builds are meaningfully reduced
  - The total quantity is still significant – 50% (2030) and 75% (2035) of the current interconnection queue volume

RESOLVE Solar Build vs. IX Queue (MW)



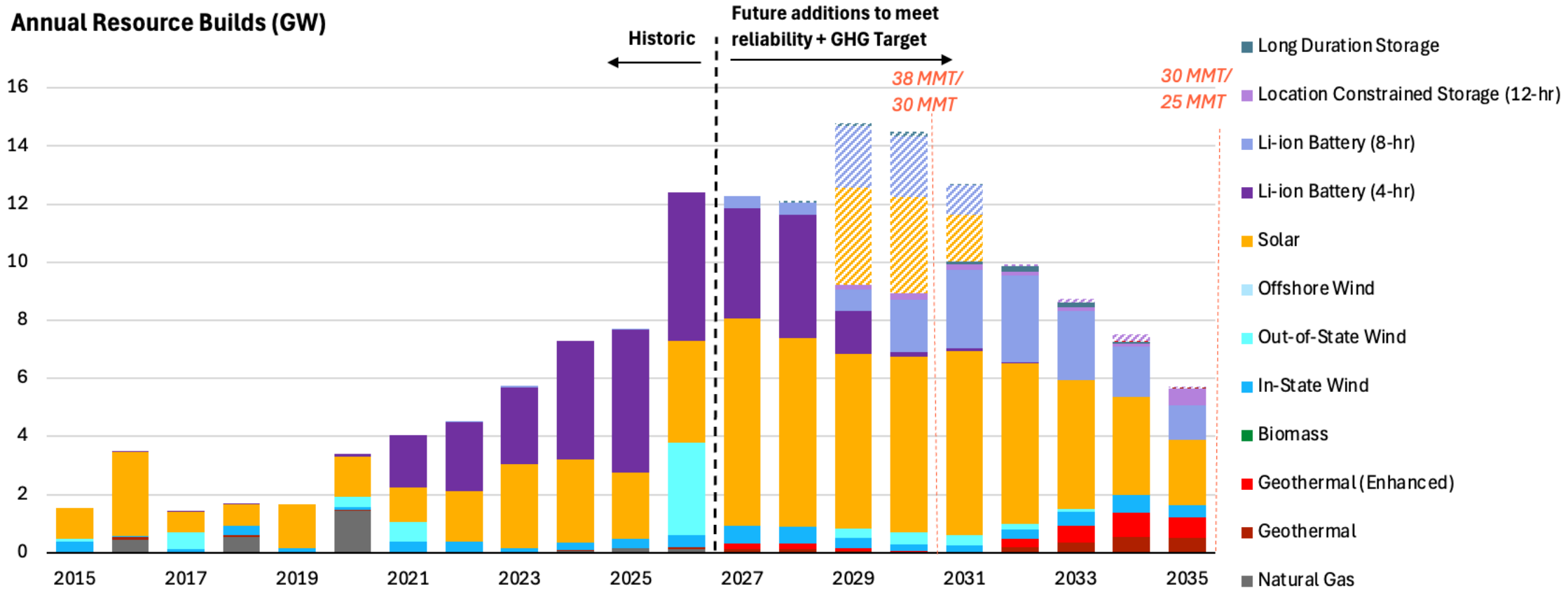
RESOLVE In-State Wind Build vs. IX Queue (MW)



CAISO Queue and Cluster 15 data accessed 5/5/2026

Annual Build Rates to Meet Near-Term GHG Targets

- Meeting 38 MMT by 2030 requires accelerating near-term solar build rates from ~3 GW/yr to 6.5 GW/yr, while meeting 30 MMT would require ~8 GW/yr of new solar



Builds are interpolated and smoothed between model years; 2026 build is a combination of resources already online this year and resources with high-confidence online dates later in the year provided by CAISO

Summary of GHG Target Impacts on RESOLVE Portfolios

- Near-term build rates are unrealistically extreme to meet the 30 MMT by 2030 GHG target; the 38 MMT by 2030 target for the recommended base case *partially* mitigates this
  - **Historical solar build rate (2023-2026): ~3 GW/yr**
  - **Build rate to achieve 38 MMT by 2030: ~6.5 GW/yr** (25 GW new solar by 2030, 50 GW by 2035)
  - **Build rate to achieve 30 MMT by 2030: ~8 GW/yr** (35 GW new solar by 2030, 58 GW by 2035)
- Near-term (2030-35) GHG abatement costs meaningfully decrease from ~$450-1150/ton to meet 30MMT, to ~$350-500/ton in the recommended base case
- Both the recommended base case and a 30 MMT by 2030 case require incremental transmission above the 26-27 TPP primarily to accommodate incremental in-state resources; the GHG target does not have a significant impact on RESOLVE-selected upgrades
  - Actual approved upgrades to be determined through CAISO's TPP studies after busbar mapping

RESOLVE Baseline			*RESOLVE Selections*		
Year	**Solar (GW)**	**Battery Storage (GW)**	**Year**	**Solar (GW)**	**Battery Storage (GW)**
2018	0.7	0.0	**2027**	7.2	4.2
2019	1.5	0.0	**2028**	6.5	4.7
2020	1.4	0.1	**2029**	6.0	2.2
2021	1.2	1.8	**2030**	6.0	2.0
2022	1.7	2.4	**2031**	6.3	2.8
2023	2.9	2.7	**2032**	5.5	3.0
2024	2.9	4.1	**2033**	4.4	2.4
2025	2.2	4.9	**2034**	3.4	1.7
2026	3.6	5.2	**2035**	2.2	1.2

Above: A table of historical solar and storage builds and RESOLVE selected **solar and storage builds under a 38 MMT 2030 target.** Historical values are based on RESOLVE baseline resources.[1]

1 Numbers align with CAISO's Master Control Area Generating Capability List (MGC) but differ in some cases because hybrid solar and storage resources have been incorporated here whereas they are reported as a separate category in the MGC.

Impacts of Offshore Wind on the RESOLVE Portfolio

- Two of the five cases presented for the 27-28 TPP force in 4.5 GW of offshore wind by 2042, a partial buildout of the maximum procurement volumes considered in the Commission's need determination analysis pursuant to D.24-08-064, related to Assembly Bill (AB) 1373:
  - 2037: 2.9 GW at Morro Bay
  - 2042: 1.6 GW at Humboldt
- **A base case portfolio without offshore wind lowers system costs by ~$2 Billion/yr**, compared to a case with 4.5 GW offshore wind
- Although offshore wind procurement reduces the need for solar, storage, and onshore wind capacity, significant amounts of each are still selected
- Offshore wind procurement does not displace other (onshore) transmission upgrade needs; the transmission needed to deliver Humboldt offshore wind increases costs, without a clear alternative use for these lines should offshore wind not materialize
- Due to its long lead time, offshore wind does not mitigate extreme near-term build rates needed to meet a 30 MMT by 2030 (and 25 MMT by 2035) GHG target

Recent LSE Plans Include Less Offshore Wind Relative to 2022 Plans

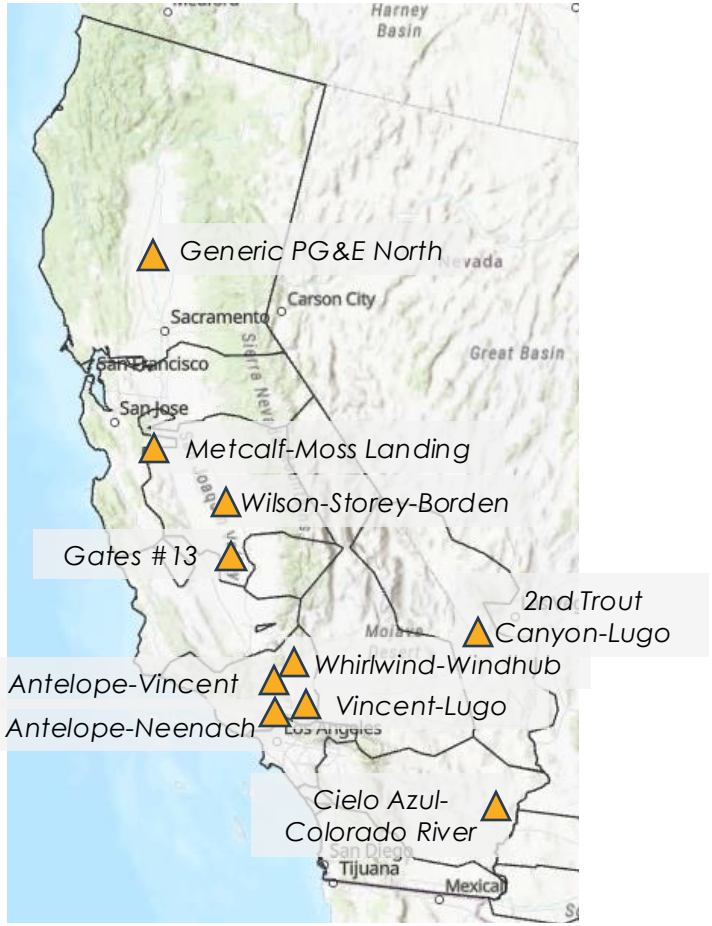
- Load Serving Entities (LSE) Integrated Resource Plans communicate their preferences and intentions for future procurements, as well as their views on resource viability
- LSEs only included 496 MW of offshore wind in their 2026 plans, compared to 4,642 MW in their 2022 plans
  - LSEs that did include offshore wind in their portfolios were largely Electric Service Providers that did so as their prorated share of a potential centralized procurement

	LSE	MW OSW in 2022 Portfolio	MW OSW in 2026 Portfolio
IOUs	PGE	826	0
	SCE	1799	0
	Other IOUs	0	0
CCAs	CCCE	200	0
	CPASC	170	0
	DCE	0	16
	EBCE	639	0
	MCE	95	0
	OCPA	100	0
	PCEA	288	0
	PIONEER	40	0
	RCEA	150	17
	SDCP	300	0
	VCEA	35	0
	Other CCAs	0	0
ESPs	All ESPs	0	463
	Total	**4642**	**496**

Selected Transmission Upgrades in Recommended Base Case

- Transmission upgrades are largely driven by incremental solar and storage builds, relative to the 26-27 TPP, plus additional long lead-time (in-state and out-of-state) resources in the long-term
- By 2037, RESOLVE selects ten new transmission upgrades, largely clustered near the LA Basin and Central Valley (i.e. PG&E Fresno); a conceptual 2nd Trout Canyon-Lugo upgrade is also selected to support out-of-state resources
- Additional upgrades selected after 2037 and by 2042, support resources interconnecting in PG&E

2037



2042

[1] Transmission upgrades selected by RESOLVE are preliminary and indicative, with additional study performed in busbar mapping and by CAISO before being approved in the CAISO Transmission Planning Process
[2] Selections of less than 100 MW not shown
[3] RESOLVE optimization uses the 2024 CAISO Whitepaper; busbar mapping for the 27-28 TPP will utilize the latest 2026 Whitepaper

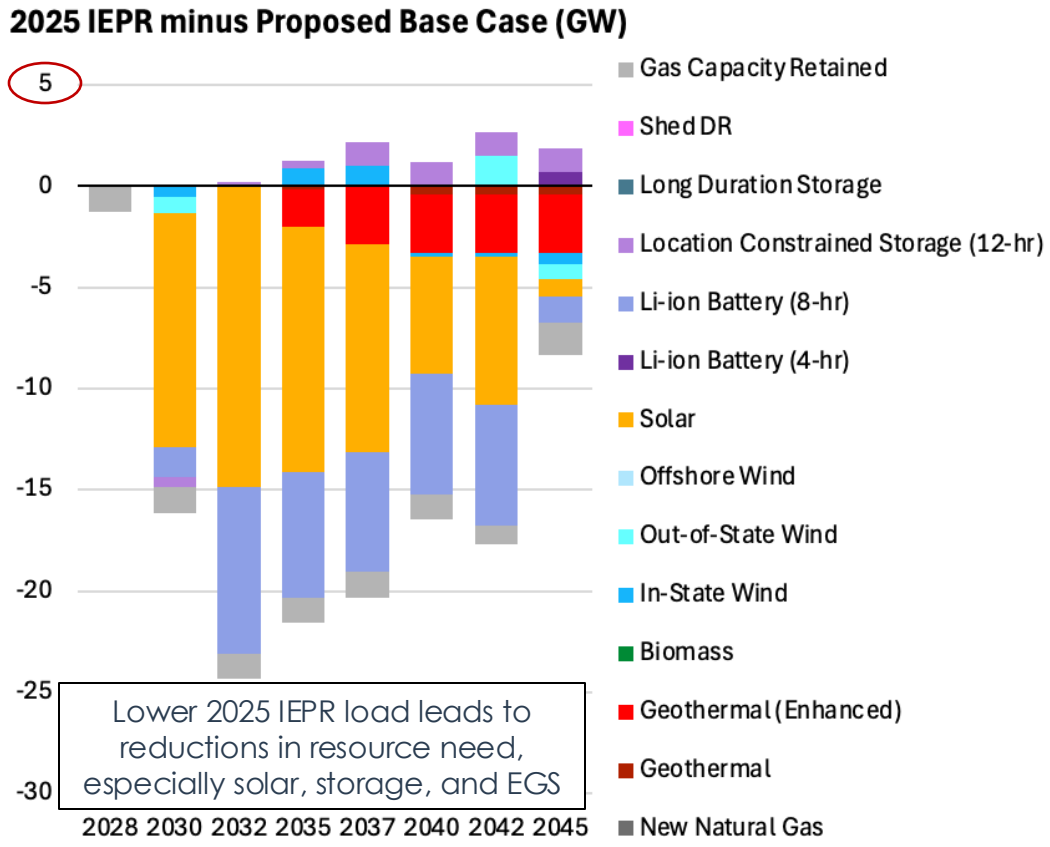
Additional Findings from Recommended Base Case Scenario

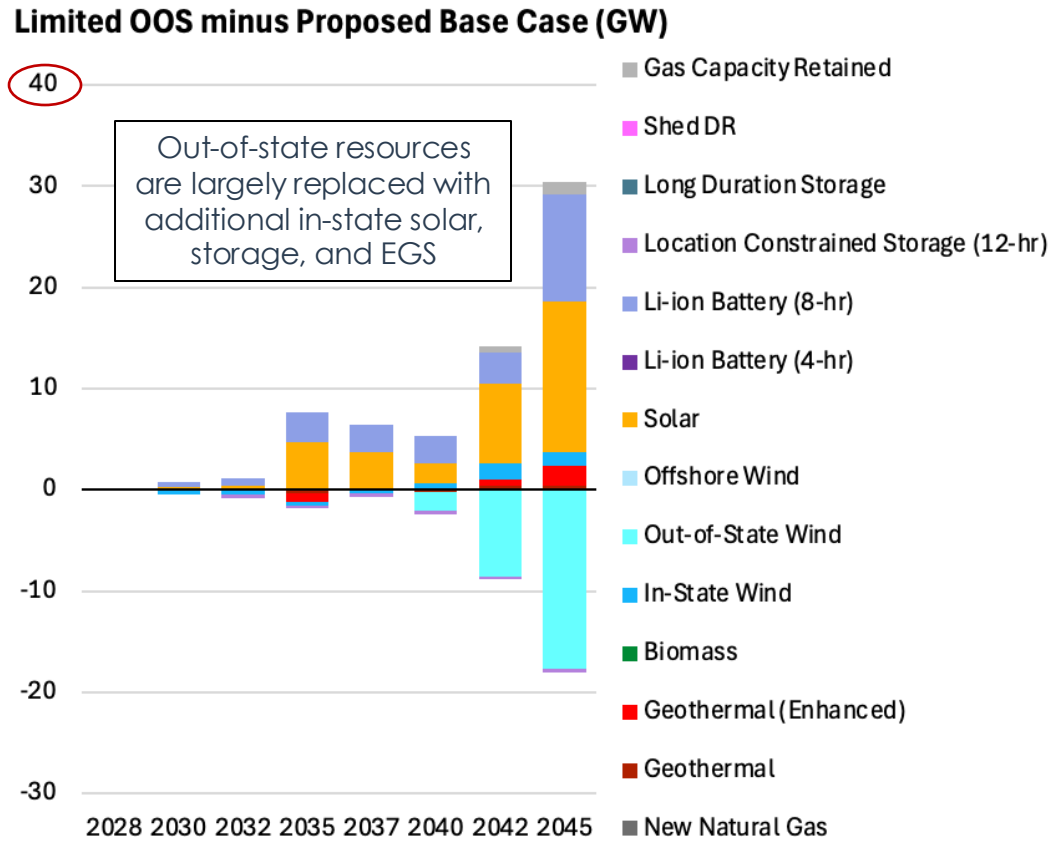
- The GHG target binds in every year, driving an over-reliable portfolio until 2040
  - Both reliability (planning reserve margin constraint) and GHG bind starting in 2040
- Solar and storage are heavily saturated by the mid-2030s, driving down the storage marginal ELCC significantly and making higher ELCC resources such as geothermal and out-of-state wind more important in the long run
- Despite near-term limitations in potential, more geothermal (especially enhanced geothermal) is selected in the long-term than for the 26-27 TPP, continuing a trend of growing geothermal selection in successive TPPs
- Competition for transmission headroom in the near-term limits the selection of in-state wind and some out-of-state resources through the mid-2030s
  - Out-of-state resources (wind and geothermal) are assumed to utilize many of the same major CAISO MIC hubs and will be restudied in busbar mapping with updated constraint information[1]
- Additional transmission upgrades are needed, relative to the 26-27 TPP, primarily to support incremental solar and storage (though key upgrades also support EGS and out-of-state resources)
- A large expansion of the PG&E-SCE transmission path (Path 15/Path 26) is selected, nearly doubling PG&E-SCE import/export capability
  - ~1 GW by 2037, ~3 GW by 2042, all ~5.5 GW made available by 2045

1 Due to timing constraints, the 2024 transmission capability estimates were used to run RESOLVE while the 2026 estimates will be used during busbar mapping.

Additional Findings from Sensitivity Scenarios

- The 2025 IEPR and Limited Out-of-State (OOS) Resource sensitivities provide a directionally lower and higher outlook for resource and transmission needs, respectively, compared to the recommended base case

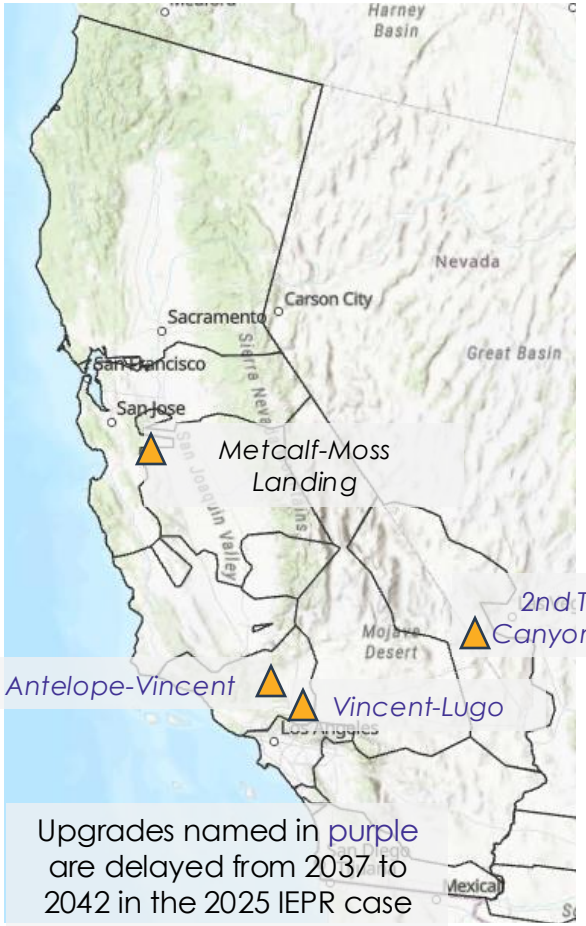




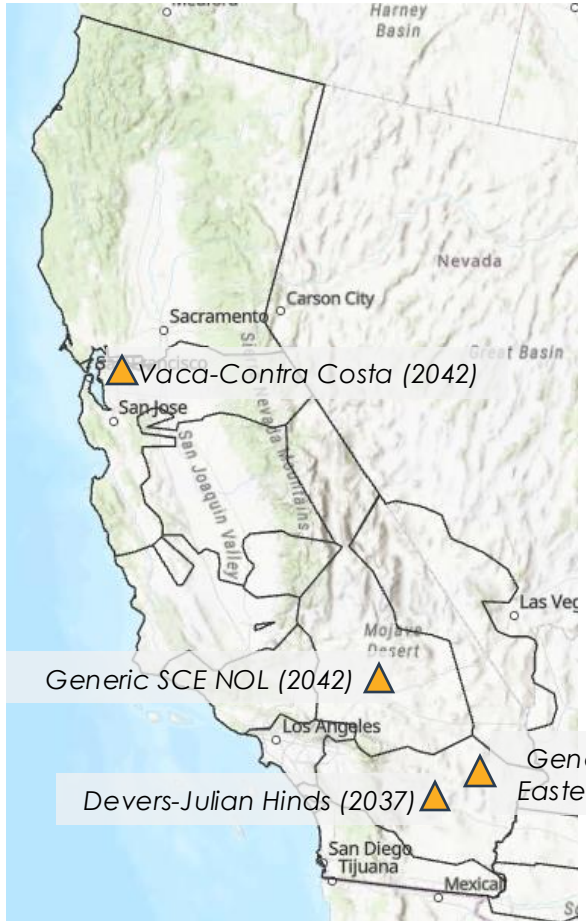
Incremental/Decremental Transmission Upgrades in Sensitivity Scenarios

- With lower load (2025 IEPR), some transmission upgrades are delayed, but by 2042, most of the same upgrades as the recommended base case are selected
- With limited access to out-of-state resources, incremental transmission upgrades, particularly in southern California, are needed to support incremental in-state resources
- An expansion of the PG&E-SCE transmission path (Path 15/Path 26) in similar amounts to the recommended base case is selected across these cases (~1 GW by 2037, ~3-4 GW by 2042)

Not in 2025 IEPR Case



Incremental in Limited OOS Case



1 Transmission upgrades selected by RESOLVE are preliminary and indicative, with additional study performed in busbar mapping and by CAISO before being approved in the CAISO Transmission Planning Process
2 Selections of less than 100 MW not shown
3 RESOLVE optimization uses the 2024 CAISO Whitepaper; busbar mapping for the 27-28 TPP will utilize the latest 2026 Whitepaper

Implications for the 2027 PSP and 2028-30 CTP[1]

- Evolving assumptions on long lead-time (LLT) resource availability create uncertainty for 10- to 15-year transmission system planning
  - LLT resources, both in-state and out-of-state, remain critical to both the 10- and 15-year portfolios
  - However, as LLT resources face ongoing delays, RESOLVE portfolios backfill with solar and storage additions, which can change the upgrades identified to meet 10- to 15-year system needs
  - A 20-year transmission plan with multiple distinct scenarios, as required by FERC 1920, will need to encapsulate an even broader range of uncertain futures
- Staff are considering how to better incorporate decision making under uncertainty (DMUU) into the portfolio development of the PSP and 2028-30 CTP, focusing on:
  - **Robust planning** methods that more explicitly account for DMUU can support development of a more robust transmission plan that is resilient across difference load and resource futures
    - For instance, these methods can support identifying transmission upgrades that could be repurposed for alternative resources (e.g., out-of-state wind instead of out-of-state geothermal) to mitigate against the risk that certain resources may not materialize
  - **Adaptive planning** can enable CPUC and CAISO can identify "offramps" for further out approved transmission projects if conditions evolve and they are no longer robustly identified as part of future TPP analysis
- Additional future areas of exploration
  - The role of additional emerging technologies in providing resource diversity (CCS, hydrogen, etc.)
  - The potential use of the Social Cost of Carbon as a GHG target offramp in RESOLVE
  - Continued evaluation of impacts on reliability, clean energy needs, and costs if DCPP could be counted in IRP

1 CAISO has proposed for the Comprehensive Transmission Plan (CTP) to replace the Transmission Planning Process (TPP) in 2028 and for it to occur on a two-year cadence

Summary of Input Updates for 27-28 TPP Modeling

Summary of RESOLVE Updates Since 26-27 TPP (1)

Data	Change
Baseline Resources	Updated with more recent CAISO (MGC, GIRR) and WECC (ADS) data; updated thermal resource classifications including CHP
RESOLVE Minimum Builds	Updated to the June 2025 LSE filings, incremental to the updated baseline
External Region Resources	Updated with new non-CAISO utility IRPs
Minimum Gas Retention	Updated with more recent CAISO LCTS study; CCS candidates excluded from non-retention decisions
In-State Resource Potential	Minor increases to Northeast CA and Baja California Wind potential
Out-of-State Resource Potential	Specific in-development, proposed, and generic transmission options and tie-in locations used as the basis for revising OOS wind, geothermal, and EGS resource potential; removed UT hydrothermal resource potential and increased UT EGS potential to 2,000 MW
First Available Years	Adjusted lead time assumed for generic in-state wind (2034), geothermal and EGS (2034) and generic out-of-state wind and geothermal (2037/2042); offshore wind available year adjusted for federal permitting delays
Near-Term Build Limits	Wind and geothermal limits based on queue analysis and stakeholder feedback until above years; solar near-term build limit adjusted to 13 GW by 2028
Out-of-State Transmission Costs	Specific transmission options studied by CAISO are costed based on per-unit estimates for HVDC and HVAC options

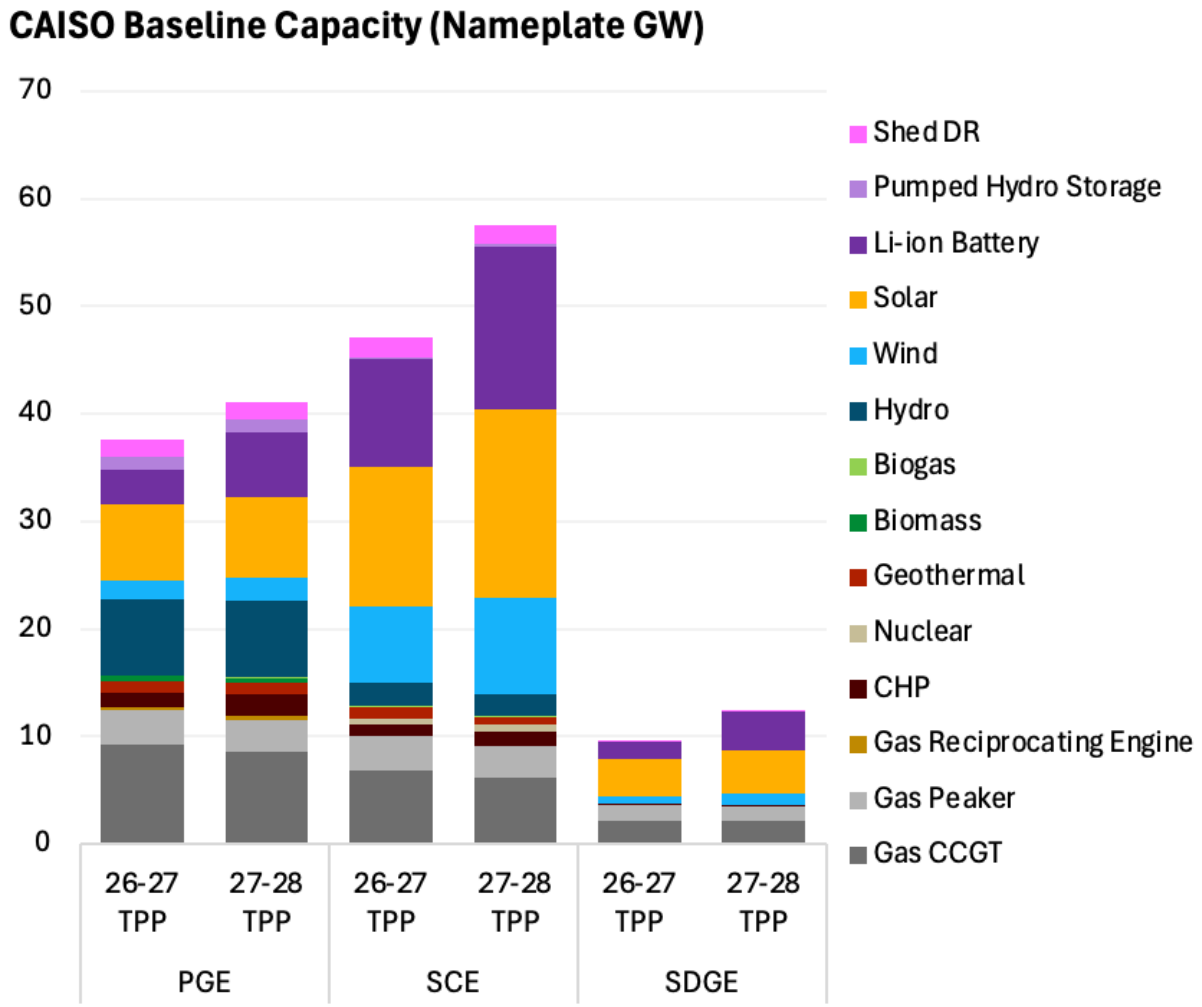
Summary of RESOLVE Updates Since 26-27 TPP (2)

Data	Change
SunZia Wind Representation	SunZia wind modeled as a baseline (existing) resource; 2,131 MW limit for delivery into CAISO enforced (with excess dumped into the SW Zone); upgrades in 2034 allow SunZia to receive FCDS[1] and expand simultaneous flow constraints by 2,131 MW
CAISO Transmission Constraints & Upgrades	Approved policy-driven project from the 25-26 TPP (Trout Canyon-Lugo), as well as a 2nd generic upgrade in EOP and a new constraint affecting AZ solar and storage
PG&E-SCE Path Expansion	Incorporated Busbar Mapping Working Group feedback to refine Path 15/Path 26 expansion options
Cap-and-Trade (Carbon) Price	Updated from 2023 to 2025 forecast
Modeling of Reliability Procurement Orders	D.26-02-057 procurement order modeled as an adder to the RESOLVE PRM target
Forced Outage Rates & Static ELCC	EFOR incorporated as a derate to the monthly Pmax of thermal and storage resources, for RESOLVE-SERVM calibration and better representation of resource availability
LDES ELCC Multipliers	Improved estimates of LDES ELCC based on SERVM analysis of the 2025 LSE Plan Filing Requirements portfolio
Historical Weather-Varying Profiles	2023 and 2024 weather years added; solar profiles calibrated with 30-min NSRDB data and CAISO historical settlement data, solar cf decreases by ~1% on average

1 Full Capacity Deliverability Status

Baseline Resources

- The resource baseline was updated to reflect online and in-development resources for both CAISO and non-CAISO zones as of September 2025
- Key changes for the 27-28 TPP include:
  - Several GW of new resources coming online or beginning development
  - In-development resource data source changed from LSE Filings to CAISO Generator Interconnection Resource ID Report (GIRR), representing higher-confidence units only
    - A handful of units on the previous baseline were not on the GIRR and dropped from the baseline (e.g. delayed projects, and/or projects with COD 2028 or later)
    - Incremental contracts from LSE filings are included in RESOLVE minimum builds instead
  - Re-assignment of CHP and non-CHP gas units based on CEC and EIA data[1]



1 CAISO CHP is forced to phaseout from 2036-2040; this is done as a post-processing step to generator list data.

Total CAISO Baseline Capacity for 27-28 TPP

Resource Type (GW)	2028	2030	2032	2035	2037	2040	2042	2045
Natural Gas	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
CHP	3.5	3.5	3.5	3.5	2.1	-	-	-
Nuclear	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Geothermal	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Biomass	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Biogas	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hydro	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
In-State Wind	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Out-of-State Wind	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Solar[1]	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0
Li-ion Battery (4-hr)	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6
Li-ion Battery (8-hr)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Location Constrained Storage (12-hr)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Shed DR	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4

1 Utility-scale only; BTM solar capacity varies in the 2025 IEPR sensitivity

RESOLVE Minimum Builds for LSE Contracts

- While the IRP baseline (existing and in-development units) used in RESOLVE and SERVM is updated every ~2 years, LSEs are consistently contracting new resources; minimum builds allow these more recent contracts to be reflected in modeling
- "Development" contracts incremental to the baseline found in the June 2025 IRP Compliance Filings-are forced-in to RESOLVE as minimum builds

PG&E Minimum Builds (MW)

Technology	2028	2030	2032
Geothermal	144	184	184
Biomass	3	3	3
Solar	528	648	758
Battery Storage (4-hr)	1,988	2,148	2,258
Battery Storage (8-hr)	94	94	94
Location-Constrained Storage	-	-	-

SCE Minimum Builds (MW)

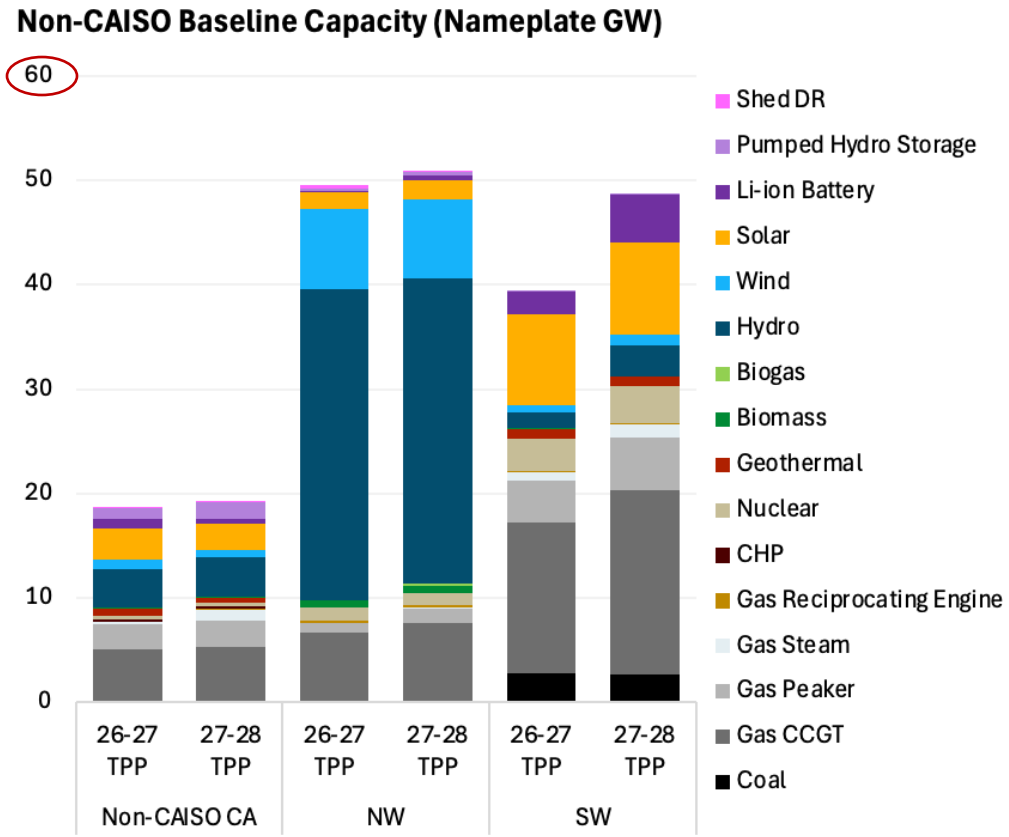
Technology	2028	2030	2032
Geothermal	459	526	550
Biomass	-	-	-
Solar	1,454	1,519	1,519
Battery Storage (4-hr)	3,048	3,321	3,321
Battery Storage (8-hr)	726	951	951
Location-Constrained Storage	-	200	200

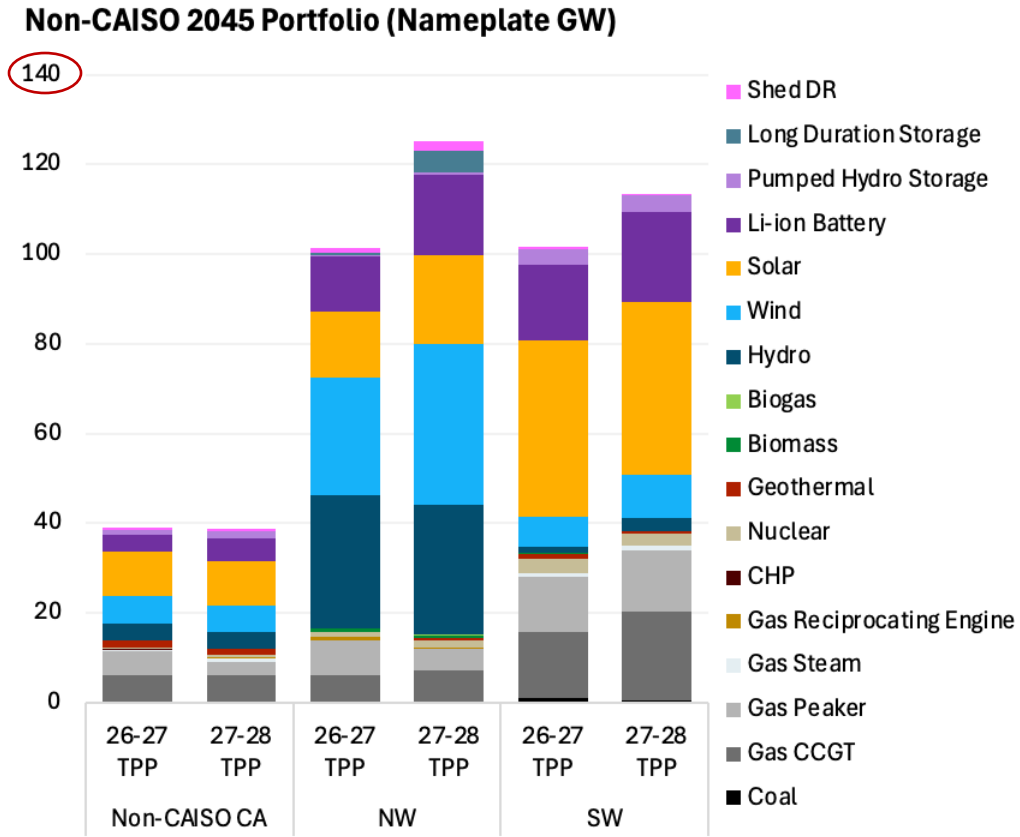
SDG&E Minimum Builds (MW)

Technology	2028	2030	2032
Geothermal	26	66	66
Biomass	-	-	-
Solar	23	23	23
Battery Storage (4-hr)	39	39	39
Battery Storage (8-hr)	-	-	-
Location-Constrained Storage	-	-	-

External (Non-CAISO) Region Resources

- Non-CAISO zones were updated based on the latest WECC Anchor Dataset (baseline resources) and new IRP reports by non-CAISO utilities (future builds & loads)

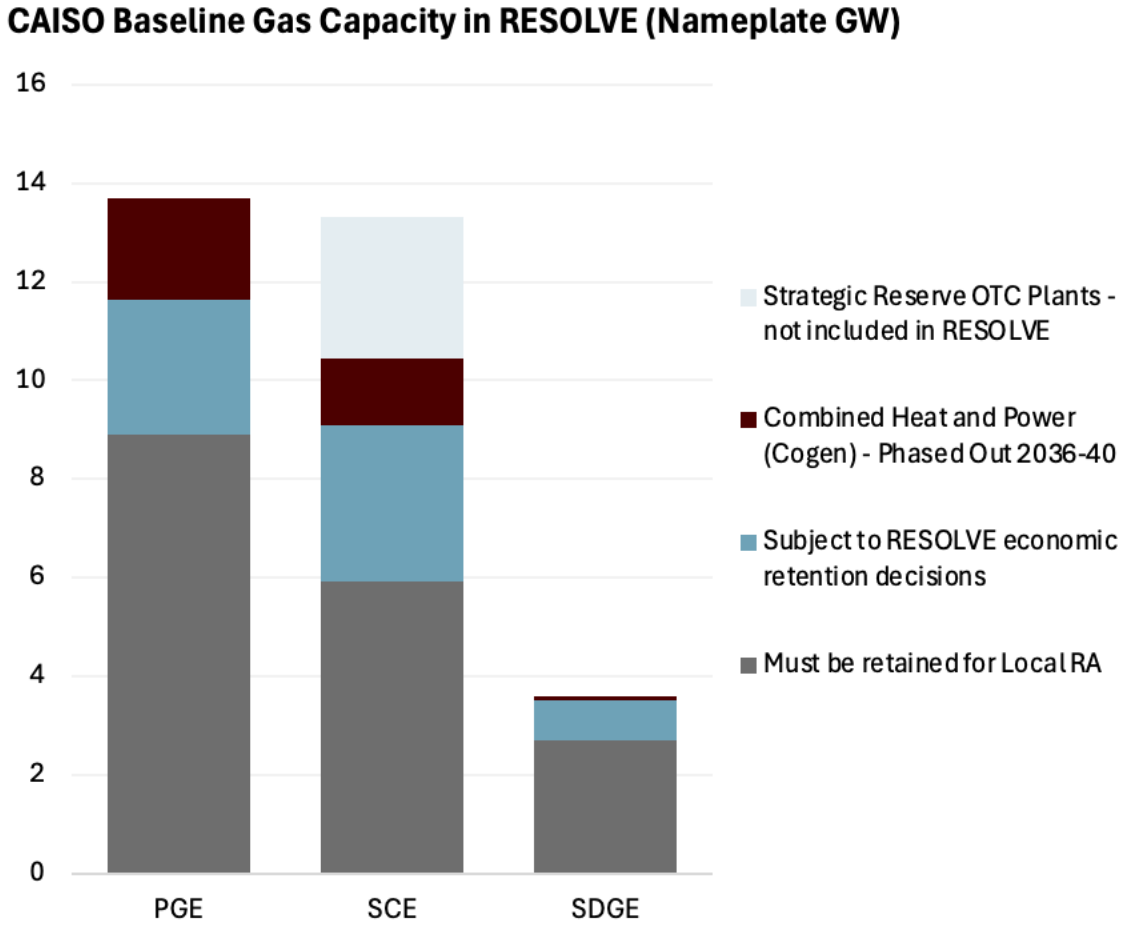




Non-CAISO CA = IID, LDWP (LA + BUGL), NCNC (BANC + TID)

Minimum Gas Retention Constraints

- CAISO Natural Gas CCGT, Peakers, and Reciprocating Engines are subject to RESOLVE economic retention decisions
  - Weighs fixed cost (escalating over time) against RA value; decision is to retain or non-retain on CAISO system (could serve non-CAISO load)
  - Latest CAISO Local Capacity Technical Study data for gas capacity replaceable by 4-hr battery incorporated
- **New to the 27-28 TPP, existing gas facilities that have a higher capability to retrofit to CCS equipment will be excluded from non-retention**
- No change to assumptions on Combined Heat and Power (phased out 2036 to 2040) or Strategic Reserve OTC steam units (not modeled)



Process for Developing Resource Potential

Raw Resource Potential	Techno-Economic Screen	Environmental Screen

• Solar insolation
• Wind speed
• Known geothermal fields
• EGS temperature-at-depth estimates
• Pumped hydro storage sites
	• Minimum capacity factor thresholds
	• Ground slope
	• Urban areas and population density
	• Feasibility screens (e.g. setback from airports)
		• CEC Core Land-Use Screen:
		  • Protected areas
		  • Farmland
		  • Habitats
		  • Endangered species

Technology Candidate Resource Potential

Resource	26-27 TPP (MW)	27-28 TPP (MW)	Notes
Solar	358,653	358,653	-
In-State Wind	10,344	11,031	Additional MWs introduced in Northeast CA and Baja California
Out-of-State Wind	19,036	35,600	Expanded supply curve of generic transmission pathways
Offshore Wind	28,925	28,925	-
Location-Constrained LDES	10,430	10,630	200 MW of LDES no longer in baseline (due to COD delay) and modeled as a generic resource
Biomass	1,156	1,156	-
Conventional Geothermal	5,554	5,016	Updated NVE queue analysis; removed UT geothermal
Enhanced Geothermal (Near-Field)	12,992	13,413	Updated NVE queue analysis; UT EGS increased to 2,000 MW
Enhanced Geothermal (Deep)	17,016	17,016	-

Summary of Technology First Available Years

- First available year for generic in-state wind and geothermal resources not identified in generator interconnection queues updated to reflect increased development lead-time for these technologies

Resource	26-27 TPP	27-28 TPP	Notes
Solar	2026-2028	2028-2030	13 GW build limit through 2028[1]
In-State Wind	2026-2035	2028-2034	**Queue resources only before 2034**
Out-of-State Wind	2026-2040	2030-2042	SunZia now in baseline; **Generic resources not available until 2037-2042**
Offshore Wind	2032-2040	2036-2041	Accounts for federal permitting delays
Location-Constrained LDES	2030-2037	2030-2037	
Li-ion Battery	2026	2028	
Generic LDES	2031	2031	
Biomass	2028	2028	
Conventional Geothermal	2026-2035	2028-2037	**Queue resources only before 2034 (In-State)**
Enhanced Geothermal (Near-Field)	2030-2035	2029-2037	**Queue resources only before 2034 (In-State)**
Enhanced Geothermal (Deep)	2035	2034	In-State only
Natural Gas	2030	2030	

1 Reflects a near-term solar build limit of based on deployment data from LBNL Tracking the Sun (https://emp.lbl.gov/utility-scale-solar) and the CAISO Master Generating Capability List (MGC) (http://oasis.caiso.com/mrioasis/logon.do), with some acceleration from the historical build rate assumed to meet the GHG target and capture tax credits before expiration

Candidate Resource Potential by Model Year

- First available year for generic wind and geothermal resources not identified in generator interconnection queues updated to reflect increased development lead-time for these technologies
  - 2034 for in-state wind
  - 2035 for geothermal
  - 2037/2042 for out-of-state wind
- Natural gas, li-ion battery, and generic LDES have unlimited potential once they become available; full biomass potential available in 2028

Resource Type (GW)	2028	2030	2032	2035	2037	2040	2042	2045
Geothermal	0.2	0.3	0.4	4.4	5.0	5.0	5.0	5.0
Geothermal (Enhanced)	0.4	1.7	3.4	23.5	30.4	30.4	30.4	30.4
In-State Wind	1.2	2.0	2.5	11.0	11.0	11.0	11.0	11.0
Out-of-State Wind	-	0.9	2.6	2.6	8.6	8.6	35.6	35.6
Offshore Wind	-	-	-	-	4.9	7.6	28.9	28.9
Solar	13.0	358.7	358.7	358.7	358.7	358.7	358.7	358.7
Location Constrained Storage (12-hr)	-	0.5	2.4	4.3	10.6	10.6	10.6	10.6
Shed DR	12.7	12.9	13.1	13.3	13.5	13.7	13.9	14.1

Denotes major change in resource availability (relative to 26-27 TPP)

Wind and Geothermal Queue Analysis Methodology

- Interconnection queues from CAISO and neighboring BAAs are aggregated to a single dataset with over 13,000 project submittals
- Attributes for each project include resource type, resource capacity, point of interconnection, study area, study status, interconnection agreement status, and online date
- Resources that have been canceled, terminated, or decommissioned are removed from consideration
- Hybrid resources that do not specific resource capacity by sub-resource are left grouped as hybrid.
- The final aggregated dataset excludes queue projects with an online date of 2024 or earlier[1]

In-State Queues	Out-of-State Queues
CAISO	AZPS
Cluster 15	Idaho Power
IID	BPA
LADWP	IPA
PG&E WDAT	PacifiCorp
SCE WDAT	PGE Oregon
SMUD	PNM
SDG&E WDAT	Navajo-Crystal
	NEVP
	TANC

1 Except for 1,015 MW of wind in the NVE queue in Northeast California that could interconnect via Hilltop

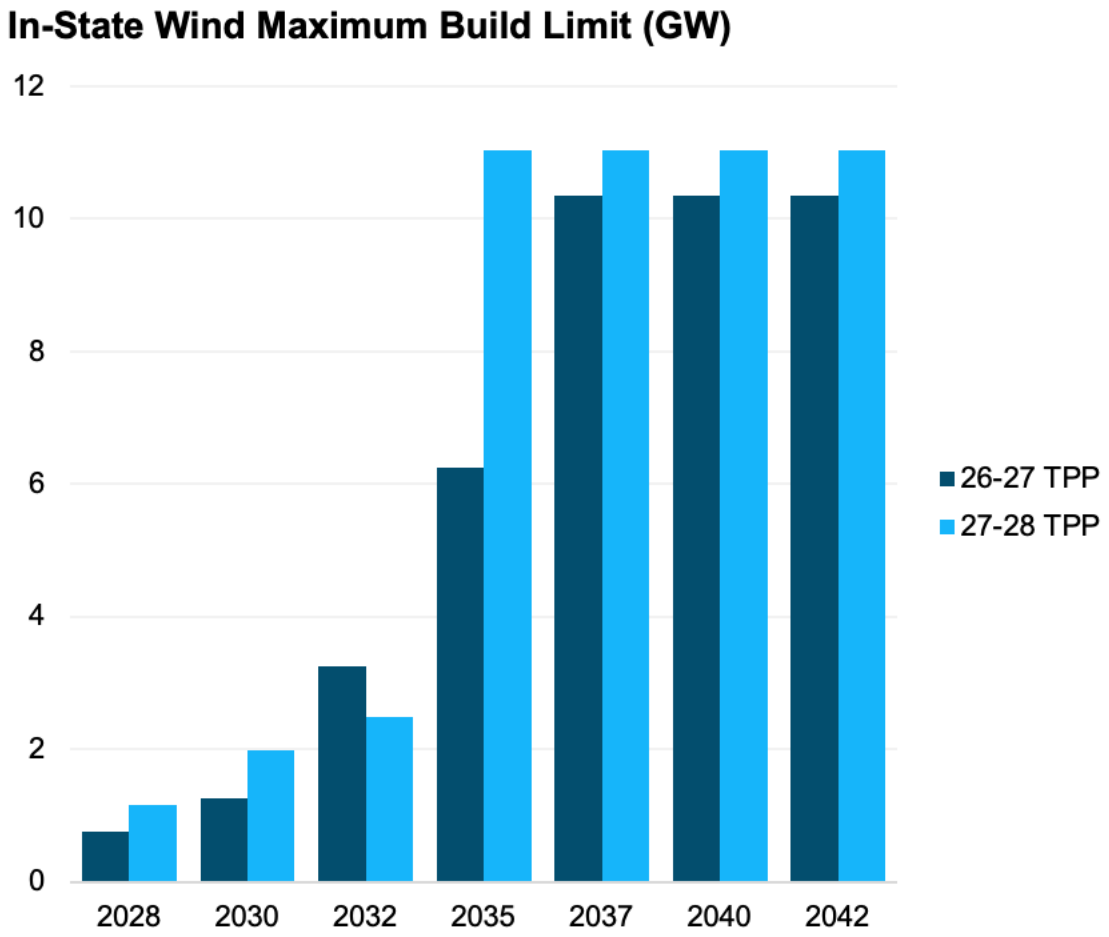
In-State Wind Availability Updates

26-27 TPP Assumptions:

- Technology-wide annual build limits (250 MW per year thru 2031, with an additional 1 GW per year thru 2035)
- Regional near-term build limits based on queue data (thru 2034)
- Geospatial resource potential limits for generic wind (incremental to queue) with first available year in 2035

Updates for 27-28 TPP:

- Remove technology-wide annual build limits
- Update regional near-term build limits based on latest queue data (thru 2033)
- Geospatial resource potential limits for generic wind (incremental to queue) with first available year in 2034
    - Northeast CA (1,015 MW) and Baja California (1,910 MW) potentials updated to reflect latest commercial interest, totaling ~700 MW of additional resource potential by 2034



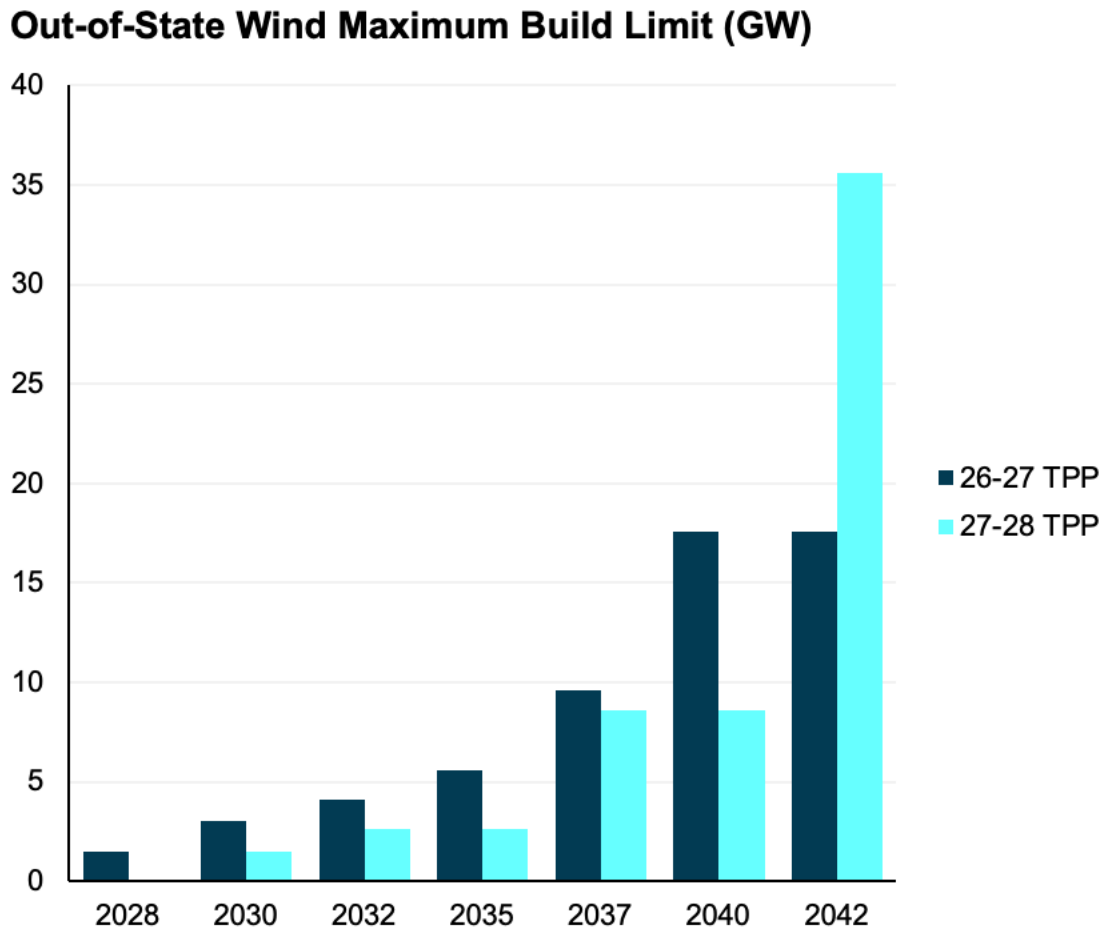
Out-of-State Wind Availability Updates

26-27 TPP Assumptions:

- In-development projects with TPD reservations modeled explicitly (SunZia, SWIP, TWE)[1]
- Additional in-development projects also modeled as selectable by CAISO (TWE HVDC, RioSol)
- Additional tranches of generic OOS wind available from 2036-2040

Updates for 27-28 TPP:

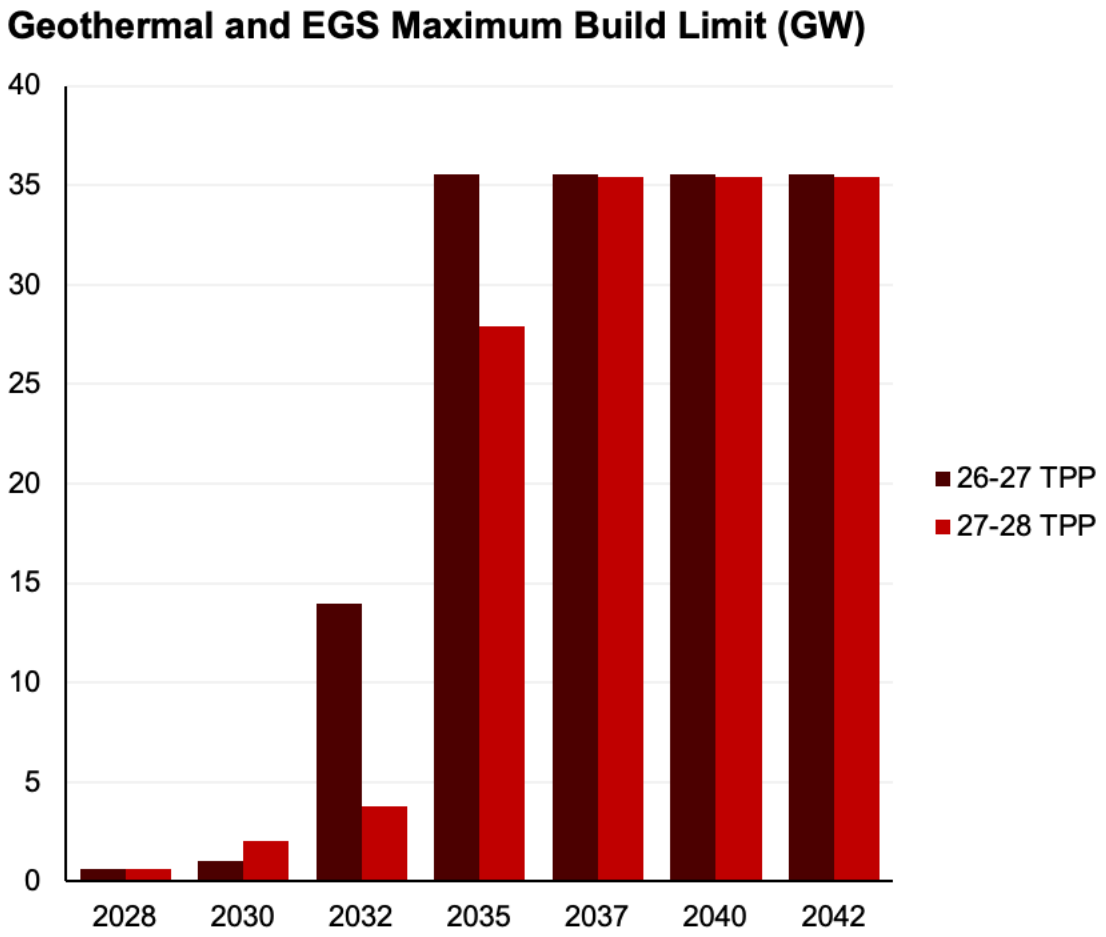
- SunZia moved to baseline, no longer candidate resource
- Removed TWE HVDC and RioSol as near-term options
- Additional generic transmission pathways and delivery points represented, extending total supply curve in 2037 and 2042
- Generic OOS wind tranches with 2037 COD assume HVAC lines developed along existing rights-of-way
- Generic OOS wind tranches with 2042 COD assume HVAC or HVDC lines along greenfield paths



1 Refer to slide 46 for more detail on these transmission projects.

Total Geothermal Availability Updates

- Resource availability through 2030 is increased due to relaxed near-term build limits, additional review of queue projects, and commercial interest data received from stakeholders
- In 2032, resource potential is greatly reduced due to delayed availability of generic in-state and Oregon conventional geothermal resources (resources lacking indicators of high-confidence commercial interest), as well as transmission access limiting the availability of other out-of-state EGS resources (NV, ID)
    - However, 2,000 MW of Utah EGS is introduced starting in this year, assumed to be delivered via High West Transmission
- In 2035, resource potential is slightly reduced due to delayed availability of out-of-state resources assumed to require new transmission investments
- Total resource potential by 2037 remains unchanged



Modeling Out-of-State Resources in RESOLVE

- **The availability of out-of-state (OOS) resources (wind, geothermal) is primarily limited by transmission availability and development lead-times, not land availability (resource potential) or resource lead-times**
- OOS resources can be delivered to CAISO under planned or in-development transmission lines, on which CAISO has secured transmission rights; or over new (generic) transmission lines
  - All OOS resources are assumed to be MIC-expanding in RESOLVE; delivery over existing transmission lines is not considered
- Planned transmission lines on which CAISO has secured rights to deliver OOS resources are modeled explicitly, with cost adders and first available years adopted from recent TPP reports
- Generic transmission lines that would need to be built to deliver additional OOS resources will be represented via per-unit cost estimation based on available data, with first available years informed by a 10- to 15-year development timeline

In-Development Transmission for OOS Resources

- **SunZia Wind (NM)**: now reflected in the IRP Baseline
- **TransWest Express (WY)**: 1.5 GW of the 3 GW HVDC line from Aeolus to IPP is contracted to CAISO, delivered via a second 1.5 GW HVAC line from IPP to Harry Allen; 900 MW of wind resource at Aeolus is under development with estimated COD by 2030[1], with the remaining capacity assumed available in 2032
- **SWIP-North (ID)**: CAISO has secured rights for 1,100 MW of this line with resource delivery at Harry Allen; Taurus Wind, LLC is a 1 GW nameplate project under development at Midpoint, ID[2], assumed available in 2032
- **Three pathways** for near-term delivery of **OOS EGS resources** are being introduced this cycle:
  - The proposed **High West** Transmission Project[3], which could deliver 2,000 MW of Utah EGS to CAISO, available in 2032
  - 270 MW of Nevada EGS in the interconnection queue[4] that could secure rights on **Greenlink West** with delivery to Harry Allen, available in 2029
  - 800 MW of Nevada EGS projects that could utilize capacity on **SWIP-N**[5], available in 2028
- Costs for in-development transmission projects are taken from the 2021-2022 TPP (TransWest), SWIP-N Application Memo (SWIP-N), public reporting on Greenlink, and per-unit cost estimation of High West
- Total resource selections on SWIP-N are capped at 1,100 MW

1 https://www.oasis.oati.com/ppw/, Cluster 1 (C1-35) and Transition Cluster 2 (T2-057); 2 https://www.oasis.oati.com/ipco/ (635);
3 https://stakeholdercenter.caiso.com/Common/DownloadFile/4f62ffb1-69ca-40a8-b30b-0436d1e79b7d;
4 https://www.oasis.oati.com/NEVP/ (Executed; Company LB and Company LM);
5 https://www.oasis.oati.com/NEVP/ (25-00404 thru 25-00408)

Per-Unit Cost Estimation for Generic OOS Transmission

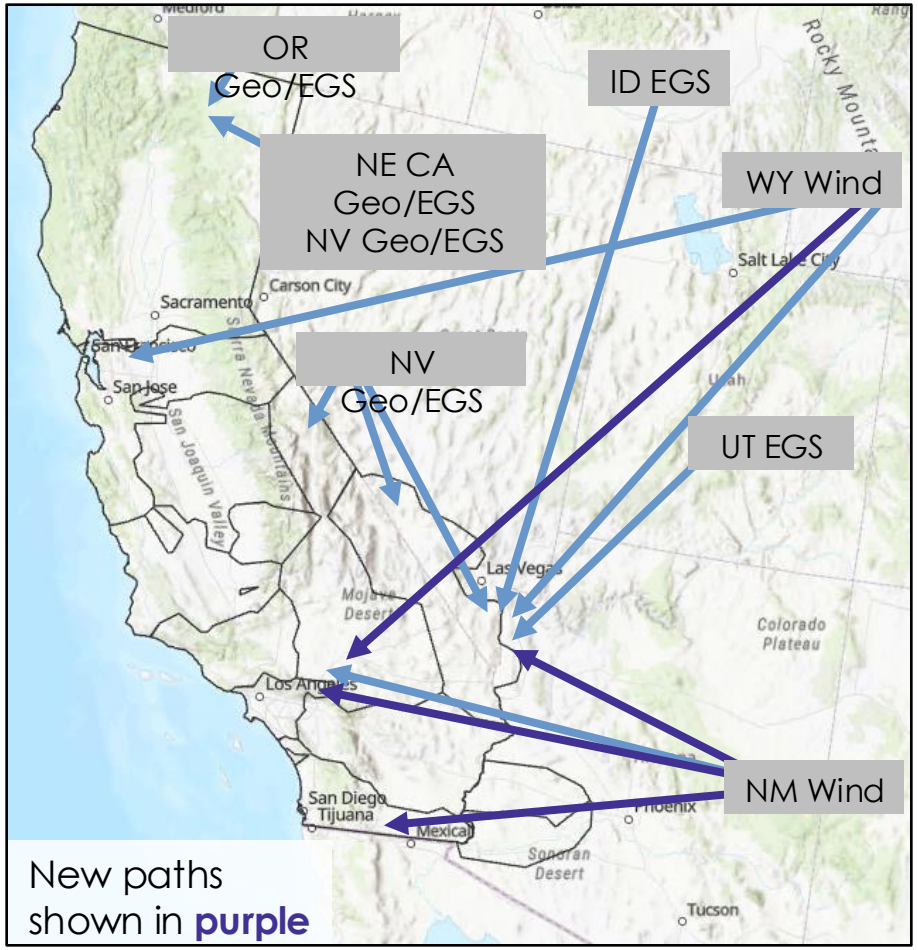
- To estimate the costs of generic transmission lines, per-unit cost estimates as reported in the CAISO 20-Year Transmission Outlook[1] are used:
  - HVAC (500 kV): $6M/mi, single-circuit, 1,500 MW per line
  - HVDC (500 kV): $7M/mi, double-circuit, 3,000 MW per line + 2x HVDC converter stations ($1.5B total)
  - Substations: $125M, 2 per line plus 1 every 200 miles
- The length of each transmission line is determined by applying a routing factor that considers terrain and other factors:
  - For lines over mostly flat terrain, a 1.15x factor to the straight-line path length is applied
  - For lines over mountainous terrain, a 1.5x factor is applied
- For lines that use an existing right-of-way (ROW) from planned interregional transmission projects, a 15% haircut to the final cost is assumed to account for reduced site work and permitting costs
- **In RESOLVE, transmission costs for OOS resources are bundled with the resource cost**

1 https://www.caiso.com/documents/2024-20-year-transmission-outlook-jul-31-2024.pdf; all values reported in 2023$; costs assumed to include contingency and AFUDC, as well as series compensation (to maintain transfer capability)

Delivering Generic OOS Resources to CAISO

- Likely tie-in locations for out-of-state resources were identified through coordination with the Working Group

Resource	Tie-in Location	Type	Total Potential (MW)	First Year
NM Wind	Imperial Valley	HVAC	3,000	2036-2041
NM Wind	Rancho Vista	HVAC	3,000	2036-2041
NM Wind	Eldorado	HVAC	1,500	2041
NM Wind	Lugo	HVDC	3,000	2041
WY Wind	Tesla	Both	6,000	2036-2041
WY Wind	Eldorado	Both	7,500	2036-2041
WY Wind	Lugo	HVDC	6,000	2041
ID EGS	Harry Allen	HVDC	1,872	2037
NV Geo/EGS	Eldorado *(1)*	HVDC	783 / 3,376 *(2)*	2035-2037
NV Geo/EGS	Control *(1)*	HVAC		
NV Geo/EGS	Beatty *(1)*	HVDC		
NV Geo/EGS	Malin	HVAC	288 / 873	2035-2037
NE CA Geo/EGS	Malin	HVAC	178 / 178	2037
OR Geo/EGS	Malin	HVAC	520 / 1,893	2037

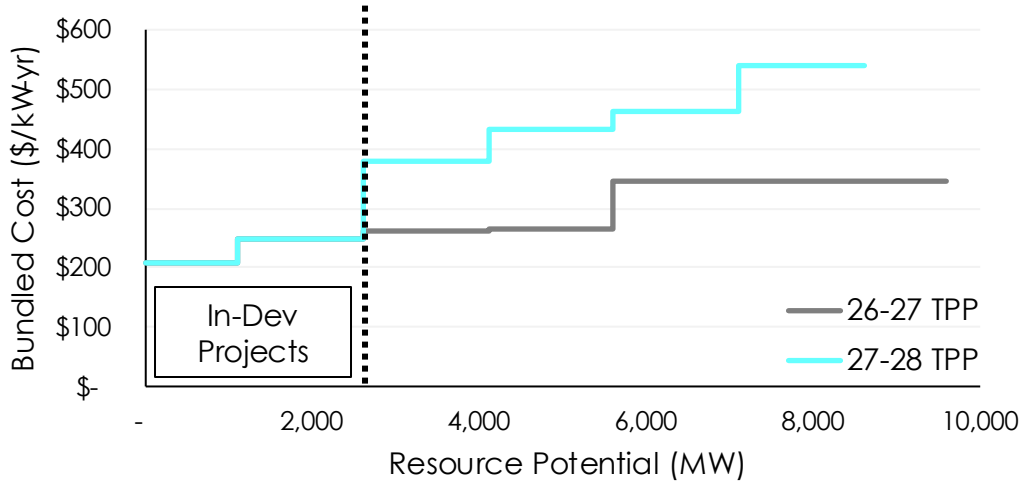


1 The delivery points for SCE Nevada Geothermal/EGS resources are subject to optimization decisions in RESOLVE among these three locations
2 Relative to the Final 2025 I&A, the resource potential for SCE Nevada Geothermal/EGS reflects adjustments accounting for known geothermal contracts to non-CAISO LSEs and procurement forecasts from the NVE IRP

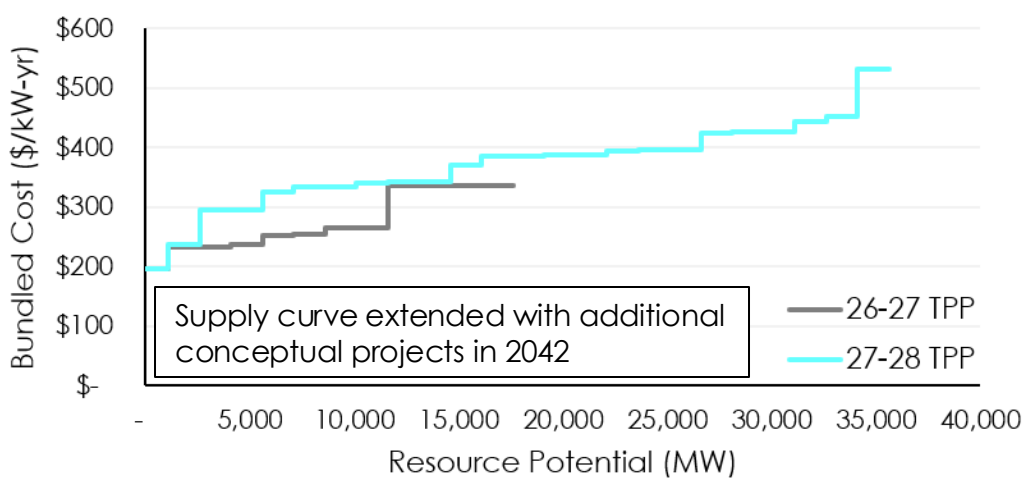
Revised Out-of-State Wind Supply Curve

- Transmission options provided by CAISO were used as the basis for updating resource potentials and transmission costs for New Mexico and Wyoming Wind
- 1.5 GW of capability assumed per AC line, and 3 GW per HVDC line, totaling 15 new line options, 9 GW by 2036, and **36 GW of potential by 2041**
- Transmission costs were derived from GIS analysis and CAISO per-unit costs

Out-of-State Wind Supply Curve, 2037



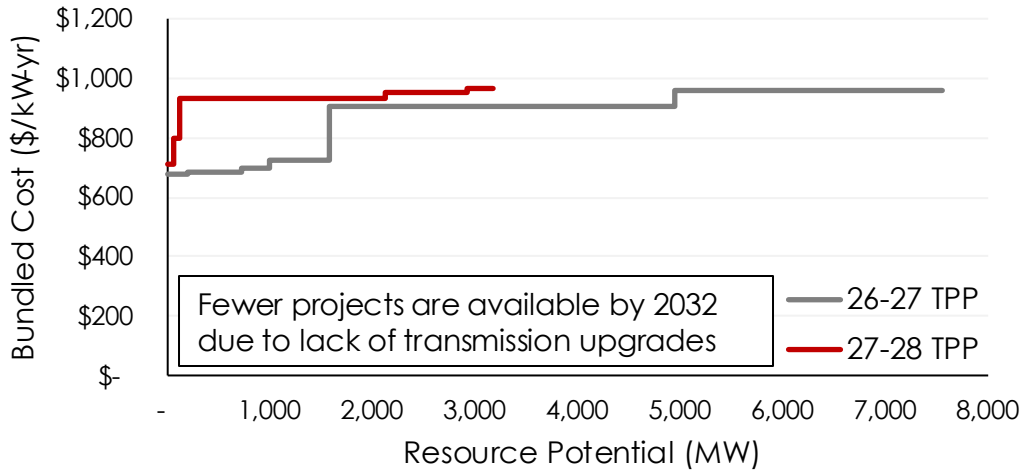
Out-of-State Wind Supply Curve, 2042



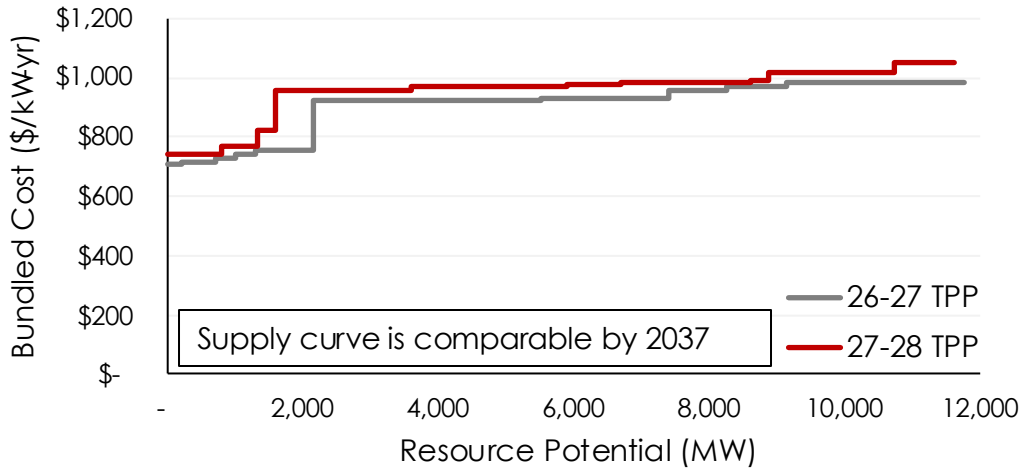
Revised Out-of-State Geothermal Supply Curve

- Transmission options provided by CAISO were used as the basis for updating resource potentials and transmission costs for New Mexico and Wyoming Wind
- 1.5 GW of capability assumed per AC line, and 3 GW per HVDC line, totaling 15 new line options, 9 GW by 2036, and **36 GW of potential by 2041**
- Transmission costs were derived from GIS analysis and CAISO per-unit costs

Out-of-State Geothermal and EGS Supply Curve, 2032



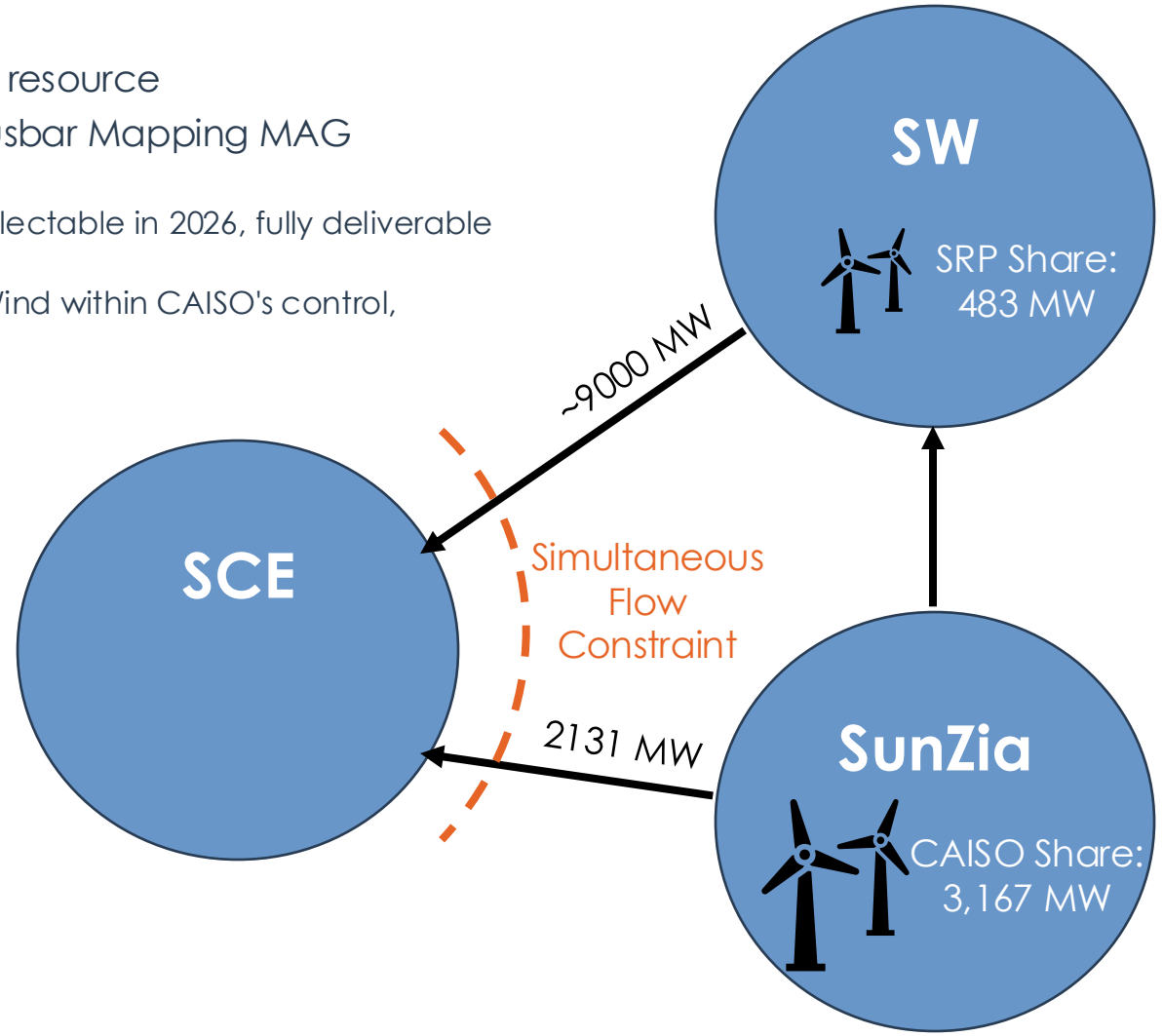
Out-of-State Geothermal and EGS Supply Curve, 2037



Representation of SunZia Wind

- SunZia Wind is now energized and is modeled as a baseline resource
- Additional conversations with CAISO since the June 2026 Busbar Mapping MAG Webinar led to an updated representation of SunZia Wind
  - 26-27 TPP: 2,131 MW project available as a "specified import", selectable in 2026, fully deliverable to CAISO and counting for RA
  - 27-28 TPP: a more nuanced representation 3,167 MW of SunZia Wind within CAISO's control, including a special SunZia remote resource zone

- 2,131 MW of transmission service rights (TSRs) that have been transferred to CAISO are modeled as a direct line
  - Excess hourly generation is dumped into the SW region and does not count towards CAISO RPS/CES targets
  - These TSRs are subject to the simultaneous flow constraints for CAISO and SW regions
- Starting in 2034, planned transmission upgrades within CAISO make SunZia Wind deliverable:
  - SunZia Wind provides RA (using the out-of-state wind ELCC curve)
  - The hourly simultaneous flow constraints are increased by 2,131 MW
- The transmission line delivering energy to SunZia West (Pinal Central) is rated at 3,021 MW (of the 3,650 MW project size); the SunZia Wind profile is clipped so that any generation above the transmission limit is curtailed



CAISO Transmission Constraints and Upgrades

- The findings from the CAISO 25-26 Transmission Plan, as well as a new constraint for Arizona resources, have been added to RESOLVE
- When transmission upgrades get approved by CAISO in the TPP, the RESOLVE model is updated to "sink" those projects' costs by forcing in approved upgrades
  - Given the approval of the Trout Canyon-Lugo 500 kV transmission line, starting in 2035, the available TPD behind this constraint will be augmented by 5,410 MW
  - Since RESOLVE may determine additional out-of-state resources delivered to EOP cost-effective, an additional tranche of transmission upgrades will be introduced to provide additional headroom (5,410 MW at $2.1B, available 2037)
- A new constraint with 4 GW headroom has been added to the SDGE Arizona study area, to more accurately represent deliverability limitations in this area
  - RESOLVE and the busbar mapping process will now include the Hoodoo Wash–North Gila and Palo Verde–Colorado River Deliverability Constraint

RESOLVE PG&E-SCE Transmission Upgrade Tranches

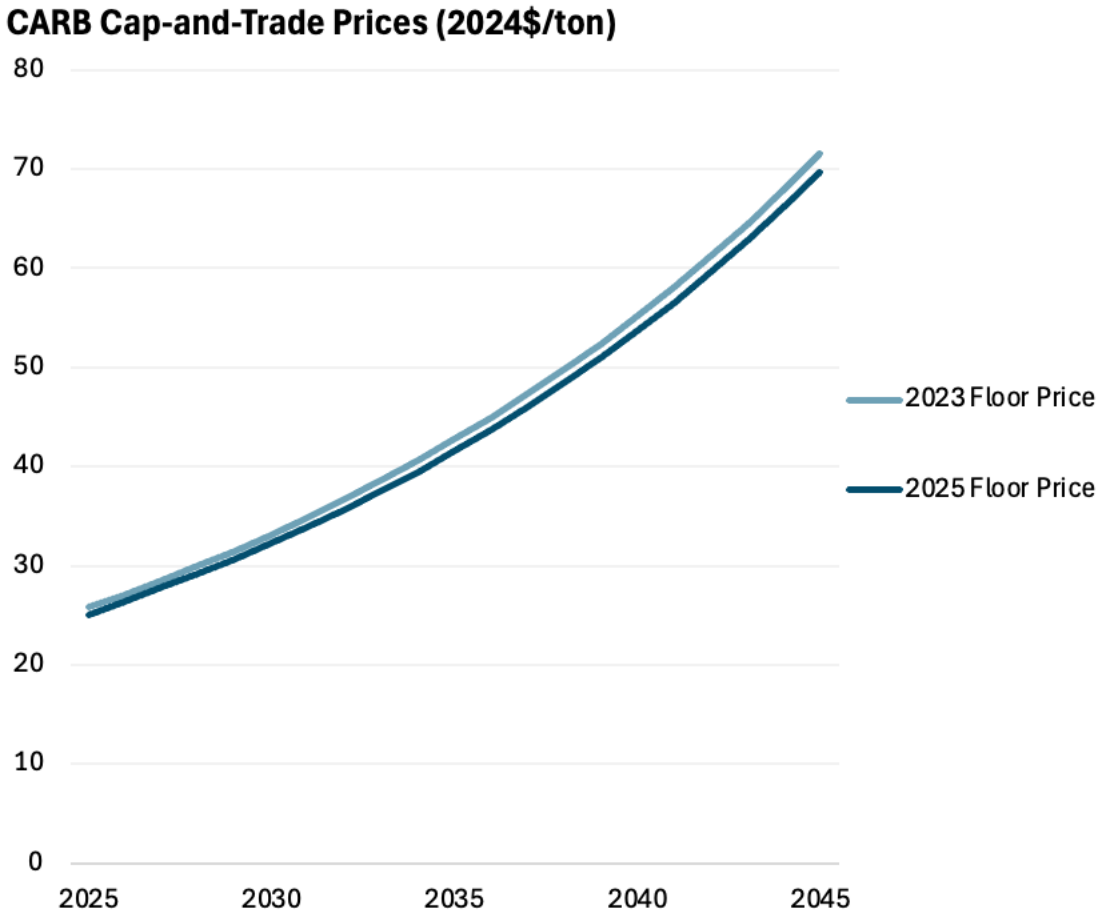
- A Path 26 upgrade studied in isolation (which was introduced as an upgrade tranche in the 26-27 TPP RESOLVE analysis) would not provide significant congestion reduction, as Path 15 would remain constrained
  - Revised Tranche 1 reflects a new Windhub to Tesla 500 kV line, as studied in the 2025-26 TPP, providing an incremental 2,500 MW of transfer capacity
  - Revised Tranche 2 reflects additional Path 26/15 reinforcements, as well as an extension to Lugo
- RESOLVE may select each tranche sequentially, if they are found to be cost optimal, on top of the existing PGE<>SCE transmission capability (3,000 MW from SCE to PGE, 4,000 MW from PGE to SCE)

Tranche #	Incremental Upgrade (MW)	Total Upgrade (MW)	Total Path Rating (MW)	Cost of Tranche (2024 $)	Levelized Cost ($/kW-yr)[1]	First Available Year	Description	Source
Tranche 1 (Path 26/15)	2,500	2,500	5,500 (SCE to PGE) 6,500 (PGE to SCE)	$3,187 M	$100	**2037**	New Windhub to Tesla line (Alternative 6 from the 25-26 TPP Congestion Economic Study[2])	CAISO 25-26 TPP[2]
Tranche 2 (Path 26/15 + Extension)	3,000	5,500	8,500 (SCE to PGE) 9,500 (PGE to SCE)	$6,090 M	$158	**2040**	Path 15 upgrade (Alternative 8 from the 23-24 TPP Congestion Economic Study[3]) Two new Vincent to Midway 500 kV lines[4] New Lugo to Vincent 500 kV line[4]	CAISO 23-24 TPP[3] CAISO per-unit cost guide[4]

1 Real 2024$; assumes a 7.80% CRF
2 https://stakeholdercenter.caiso.com/InitiativeDocuments/Board-Approved-2025-2026-Transmission-Plan.pdf
3 https://www.caiso.com/documents/appendix-g-board-approved-2023-2024-transmission-plan.pdf
4 https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook-2023-2024

Cap-and-Trade (Carbon) Price

- Updated from 2023 to 2025 IEPR forecast[1], resulting in a decrease in price of roughly $2/ton
- RESOLVE uses the floor Carbon Price; this value, plus the GHG Emissions constraint shadow price reported by RESOLVE, equal the total GHG abatement cost



1 https://efiling.energy.ca.gov/GetDocument.aspx?tn=268720&DocumentContentId=105875

Modeling of Reliability Procurement Orders

- In recent years, the CPUC has put out multiple procurement orders to maintain reliability, which are modeled in RESOLVE in addition to the Planning Reserve Margin (PRM) target
  - D21-06-035[1]: 11.5 GW NQC (2023-26)
  - D23-02-040[2]: additional 4 GW NQC (2027-28)
  - D24-02-047[3]: extended deadline for LLT procurement (1 GW clean firm, 1 GW long-duration storage) to 2031
  - D26-02-057[4]: additional 6 GW NQC (2030-32), including 1.5 GW either clean firm or long-duration storage
- The first three orders are modeled using resource-specific ELCCs defined for MTR procurement[5]
- For the most recent order (D.26-02-057), resource-specific ELCCs were not available at the time of 27-28 TPP modeling, so the procurement need was modeled as an adder to the PRM target, based on the need determination analysis[6]
  - The adder is calculated as the amount the procurement order exceeds the need found in each year; e.g. in 2032, SERVM found a need of 5,900 MW and 6,000 MW were ordered; adder is 100 MW
  - For the 2025 IEPR sensitivity, the adder is set so that the same level of reliability (PCAP MW) is reached in 2030-32 as the base case, to match the assumptions under which the procurement was ordered (i.e. 2024 IEPR)
  - The firm/long-duration storage requirement was evaluated *ex post* from RESOLVE outputs; in all cases RESOLVE built sufficient resources to meet the requirement
- In future modeling efforts, staff expect to model the D.26-02-057 order using resource-specific procurement ELCCs, similar to the other procurement orders

1 https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M389/K603/389603637.PDF;
2 https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M502/K956/502956567.PDF;
3 https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M525/K918/525918033.PDF;
4 https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M601/K777/601777006.PDF;
5 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/20230210_irp_e3_astrape_updated_incremental_elcc_study.pdf ;
6 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2025_09_need-determination-analysis.pdf

Forced Outage Rates Incorporation in RESOLVE Operational Module

- As a step to further calibrate RESOLVE and SERVM models for GHG emissions, SERVM forced outage rates (EFOR) are now incorporated in RESOLVE's representative day dispatch module
  - Outages reduce the availability of storage and thermal resources to serve load
- The EFOR is incorporated into RESOLVE as a % derate to the monthly Pmax used for system dispatch
  - Monthly Pmax also incorporates scheduled maintenance, which is largely concentrated in spring & fall
- Staff calculated technology-averaged EFOR using historic CAISO outage data[1]
- Additional RESOLVE <> SERVM calibration will be completed prior to the next PSP

Resource Class	Average EFOR%
Biogas	7.1%
Biomass	5.5%
Combined Cycle	5.9%
Combined Heat and Power (CHP)	10.0%
Combustion Turbine (Peaker)	6.8%
Geothermal (existing)	24.6%
Geothermal (candidate)	10.6%
Nuclear	0.4%
Reciprocating Engine	1.9%
Li-ion Battery	9.9%
Pumped Hydro Storage (existing)	0.8%

1 In addition to annual technology-averaged EFOR, monthly ambient temperature derates are also captured in RESOLVE

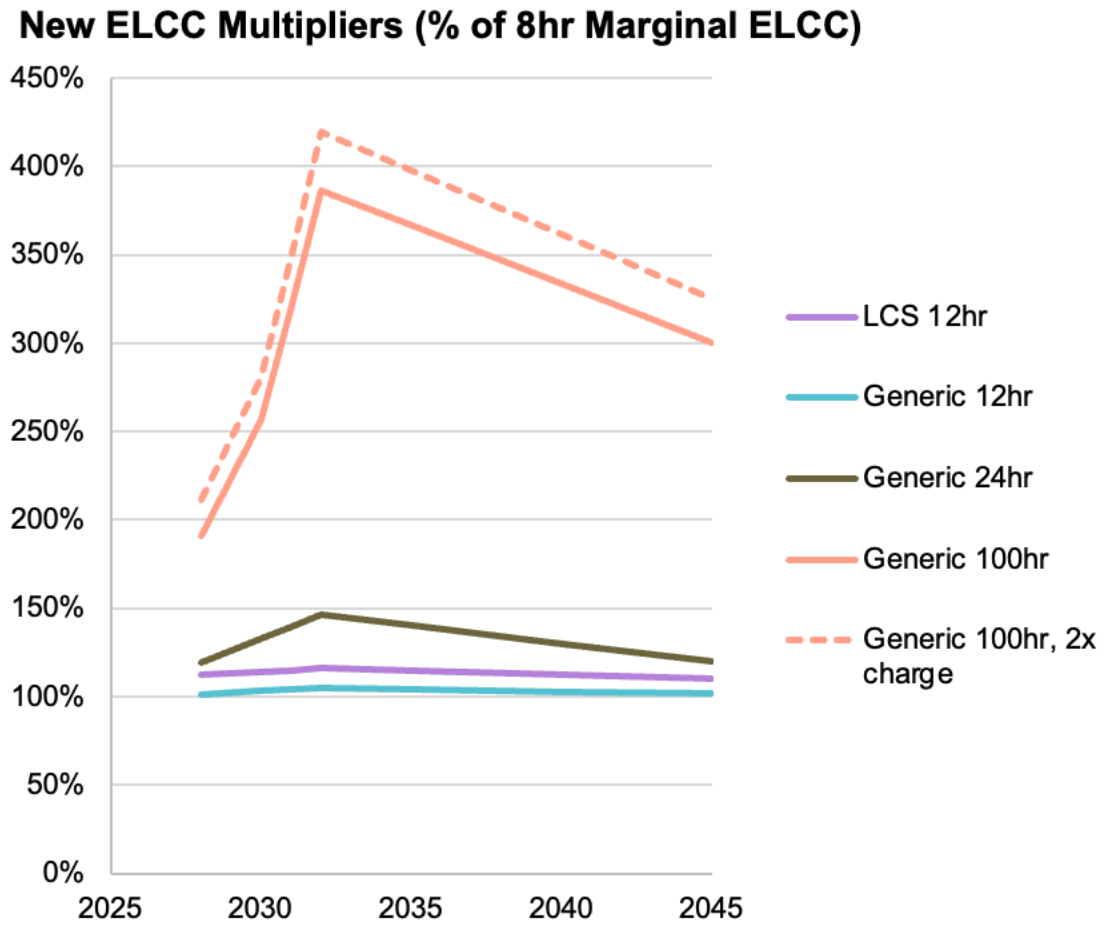
ELCC Updates

- EFORd values (as opposed to EFOR) are used to allocate thermal ELCC across different technology classes
  - EFOR: outage rate in all hours resource could run
  - EFORd: outage rate in hours of active demand for the resource to run
- Peaker and geothermal ELCCs have been reduced significantly with updated EFORd data
- Separate ELCCs for existing and candidate geothermal are used, to reflect the lower EFORd% of binary geothermal units that are assumed for candidates
- EGS ELCCs vary by location, ranging from 81-88%

Resource Class	26-27 TPP ELCC (% of Nameplate)	27-28 TPP ELCC (% of Nameplate)
Biogas	72.9%	67.1%
Biomass	75.5%	76.4%
Combined Cycle	92.0%	92.3%
Combined Heat and Power (CHP)	70.2%	73.7%
Combustion Turbine (Peaker)	80.9%	94.1%
Geothermal (existing)	94.6%	74.5%
Geothermal (candidate)	94.6%	88.6%
Nuclear	100%	99.0%
Reciprocating Engine	96.3%	98.6%
DR + Pumping Loads (existing)	60.5%	60.5%
Hydro	55.8%	55.8%
Pumped Hydro Storage (existing)	100%	100%

Long Duration Storage (LDES) ELCC Multipliers

- **Long-duration energy storage (LDES) ELCC surface multipliers are used for 12-hr location-constrained storage (LCS) and 12-, 24-, and 100-hr generic LDES**
  - LDES ELCCs in RESOLVE are represented via multipliers (>100%) applied to the 8-hr storage ELCC dimension
- **LDES multipliers were developed by comparing LDES marginal ELCCs (mELCC) against 8-hr storage mELCCs based on the compliance ELCC study conducted in summer 2026[1]**
  - Multipliers extrapolated from 2031-2032 last-in mELCC results from compliance ELCC study, shown as reference in graph
  - Multiplier years were reindexed after comparing preliminary 27-28 TPP portfolio results to the final portfolio from the compliance ELCC study along key metrics
    - Example: 2031 multiplier for Generic 12-hr from compliance ELCC study mapped to 2028 based on total energy storage in MWh
  - Minor adjustments were made to multipliers to yield reasonable results (e.g., mELCCs no greater than 100%, 100hr multiplier decline to 300% in 2045 and other multipliers scaled down proportionally, LCS 12-hr and Generic 24-hr scaled up from Generic 12-hr)



[1] Original scope proposed to use the mELCCs from the 2026 Filing Requirements portfolio but overall storage penetrations were much lower; procurement ELCC study was determined to be more appropriate reference

Historical Weather-Varying Profiles

- Weather years 2023 and 2024 were added to solar, wind, hydro, and baseline load consumption profiles
- The solar model was updated to calibrate to 30-minute (instead of 60-minute) NSRDB data, better calibrating to historical CAISO production in most locations
  - This change leads to a ~1% (absolute) drop in solar capacity factor on average, which decreases GHG-free energy output and therefore increases the size of the portfolio to meet the GHG target

Load Forecast for 27-28 TPP

Single Forecast Set Agreement and Use of 2024 IEPR

- The staff of the joint agencies and California ISO have agreed that the California ISO's Transmission Planning Process (TPP) bulk system, economic, and policy studies and CPUC's Integrated Resource Plan (IRP) will use the 2024 IEPR Update Planning Forecast[1]

1 Single Forecast Set Agreement can be found here: https://efiling.energy.ca.gov/GetDocument.aspx?tn=269506&DocumentContentId=106596

Definitions and Uses of the IEPR Load Forecast

- The IEPR load forecast is used to develop:
  - Hourly load profiles to evaluate load & resource balance in RESOLVE and SERVM
  - Policy targets (reliability, clean energy) for RESOLVE
    - Gross peak is the basis for the reliability (PRM) target
    - Retail sales are the basis for clean energy (RPS and CES targets)
  - BTM resource inputs for RESOLVE and SERVM

Term	Definition
Retail Sales	load at the meter
Managed Load/Peak	load served by LSEs (sales + T&D losses)
Gross Load/Peak	total electricity consumed (managed + BTM PV)
Planning Scenario	The "mid" load forecast from IEPR used as the default assumption for IRP modeling
Additional Achievable Energy Efficiency (AAEE)	energy efficiency incremental to existing levels
Additional Achievable Fuel Substitution (AAFS)	building electrification incremental to existing levels
Additional Achievable Transportation Electrification (AATE)	policy-driven electric vehicle adoption, incremental to existing levels and to baseline (economic) adoption)

Summary of Changes from the 2024 to 2025 IEPR

- The 2025 IEPR forecast[1] has an **overall decrease in electrification (buildings and transportation) reflecting recent policy rollbacks/headwinds**
  - Reductions in electric vehicles and building electrification due to policy rollbacks
  - Increase in energy efficiency, largely driven by building codes (Title 24) and programs
- The decrease in electrification loads is partially offset by **forecasted growth in data centers**
- For the planning scenario, the 2025 IEPR **peaks and annual load decrease** compared to the aggressive 2024 IEPR, but are **similar to 2023 IEPR levels**
- The 2025 IEPR planning scenario remains **summer peaking through the entire forecast horizon**, unlike the previous two vintages (winter managed peaks in the 2040s), primarily due to a decrease in forecasted building electrification

1 All the analysis in this deck of the 2025 IEPR excludes known loads.

Changes from 2024 to 2025 IEPR by Load Modifier

Component	Policy Impacts and Changes from 2024 IEPR	Impact
Baseline	Economic indicators forecast (GDP, population, housing, etc.)	Decrease in load
Climate Impacts	Minor updates to climate-driven load impacts	negligible
Baseline Electric Vehicles (EVs)	Repeal of IRA tax credits[1]	Decrease in load
Policy-Driven (AATE) EVs	Repeal of EPA Waiver[2]	**Decrease in load**
Energy Efficiency (AAEE)	Repeal of IRA tax credits[1]; DOE Efficiency Standards[3]; Increased Title 24 impacts[5]	**Decrease in load**
Building Electrification (AAFS)	Withdrawal of CARB State Implementation Plan (SIP)[4]; Repeal of IRA tax credits[1]; DOE Efficiency Standards[3]; Increased Title 24 impacts[5]	**Decrease in load**
Data Centers	Updated application data and weighting for uncertainty[5]	**Increase in load**
BTM Storage Losses	Repeal of IRA tax credits[1]; higher long-term new housing forecast[5]	Negligible (on net)
BTM Solar	Repeal of IRA tax credits[1]; higher long-term new housing forecast[5]	Increase in load (near-term) Decrease in load (long-term)
Known Loads	*New Load Modifier, aggregated within Baseline (Local Reliability + Known Loads scenario only, **not used in the 27-28 TPP**), representing distribution-level interconnection requests*[5]	**Known loads are not included in the 27-28 TPP**

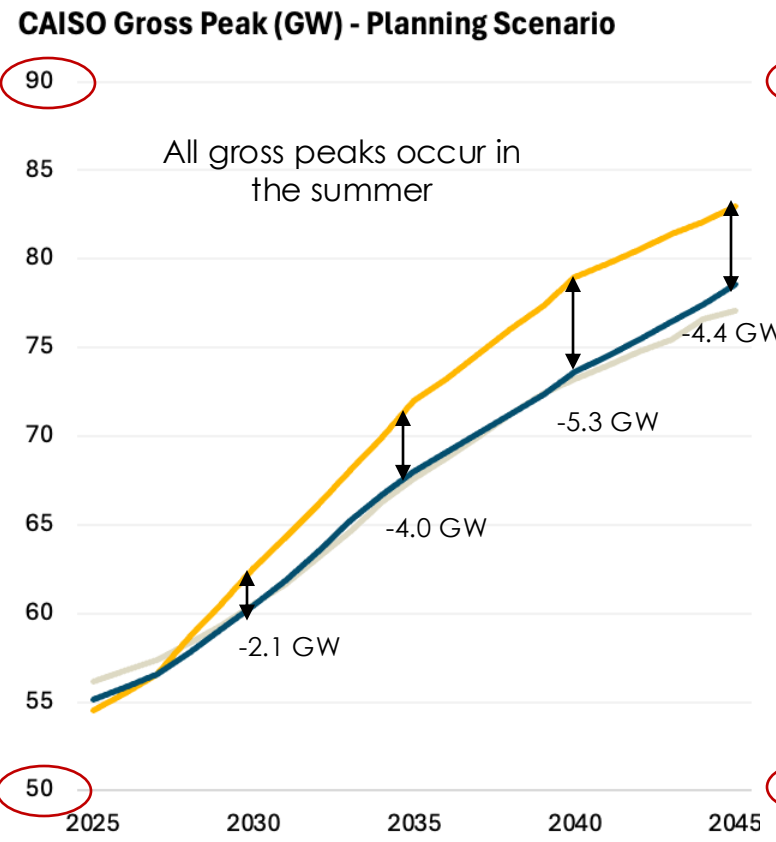
Largest drivers of change

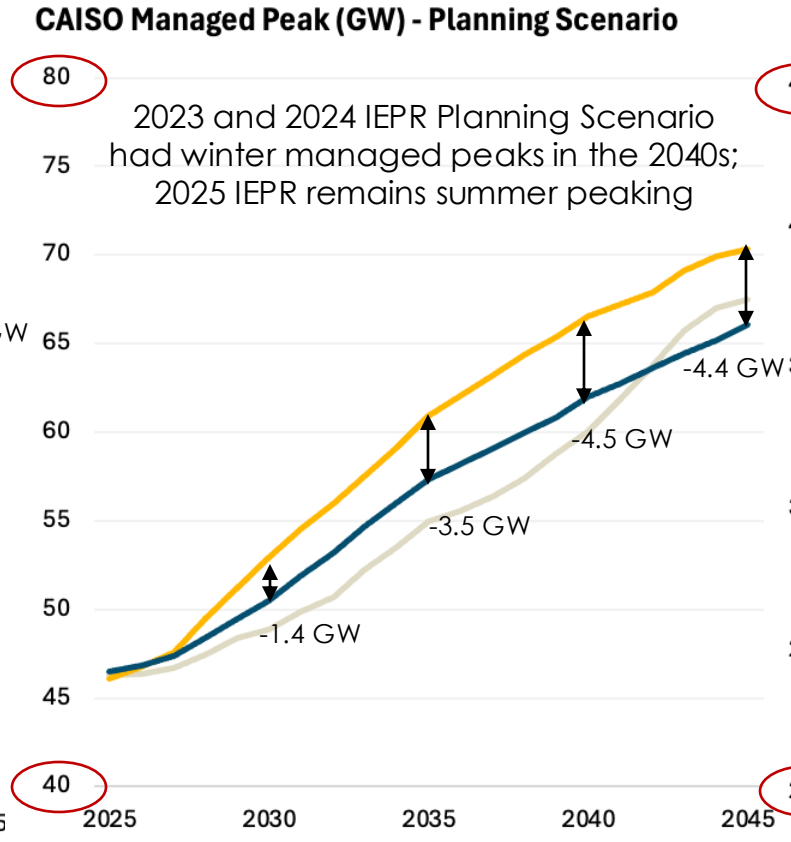
Tariff impacts are excluded from IEPR due to large uncertainty!

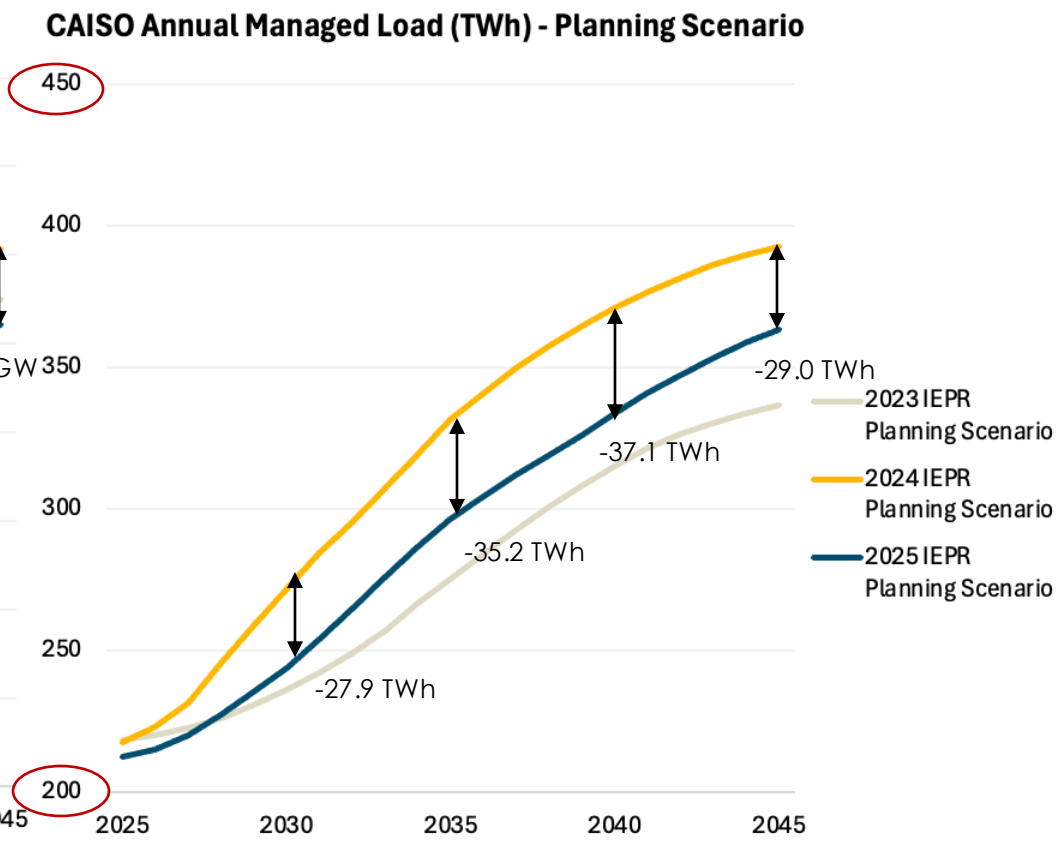
1 https://www.congress.gov/bill/119th-congress/house-bill/1/text
2 https://calmatters.org/environment/2025/05/california-electric-car-mandate-senate-revoke-waiver/
3 https://www.energy.gov/articles/doe-finalizes-efficiency-standards-water-heaters-save-americans-over-7-billion-household
4 https://ww2.arb.ca.gov/sites/default/files/2025-08/09-11-–2025%20Joint%20Meeting%20Building%20Decarbonization%20Memo.pdf
5 https://www.energy.ca.gov/event/workshop/2025-11/iepr-commissioner-workshop-load-modifier-energy-demand-forecast-results

IEPR Load Forecast Changes by Year

- Differences from 2024 to 2025 IEPR shown







Excludes impacts of BTM CHP phaseout (2036-2040) implemented in IRP modeling

AB1373 Procurement Assumptions

Input from D.24-08-064 Procurement, per AB 1373

- AB 1373 (Garcia, 2023) authorizes centralized procurement of specified Long Lead-Time (LLT) resources[1], including geothermal, offshore wind, and long duration storage (LDES) with different durations
- For the 27-28 TPP, all cases (except least-cost) require RESOLVE to select **half of the maximum procurement amounts, excluding offshore wind** specified by the CPUC need determination (D.24-08-064), to come online by 2037[2]
- **For cases with offshore wind**, online dates are assumed as:
  - Morro Bay (2.9 GW) online in 2037
  - Humboldt (1.6 GW) online in 2042

AB1373 Builds

Procurement Type	Minimum Build	Note
Geothermal	0.5 GW	
Long Duration Storage (12+hr)	0.5 GW	
Long Duration Storage (Multi-Day)	0.5 GW	
Offshore Wind - Morro Bay	2.9 GW	Online 2037
Offshore Wind - Humboldt	1.6 GW	Online 2042

1 Centralized procurement activity would be carried out by the California Department of Water Resources (DWR), when requested by the CPUC

2 https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M539/K202/539202613.PDF

RESOLVE Results: 27-28 TPP Recommended Base Case Portfolio

38 MMT by 2030, 30 MMT by 2035, No Offshore Wind

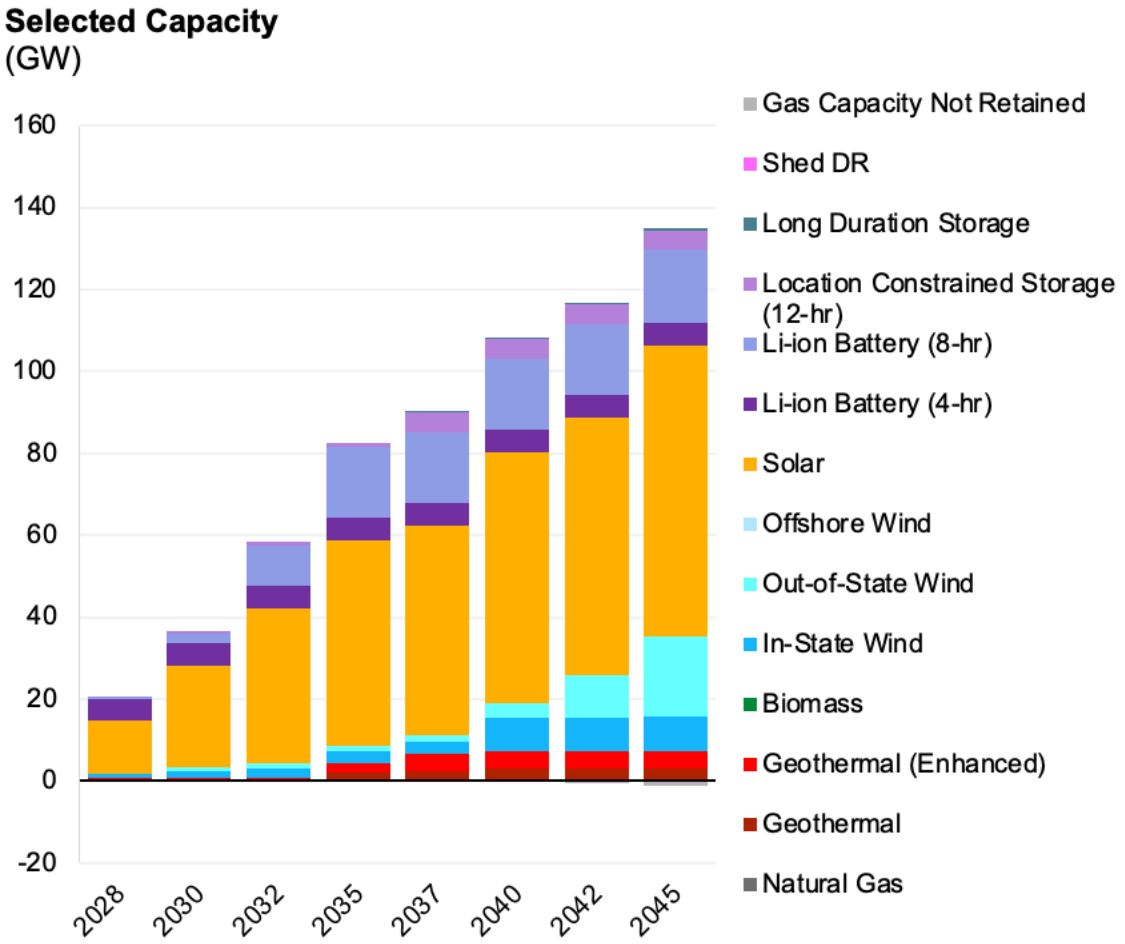
Recommended 27-28 TPP Base Case Overview

- The recommended base case makes two significant changes to policy assumptions from the 26-27 TPP base case:
  - **Modifies the near-term GHG target, from 30 MMT to 38 MMT in 2030, and from 25 MMT to 30 MMT in 2035**
  - **Removes offshore wind, which was forced in at 4.5 GW in the previous three TPP cycles**
- Similar to the 26-27 TPP, the 27-28 TPP base case includes a partial buildout of the maximum procurement volumes considered in the Commission's need determination analysis pursuant to D.24-08-064, related to Assembly Bill (AB) 1373
- CAISO's study of these portfolios focuses on model years that are 10 and 15 years in the future (i.e. 2037 and 2042), though intermediate and near-term years are also modeled

27-28 TPP Recommended Base Case

Portfolio Summary

- Geothermal (both conventional and enhanced) is selected as it becomes available for reliability value and high-capacity factor, GHG-free energy
  - Most geothermal potential is selected by 2037 to capture tax credits before they expire
- Relatively small amounts of onshore wind are selected by the mid-2030s, then scale up rapidly in the 2040s
  - Transmission constraints limit in-state wind selection in the mid-2030s
  - Most out-of-state wind is not available until 2042 due to long transmission lead times required for deliverability
- Solar and storage (especially 8-hr) are the scalable resources to meet GHG reduction and reliability, especially through 2035
  - As alternative resources become available starting in the mid-2030s, solar and storage build rates slow into the 2040s
- No offshore wind is selected
- No multi-day storage is selected above forced-in partial AB 1373 amounts; RESOLVE exceeds AB 1373 amounts of geothermal and location-constrained (12-hr) storage
- Small amounts of gas capacity with high fixed costs are not retained



27-28 TPP Recommended Base Case

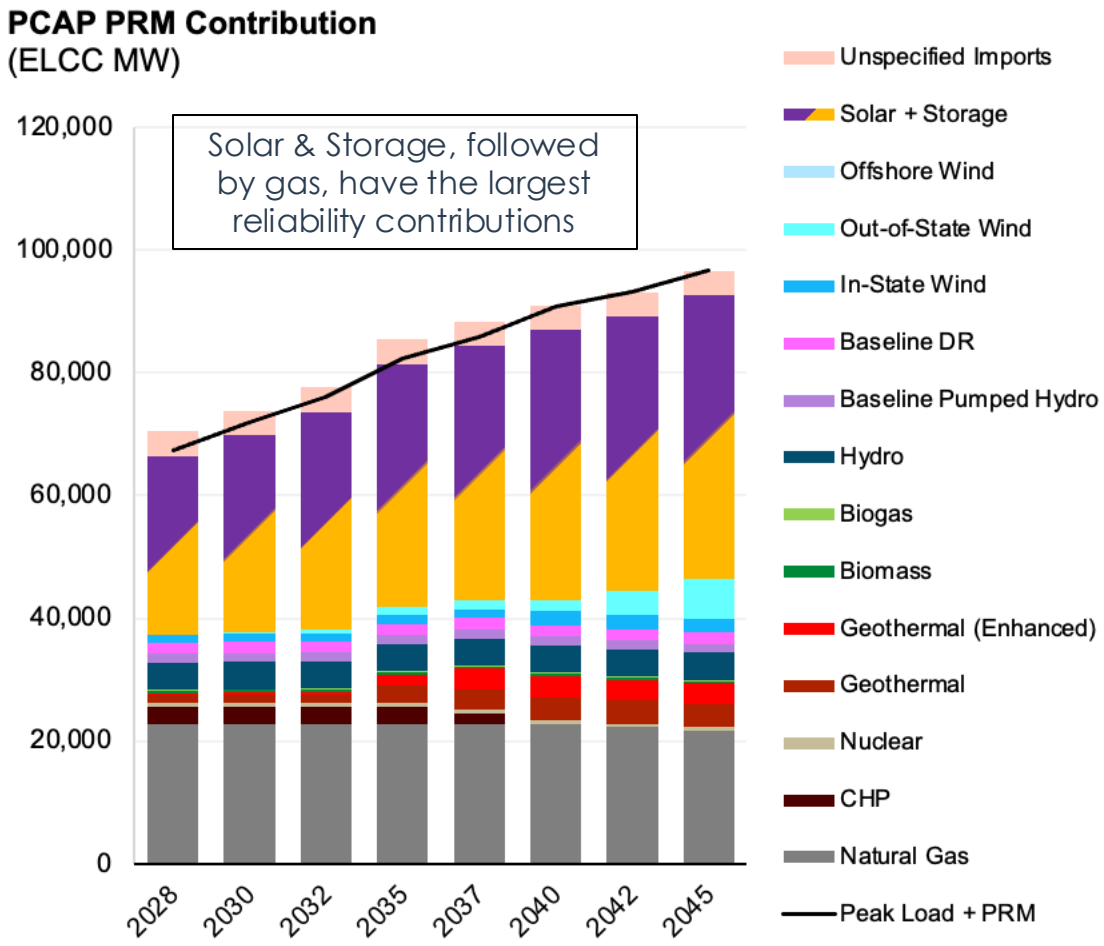
Selected Builds

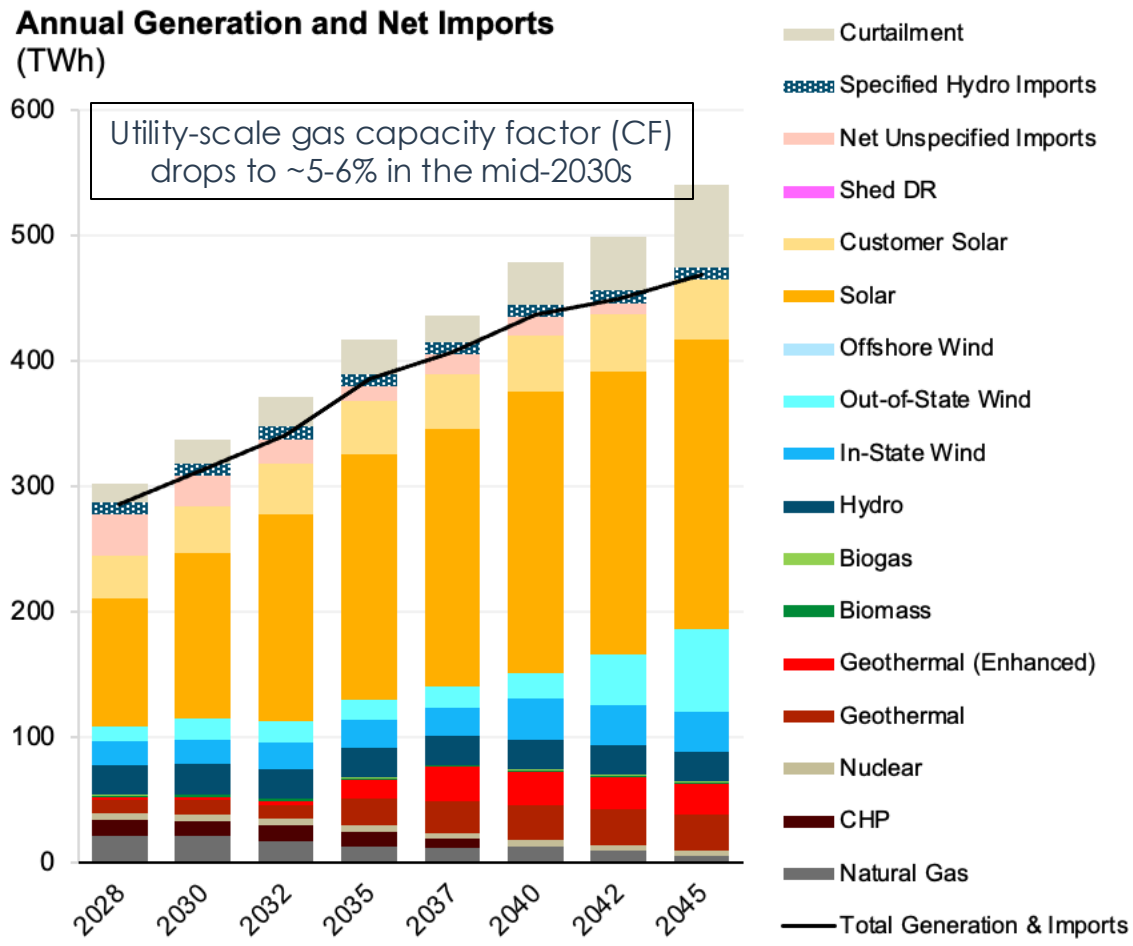
Resource Type (cumulative GW)	2028	2030	2032	2035	2037	2040	2042	2045
Natural Gas	-	-	-	-	-	-	-	-
Geothermal	0.2	0.3	0.3	1.9	2.5	3.0	3.0	3.0
Geothermal (Enhanced)	0.4	0.4	0.5	2.3	4.1	4.2	4.2	4.2
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-State Wind	1.2	1.7	2.1	2.9	2.9	8.3	8.3	8.7
Out-of-State Wind	-	0.9	1.5	1.5	1.5	3.6	10.3	19.5
Offshore Wind	-	-	-	-	-	-	-	-
Solar	13.0	24.7	37.8	50.1	51.2	61.0	62.8	71.0
Li-ion Battery (4-hr)	5.1	5.5	5.6	5.6	5.6	5.6	5.6	5.6
Li-ion Battery (8-hr)	0.8	2.5	9.8	17.1	17.4	17.4	17.4	17.8
Location Constrained Storage (12-hr)	-	0.5	0.9	1.2	4.7	4.7	4.7	4.7
Generic Storage (12-hr)	-	-	-	-	-	-	-	-
Generic Storage (24-hr)	-	-	-	-	0.0	0.0	0.0	0.0
Generic Storage (100-hr)	-	-	-	-	0.5	0.5	0.5	0.5
Shed DR	-	-	-	-	-	-	-	-
Gas Capacity Not Retained	-	-	-	-	-	-	*(0.6)*	*(1.2)*

Represents new resources (nameplate GW), both LSE planned and RESOLVE selected, above the IRP modeling resource baseline; Note: RESOLVE build exceeds AB 1373 amounts of geothermal and location-constrained (12-hr) storage

27-28 TPP Recommended Base Case

Reliability and Energy Mix

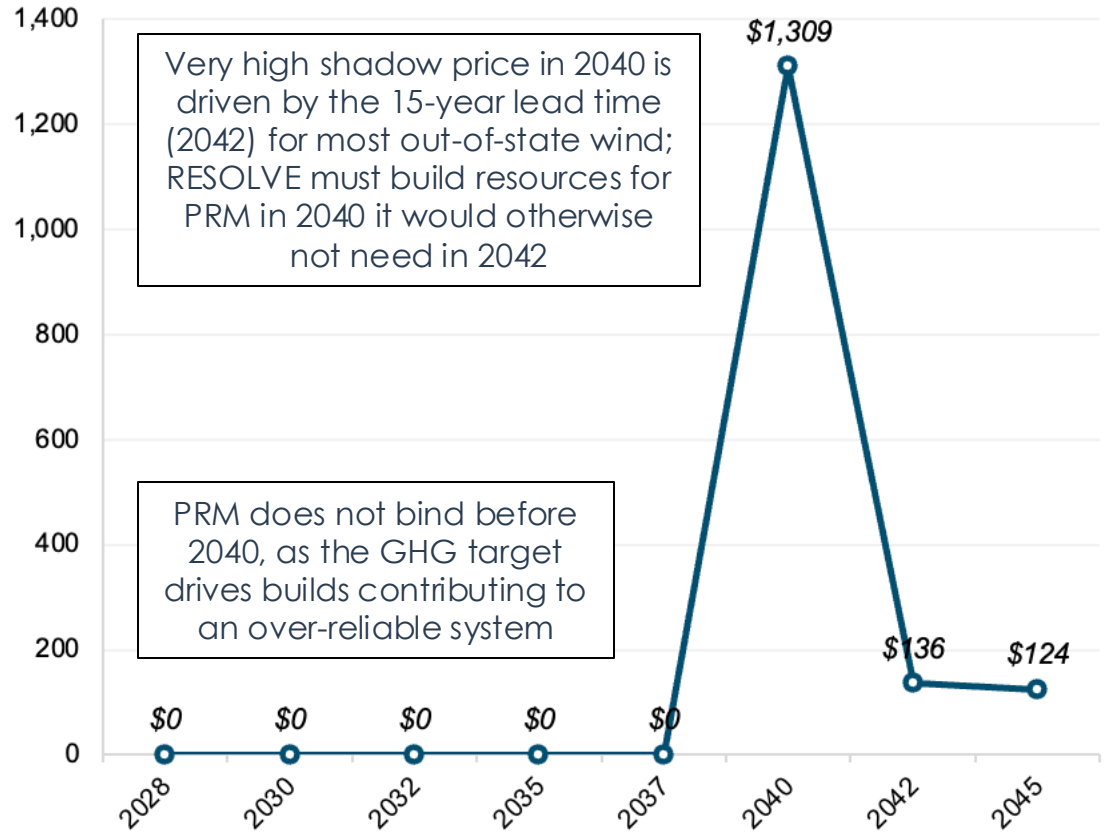




Planning Reserve Margin (PRM) and GHG Constraints

Shadow prices represent the cost of meeting a constraint, i.e. the cost of the last kW of firm capacity or the last ton of GHG emissions reduction

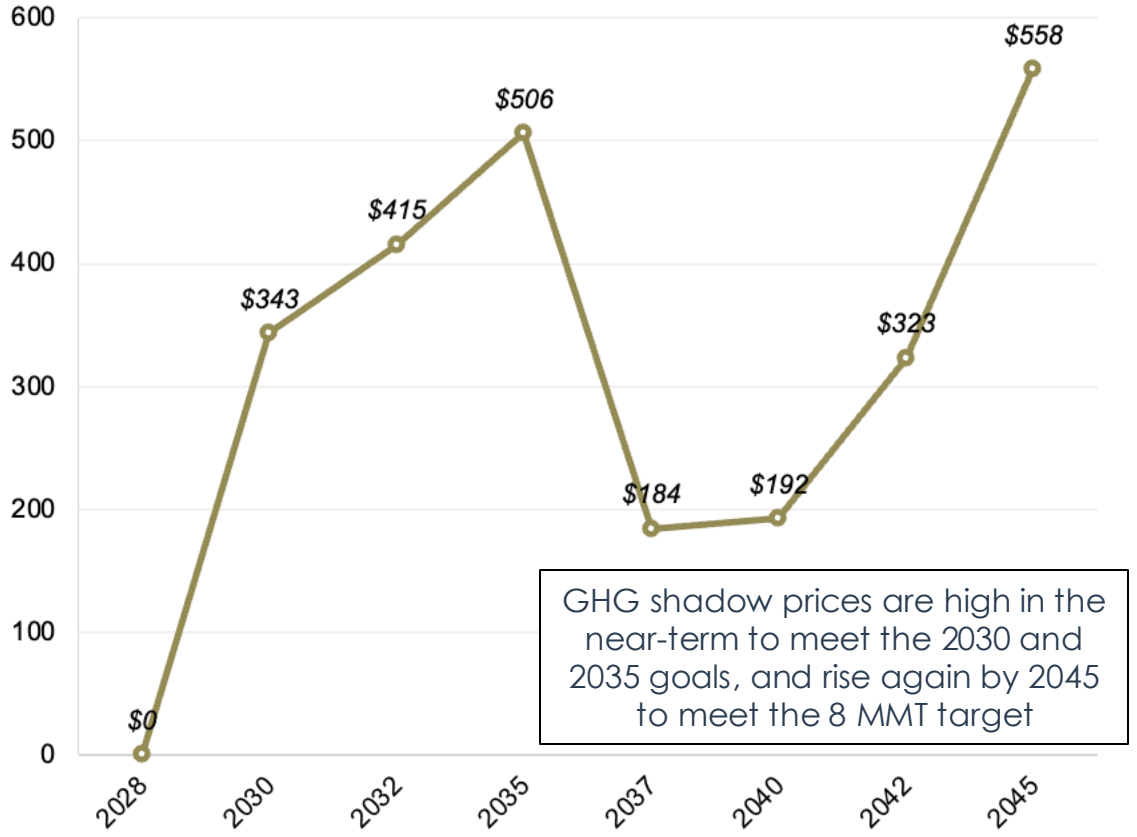
PRM Shadow Prices
($/kW-year)



Very high shadow price in 2040 is driven by the 15-year lead time (2042) for most out-of-state wind; RESOLVE must build resources for PRM in 2040 it would otherwise not need in 2042

PRM does not bind before 2040, as the GHG target drives builds contributing to an over-reliable system

GHG Target Shadow Price
($/ton CO_2)

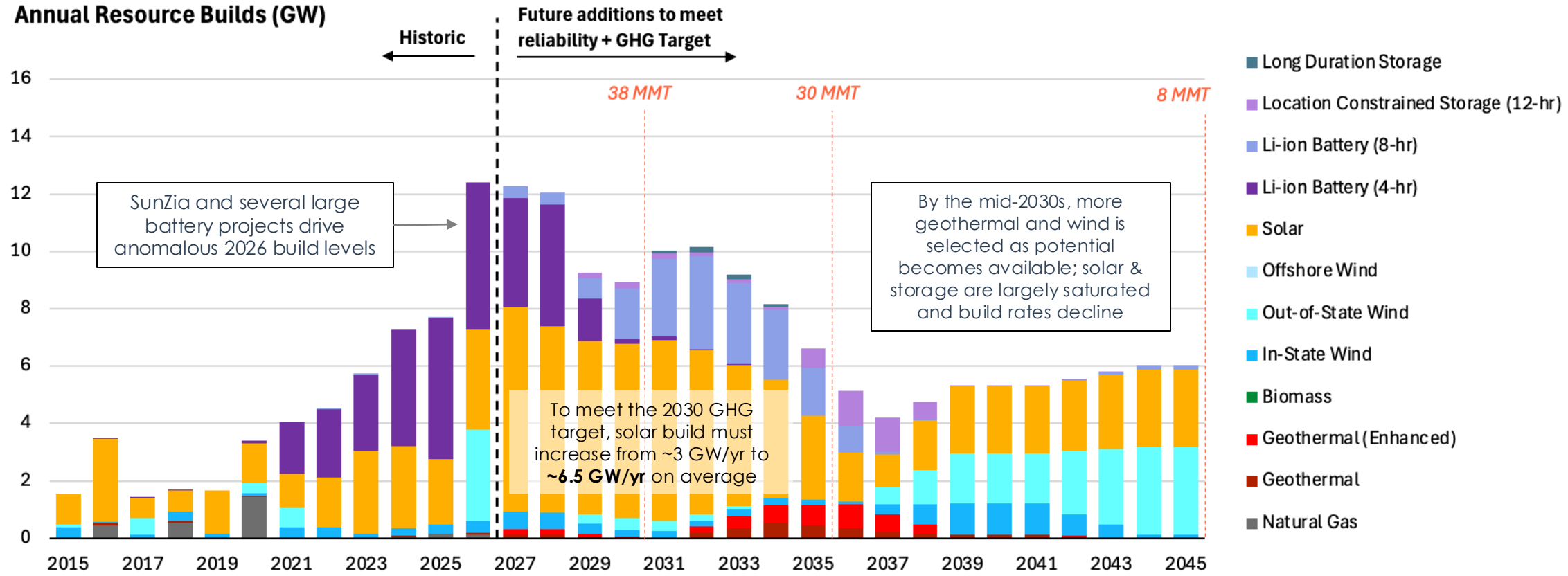


GHG shadow prices are high in the near-term to meet the 2030 and 2035 goals, and rise again by 2045 to meet the 8 MMT target

27-28 TPP Recommended Base Case

Resource Build Rate

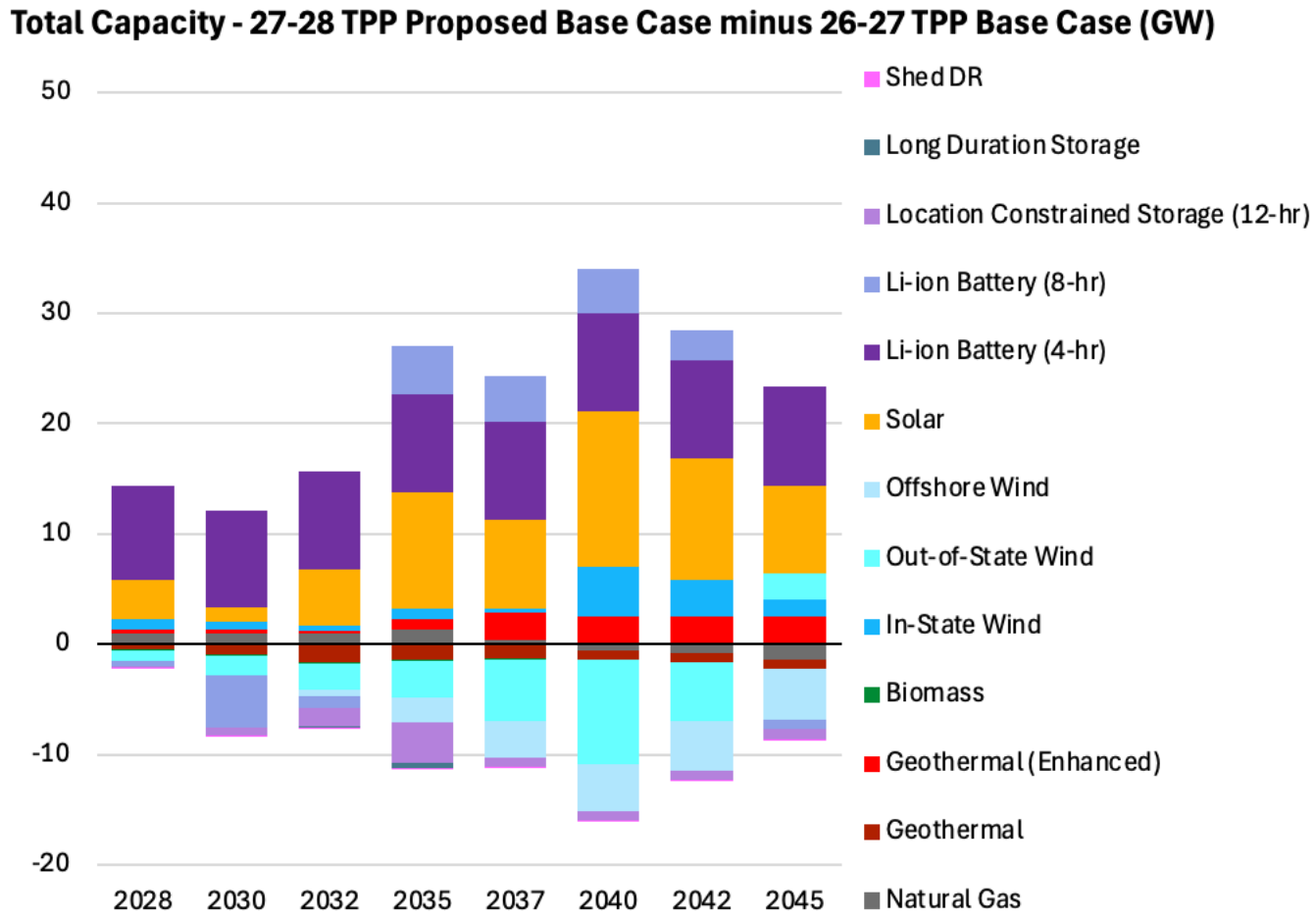
- ***The 2030 and 2035 GHG targets, combined with limited geothermal and wind availability through the mid-2030s, drive high solar and storage build rates in the near-term***



Builds are interpolated and smoothed between model years; 2026 build is a combination of resources already online this year and resources with high-confidence online dates later in the year provided by CAISO

Total Capacity Comparison with 26-27 TPP Base Case

- Differences from the 26-27 TPP are driven by:
  - **Delayed availability of long lead time resources** (geothermal, wind) in the near-term, particularly out-of-state wind
  - Offshore wind no longer forced into the base case
  - Significant additions of 4-hr batteries in the baseline, reflecting recent LSE contracting
  - Smaller impacts from other input updates (new solar profiles with lower cf, incorporation of forced outage rates for SERVM-RESOLVE calibration)
- A net increase in geothermal (additional EGS) is selected by 2037
- By 2045, differences in onshore wind builds with 26-27 TPP are relatively small



26-27 TPP results interpolated between model years where necessary; natural gas differences include both utility-scale and CHP

27-28 TPP Recommended Base Case

Selected Builds by Study Area (2037)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	25	-	-	-	-
PGE_Fresno	-	-	-	7,837	1,176	6,129	-	-	-	-	-	269
PGE_GBA	247	-	-	2,169	344	59	-	-	-	-	-	565
PGE_Kern	3	-	-	9,707	345	411	47	-	-	-	-	5
PGE_NGBA	762	-	-	1,618	-	-	-	643	288	266	297	-
PGE_Northeast_CA	-	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	5,508	493	-	-	-	-	-	-	-
SCE_Eastern	467	-	-	8,534	240	85	365	32	-	-	-	-
SCE_EOP	255	1,500	-	9,897	593	604	500	-	783	-	2,329	-
SCE_Metro	-	-	-	502	1,405	7,569	-	-	-	-	-	-
SCE_NOL	-	-	-	522	-	6	486	-	-	-	-	-
SCE_Northern	700	-	-	3,190	590	1,747	3,217	-	-	-	-	-
SDGE_Arizona	-	-	-	1,075	-	328	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	456	-	-	643	39	461	100	529	-	238	-	-

Plus 500 MW total 100-hr storage in SCE

Selected Builds by Study Area (2036/2037) – Change from 26-27 TPP Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	25	-	-	-	-
PGE_Fresno	-	-	-	4,381	950	3,283	-	-	-	-	-	4
PGE_GBA	-	-	-	1,208	- 268	13	- 165	-	-	-	-	535
PGE_Kern	3	-	- 2,924	32	- 23	43	- 770	-	-	-	-	5
PGE_NGBA	-	-	-	- 339	79	-	-	- 25	- 520	- 367	- 480	-
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	178	-	-
SCE_Arizona	-	- 2,936	-	567	- 411	-156	-	-	-	-	-	-
SCE_Eastern	146	-	-	3,549	- 230	85	- 1,435	25	-	-	-	-
SCE_EOP	-	- 2,600	-	9,207	- 45	- 95	-	-	- 103	-	2,329	-
SCE_Metro	-	-	-	497	40	485	-	-	-	-	-	-
SCE_NOL	-	-	-	244	- 542	-	99	- 142	-	-	-	-
SCE_Northern	700	-	-	- 3,155	- 33	1,112	1,937	-	-	-	-	-
SDGE_Arizona	-	-	-	- 12,903	- 85	- 886	-	-	-	-	-	-
SDGE_Baja_California	- 353	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	- 182	-	-	453	- 635	461	- 401	-	-	238	-	-

Incremental in-state wind concentrated SCE Northern

SunZia in baseline; SWIP-N not selected until 2042; other in-dev options removed

AZ deliverability constraints shift significant amounts of solar, mostly to SCE EOP

Shift in Location-Constrained Storage locations

Utah EGS is newly available in this TPP

27-28 TPP Recommended Base Case

Selected Builds by Study Area (2042)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	16	25	-	-	-	-
PGE_Fresno	-	-	-	7,837	1,176	6,129	-	-	-	-	-	269
PGE_GBA	247	951	-	2,169	344	59	-	-	-	-	-	565
PGE_Kern	245	-	-	9,730	345	411	47	-	-	-	-	5
PGE_NGBA	1,893	-	-	4,383	393	-	-	643	808	266	297	-
PGE_Northeast_CA	1,015	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	5,508	493	-	-	-	-	-	-	-
SCE_Eastern	467	-	-	8,534	240	85	365	32	-	-	-	-
SCE_EOP	255	8,359	-	13,440	593	604	500	-	783	-	2,329	-
SCE_Metro	-	-	-	544	1,405	7,569	-	-	-	-	-	-
SCE_NOL	12	-	-	522	-	6	486	-	-	-	-	-
SCE_Northern	2,338	-	-	5,619	590	1,747	3,217	-	-	-	-	-
SDGE_Arizona	-	-	-	3,771	-	328	-	-	-	-	-	-
SDGE_Baja_California	1,958	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	923	-	-	751	39	461	100	529	-	238	-	-

Plus 500 MW total 100-hr storage in SCE

Selected Builds by Study Area (2041/2042) – Change from 26-27 TPP Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	16	25	-	-	-	-
PGE_Fresno	-	-	-	1,703	950	3,283	-	-	-	-	-	4
PGE_GBA	-	- 3,049	-	990	- 268	13	- 165	-	-	-	-	535
PGE_Kern	245	-	- 2,924	56	- 23	43	- 770	-	-	-	-	5
PGE_NGBA	252	-	- 1,607	2,426	79	-	-	- 25	-	- 341	- 480	-
PGE_Northeast_CA	1,015	-	-	-	-	-	-	-	-	178	-	-
SCE_Arizona	-	- 8,936	-	567	- 411	-156	-	-	-	-	-	-
SCE_Eastern	146	-	-	1,714	- 230	85	- 1,435	25	-	-	-	-
SCE_EOP	-	4,259	-	12,750	- 45	- 95	-	-	- 103	-	2,329	-
SCE_Metro	-	-	-	157	40	485	-	-	-	-	-	-
SCE_NOL	12	-	-	244	- 542	-	99	- 142	-	-	-	-
SCE_Northern	2,338	-	-	- 1,659	- 33	1,112	1,937	-	-	-	-	-
SDGE_Arizona	-	-	-	- 10,436	- 85	328	-	-	-	-	-	-
SDGE_Baja_California	304	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	284	-	-	561	- 635	461	- 401	529	-	238	-	-

Incremental in-state wind concentrated in Northeast CA (newly selected), SCE Northern

New Mexico out-of-state wind previously assumed to interconnect in AZ now mapped to EOP

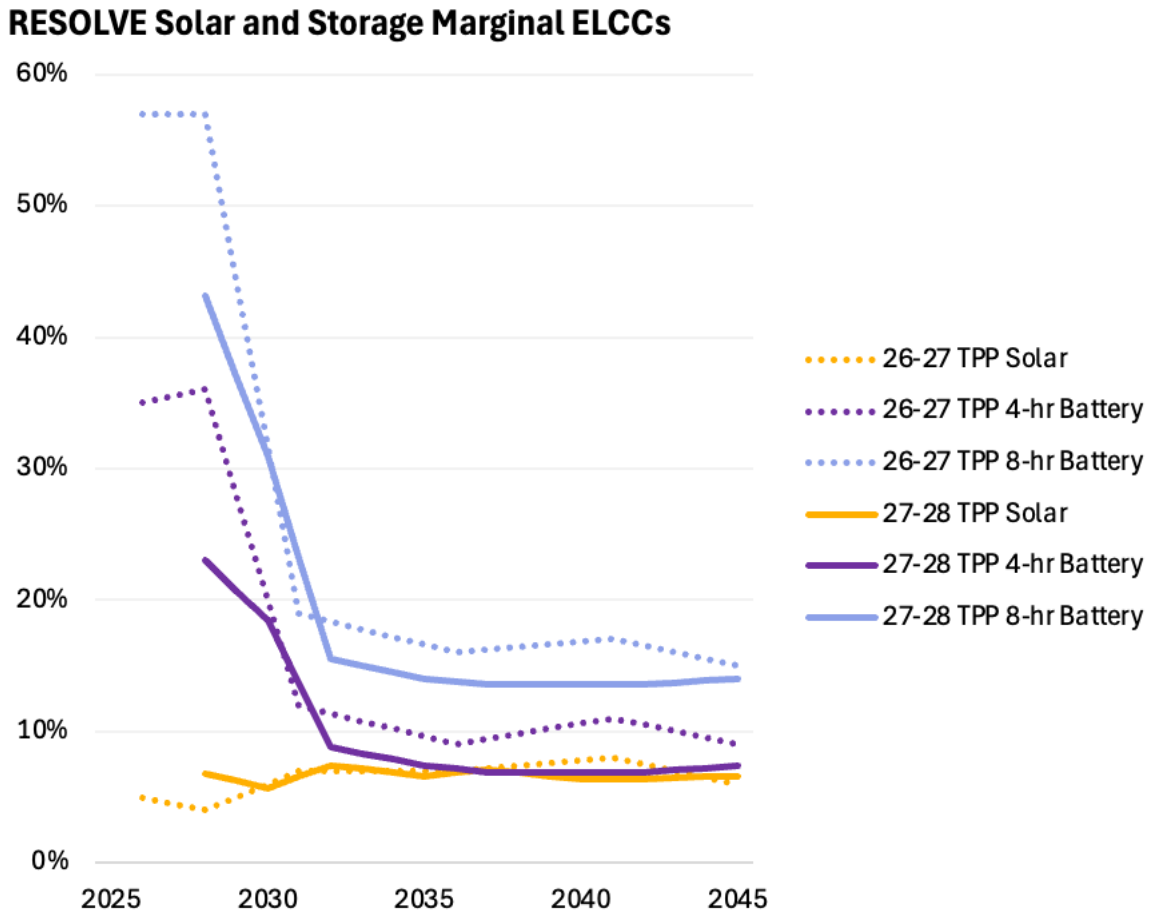
AZ deliverability constraints shift significant amounts of solar, mostly to SCE EOP

Shift in Location-Constrained Storage locations

Utah EGS is newly available in this TPP

High Solar & Storage Penetration Drives a Decline in ELCCs

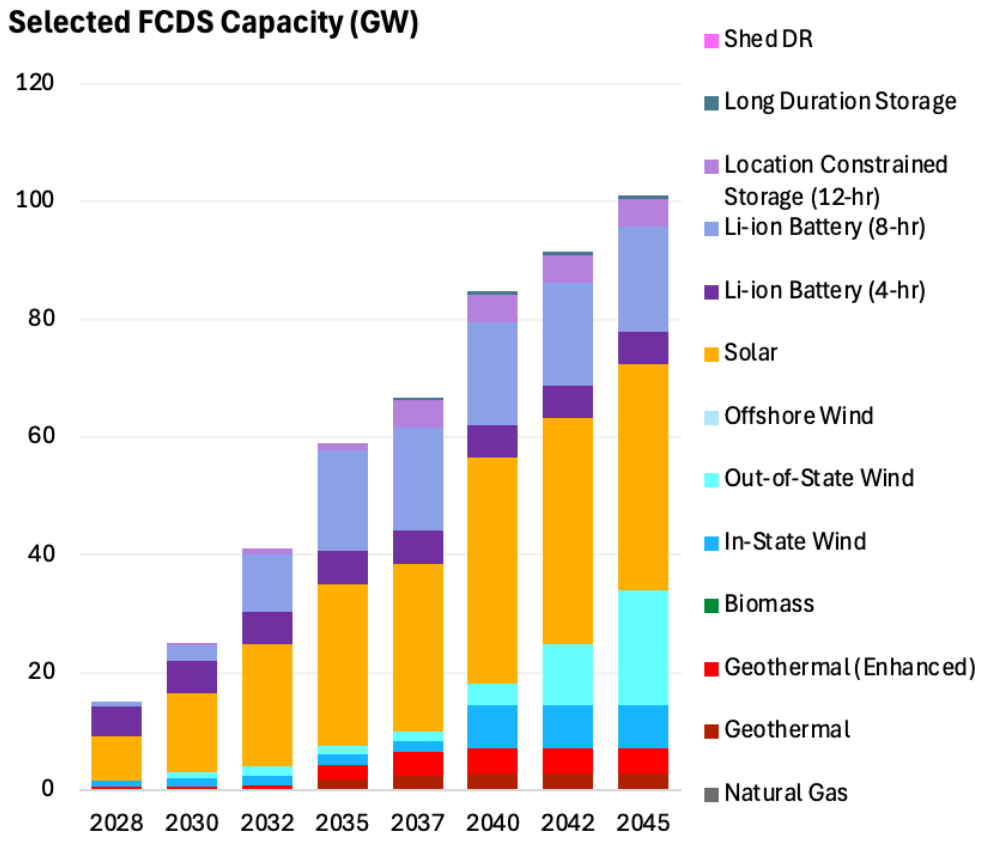
- The high near-term build of solar and storage cause storage ELCCs to saturate very quickly
  - Marginal ELCCs for 4-hr storage fall to less than 10% by 2032
- Marginal ELCCs are slightly lower than the 26-27 TPP from the mid-2030s onward; as a result, small amounts solar and storage is built in the last 10 years of the analysis as higher ELCC geothermal and wind resources become available
  - NOTE: these marginal ELCCs are based on GHG-driven additions and are not comparable to the forthcoming incremental ELCCs that will be published for 2030-2032 ordered procurement to meet reliability only (and not GHG targets)

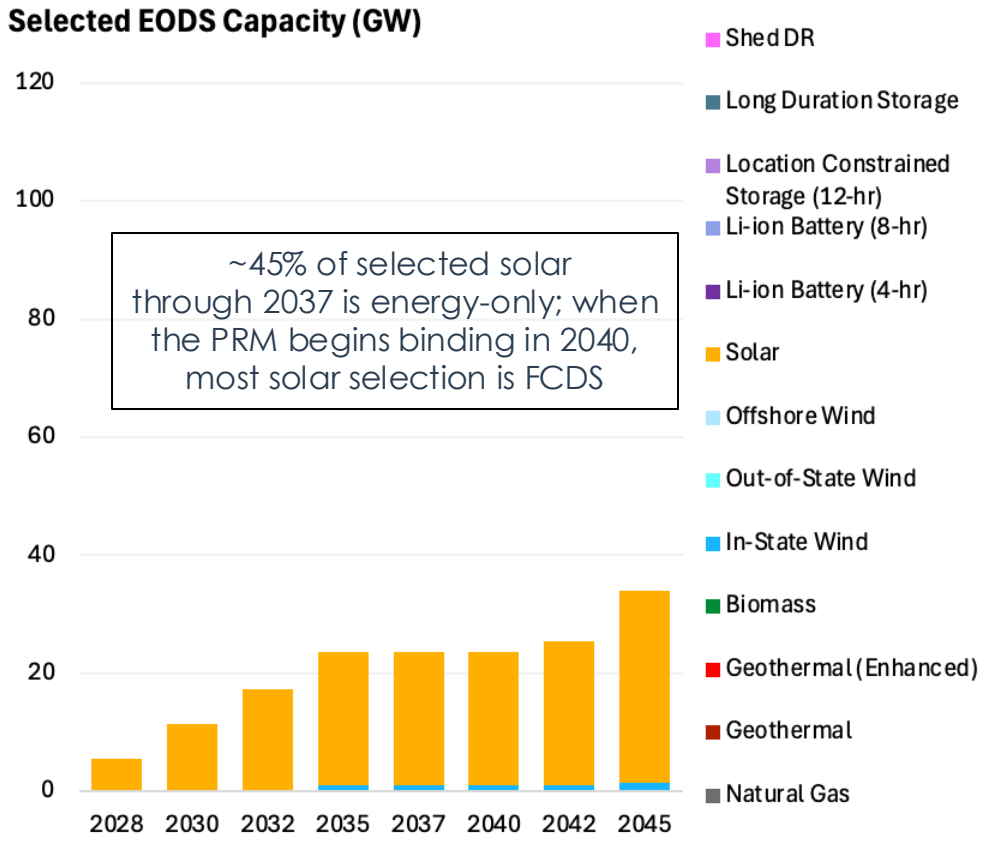


ELCC results interpolated between model years where necessary

Fully Deliverable (FCDS) and Energy-Only Resources

- RESOLVE can opt to make solar and in-state wind either FCDS or energy-only; similar to past TPPs, a meaningful amount of solar is energy only



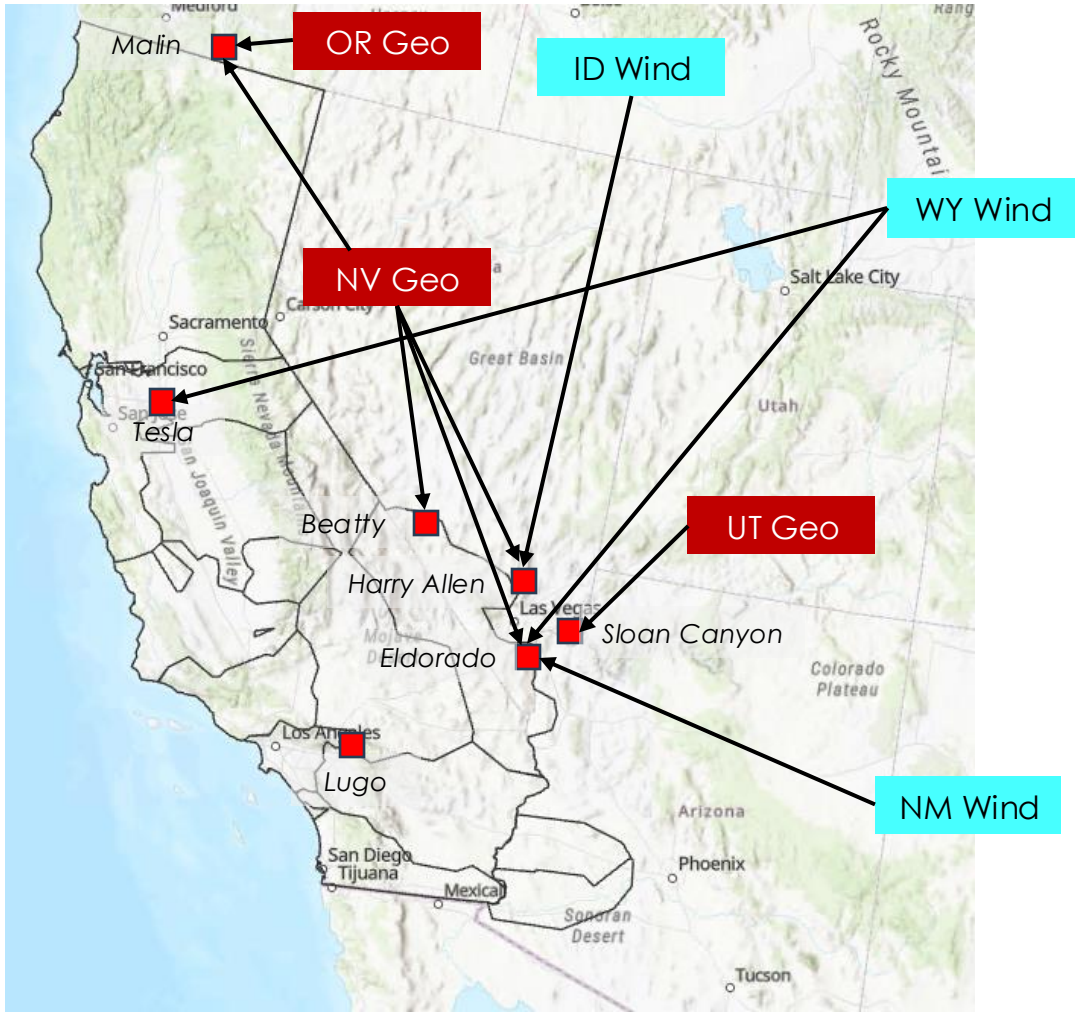


27-28 TPP Recommended Base Case

Out-of-State Resource Tie-in Locations

- **Multiple points of interconnection accommodate either wind or geothermal**; allocating TPD at these locations can mitigate risk if either wind or geothermal projects do not materialize
- High West, TransWest, and SWIP-N all utilized by RESOLVE; new HVDC transmission lines are selected for generic New Mexico and Wyoming wind
- **Several out-of-state resources compete for Tx headroom in the Harry Allen/Sloan Canyon/Eldorado area**, delaying Idaho wind (SWIP-N) selection to 2040; the second Trout Canyon Lugo upgrade relieves some of this
  - Nevada Geothermal split into four alternative pathways to help alleviate this competition
- Wyoming **wind delivered north of Path 15/26 (Tesla) is selected at a higher transmission cost** compared to other transmission paths delivering south of Path 15/26
- Several GW of additional out-of-state wind is selected by RESOLVE in 2045, interconnecting at Lugo and Eldorado

Major Transmission Pathways Selected by 2042



Officially selected transmission upgrades are determined by the CAISO Transmission Plan; Selections of less than 100 MW not shown

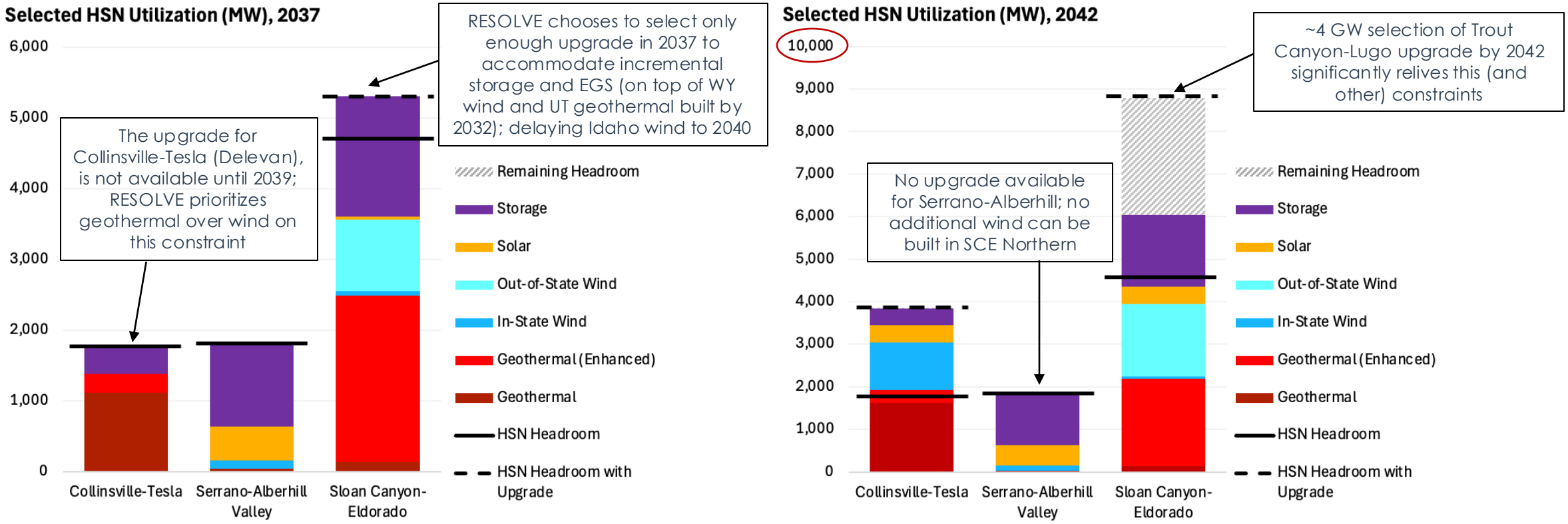
Transmission Constraint Impacts on Wind

- Although all in-state wind potential becomes available by 2035, much of it is not selected in the 10-year timeframe (2037) due to binding transmission constraints, driven by competition from near-term solar and storage and/or geothermal resources also becoming available by 2035
  - This also impacts Idaho Wind utilizing SWIP-N
- By 2042, most of the wind potential is selected as additional transmission upgrades become available

Wind Resource	Selected by 2037	Remaining potential in 2037	Binding transmission constraints	Additional built by 2042?
PG&E GBA	247 MW	-	n/a	n/a
PG&E Kern	3 MW	242 MW	multiple	Yes, on generic transmission
PG&E NGBA	762 MW	1,131 MW	Collinsville – Tesla 500kV and Carberry – Round Mtn 230kV	Yes, with upgrade
PG&E Northeast CA	-	1,015 MW	Collinsville – Tesla 500kV	Yes, with upgrade
SCE Eastern	467 MW	352 MW	Serrano – Alberhill Valley Area	No – no upgrade available
SCE EOP	255 MW	-	n/a	n/a
SCE NOL	-	1,243 MW	multiple	No – upgrades not available or very expensive
SCE Northern	700 MW	1,733 MW	multiple	Yes, with upgrade
SDG&E Imperial	456 MW	467 MW	East of Miguel	Yes, tx headroom increases due to approved upgrades
SDG&E Baja California	-	1,958 MW	East of Miguel	Yes, tx headroom increases due to approved upgrades
SCE Idaho (out-of-state)	-	1,100 MW	Sloan Canyon – Eldorado Area	Yes, with upgrade

Example Binding Transmission Constraints Impacting Wind

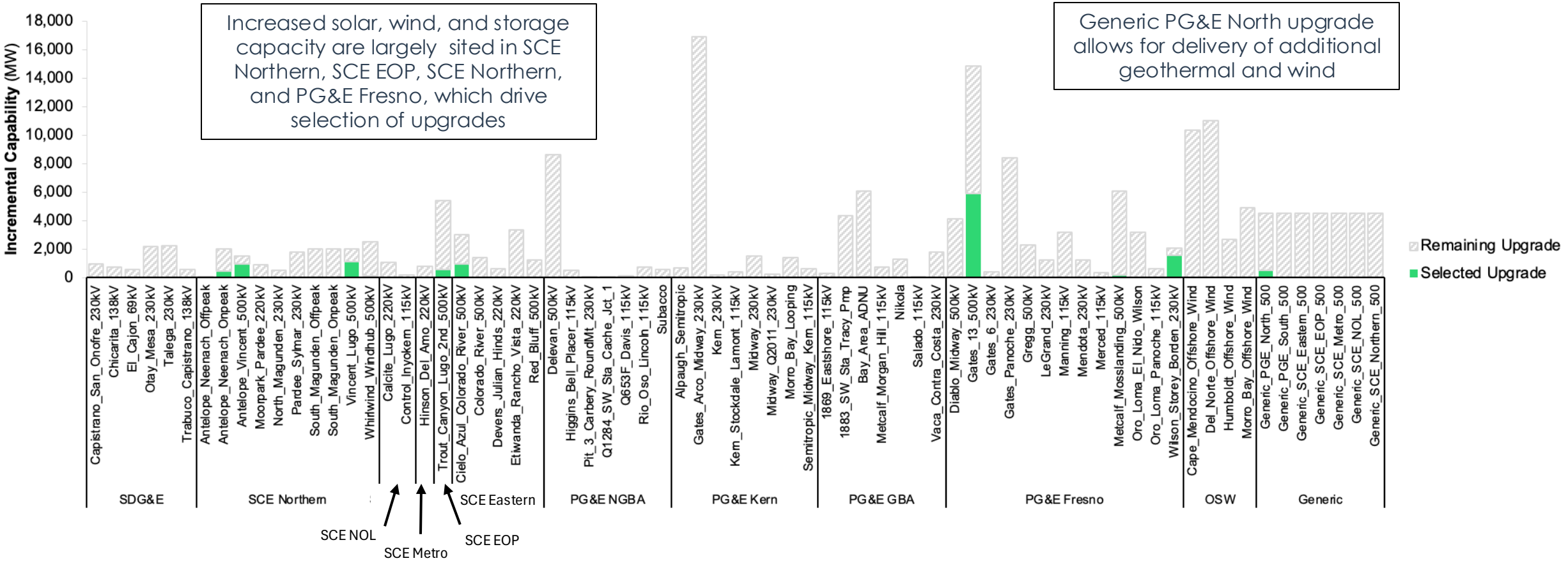
- These examples impact PG&E NGBA, SCE Northern, and SDG&E Imperial/Baja CA; little to no headroom is available to accommodate wind in 2037
- In some cases (e.g. Sloan Canyon-Eldorado), transmission upgrades are available in 2037, but RESOLVE prioritizes other resources (primarily geothermal before tax credits expire) before selecting upgrades to allow for more wind build in the 2040s



27-28 TPP Recommended Base Case

RESOLVE-Selected Transmission Upgrades (2037)

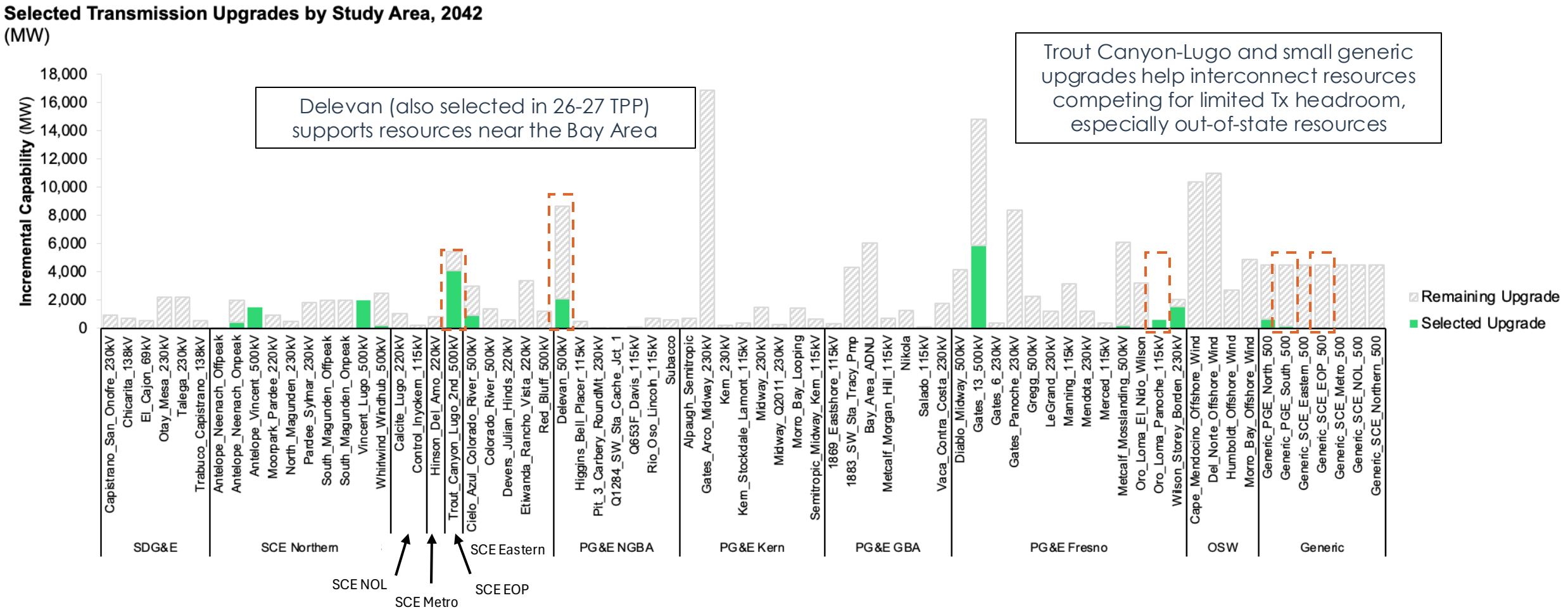
Selected Transmission Upgrades by Study Area, 2037
(MW)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

27-28 TPP Recommended Base Case

RESOLVE-Selected Transmission Upgrades (2042)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE-Selected Transmission Upgrades – Changes from 26-27 TPP (2036/2037)

- **~6 GW additional capacity expansion supporting transmission upgrades** selected in the 10-year outlook, at an additional cost of $0.4 Billion ($37 Million/yr), primarily to procure in-state solar and storage resources

Constraint	Upgrade	Study Area	Cost ($/kW-yr)	27-28 TPP (2037)	26-27 TPP (2036)	27-28 TPP MW	26-27 TPP MW
Antelope-Vincent Area Deliverability Constraint	Antelope Vincent 500kV	SCE Northern	$0.82	✓	✗	961	0
Windmaster-Delta pumps 230 kV line	Bay Area ADNU	PG&E GBA	$6.41	✓	✗	31	0
DCRT Area Deliverability Constraint	Cielo Azul Colorado River 500kV	SCE Eastern	$14.31	✓	✗	955	0
Diablo-Gates 500 kV line	Diablo Midway 500kV	PG&E Fresno	$18.65	✓	✗	48	0
	Generic PGE North 500		$41.20	✓	✗	500	0
Metcalf-Mosslanding 500kV	Metcalf Mosslanding 500kV	PG&E Fresno	$3.05	✓	✗	190	0
Vincent-Lugo Area Deliverability Constraint	Vincent Lugo 500kV	SCE Northern	$3.98	✓	✗	1093	0
Windhub Area Deliverability Constraint	Whirlwind Windhub 500kV	SCE Northern	$22.69	✓	✗	137	0
Borden-Storey #1 230kV line	Wilson Storey Borden 230kV	PG&E Fresno	$2.26	✓	✗	1536	0
Lugo – Victorville Area Deliverability Constraint	Trout Canyon Lugo 2nd 500kV	SCE EOP	$33.67	✓	**Not available**	579	n/a
Control to Inyokern constraint	Control Inyokern 115kV	SCE NOL	$163.97	✗	✓	0	186
Morro Bay Offshore Wind Constraint	Morro Bay Offshore Wind	Offshore Wind	$2.09	✗	✓	0	2924

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

RESOLVE-Selected Transmission Upgrades – Changes from 26-27 TPP (2041/2042)

- **~10 GW additional transmission upgrades** selected, though there are **net incremental savings due to the removal of offshore wind**

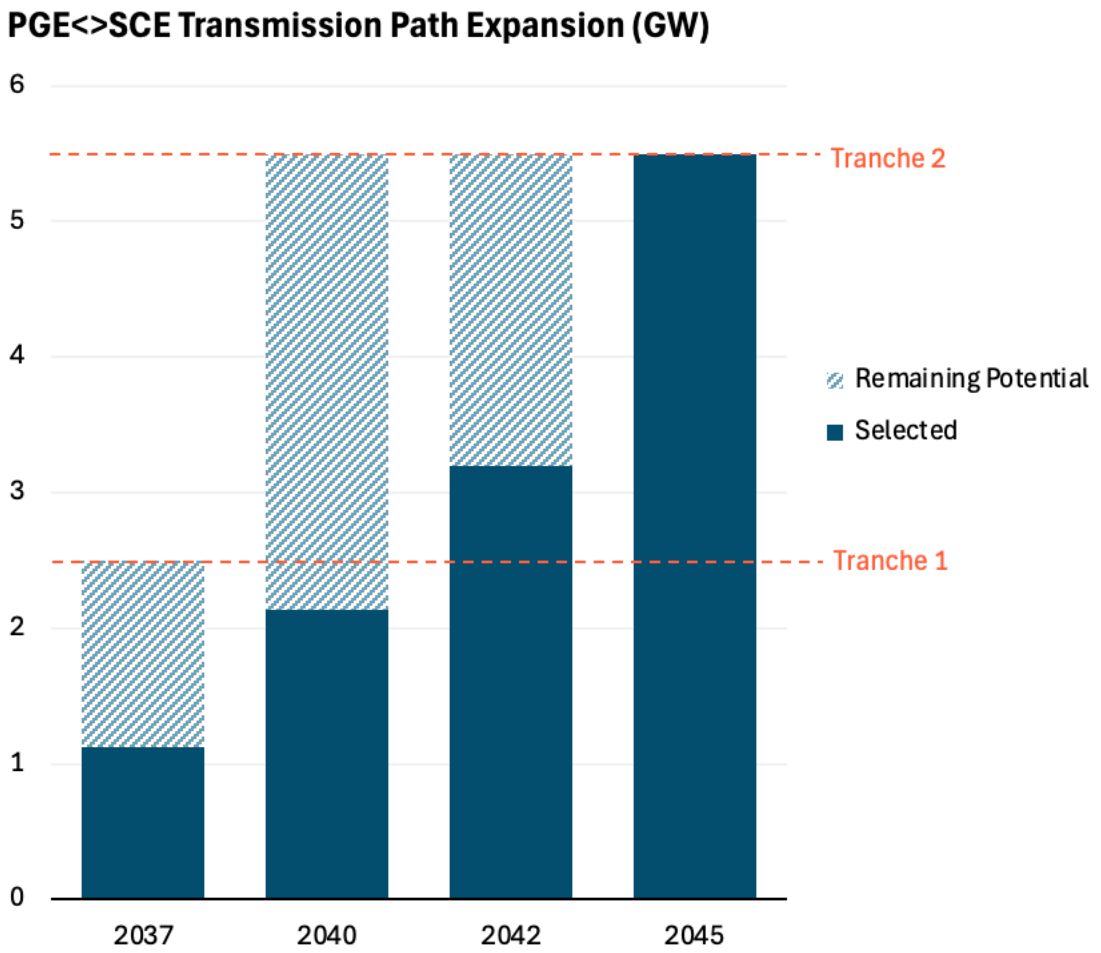
Constraint	Upgrade	Study Area	Cost ($/kW-yr)	27-28 TPP (2037)	26-27 TPP (2036)	27-28 TPP MW	26-27 TPP MW
Antelope-Vincent Area Deliverability Constraint	Antelope Vincent 500kV	SCE Northern	$0.82	✓	✗	1500	0
Windmaster-Delta pumps 230 kV line	Bay Area ADNU	PG&E GBA	$6.41	✓	✗	31	0
DCRT Area Deliverability Constraint	Cielo Azul Colorado River 500kV	SCE Eastern	$14.31	✓	✗	955	0
Diablo-Gates 500 kV line	Diablo Midway 500kV	PG&E Fresno	$18.65	✓	✗	48	0
	Generic PGE North 500		$41.20	✓	✗	642	0
	Generic PGE South 500		$41.20	✓	✗	125	0
	Generic SCE EOP 500		$41.20	✓	✗	39	0
Metcalf-Mosslanding 500kV	Metcalf Mosslanding 500kV	PG&E Fresno	$3.05	✓	✗	190	0
Panoche-Oro Loma 115kV Line	Oro Loma Panoche 115kV	PG&E Fresno	$0.00	✓	✗	588	0
Vincent-Lugo Area Deliverability Constraint	Vincent Lugo 500kV	SCE Northern	$3.98	✓	✗	2000	0
Windhub Area Deliverability Constraint	Whirlwind Windhub 500kV	SCE Northern	$22.69	✓	✗	222	0
Lugo – Victorville Area Deliverability Constraint	Trout Canyon Lugo 2nd 500kV	SCE EOP	$33.67	✗	Not available	4092	n/a
Control to Inyokern constraint	Control Inyokern 115kV	SCE NOL	$163.97	✗	✓	0	186
Etiwanda-Rancho Vista Area Deliverability Constraint	Etiwanda Rancho Vista 220kV	SCE Eastern	$2.46	✗	✓	0	709
Humboldt Bay Offshore Wind Constraint	Humboldt Offshore Wind	Offshore Wind	$120.06	✗	✓	0	1607
Morro Bay Offshore Wind Constraint	Morro Bay Offshore Wind	Offshore Wind	$2.09	✗	✓	0	2924

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

27-28 TPP Recommended Base Case

PG&E-SCE Transmission Path Expansion

- Path 26/Path 15 expansion(s) are selected primarily to increase import capacity into PG&E
- Path expansion is selected by RESOLVE as soon as it becomes available in 2037, with the full first tranche built by 2042
- The second tranche selected in full by 2045, more than doubling the transmission capacity
- In the 26-27 TPP base case, 1 GW expansion was selected by 2036, but less was selected than the 27-28 TPP in the longer term (no additional selection by 2041, ~3.7 GW total by 2045)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE Results:
38 MMT + OSW Base Case

38 MMT by 2030, 30 MMT by 2035, 4.5 GW Offshore Wind

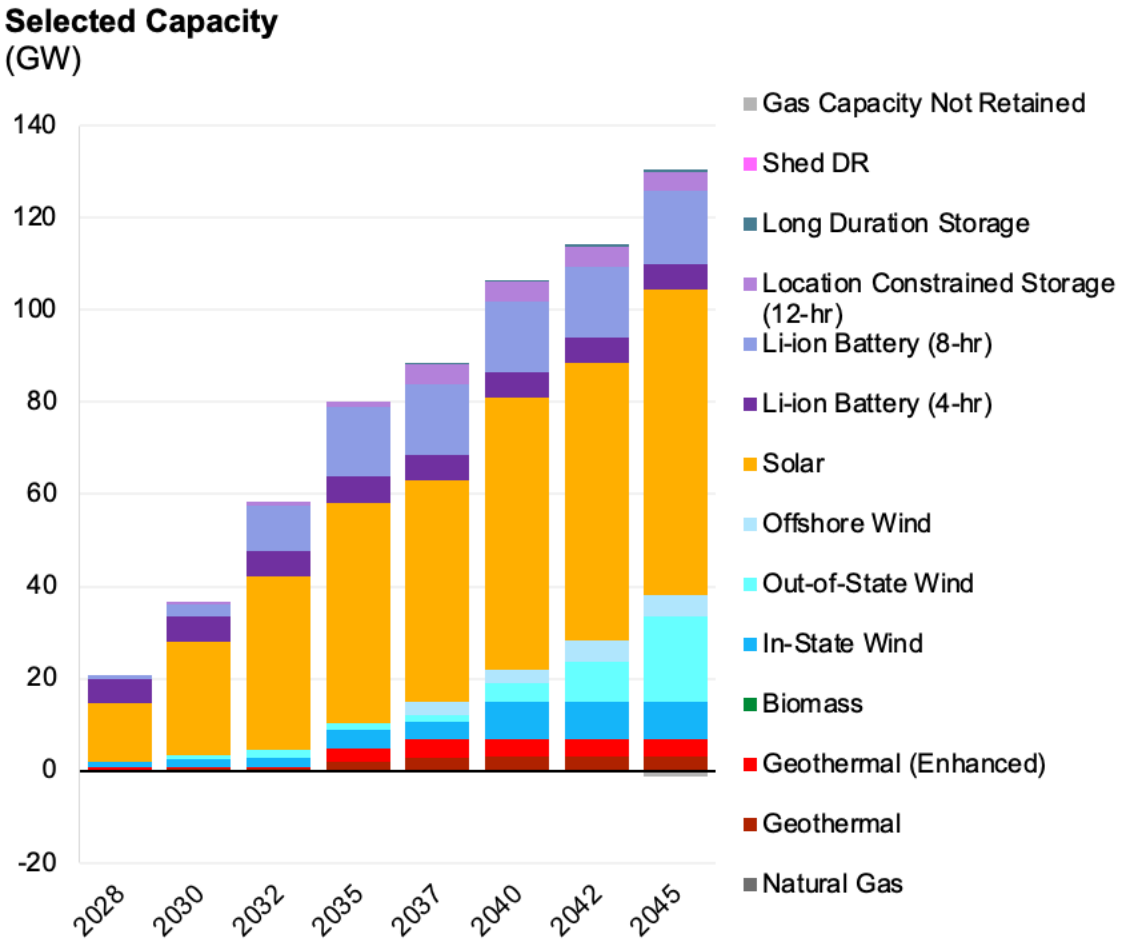
38MMT + OSW Case Overview

- Relative to the Recommended 27-28 TPP Base Case, the 38MMT + OSW case:
  - Includes partial buildout of the maximum procurement volumes considered in the Commission's need determination analysis pursuant to D.24-08-064, related to Assembly Bill (AB) 1373. However, unlike the recommended base case which excluded offshore wind, **4.5GW of forced-in offshore wind is included.**
- All other assumptions are the same as the recommended base case including the modified near-term GHG target, adjusted from 30 MMT to 38 MMT in 2030, and from 25 MMT to 30MMT in 2035

38MMT + OSW

Portfolio Summary

- Geothermal (both conventional and enhanced) is selected as it becomes available for reliability value and high-capacity factor, GHG-free energy
  - Most geothermal potential is selected by 2037 to capture tax credits before they expire
- Relatively small amounts of onshore wind are selected by the mid-2030s, then scale up rapidly in the 2040s
  - Transmission constraints limit in-state wind selection in the mid-2030s
  - Most out-of-state wind is not available until 2042 due to long transmission lead times required for deliverability
- Solar and storage (especially 8-hr) are the scalable resources to meet GHG reduction and reliability, especially through 2035
  - As alternative resources become available starting in the mid-2030s, solar and storage build rates slow into the 2040s
- No offshore wind or multi-day storage are selected above forced-in partial AB1373 amounts; RESOLVE exceeds AB1373 amounts of geothermal and location-constrained (12-hr) storage
- Small amounts of gas capacity with high fixed costs are not retained



38MMT + OSW

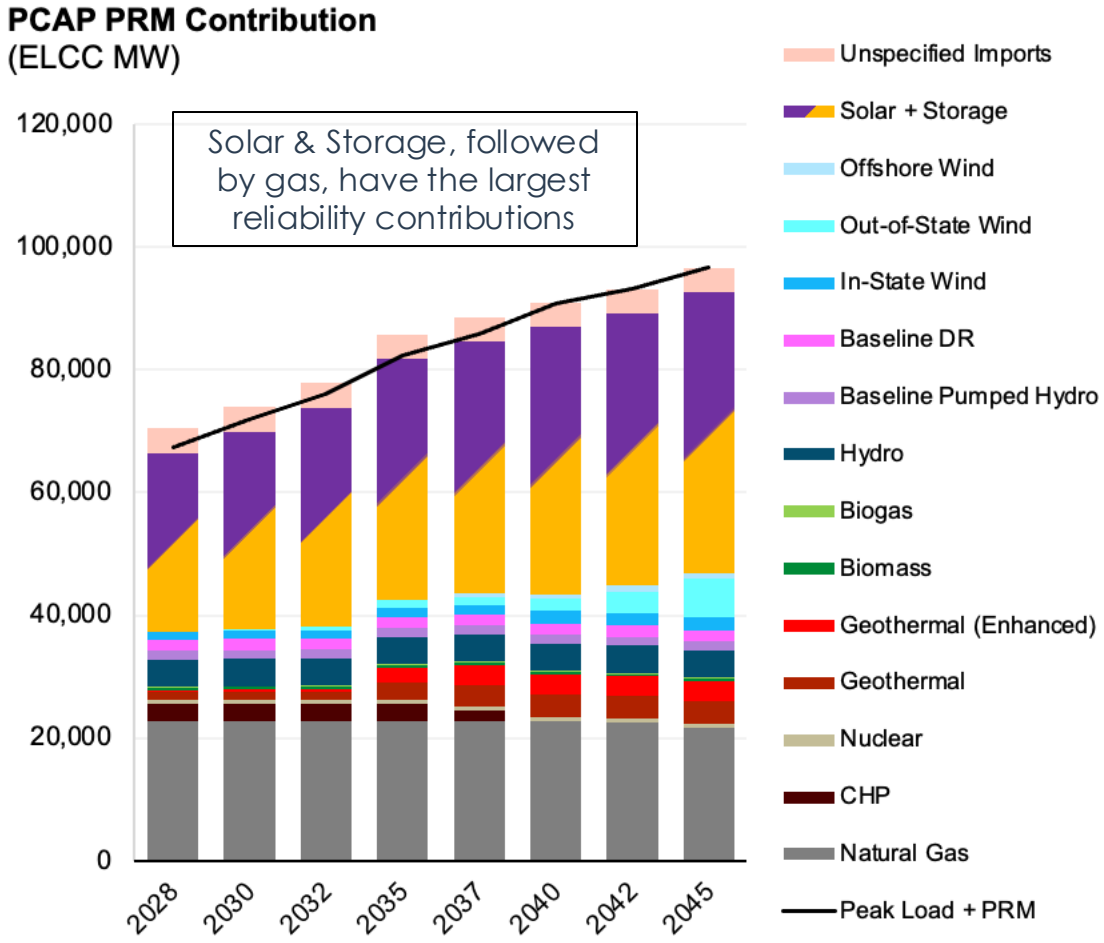
Selected Builds

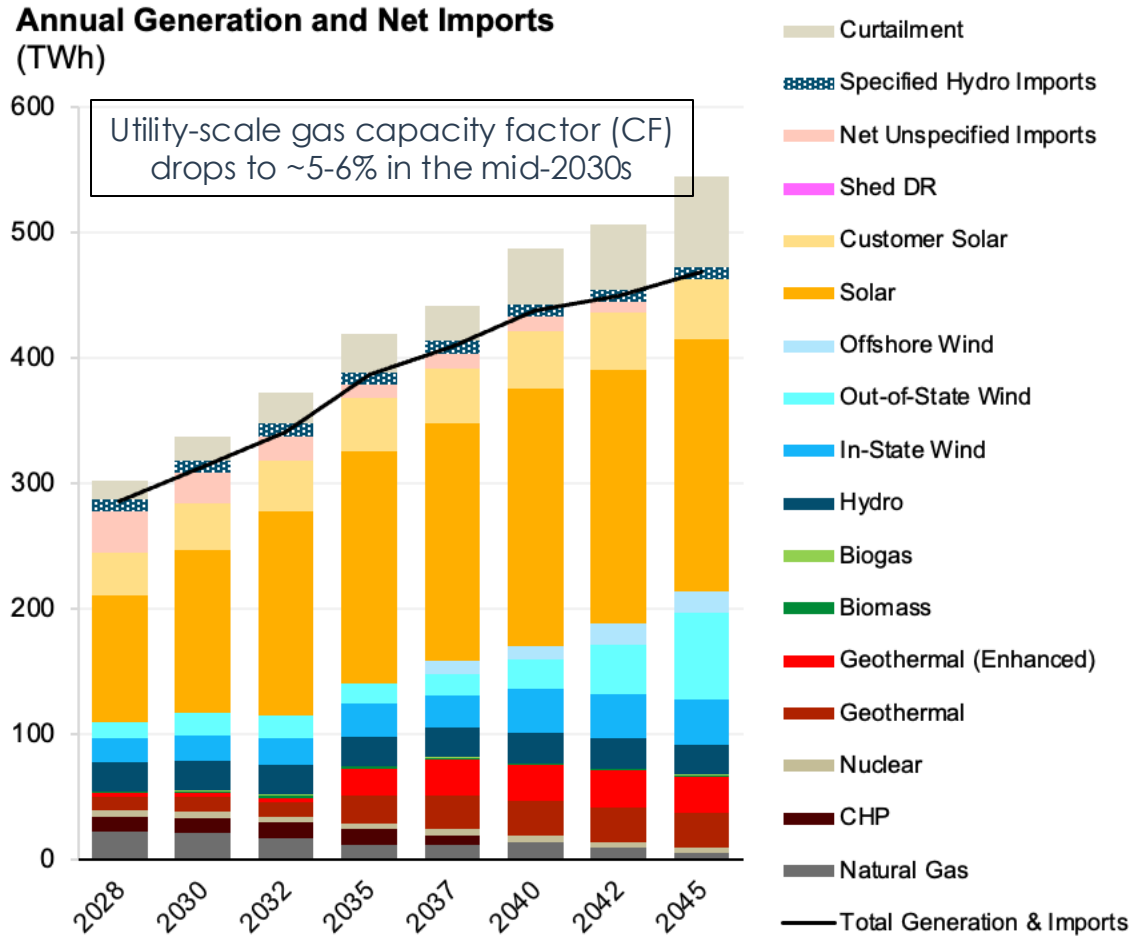
Resource Type (cumulative GW)	2028	2030	2032	2035	2037	2040	2042	2045
Natural Gas	-	-	-	-	-	-	-	-
Geothermal	0.2	0.3	0.3	1.9	2.8	3.0	3.0	3.0
Geothermal (Enhanced)	0.4	0.4	0.5	3.0	4.0	4.0	4.0	4.0
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-State Wind	1.2	1.7	2.1	3.9	3.9	7.9	7.9	8.1
Out-of-State Wind	-	0.9	1.5	1.5	1.5	4.0	8.7	18.4
Offshore Wind	-	-	-	-	2.9	2.9	4.5	4.5
Solar	13.0	24.5	37.7	47.8	47.8	59.1	60.4	66.4
Li-ion Battery (4-hr)	5.1	5.5	5.6	5.6	5.6	5.6	5.6	5.6
Li-ion Battery (8-hr)	0.8	2.7	9.8	15.0	15.4	15.4	15.4	15.9
Location Constrained Storage (12-hr)	-	0.5	0.9	1.1	4.2	4.2	4.2	4.2
Generic Storage (12-hr)	-	-	-	-	-	-	-	-
Generic Storage (24-hr)	-	-	-	-	0.5	0.5	0.5	0.5
Generic Storage (100-hr)	-	-	-	-	0.0	0.0	0.0	0.0
Shed DR	-	-	-	-	-	-	-	-
Gas Capacity Not Retained	-	-	-	-	-	-	*(0.4)*	*(1.2)*

Represents new resources (nameplate GW), both LSE planned and RESOLVE selected, above the IRP modeling resource baseline; Note: RESOLVE build exceeds AB 1373 amounts of geothermal and location-constrained (12-hr) storage

38MMT + OSW

Reliability and Energy Mix

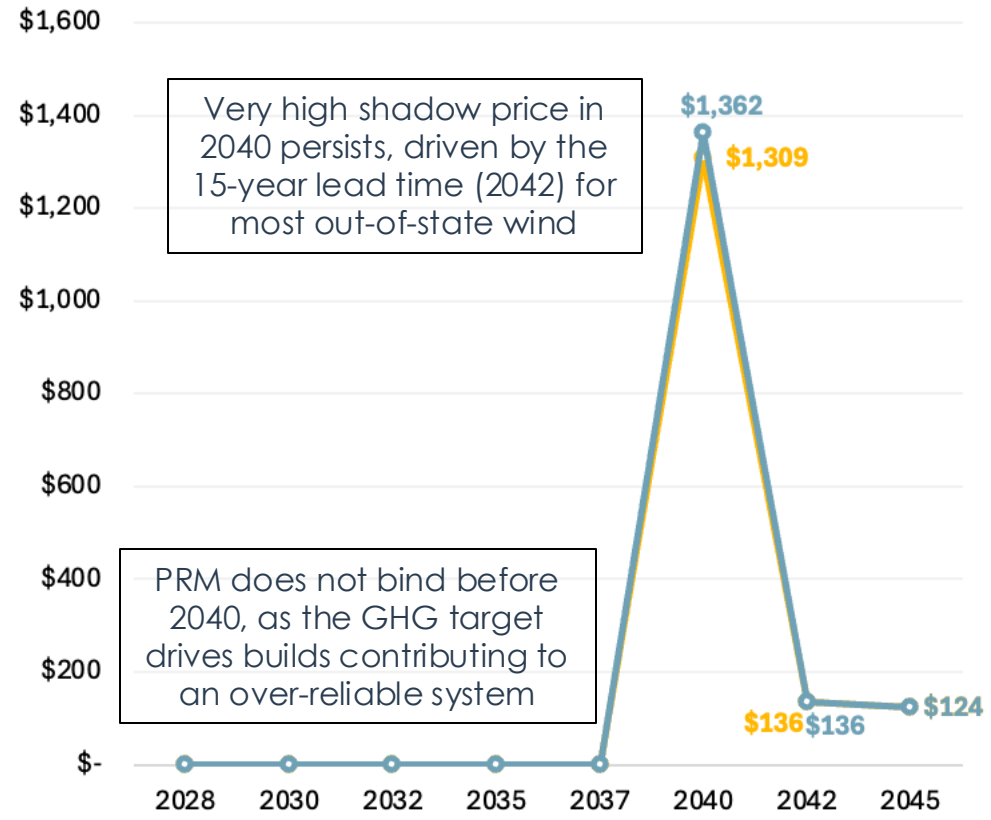




Planning Reserve Margin (PRM) and GHG Constraints

- Shadow prices represent the cost of meeting a constraint, i.e. the cost of the last kW of firm capacity or the last ton of GHG emissions reduction

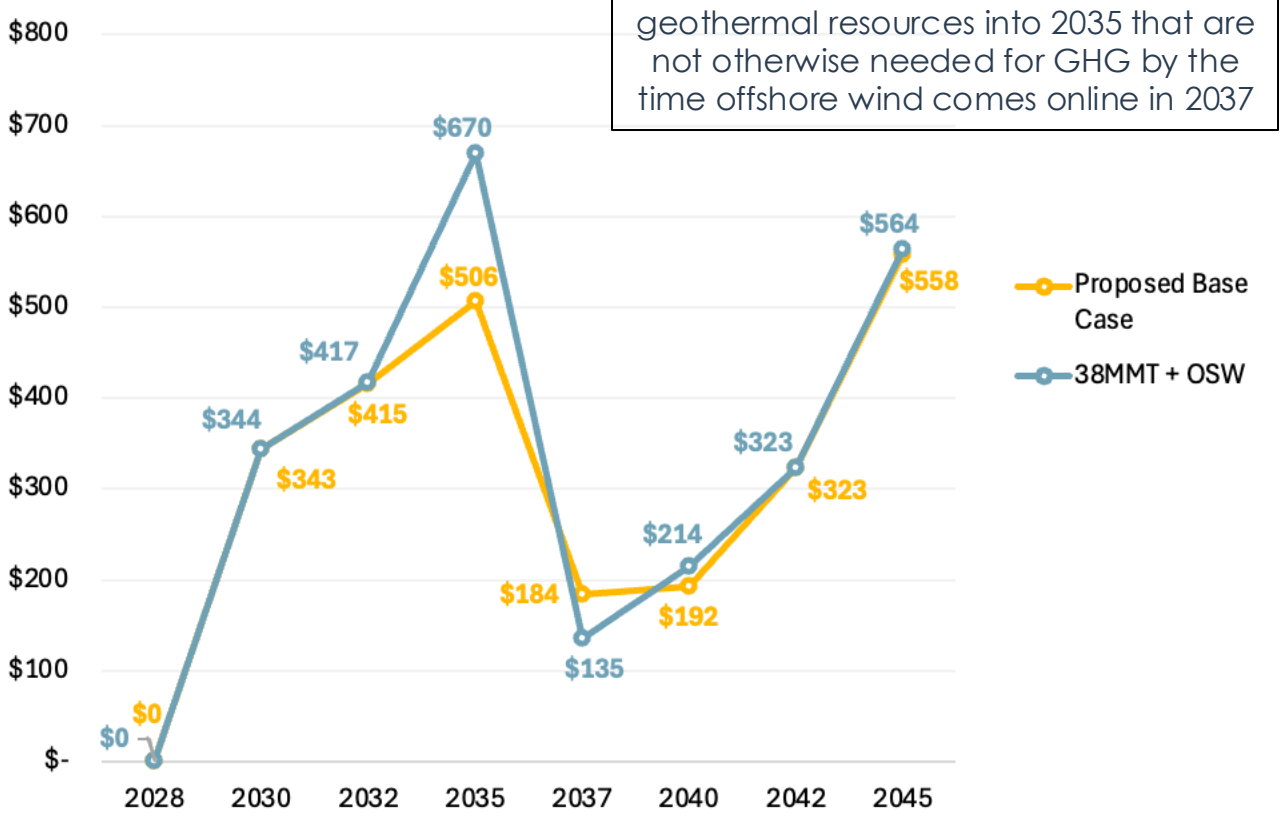
Planning Reserve Margin Shadow Price ($/kW-yr)



Very high shadow price in 2040 persists, driven by the 15-year lead time (2042) for most out-of-state wind

PRM does not bind before 2040, as the GHG target drives builds contributing to an over-reliable system

GHG Target Shadow Price ($/ton CO_2)

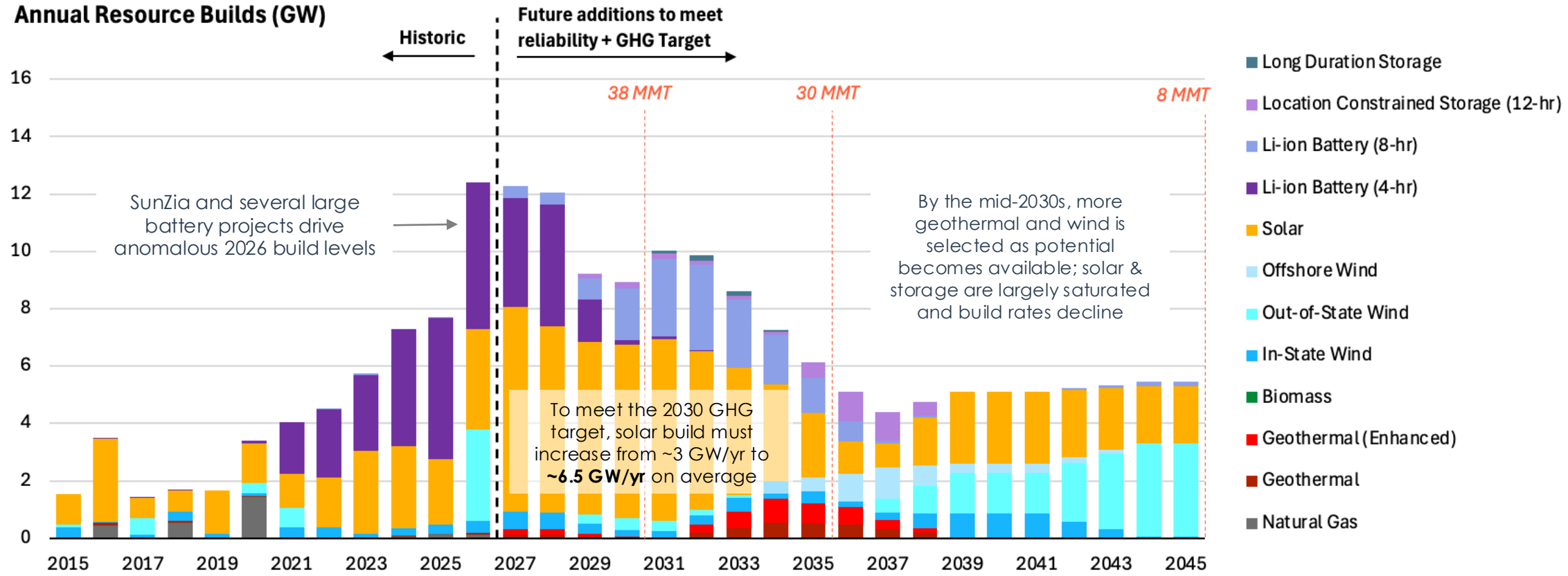


GHG shadow prices are higher in 2035, as RESOLVE must accelerate wind and geothermal resources into 2035 that are not otherwise needed for GHG by the time offshore wind comes online in 2037

38MMT + OSW

Resource Build Rate

- Offshore wind does not affect near-term build rates, which are driven by the 2030 and 2035 GHG targets, and limited geothermal and wind availability through the mid-2030s

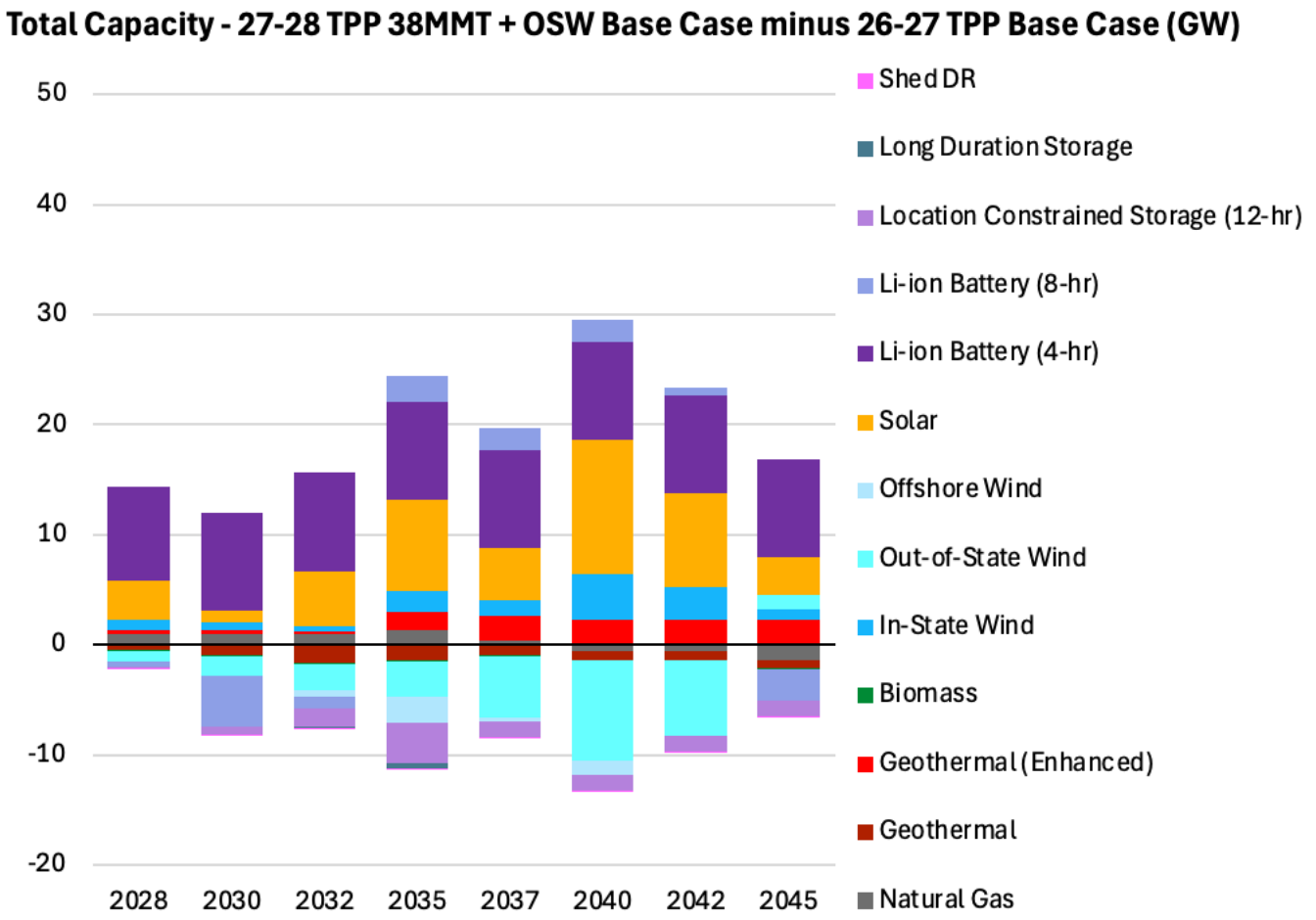


Builds are interpolated and smoothed between model years; 2026 build is a combination of resources already online this year and resources with high-confidence online dates later in the year provided by CAISO

38MMT + OSW

Total Capacity Comparison with 26-27 TPP Base Case

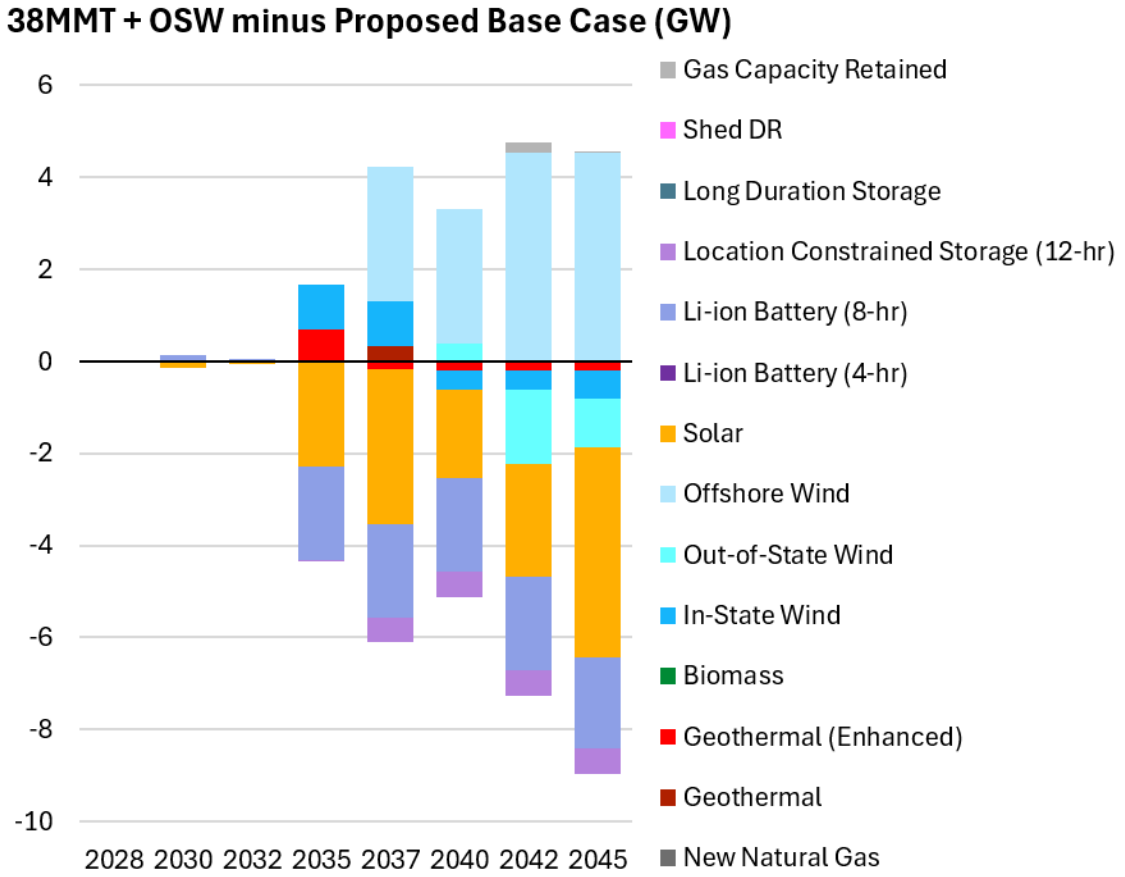
- Similar to the recommended base case, Differences from the 26-27 TPP are driven by:
  - **Delayed availability of long lead time resources** (geothermal, wind) in the near-term, particularly out-of-state wind
  - Significant additions of 4-hr battery in the baseline, reflecting recent LSE contracting
  - Smaller impacts from other input updates (new solar profiles with lower cf, incorporation of forced outage rates for SERVM-RESOLVE calibration)
- A net increase in geothermal (additional EGS) is selected by2037
- By 2045, differences in onshore wind builds with 26-27 TPP are relatively small



26-27 TPP results interpolated between model years where necessary; natural gas differences include both utility-scale and CHP

Total Capacity Comparison with Recommended Base Case

- Near term builds are similar through 2032
- Forced-in offshore wind primarily displaces solar, storage, and out-of-state wind
- Some onshore wind and geothermal slightly accelerated to 2035 and 2037, displacing solar and storage while providing diversity benefits and GHG-free energy in the years before the offshore wind projects are brought online



System Cost Comparison with Recommended Base Case

RESOLVE-Optimized Costs[1] ($MM in 2024$)

Case	2028	2030	2032	2035	2037	2040	2042	2045	NPV
Recommended Base Case	$13,316	$16,667	$20,080	$25,190	$27,746	$30,420	$32,378	$40,287	*$421,454*
38MMT + OSW	$13,329 +13 (0.1%)	$16,659 -8 (0.1%)	$20,107 +27 (0.1%)	$25,281 +92 (0.4%)	$29,338 +1,592 (5.7%)	$31,867 +1,447 (4.8%)	$34,481 +2,103 (6.5%)	$42,561 +2,274 (5.6%)	*$439,108* *+17,654* *(4.2%)*

- With offshore wind forced into the portfolio, costs are higher; reaching ~$2 Billion/yr starting in 2042

1 RESOLVE-optimized costs account for ~15-30% of total system costs (increasing over time); non-optimized baseline generation, transmission, and distribution make up the rest of the revenue requirement

38MMT + OSW

Selected Builds by Study Area (2037)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	310	-	-	-	-
PGE_Fresno	-	-	-	6,539	1,176	4,616	-	-	-	-	-	269
PGE_GBA	247	-	-	2,566	344	59	-	-	-	-	-	312
PGE_Kern	183	-	2,924	9,418	345	105	-	-	-	-	-	3
PGE_NGBA	1,832	-	-	1,590	393	-	-	668	302	228	-	-
PGE_Northeast_CA	-	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	5,508	493	-	-	-	-	-	-	-
SCE_Eastern	467	-	-	8,534	240	85	365	32	-	-	-	-
SCE_EOP	255	1,500	-	8,168	593	931	500	-	783	-	2,988	-
SCE_Metro	-	-	-	502	1,405	7,569	-	-	-	-	-	-
SCE_NOL	-	-	-	491	-	6	486	-	-	-	-	-
SCE_Northern	700	-	-	4,079	590	1,201	2,756	-	-	-	-	-
SDGE_Arizona	-	-	-	-	-	328	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	396	-	-	448	39	461	78	529	-	-	-	-

Plus 489 MW total 24-hr storage in SCE and 11 MW 100-hr storage in PGE

Selected Builds by Study Area (2037) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	286	-	-	-	-
PGE_Fresno	-	-	-	- 1,298	-	- 1,512	-	-	-	-	-	-
PGE_GBA	-	-	-	397	-	-	-	-	-	-	-	- 253
PGE_Kern	181	-	2,924	- 289	-	- 307	- 47	-	-	-	-	- 2
PGE_NGBA	870	-	-	- 28	-	-	-	25	14	- 38	- 297	-
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Eastern	-	-	-	-	-	-	-	-	-	-	-	-
SCE_EOP	-	-	-	- 1,730	-	327	-	-	-	-	660	-
SCE_Metro	-	-	-	-	-	-	-	-	-	-	-	-
SCE_NOL	-	-	-	- 31	-	-	-	-	-	-	-	-
SCE_Northern	-	-	-	890	-	- 545	- 461	-	-	-	-	-
SDGE_Arizona	-	-	-	- 1,075	-	-	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	- 60	-	-	- 195	-	-	- 22	-	-	- 238	-	-

Incremental in-state wind concentrated PG&E NGBA and Kern

Decreases in solar concentrated in SCE EOP, PG&E Fresno, and Arizona

38MMT + OSW

Selected Builds by Study Area (2042)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	310	-	-	-	-
PGE_Fresno	-	-	-	6,539	1,176	4,616	-	-	-	-	-	269
PGE_GBA	247	933	-	2,566	344	59	-	-	-	-	-	312
PGE_Kern	183	-	2,924	9,418	345	105	-	-	-	-	-	3
PGE_NGBA	1,893	-	1,607	5,017	393	-	-	668	498	228	-	-
PGE_Northeast_CA	1,015	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	5,508	493	-	-	-	-	-	-	-
SCE_Eastern	646	-	-	8,534	240	85	365	32	-	-	-	-
SCE_EOP	255	6,391	-	11,432	593	931	500	-	783	-	2,988	-
SCE_Metro	-	-	-	544	1,405	7,569	-	-	-	-	-	-
SCE_NOL	12	-	-	491	-	6	486	-	-	-	-	-
SCE_Northern	1,792	-	-	5,975	590	1,201	2,756	-	-	-	-	-
SDGE_Arizona	-	-	-	3,781	-	328	-	-	-	-	-	-
SDGE_Baja_California	1,958	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	923	373	-	556	39	461	78	529	-	-	-	-

Plus 489 MW total 24-hr storage in SCE and 11 MW 100-hr storage in PGE

Selected Builds by Study Area (2042) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	- 16	286	-	-	-	-
PGE_Fresno	-	-	-	- 1,298	-	- 1,512	-	-	-	-	-	-
PGE_GBA	-	- 18	-	397	-	-	-	-	-	-	-	- 253
PGE_Kern	- 62	-	2,924	- 312	-	- 307	- 47	-	-	-	-	- 2
PGE_NGBA	-	-	1,607	633	-	-	-	25	- 310	- 64	- 297	-
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Eastern	179	-	-	-	-	-	-	-	-	-	-	-
SCE_EOP	-	- 1,968	-	- 2,008	-	327	-	-	-	-	660	-
SCE_Metro	-	-	-	-	-	-	-	-	-	-	-	-
SCE_NOL	-	-	-	- 31	-	-	-	-	-	-	-	-
SCE_Northern	- 546	-	-	356	-	- 545	- 461	-	-	-	-	-
SDGE_Arizona	-	-	-	10	-	-	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	-	373	-	- 195	-	-	- 22	-	-	-	-	-

Decreases for wind concentrated in SCE Northern (in-state) and New Mexico (out-of-state)

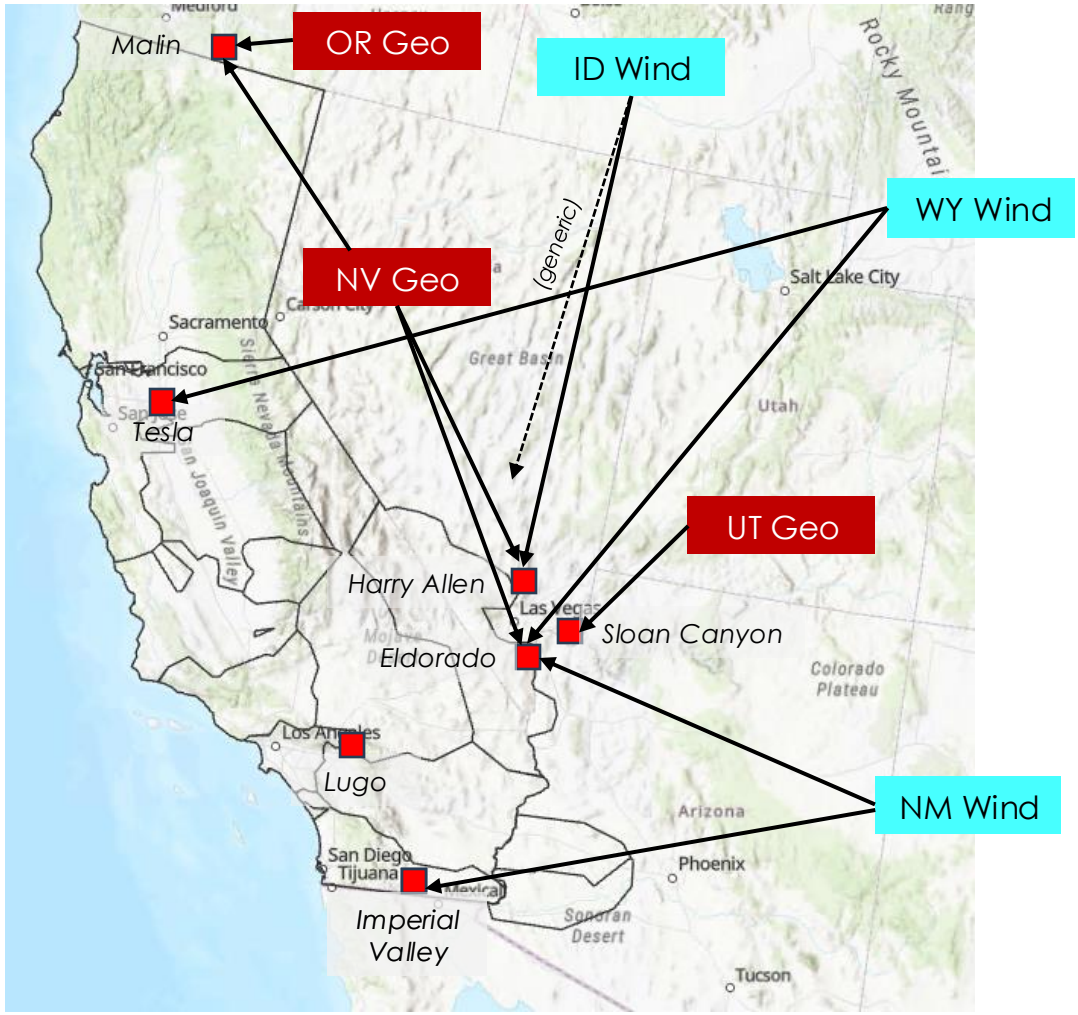
Decreases in solar concentrated in SCE EOP and PG&E Fresno

38MMT + OSW

Out-of-State Resource Tie-in Locations

- **Multiple points of interconnection accommodate either wind or geothermal**; allocating TPD at these locations which can be reallocated may mitigate risk if either wind or geothermal projects do not materialize
- High West, and TransWest all utilized by RESOLVE; primarily HVDC transmission lines are used for incremental New Mexico and Wyoming wind
- **Several out-of-state resources compete for Tx headroom in the Harry Allen/Sloan Canyon/Eldorado area**; additional selection of Nevada geothermal at Harry Allen leads to reallocation of Idaho Wind (SWIP-N) capacity to generic substations by 2042
- Wyoming **wind delivered north of Path 15/26 (Tesla) is selected at a higher transmission cost** compared to other transmission paths delivering south of Path 15/26
- Several GW of additional out-of-state wind is selected by RESOLVE in 2045, interconnecting at Lugo and Eldorado

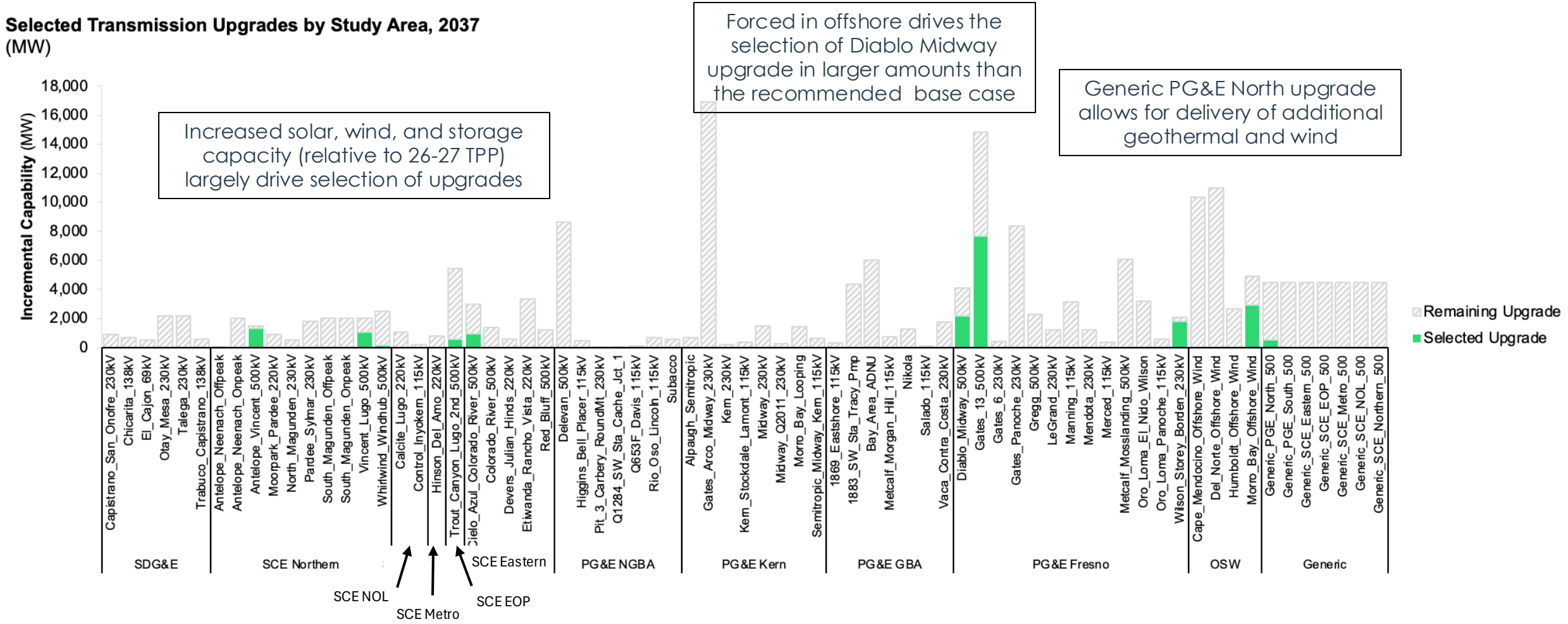
Major Transmission Pathways Selected by 2042



Officially selected transmission upgrades are determined by the CAISO Transmission Plan; Selections of less than 100 MW not shown

38MMT + OSW

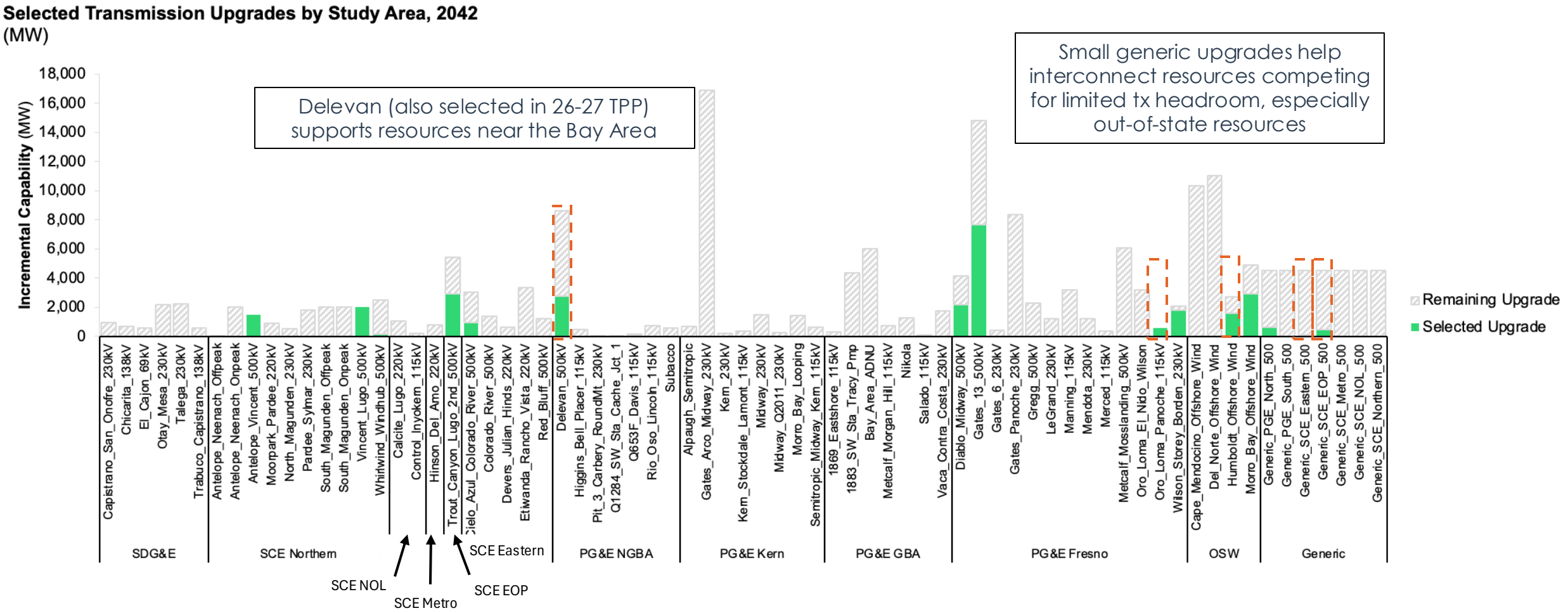
RESOLVE-Selected Transmission Upgrades (2037)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

38MMT + OSW

RESOLVE-Selected Transmission Upgrades (2042)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case

- Offshore wind procurement avoids very small amounts of alternative transmission upgrades by 2037

Constraint	Upgrade	Study Area	Cost ($/kW-yr)	38 MMT + OSW	Recommended Base Case	38MMT +OSW Case MW	Recommended Base Case MW
Morro Bay Offshore Wind Constraint	Morro Bay Offshore Wind	Offshore Wind	$2.09	✓	✗	2924	0
Antelope-Neenach Area Deliverability Constraint	Antelope Neenach Onpeak	SCE Northern	$4.64	✗	✓	0	437
Windhub Area Deliverability Constraint	Whirlwind Windhub 500kV	SCE Northern	$22.69	✗	✓	0	190

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case

- **Offshore wind procurement avoids very small amounts of alternative transmission upgrades**, driving additional net cost of ~$2.1Billion (~200 Million/year)

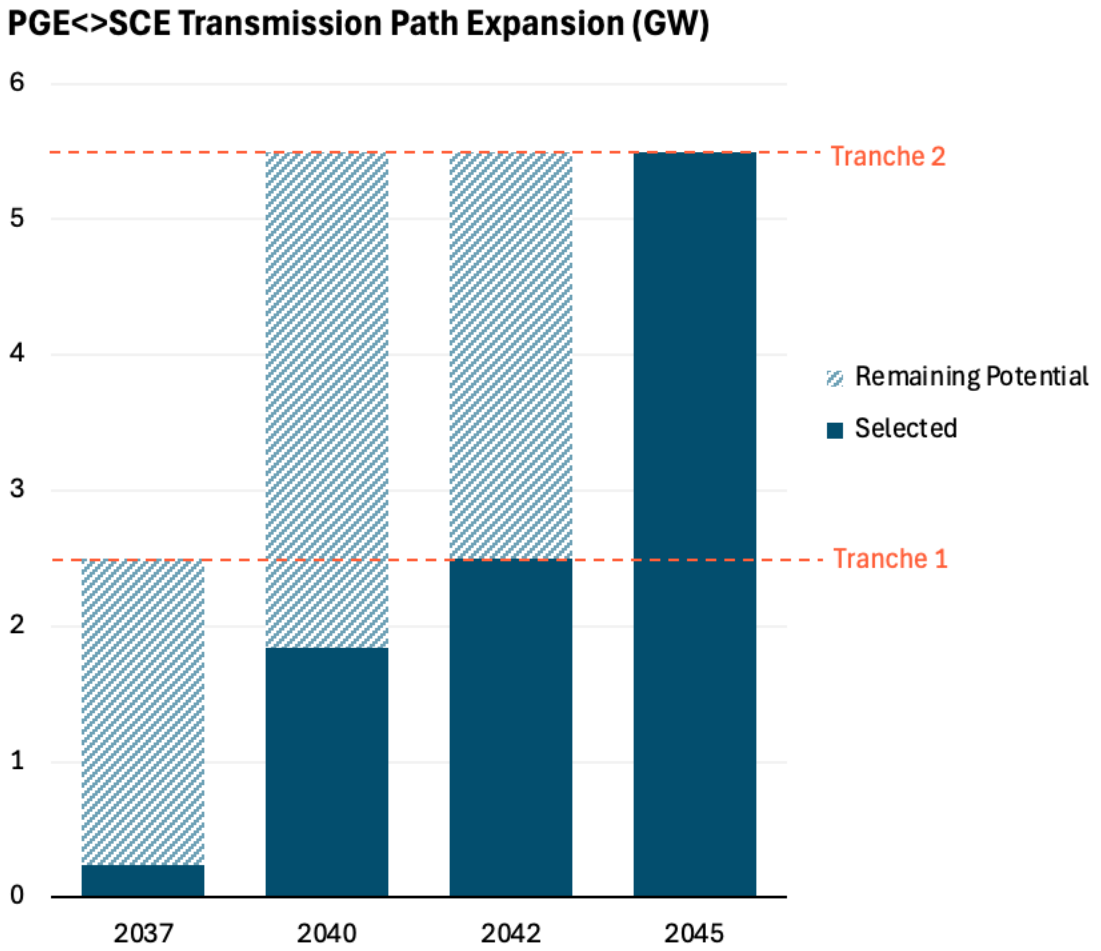
Constraint	Upgrade	Study Area	Cost ($/kW-yr)	38 MMT + OSW	Recommended Base Case	38MMT +OSW Case MW	Recommended Base Case MW
	Generic SCE Eastern 500		$61.80	✓	✗	86	0
Humboldt Bay Offshore Wind Constraint	Humboldt Offshore Wind	Offshore Wind	$120.06	✓	✗	1607	0
Morro Bay Offshore Wind Constraint	Morro Bay Offshore Wind	Offshore Wind	$2.09	✓	✗	2924	0
Antelope-Neenach Area Deliverability Constraint	Antelope Neenach Onpeak	SCE Northern	$4.64	✗	✓	0	437
	Generic PGE South 500		$41.20	✗	✓	0	125
Metcalf-Mosslanding 500kV	Metcalf Mosslanding 500kV	PG&E Fresno	$3.05	✗	✓	0	190

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

38MMT + OSW

PG&E-SCE Transmission Path Expansion

- Path 26/Path 15 expansion(s) are selected primarily to increase import capacity into PG&E
- Path expansion is selected by RESOLVE as soon as it becomes available in 2037, with the full first tranche built by 2042
  - Availability of offshore wind directly connecting to PG&E reduces the need for path expansion in 2037, compared to the recommended base case
- The second tranche selected in full by 2045, more than doubling the transmission capacity



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE Results:
30 MMT + OSW Base Case

30 MMT by 2030, 25 MMT by 2035, 4.5 GW Offshore Wind

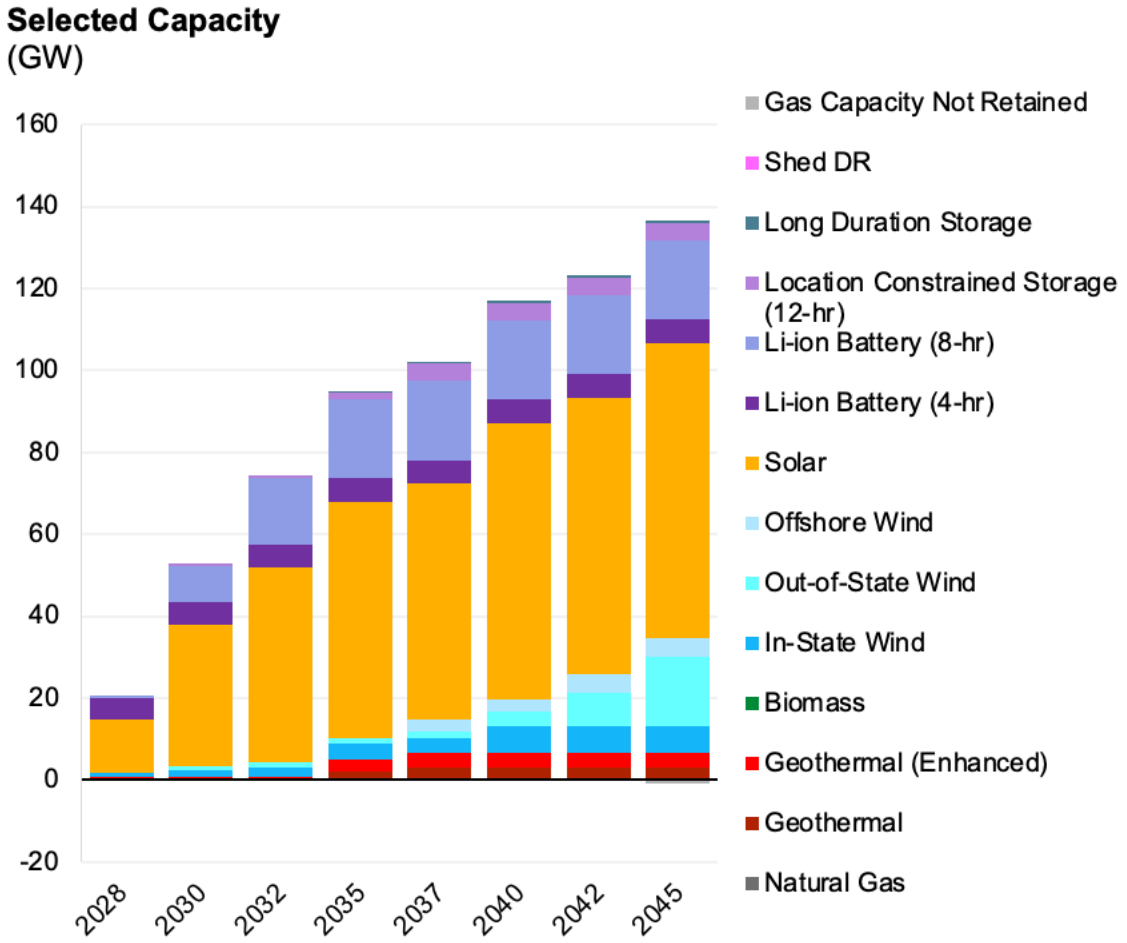
30 MMT + OSW Case Overview

- Relative to the Recommended 27-28 TPP Base Case, the 30 MMT + OSW Case:
  - Includes partial buildout of the maximum procurement volumes considered in the Commission's need determination analysis pursuant to D.24-08-064, related to Assembly Bill (AB) 1373. However, unlike the recommended base case which excluded offshore wind, **4.5GW of forced-in offshore wind is included.**
  - **Maintains a more stringent GHG target: 30 MMT in 2030, and 25 MMT in 2035**
- All other assumptions are the same as the recommended base case

30 MMT + OSW

Portfolio Summary

- Geothermal (both conventional and enhanced) is selected as it becomes available for reliability value and high-capacity factor, GHG-free energy
  - Most geothermal potential is selected by 2037 to capture tax credits before they expire
- Relatively small amounts of onshore wind are selected by the mid-2030s, then scale up rapidly in the 2040s
  - Transmission constraints limit in-state wind selection in the mid-2030s
  - Most out-of-state wind is not available until 2042 due to long transmission lead times required for deliverability
- Solar and storage (especially 8-hr) are the scalable resources to meet GHG reduction and reliability, especially through 2035
  - Solar and storage are heavily saturated by 2035 and little is built in the following ten years
- No offshore wind or multi-day storage are selected above forced-in partial AB1373 amounts; RESOLVE exceeds AB1373 amounts of geothermal and location-constrained (12-hr) storage
- Almost all gas capacity is retained (small amounts with high fixed costs not retained in the 2040s)



30 MMT + OSW

Selected Builds

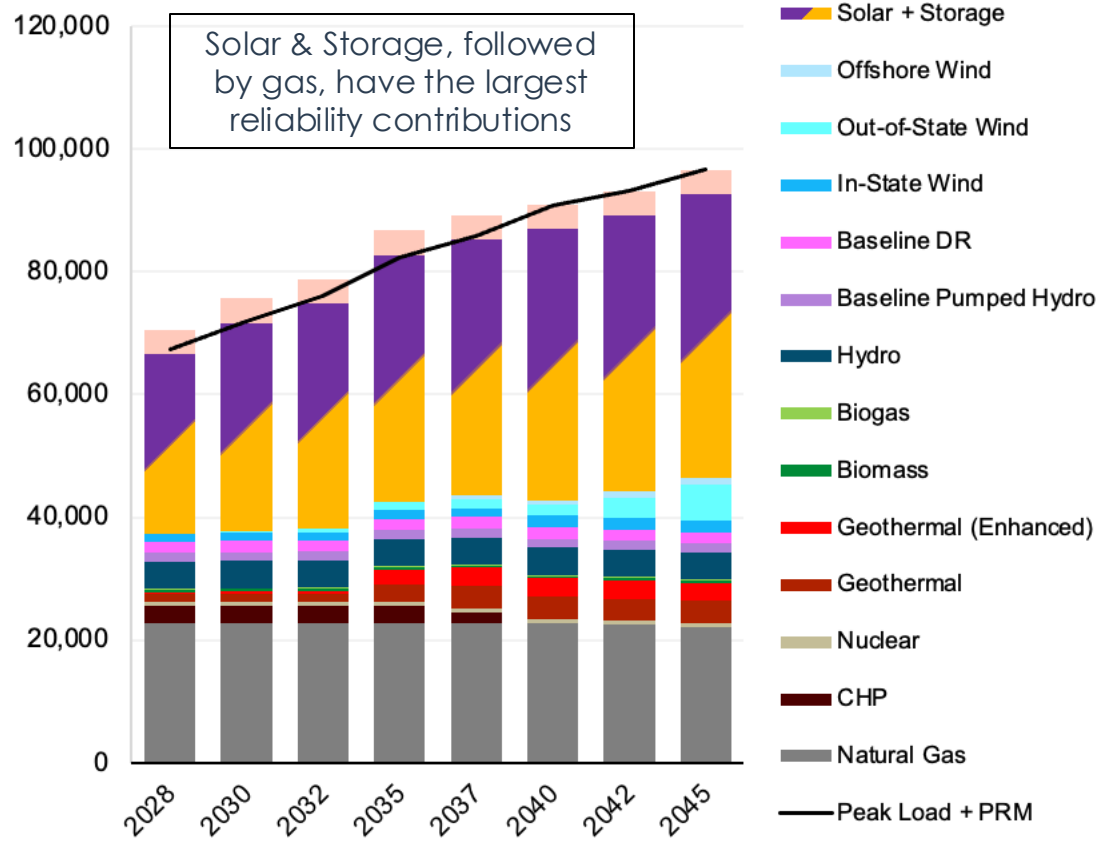
Resource Type (cumulative GW)	2028	2030	2032	2035	2037	2040	2042	2045
Natural Gas	-	-	-	-	-	-	-	-
Geothermal	0.2	0.3	0.3	1.9	2.9	2.9	2.9	2.9
Geothermal (Enhanced)	0.4	0.4	0.5	3.1	3.6	3.6	3.6	3.6
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-State Wind	1.2	1.7	2.1	3.8	3.8	6.6	6.6	6.6
Out-of-State Wind	-	0.9	1.5	1.5	1.5	3.7	8.2	17.0
Offshore Wind	-	-	-	-	2.9	2.9	4.5	4.5
Solar	13.0	34.5	47.6	57.7	57.7	67.5	67.5	72.1
Li-ion Battery (4-hr)	5.1	5.5	5.6	5.6	5.6	5.6	5.6	5.6
Li-ion Battery (8-hr)	0.8	9.0	16.0	19.2	19.4	19.4	19.4	19.4
Location Constrained Storage (12-hr)	-	0.5	0.9	1.8	4.2	4.2	4.2	4.2
Generic Storage (12-hr)	-	-	-	-	-	-	-	-
Generic Storage (24-hr)	-	-	-	-	-	-	-	-
Generic Storage (100-hr)	-	-	-	0.5	0.5	0.5	0.5	0.5
Shed DR	-	-	-	-	-	-	-	-
Gas Capacity Not Retained	-	-	-	-	-	-	*(0.3)*	*(0.8)*

Represents new resources (nameplate GW), both LSE planned and RESOLVE selected, above the IRP modeling resource baseline; Note: RESOLVE build exceeds AB 1373 amounts of geothermal and location-constrained (12-hr) storage

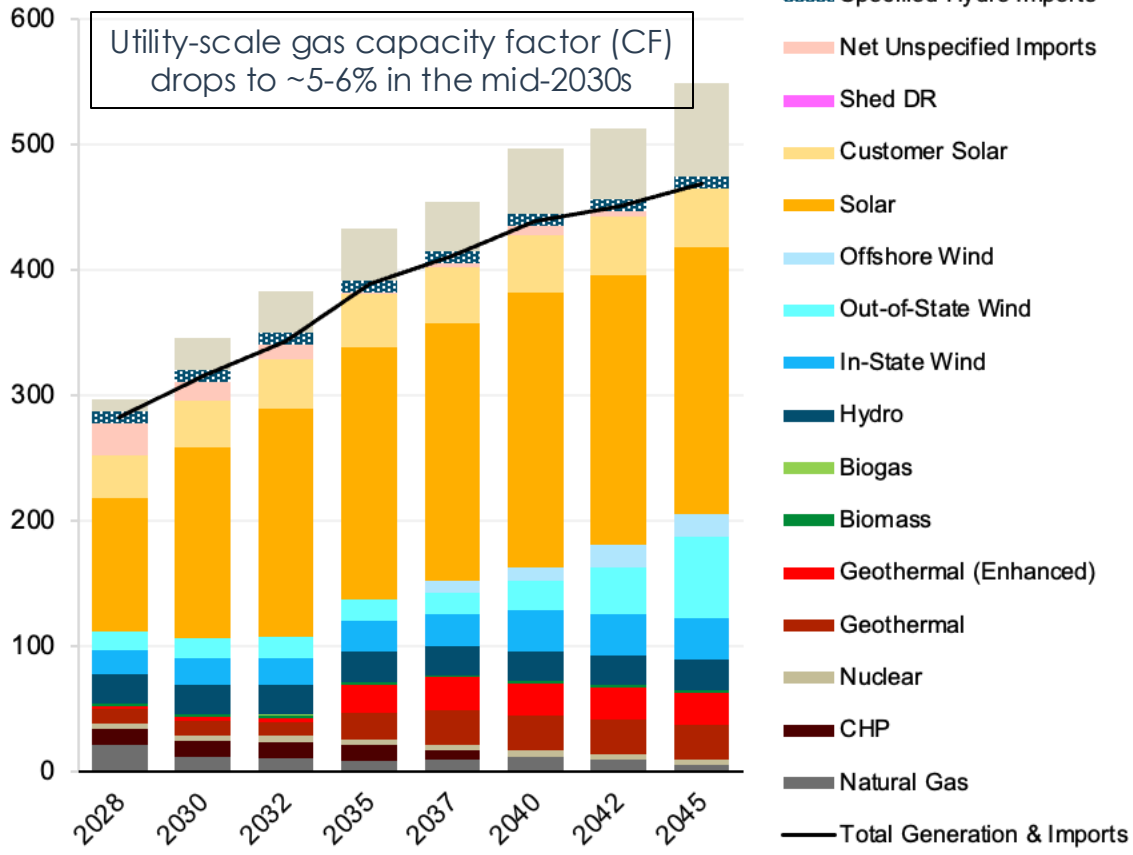
30 MMT + OSW

Reliability and Energy Mix

PCAP PRM Contribution
(ELCC MW)



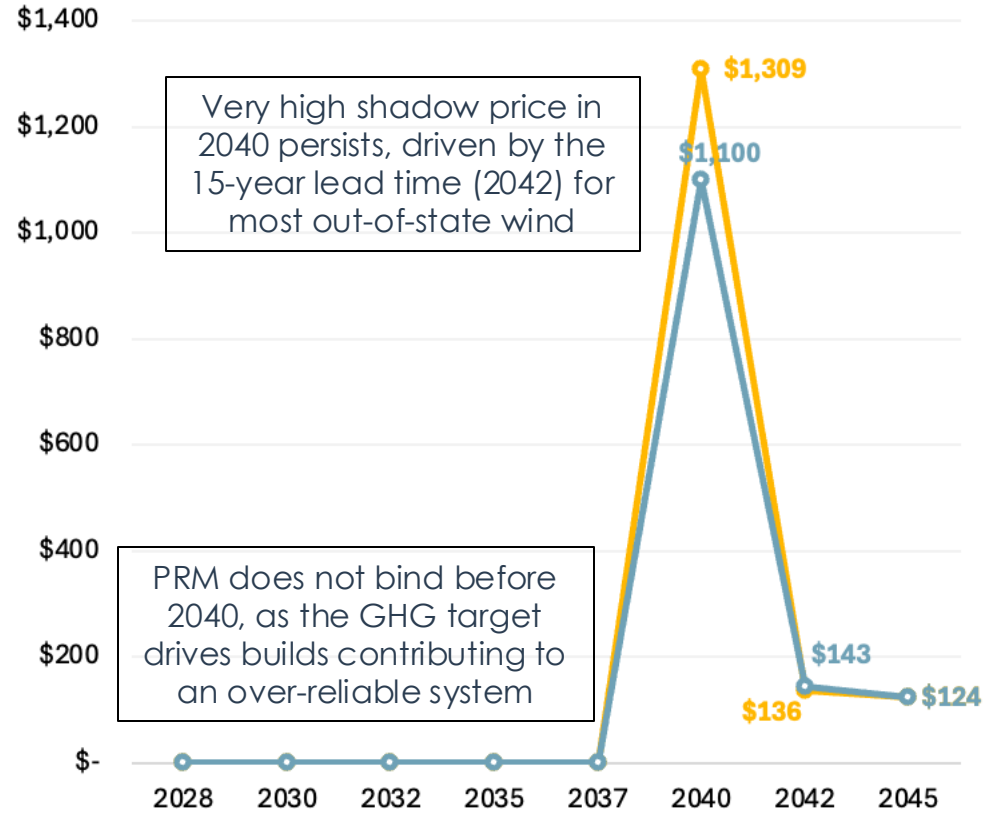
Annual Generation and Net Imports
(TWh)



Planning Reserve Margin (PRM) and GHG Constraints

- Shadow prices represent the cost of meeting a constraint, i.e. the cost of the last kW of firm capacity or the last ton of GHG emissions reduction

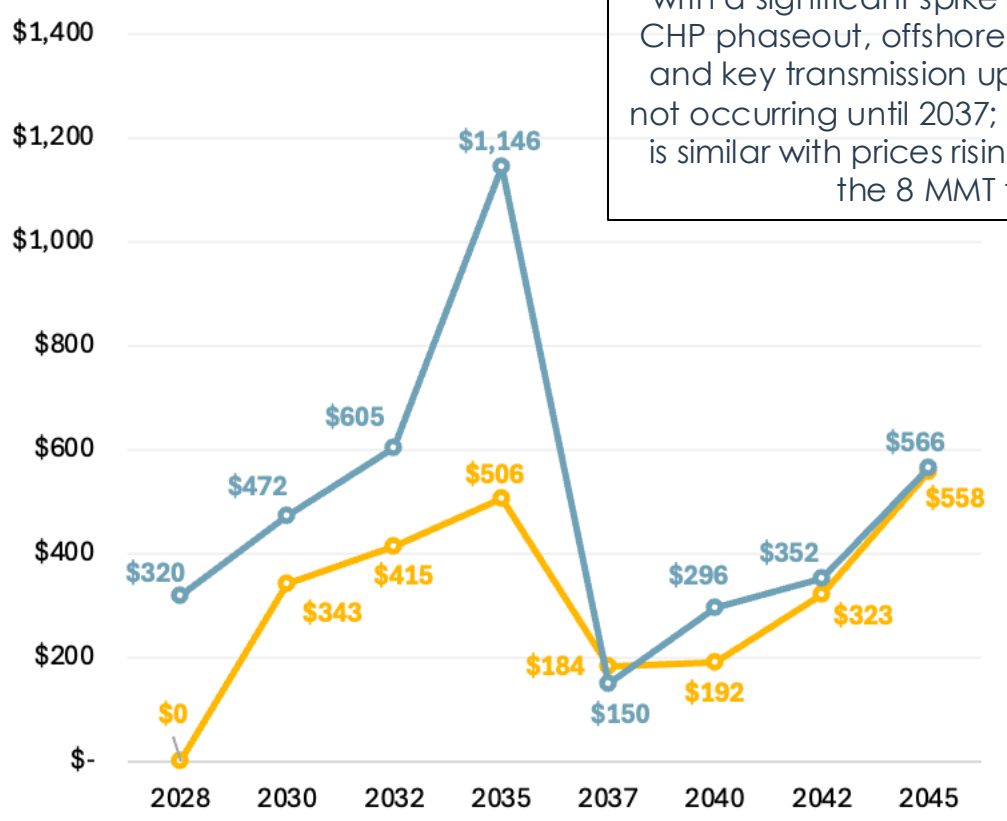
Planning Reserve Margin Shadow Price ($/kW-yr)



Very high shadow price in 2040 persists, driven by the 15-year lead time (2042) for most out-of-state wind

PRM does not bind before 2040, as the GHG target drives builds contributing to an over-reliable system

GHG Target Shadow Price ($/ton CO_2)

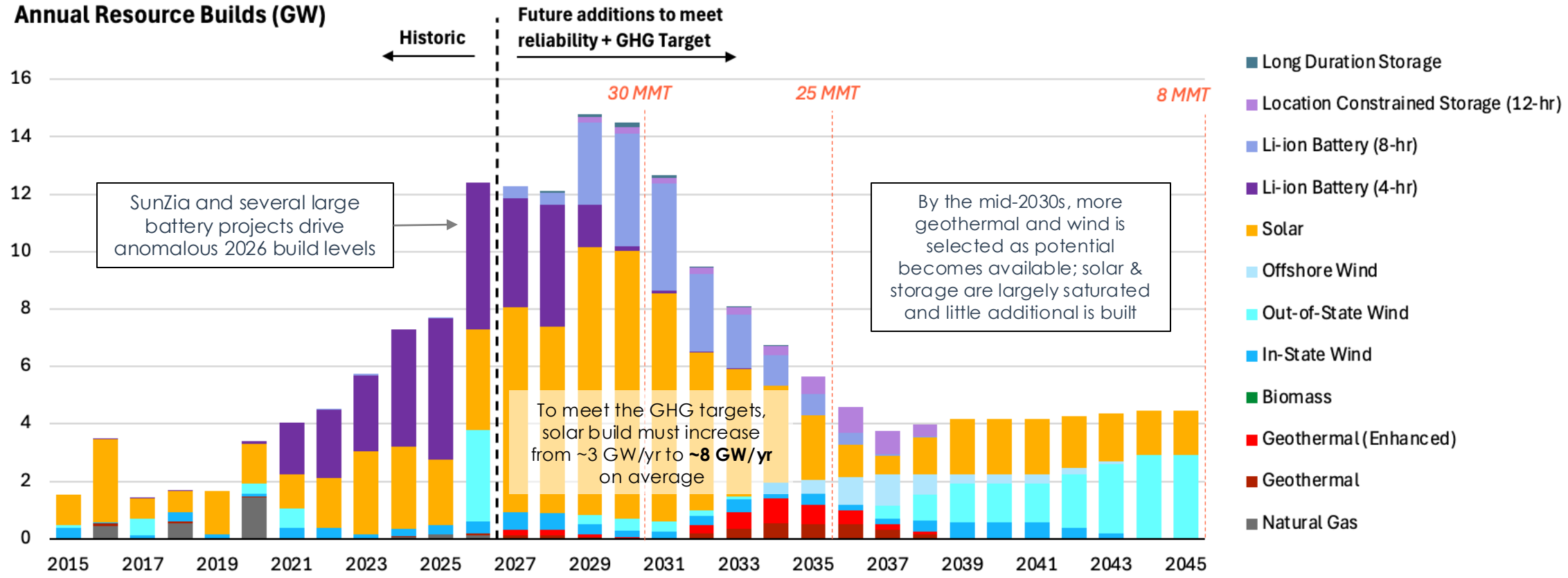


Incremental capacity needed to meet 30MMT target leads to higher GHG prices; with a significant spike in 2035 due to the CHP phaseout, offshore wind deployment, and key transmission upgrade availability not occurring until 2037; post-2035 the trend is similar with prices rising by 2045 to meet the 8 MMT target

30 MMT + OSW

Resource Build Rate

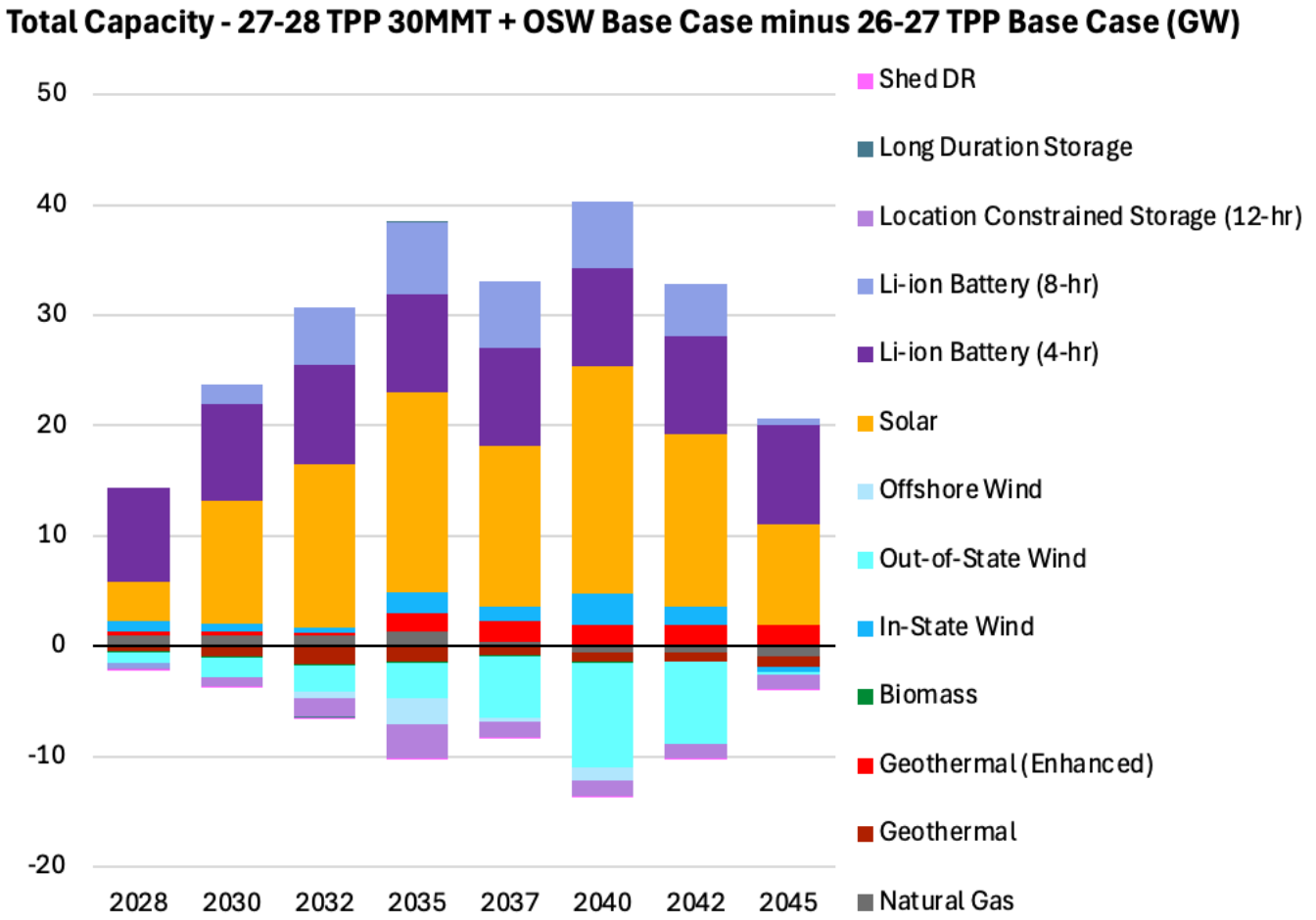
- ***Aggressive 2030 and 2035 GHG targets, combined with limited geothermal and wind availability through the mid-2030s, drive extreme solar and storage build rates in the near-term***



Builds are interpolated and smoothed between model years; 2026 build is a combination of resources already online this year and resources with high-confidence online dates later in the year provided by CAISO

Total Capacity Comparison with 26-27 TPP Base Case

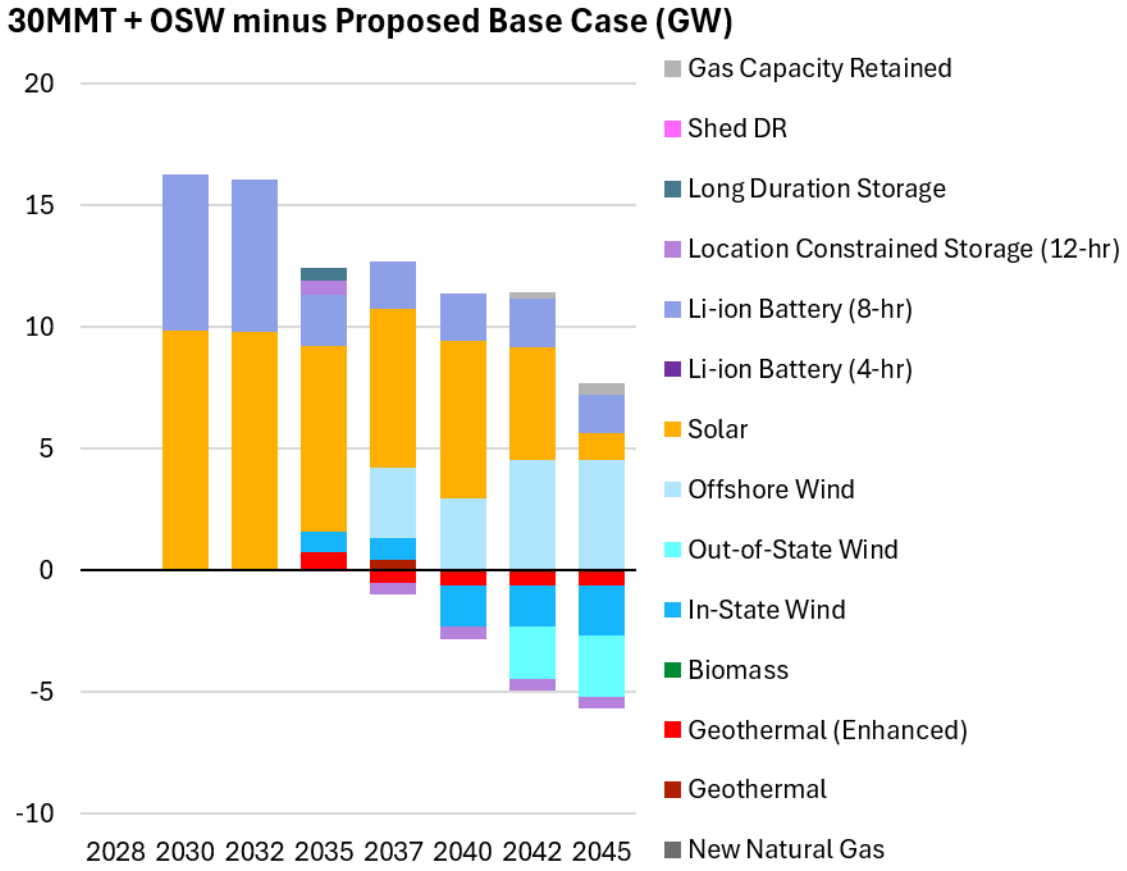
- **With the most recent inputs, meeting the GHG target requires an additional ~30 GW resources on net by 2035 compared to the 26-27 TPP, primarily solar and storage**



26-27 TPP results interpolated between model years where necessary; natural gas differences include both utility-scale and CHP

Total Capacity Comparison with Recommended Base Case

- To meet a 30MMT GHG target, ~10GW of additional solar and ~6GW of storage builds are required in 2030 and 2032
  - Additional solar & storage builds compared to the recommended base case persist through 2045
- Some onshore wind and geothermal is accelerated to 2035 and 2037
- However, by 2045 ~4.5 GW of onshore wind, plus small amounts of EGS, is displaced by offshore wind
- More gas capacity is retained by 2045



30 MMT + OSW

System Cost Comparison with Recommended Base Case

RESOLVE-Optimized Costs ($MM in 2024$)

Case	2028	2030	2032	2035	2037	2040	2042	2045	NPV
Recommended Base Case	$13,316	$16,667	$20,080	$25,190	$27,746	$30,420	$32,378	$40,287	*$421,454*
30MMT + OSW	$13,578 +262 (2.0%)	$18,031 +1,363 (8.2%)	$21,860 +1,780 (8.9%)	$27,335 +2,146 (8.5%)	$30,685 +2,939 (10.6%)	$33,005 +2,585 (8.5%)	$35,493 +3,115 (9.6%)	$43,437 +3,150 (7.8%)	*$456,005* *+34,552* *(8.2%)*

- With the 30MMT GHG target and forced-in offshore wind, costs are significantly higher; reaching ~$3 Billion/yr starting in 2042 (~$1 Billion/yr higher than the 38 MMT + OSW case)

RESOLVE-optimized costs account for ~15-30% of total system costs (increasing over time); non-optimized baseline generation, transmission, and distribution make up the rest of the revenue requirement

30MMT + OSW

Selected Builds by Study Area (2037)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	310	-	-	-	-
PGE_Fresno	-	-	-	8,391	1,176	7,128	-	-	-	-	-	265
PGE_GBA	247	-	-	3,943	344	59	400	-	-	-	-	103
PGE_Kern	3	-	2,924	9,713	345	485	-	-	-	-	-	-
PGE_NGBA	1,632	-	-	4,715	393	-	-	668	498	32	-	-
PGE_Northeast_CA	-	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	7,784	493	-	-	-	-	-	-	-
SCE_Eastern	467	-	-	8,986	240	85	365	32	-	-	-	-
SCE_EOP	255	1,500	-	7,967	593	1,608	177	-	703	-	3,057	-
SCE_Metro	-	-	-	502	1,405	8,032	-	-	-	-	-	-
SCE_NOL	-	-	-	931	-	6	488	-	-	-	-	-
SCE_Northern	700	-	-	4,281	590	1,330	2,507	-	-	-	-	-
SDGE_Arizona	-	-	-	-	-	184	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	456	-	-	509	39	461	296	529	-	-	-	-

Plus 489 MW total 100-hr storage in SCE and 11 MW in PG&E

Selected Builds by Study Area (2037) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	286	-	-	-	-
PGE_Fresno	-	-	-	553	-	999	-	-	-	-	-	- 4
PGE_GBA	-	-	-	1,774	-	-	400	-	-	-	-	- 462
PGE_Kern	-	-	2,924	5	-	74	- 47	-	-	-	-	- 5
PGE_NGBA	870	-	-	3,097	-	-	-	25	210	- 234	- 297	-
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	2,277	-	-	-	-	-	-	-	-
SCE_Eastern	-	-	-	451	-	-	-	-	-	-	-	-
SCE_EOP	-	-	-	- 1,931	-	1,004	- 323	-	- 80	-	728	-
SCE_Metro	-	-	-	-	-	463	-	-	-	-	-	-
SCE_NOL	-	-	-	409	-	-	2	-	-	-	-	-
SCE_Northern	-	-	-	1,091	-	- 417	- 710	-	-	-	-	-
SDGE_Arizona	-	-	-	- 1,075	-	- 144	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	-	-	-	- 134	-	-	- 22	-	-	- 238	-	-

Incremental in-state wind concentrated PG&E NGBA

Significant shifts in solar between locations, with most incremental sited in PG&E

Shift in Location-Constrained Storage locations

Increase in Nevada EGS selection

30 MMT + OSW

Selected Builds by Study Area (2042)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	310	-	-	-	-
PGE_Fresno	-	-	-	8,391	1,176	7,128	-	-	-	-	-	265
PGE_GBA	247	490	2,924	3,943	344	59	400	-	-	-	-	103
PGE_Kern	3	-	1,607	9,713	345	485	-	-	-	-	-	-
PGE_NGBA	1,893	-	-	6,993	393	-	-	668	498	32	-	-
PGE_Northeast_CA	1,015	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	7,784	493	-	-	-	-	-	-	-
SCE_Eastern	467	-	-	8,986	240	85	365	32	-	-	-	-
SCE_EOP	255	6,664	-	10,085	593	1,608	177	-	703	-	3,057	-
SCE_Metro	-	-	-	502	1,405	8,032	-	-	-	-	-	-
SCE_NOL	-	-	-	931	-	6	488	-	-	-	-	-
SCE_Northern	893	-	-	6,331	590	1,330	2,507	-	-	-	-	-
SDGE_Arizona	-	-	-	3,292	-	185	-	-	-	-	-	-
SDGE_Baja_California	1,958	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	923	47	-	509	39	461	296	529	-	-	-	-

Plus 489 MW total 100-hr storage in SCE and 11 MW in PG&E

Selected Builds by Study Area (2042) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	- 16	286	-	-	-	-
PGE_Fresno	-	-	-	553	-	999	-	-	-	-	-	- 4
PGE_GBA	-	- 461	-	1,774	-	-	400	-	-	-	-	- 462
PGE_Kern	- 242	-	2,924	- 17	-	74	- 47	-	-	-	-	- 5
PGE_NGBA	-	-	1,607	2,610	-	-	-	25	210	- 234	- 297	-
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	2,277	-	-	-	-	-	-	-	-
SCE_Eastern	-	-	-	451	-	-	-	-	-	-	-	-
SCE_EOP	-	- 1,695	-	- 3,355	-	1,004	- 323	-	- 80	-	728	-
SCE_Metro	-	-	-	- 42	-	463	-	-	-	-	-	-
SCE_NOL	- 12	-	-	409	-	-	2	-	-	-	-	-
SCE_Northern	- 1,445	-	-	712	-	- 417	- 710	-	-	-	-	-
SDGE_Arizona	-	-	-	- 479	-	- 144	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	-	47	-	- 242	-	-	197	-	-	- 238	-	-

Decreases for wind concentrated in SCE Northern (in-state) and Wyoming (out-of-state)

Significant shifts in solar between locations, with most incremental sited in PG&E

Shift in Location-Constrained Storage locations

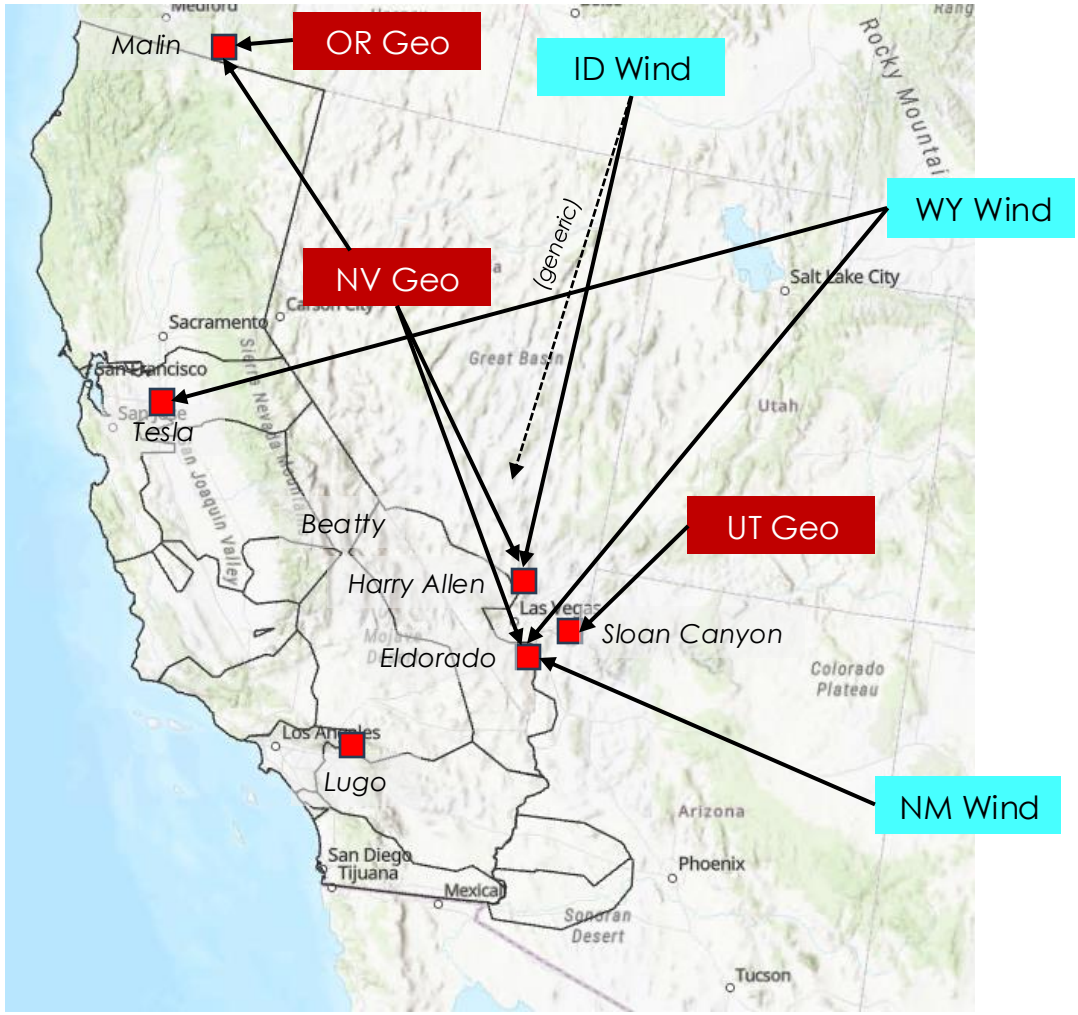
Increase in Nevada EGS selection

30 MMT + OSW

Out-of-State Resource Tie-in Locations

- **Multiple points of interconnection accommodate either wind or geothermal**; allocating TPD at these locations which can be reallocated may mitigate risk if either wind or geothermal projects do not materialize
- High West, and TransWest all utilized by RESOLVE; primarily HVDC transmission lines are used for incremental New Mexico and Wyoming wind
- **Several out-of-state resources compete for tx headroom in the Harry Allen/Sloan Canyon/Eldorado area**; additional selection of Nevada geothermal at Harry Allen leads to reallocation of Idaho Wind (SWIP-N) capacity to generic substations by 2042
- Wyoming **wind delivered north of Path 15/26 (Tesla) is selected at a higher transmission cost** compared to other transmission paths delivering south of Path 15/26, though less than the recommended base case
- Several GW of additional out-of-state wind is selected by RESOLVE in 2045, interconnecting at Lugo and Eldorado

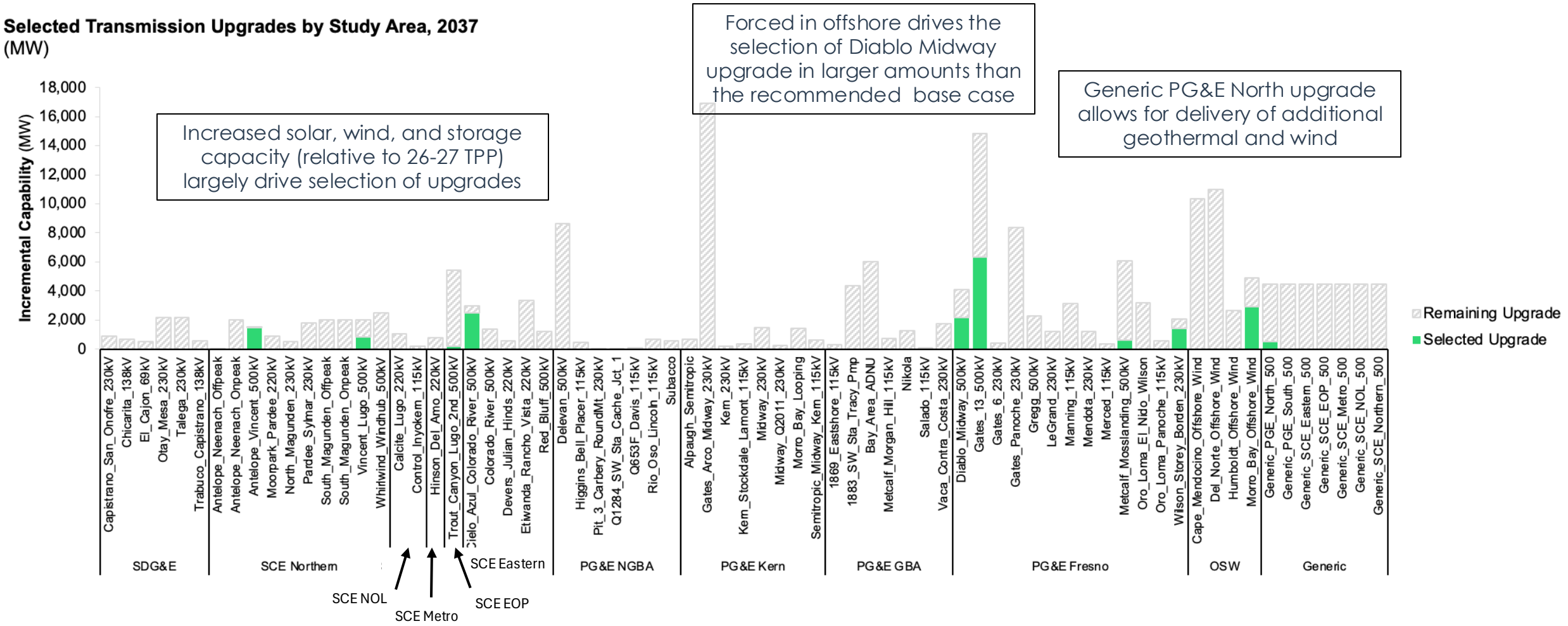
Major Transmission Pathways Selected by 2042



Officially selected transmission upgrades are determined by the CAISO Transmission Plan; Selections of less than 100 MW not shown

30 MMT + OSW

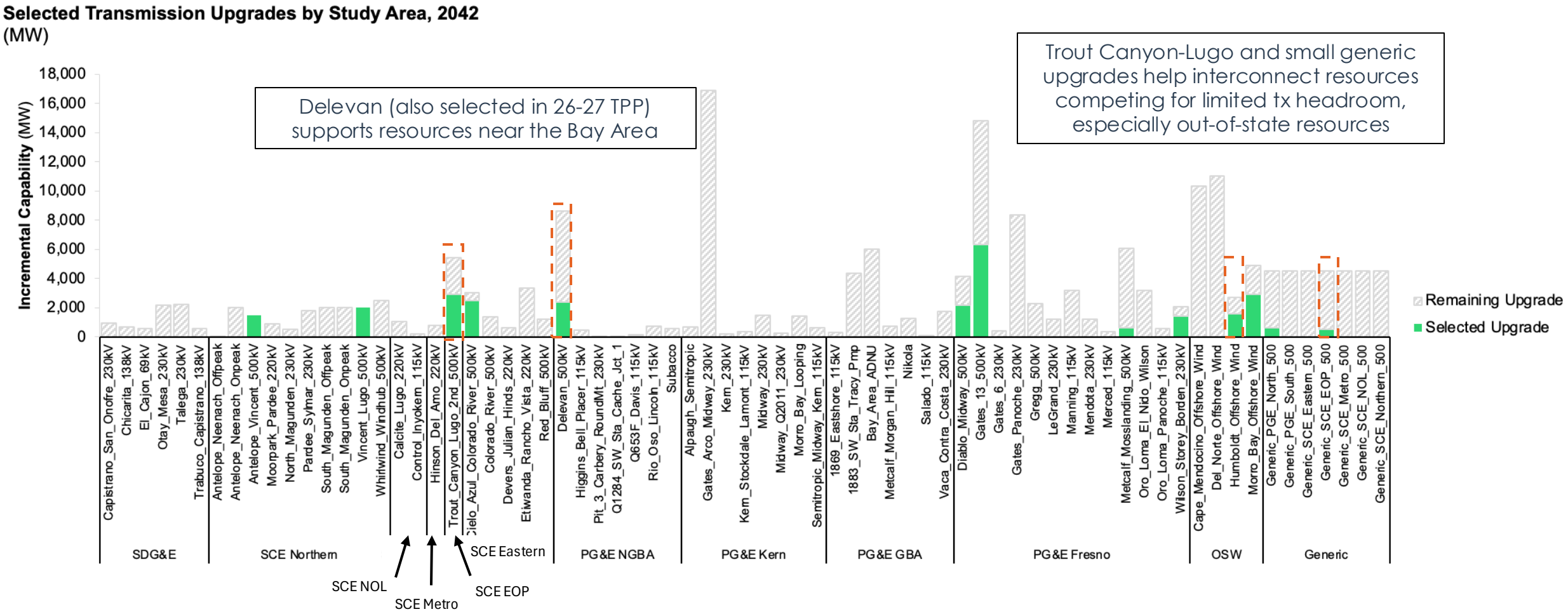
RESOLVE-Selected Transmission Upgrades (2037)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

30 MMT + OSW

RESOLVE-Selected Transmission Upgrades (2042)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case (2037)

- Offshore wind procurement avoids very small amounts of alternative transmission upgrades by 2037

Constraint	Upgrade	Study Area	Cost ($/kW-yr)	30MMT + OSW	Recommended Base Case	30MMT +OSW Case MW	Recommended Base Case MW
Morro Bay Offshore Wind Constraint	Morro Bay Offshore Wind	Offshore Wind	$2.09	✓	✗	2924	0
Antelope-Neenach Area Deliverability Constraint	Antelope Neenach Onpeak	SCE Northern	$4.64	✗	✓	0	437
Windhub Area Deliverability Constraint	Whirlwind Windhub 500kV	SCE Northern	$22.69	✗	✓	0	137

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case (2042)

- **~6 GW net additional transmission upgrades** selected, at an additional cost of ~$2 Billion (~$190 Million/yr), primarily to procure offshore wind

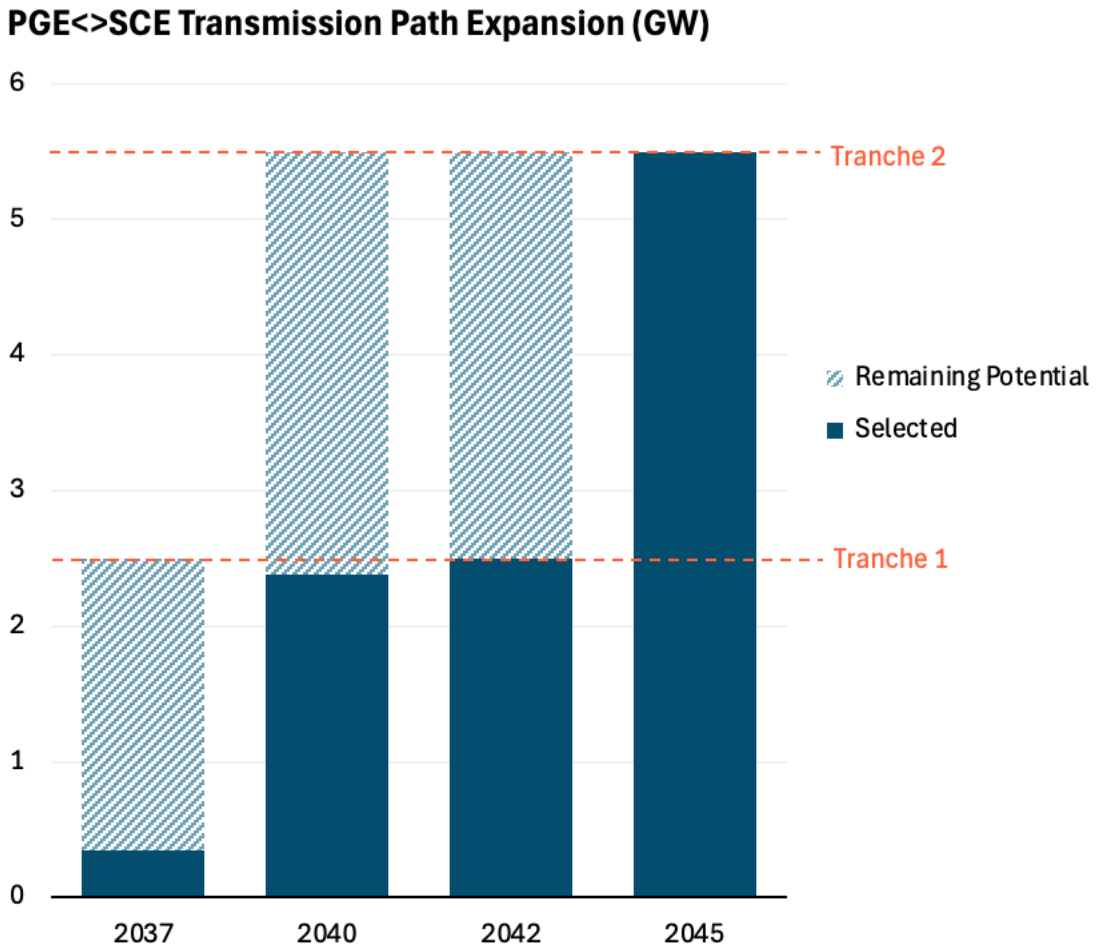
Constraint	Upgrade	Study Area	Cost ($/kW-yr)	30MMT + OSW	Recommended Base Case	30MMT +OSW Case MW	Recommended Base Case MW
Humboldt Bay Offshore Wind Constraint	Humboldt Offshore Wind	Offshore Wind	$120.06	✓	✗	1607	0
Morro Bay Offshore Wind Constraint	Morro Bay Offshore Wind	Offshore Wind	$2.09	✓	✗	2924	0
Antelope-Neenach Area Deliverability Constraint	Antelope Neenach Onpeak	SCE Northern	$4.64	✗	✓	0	437
	Generic PGE South 500		$41.20	✗	✓	0	125
Panoche-Oro Loma 115kV Line	Oro Loma Panoche 115kV	PG&E Fresno	$0.00	✗	✓	0	588
Windhub Area Deliverability Constraint	Whirlwind Windhub 500kV	SCE Northern	$22.69	✗	✓	0	222

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

30 MMT + OSW

PG&E-SCE Transmission Path Expansion

- Path 26/Path 15 expansion(s) are selected primarily to increase import capacity into PG&E
- Path expansion is selected by RESOLVE as soon as it becomes available in 2037, with the full first tranche built by 2042
  - Availability of offshore wind directly connecting to PG&E reduces the need for path expansion in 2037, compared to the recommended base case
- The second tranche selected in full by 2045, more than doubling the transmission capacity



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE Results:
2025 IEPR Load Forecast Sensitivity

38 MMT by 2030, 30 MMT by 2035, No Offshore Wind

2025 IEPR Case Overview

- The 2025 IEPR reflects more recent policy, including an **overall decrease in electrification (buildings and transportation) reflecting recent policy rollbacks/headwinds**
  - The decrease in electrification loads is partially offset by forecasted growth in data centers
- For the planning scenario, the 2025 IEPR **peaks and annual load decrease** compared to the aggressive 2024 IEPR, but are **similar to 2023 IEPR levels**
  - *2024 IEPR loads are likely not realistic under current policy*

2037

Load Forecast	Gross Peak (GW)[1]	Managed Peak (GW)	Annual Load (TWh)
2024 IEPR	74.7	63.2	349.8
2025 IEPR	70.2 -4.5 (6.0%)	59.1 -4.1 (6.5%)	311.9 -29.9 (8.5%)

2042

Load Forecast	Gross Peak (GW)[1]	Managed Peak (GW)	Annual Load (TWh)
2024 IEPR	80.5	67.9	381.6
2025 IEPR	75.4 -5.1 (6.3%)	63.6 -4.3 (6.3%)	347.4 -34.2 (9.0%)

1 Gross Peak = Managed Peak + BTM PV

2025 IEPR Sensitivity

Changes from 2024 to 2025 IEPR by Load Modifier

Component	Policy Impacts and Changes from 2024 IEPR	Impact
Baseline	Economic indicators forecast (GDP, population, housing, etc.)	Decrease in load
Climate Impacts	Minor updates to climate-driven load impacts	negligible
Baseline Electric Vehicles (EVs)	Repeal of IRA tax credits[1]	Decrease in load
Policy-Driven (AATE) EVs	Repeal of EPA Waiver[2]	**Decrease in load**
Energy Efficiency (AAEE)	Repeal of IRA tax credits[1]; DOE Efficiency Standards[3]; Increased Title 24 impacts[5]	**Decrease in load**
Building Electrification (AAFS)	Withdrawal of CARB State Implementation Plan (SIP)[4]; Repeal of IRA tax credits[1]; DOE Efficiency Standards[3]; Increased Title 24 impacts[5]	**Decrease in load**
Data Centers	Updated application data and weighting for uncertainty[5]	**Increase in load**
BTM Storage Losses	Repeal of IRA tax credits[1]; higher long-term new housing forecast[5]	Negligible (on net)
BTM Solar	Repeal of IRA tax credits[1]; higher long-term new housing forecast[5]	Increase in load (near-term) Decrease in load (long-term)
Known Loads	*New Load Modifier, aggregated within Baseline (Local Reliability + Known Loads scenario only, **not used in the 27-28 TPP**), representing distribution-level interconnection requests*[5]	(Known loads scenario only) Increase in load

Largest drivers of change

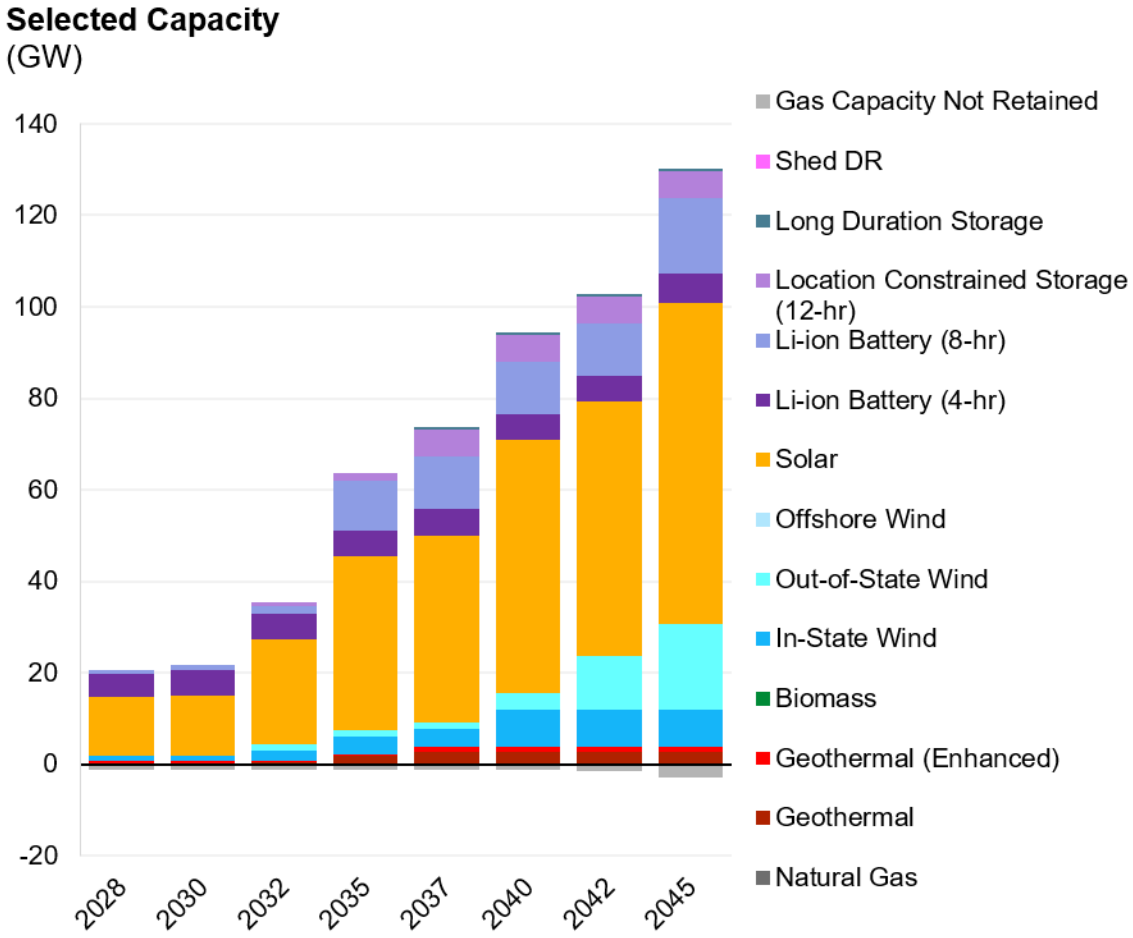
Tariff impacts are excluded from IEPR due to large uncertainty!

1 https://www.congress.gov/bill/119th-congress/house-bill/1/text
2 https://calmatters.org/environment/2025/05/california-electric-car-mandate-senate-revoke-waiver/
3 https://www.energy.gov/articles/doe-finalizes-efficiency-standards-water-heaters-save-americans-over-7-billion-household
4 https://ww2.arb.ca.gov/sites/default/files/2025-08/09-11---2025%20Joint%20Meeting%20Building%20Decarbonization%20Memo.pdf
5 https://www.energy.ca.gov/event/workshop/2025-11/iepr-commissioner-workshop-load-modifier-energy-demand-forecast-results

2025 IEPR Sensitivity

Portfolio Summary

- Geothermal (both conventional and enhanced) is selected as it becomes available for reliability value and high-capacity factor, GHG-free energy
  - Most geothermal potential is selected by 2037 to capture tax credits before they expire
- Relatively small amounts of onshore wind are selected by the mid-2030s, then scale up rapidly in the 2040s
  - Transmission constraints limit in-state wind selection in the mid-2030s
  - Most out-of-state wind is not available until 2042 due to long transmission lead times required for deliverability
- Solar and storage (especially 8-hr) are the scalable resources to meet GHG reduction and reliability, especially through 2035
  - As alternative resources become available starting in the mid-2030s, storage build rates slow into the 2040s though solar continues to scale (lower load means solar is less saturated by 2035)
- No offshore wind is selected, as lower-cost GHG-free resources are available
- Small amounts of gas capacity with high fixed costs are not retained early on, with additional non-retention in 2045



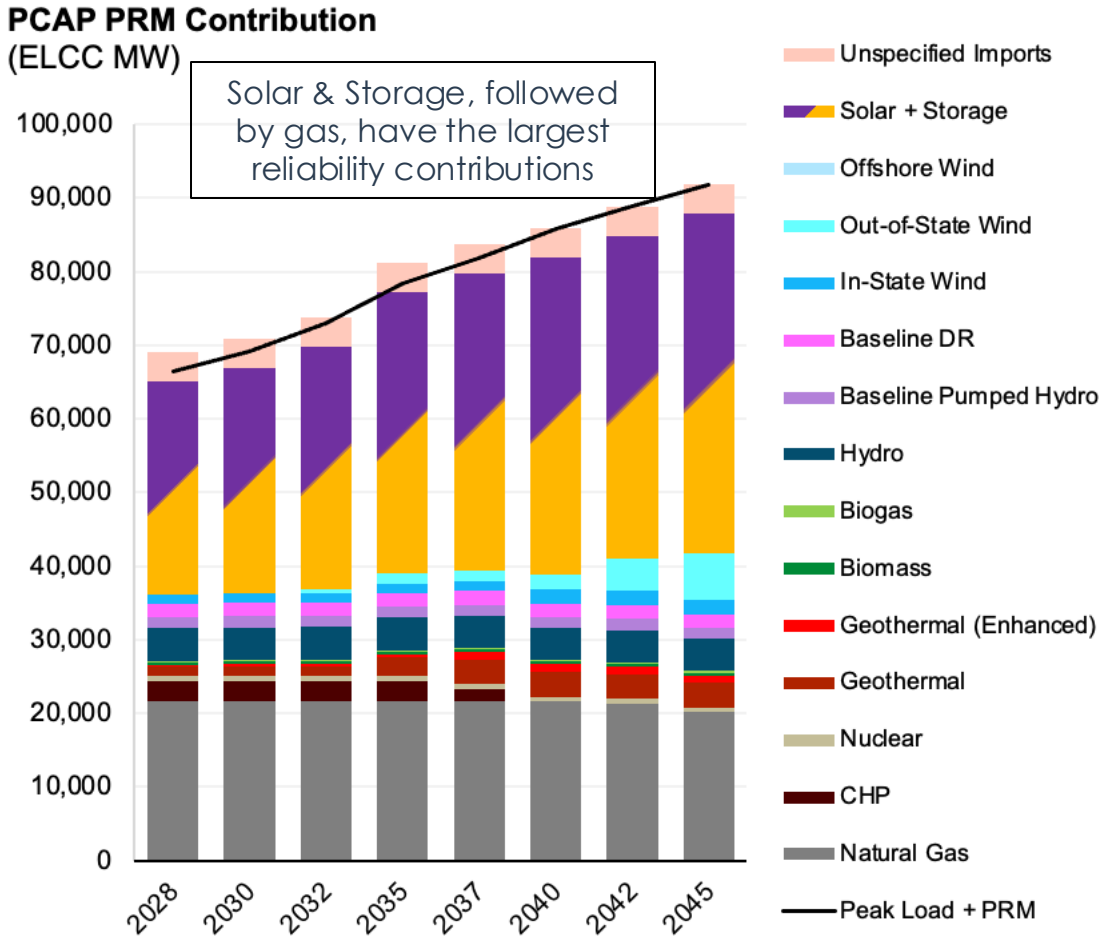
2025 IEPR Sensitivity

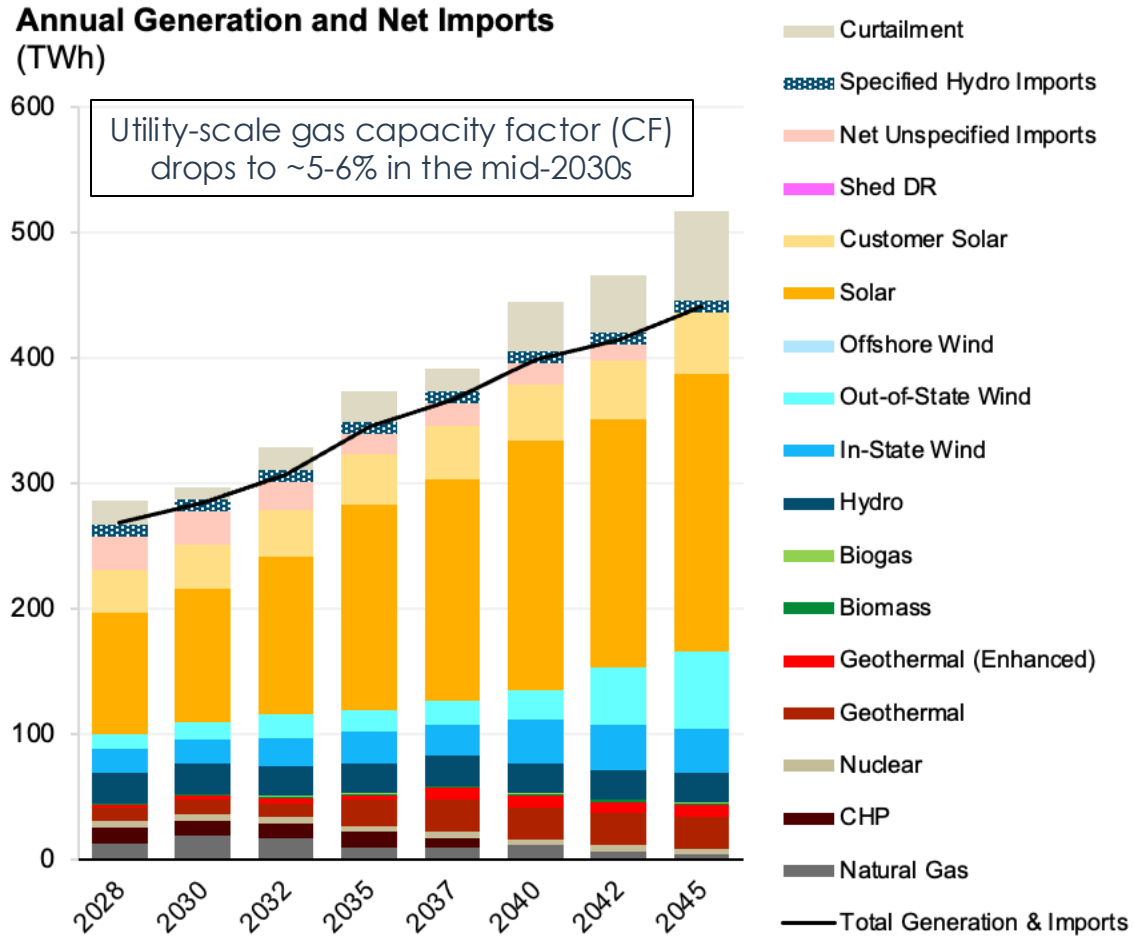
Selected Builds

Resource Type (cumulative GW)	2028	2030	2032	2035	2037	2040	2042	2045
Natural Gas	-	-	-	-	-	-	-	-
Geothermal	0.2	0.3	0.3	1.8	2.6	2.6	2.6	2.6
Geothermal (Enhanced)	0.4	0.4	0.5	0.5	1.3	1.3	1.3	1.3
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-State Wind	1.2	1.2	2.1	3.8	3.8	8.1	8.1	8.1
Out-of-State Wind	-	0.1	1.5	1.5	1.5	3.6	11.8	18.8
Offshore Wind	-	-	-	-	-	-	-	-
Solar	13.0	13.1	22.9	38.0	40.9	55.2	55.5	70.1
Li-ion Battery (4-hr)	5.1	5.5	5.6	5.6	5.6	5.6	5.6	6.3
Li-ion Battery (8-hr)	0.8	1.0	1.6	10.9	11.5	11.5	11.5	16.6
Location Constrained Storage (12-hr)	-	-	1.0	1.6	5.9	5.9	5.9	5.9
Generic Storage (12-hr)	-	-	-	-	-	-	-	-
Generic Storage (24-hr)	-	-	-	-	0.5	0.5	0.5	0.5
Generic Storage (100-hr)	-	-	-	-	-	-	-	-
Shed DR	-	-	-	-	-	-	-	-
Gas Capacity Not Retained	*(1.2)*	*(1.2)*	*(1.2)*	*(1.2)*	*(1.2)*	*(1.2)*	*(1.5)*	*(2.9)*

Represents new resources (nameplate GW), both LSE planned and RESOLVE selected, above the IRP modeling resource baseline; Note: RESOLVE build exceeds AB 1373 amounts of geothermal and location-constrained (12-hr) storage

Reliability and Energy Mix

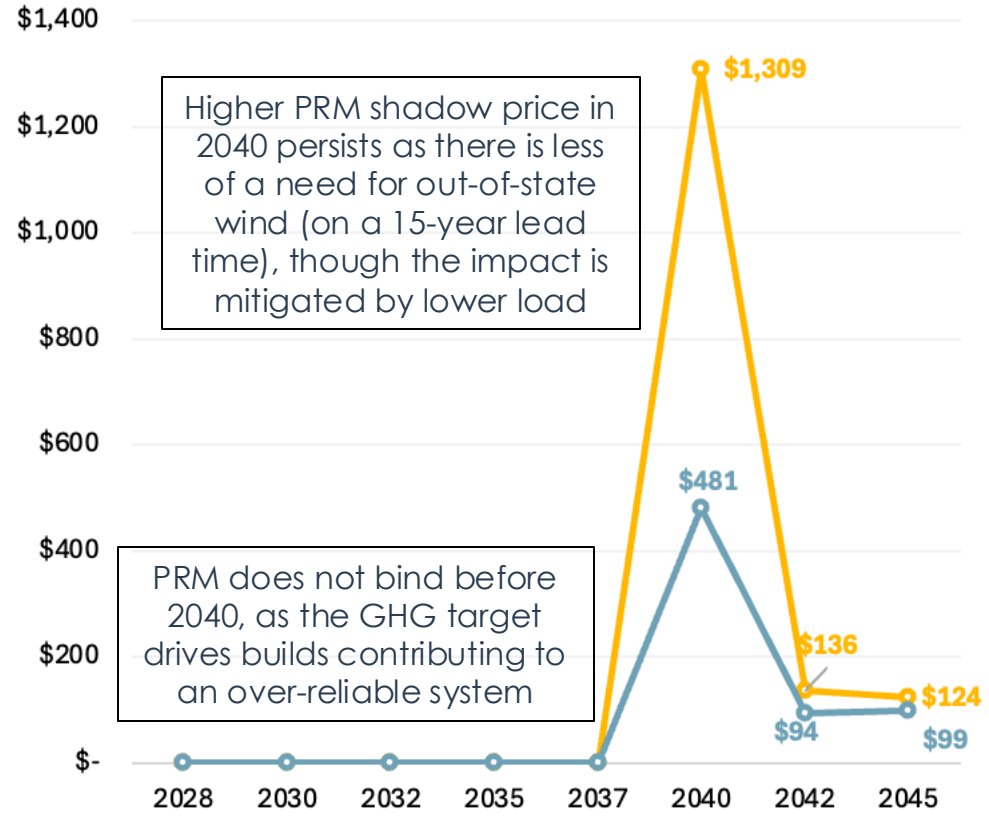




Planning Reserve Margin (PRM) and GHG Constraints

- Shadow prices represent the cost of meeting a constraint, i.e. the cost of the last kW of firm capacity or the last ton of GHG emissions reduction

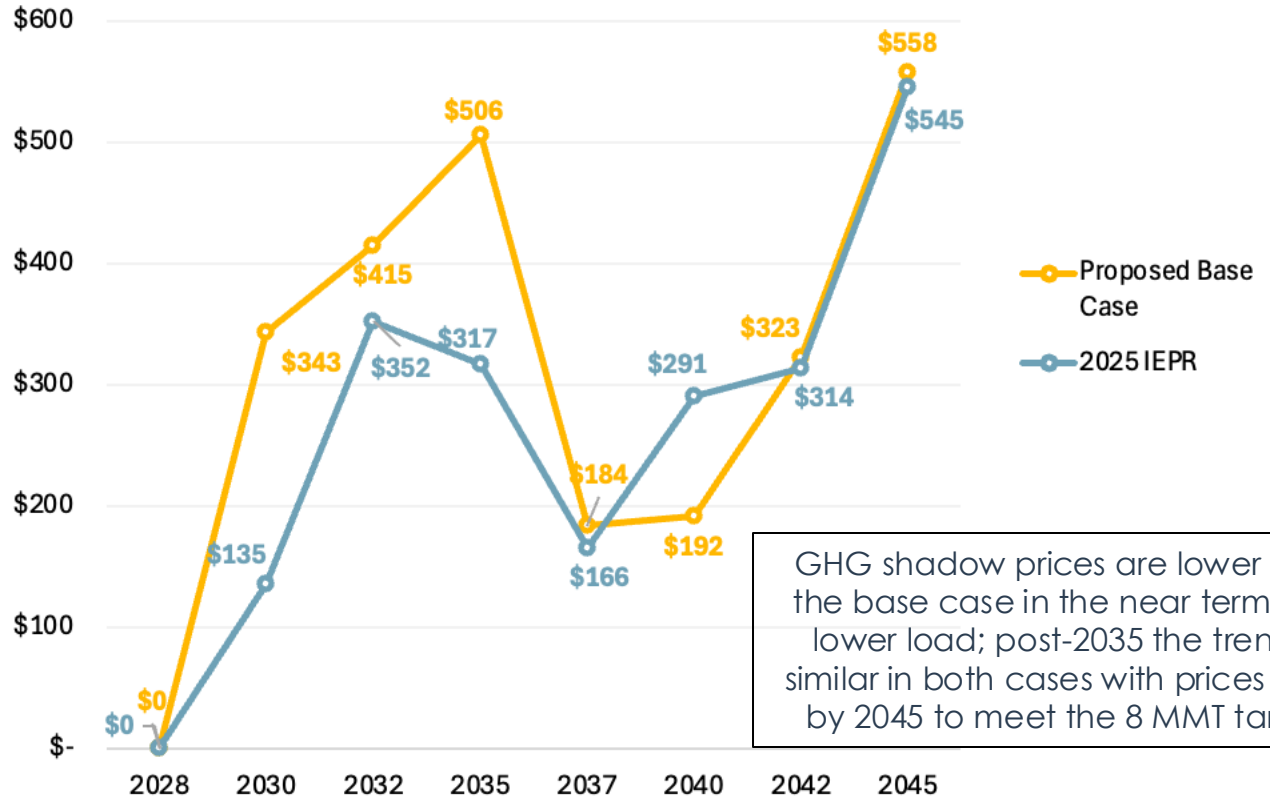
Planning Reserve Margin Shadow Price ($/kW-yr)



Higher PRM shadow price in 2040 persists as there is less of a need for out-of-state wind (on a 15-year lead time), though the impact is mitigated by lower load

PRM does not bind before 2040, as the GHG target drives builds contributing to an over-reliable system

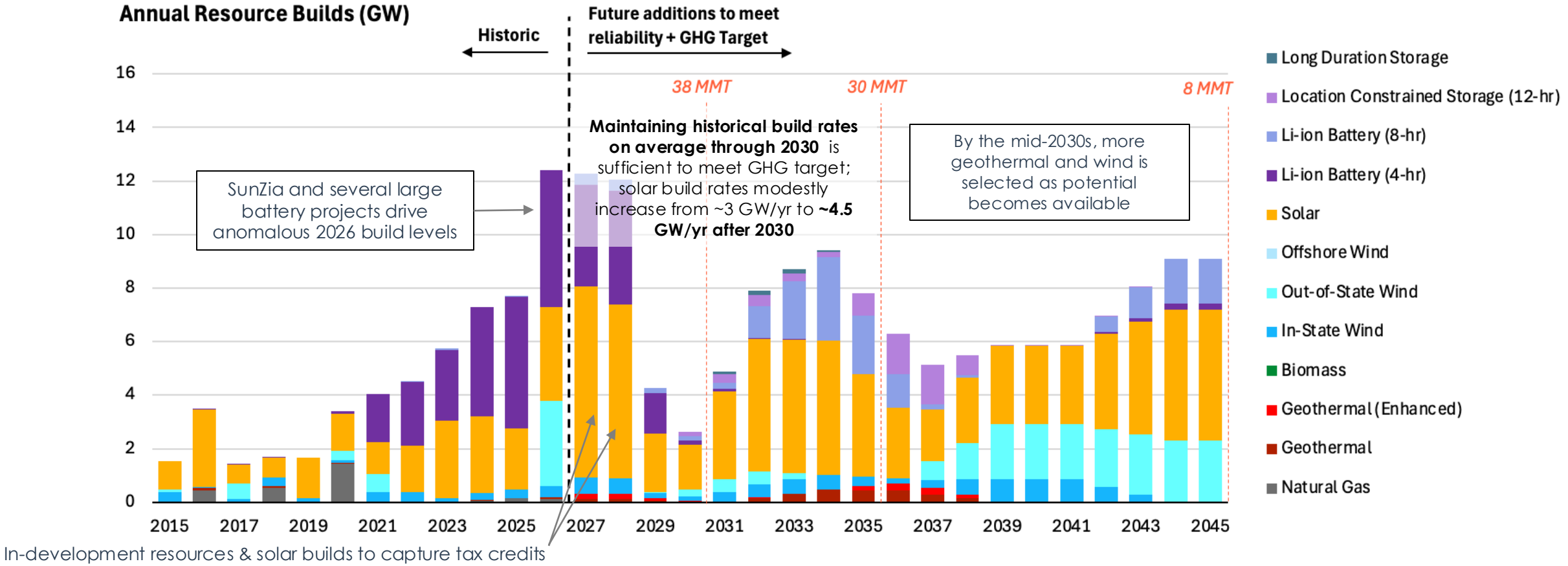
GHG Target Shadow Price ($/ton CO_2)



GHG shadow prices are lower than the base case in the near term with lower load; post-2035 the trend is similar in both cases with prices rising by 2045 to meet the 8 MMT target

Resource Build Rate

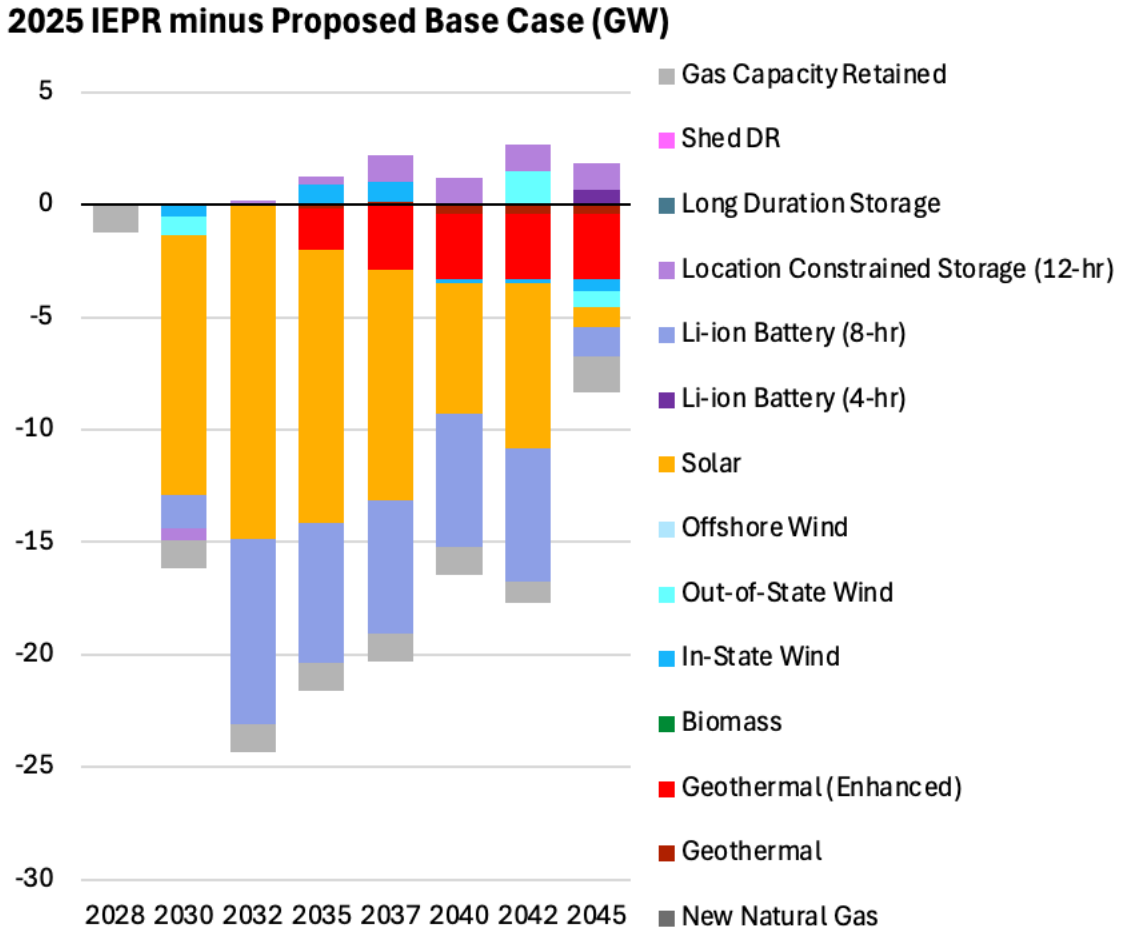
- ***The 2025 IEPR load forecast leads to significantly lower near-term builds through the mid-2030s, allowing solar and storage builds to scale more gradually***



Builds are interpolated and smoothed between model years; 2026 build is a combination of resources already online this year and resources with high-confidence online dates later in the year provided by CAISO

Total Capacity Comparison with Recommended Base Case

- Using the 2025 IEPR forecast reduces near-term solar and 8-hr storage builds through 2042, reaching a maximum of ~15 GW avoided solar and ~8 GW avoided storage in 2032
- ~3 GW less enhanced geothermal is needed under the lower load forecast
- Small shifts in long duration storage; onshore wind slightly accelerated to 2035 (in-state) and 2042 (out-of-state) with less competition for transmission headroom
- Less gas capacity is retained, and the first gas not retained occurs earlier (2028 instead of 2042)



System Cost Comparison with Recommended Base Case

RESOLVE-Optimized Costs ($MM in 2024$)

Case	2028	2030	2032	2035	2037	2040	2042	2045	NPV
Recommended Base Case	$13,316	$16,667	$20,080	$25,190	$27,746	$30,420	$32,378	$40,287	*$421,454*
2025 IEPR Sensitivity	$11,594 -1,722 (13%)	$13,223 -3,444 (21%)	$15,905 -4,175 (21%)	$19,718 -5,471 (22%)	$22,158 -5,587 (20%)	$24,798 -5,622 (19%)	$27,083 -5,295 (16%)	$35,763 -4,524 (11%)	*$356,875* *-64,579* *(15%)*

- With lower load under the 2025 IEPR load forecast, costs are significantly lower, reaching ~$5 Billion/yr less starting in 2035

RESOLVE-optimized costs account for ~15-30% of total system costs (increasing over time); non-optimized baseline generation, transmission, and distribution make up the rest of the revenue requirement

2025 IEPR Sensitivity

Selected Builds by Study Area (2037)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	322	-	-	-	-
PGE_Fresno	-	-	-	4,722	1,176	2,444	-	-	-	-	-	269
PGE_GBA	247	-	-	303	344	59	-	-	-	-	-	133
PGE_Kern	3	-	-	8,635	345	-	850	-	-	-	-	4
PGE_NGBA	1,641	-	-	522	393	-	-	643	326	228	-	-
PGE_Northeast_CA	-	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	5,161	493	-	-	-	-	-	-	-
SCE_Eastern	467	-	-	3,605	240	85	494	32	-	-	-	-
SCE_EOP	255	1,500	-	14,393	593	1,801	500	-	563	-	470	-
SCE_Metro	-	-	-	-	1,405	5,730	-	-	-	-	-	-
SCE_NOL	-	-	-	491	-	6	489	-	-	-	-	-
SCE_Northern	700	-	-	136	590	600	3,239	-	-	-	-	-
SDGE_Arizona	-	-	-	2,952	-	328	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	456	-	-	23	39	409	349	529	-	-	-	-

Plus 500 MW total 24-hr storage in SCE

Selected Builds by Study Area (2037) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	297	-	-	-	-
PGE_Fresno	-	-	-	- 3,116	-	- 3,685	-	-	-	-	-	-
PGE_GBA	-	-	-	- 1,866	-	-	-	-	-	-	-	- 432
PGE_Kern	-	-	-	- 1,072	-	- 411	803	-	-	-	-	- 2
PGE_NGBA	879	-	-	- 1,096	-	-	-	-	38	- 38	- 297	-
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	- 347	-	-	-	-	-	-	-	-
SCE_Eastern	-	-	-	- 4,929	-	-	129	-	-	-	-	-
SCE_EOP	-	-	-	4,495	-	1,198	-	-	- 219	-	- 1,859	-
SCE_Metro	-	-	-	- 502	-	- 1,839	-	-	-	-	-	-
SCE_NOL	-	-	-	- 31	-	-	2	-	-	-	-	-
SCE_Northern	-	-	-	- 3,054	-	- 1,147	22	-	-	-	-	-
SDGE_Arizona	-	-	-	1,876	-	-	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	-	-	-	- 620	-	- 53	249	-	-	- 238	-	-

Incremental in-state wind concentrated PG&E NGBA

Despite large decreases in solar need overall, additional solar is sited in SCE EOP and Arizona, which are more transmission-constrained in the base case

Significantly lower need for Nevada and Utah EGS

2025 IEPR Sensitivity

Selected Builds by Study Area (2042)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	16	322	-	-	-	-
PGE_Fresno	-	-	-	6,202	1,176	2,444	-	-	-	-	-	269
PGE_GBA	247	1,649	-	655	344	59	-	-	-	-	-	133
PGE_Kern	245	-	-	9,443	345	-	850	-	-	-	-	4
PGE_NGBA	1,893	-	-	2.449	393	-	-	643	340	228	-	-
PGE_Northeast_CA	1,015	-	-	-	-	-	-	178	-	178	-	-
SCE_Arizona	-	-	-	5,398	493	-	-	-	-	-	-	-
SCE_Eastern	819	-	-	3,605	240	85	494	32	-	-	-	-
SCE_EOP	255	8,600	-	15,318	593	1,801	500	-	563	-	470	-
SCE_Metro	-	533	-	502	1,405	5,730	-	-	-	-	-	-
SCE_NOL	8	-	-	491	-	6	489	-	-	-	-	-
SCE_Northern	1,774	-	-	5,661	590	600	3,239	-	-	-	-	-
SDGE_Arizona	-	-	-	5,531	-	328	-	-	-	-	-	-
SDGE_Baja_California	1,958	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	923	-	-	225	39	409	349	529	-	-	-	-

Plus 500 MW total 24-hr storage in SCE

Selected Builds by Study Area (2042) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	297	-	-	-	-
PGE_Fresno	-	-	-	- 1,635	-	- 3,685	-	-	-	-	-	-
PGE_GBA	-	699	-	- 1,514	-	-	-	-	-	-	-	- 432
PGE_Kern	-	-	-	- 287	-	- 411	803	-	-	-	-	- 2
PGE_NGBA	-	-	-	- 1,934	-	-	-	-	- 468	- 64	- 297	-
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	- 110	-	-	-	-	-	-	-	-
SCE_Eastern	352	-	-	- 4,929	-	-	129	-	-	-	-	-
SCE_EOP	-	241	-	1,878	-	1,198	-	-	- 219	-	- 1,859	-
SCE_Metro	-	533	-	- 42	-	- 1,839	-	-	-	-	-	-
SCE_NOL	- 4	-	-	- 31	-	-	2	-	-	-	-	-
SCE_Northern	- 564	-	-	42	-	- 1,147	22	-	-	-	-	-
SDGE_Arizona	-	-	-	1,760	-	-	-	-	-	-	-	-
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	-	-	-	- 526	-	- 53	249	-	-	- 238	-	-

Relatively small shifts for in-state wind locations

Incremental out-of-state wind interconnects at multiple locations

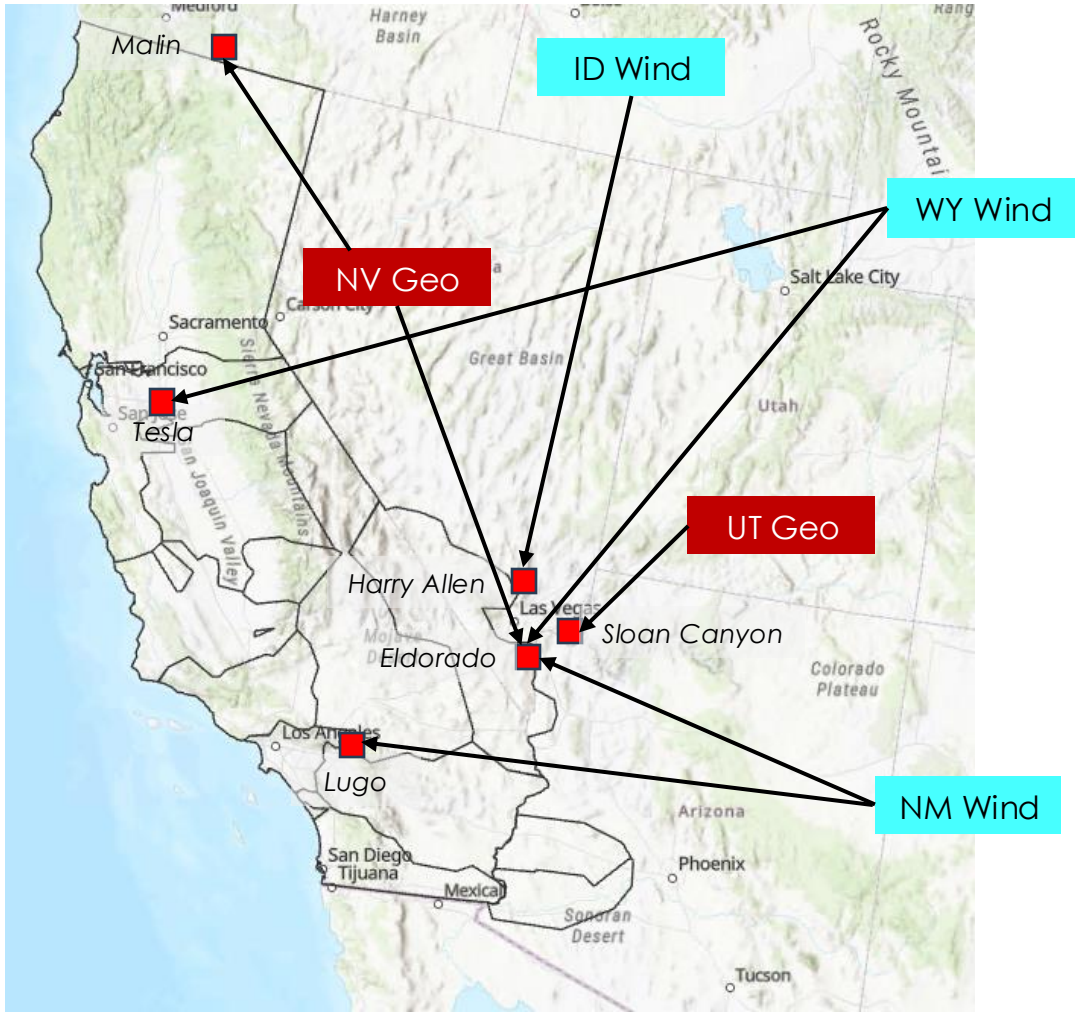
Despite large decreases in solar need overall, additional solar is sited in SCE EOP and Arizona, which are more transmission-constrained in the base case

Significantly lower need for Nevada and Utah EGS

Out-of-State Resource Tie-in Locations

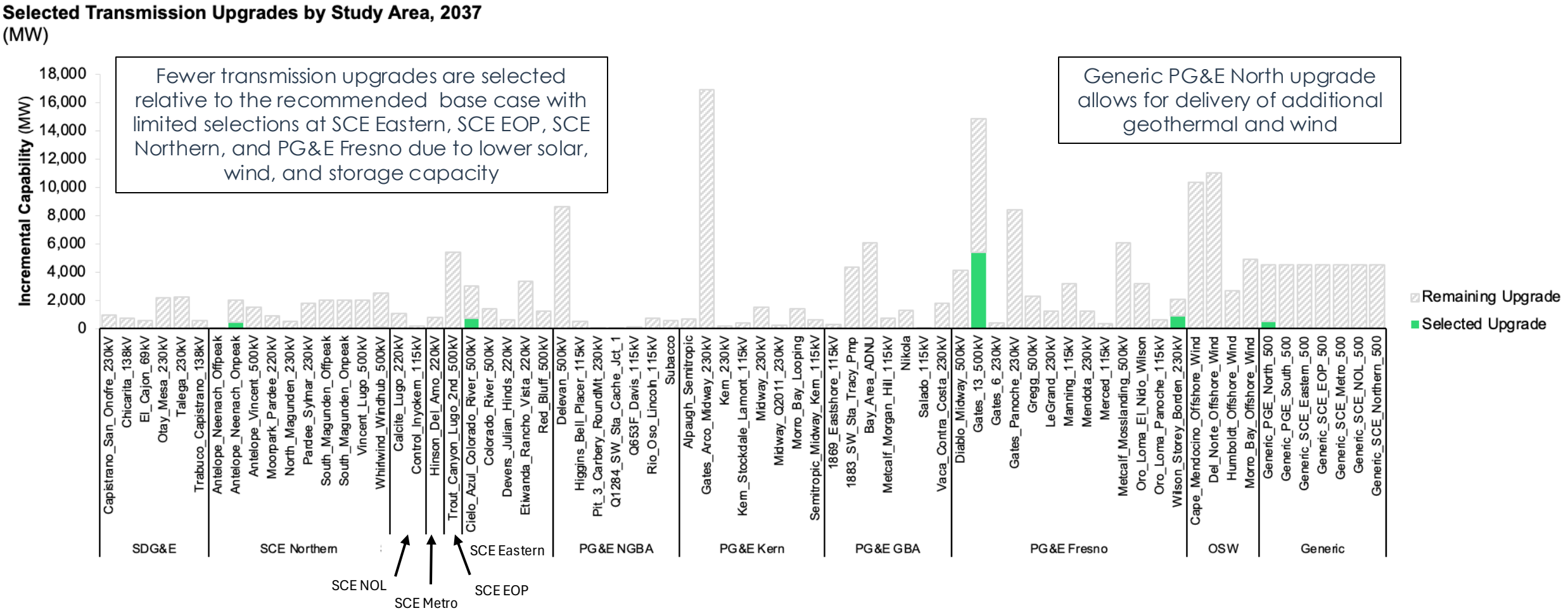
- **Multiple points of interconnection accommodate either wind or geothermal**; allocating TPD at these locations which can be reallocated may mitigate risk if either wind or geothermal projects do not materialize
- High West, TransWest, and SWIP-N all utilized by RESOLVE; HVDC transmission lines are used for incremental New Mexico and Wyoming wind
- Less out-of-state geothermal is selected overall, though out-of-state wind selection is similar (or higher, in 2042) than the recommended base case
- **Several out-of-state resources compete for Tx headroom in the Harry Allen/Sloan Canyon/Eldorado area**, delaying Idaho wind (SWIP-N) selection to 2040; the second Trout Canyon Lugo upgrade relieves some of this
- Wyoming **wind delivered north of Path 15/26 (Tesla) is selected at a higher trnasmission cost** compared to other transmission paths delivering south of Path 15/26
- Several GW additional out-of-state wind is selected by RESOLVE in 2045, interconnecting at Lugo and Eldorado

Major Transmission Pathways Selected by 2042



Officially selected transmission upgrades are determined by the CAISO Transmission Plan; Selections of less than 100 MW not shown

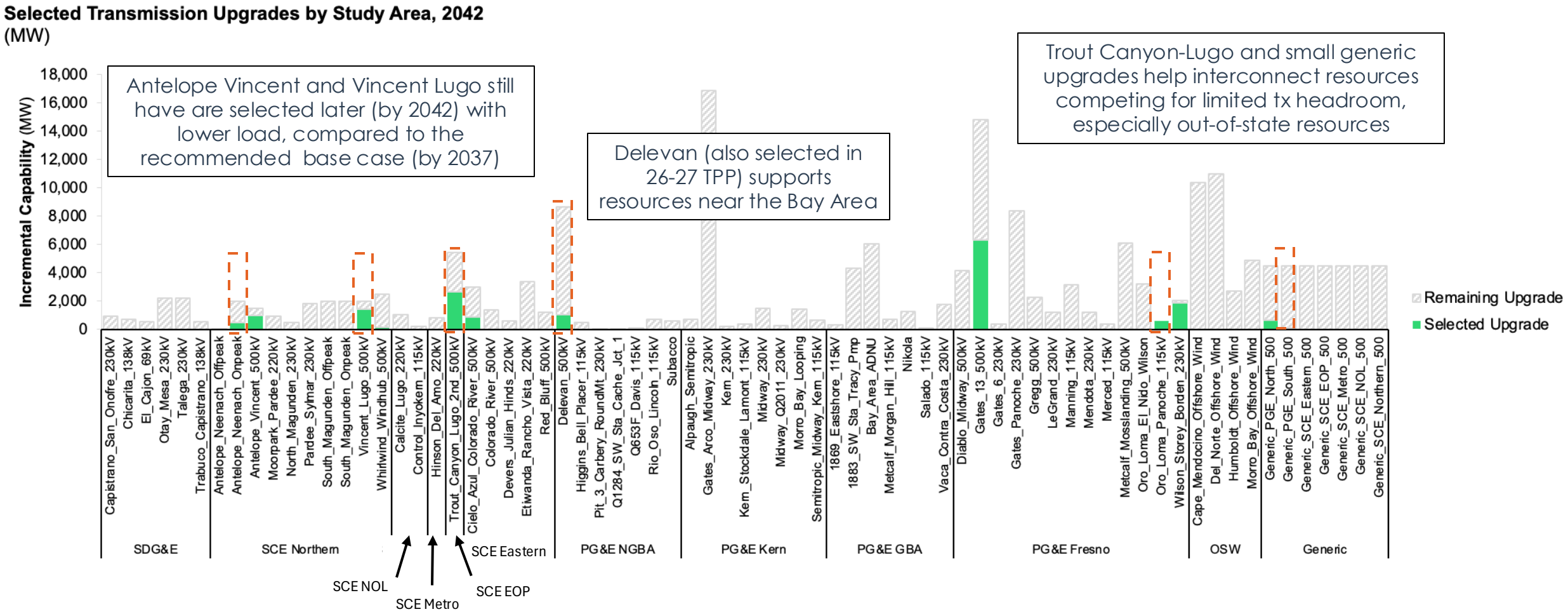
RESOLVE-Selected Transmission Upgrades (2037)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

2025 IEPR Sensitivity

RESOLVE-Selected Transmission Upgrades (2042)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case (2037)

- **~3 GW net fewer transmission upgrades** selected by 2037, with a net cost reduction of ~$0.3 Billion (~$2 Million/yr), driven by lower load

Constraint	Upgrade	Study Area	Cost ($/kW-yr)	2025 IEPR	Recommended Base Case	2025 IEPR MW	Recommended Base Case MW
Antelope-Vincent Area Deliverability Constraint	Antelope Vincent 500kV	SCE Northern	$0.82	✗	✓	0	961
Diablo-Gates 500 kV line	Diablo Midway 500kV	PG&E Fresno	$18.65	✗	✓	0	48
Metcalf-Mosslanding 500kV	Metcalf Mosslanding 500kV	PG&E Fresno	$3.05	✗	✓	0	190
Lugo – Victorville Area Deliverability Constraint	Trout Canyon Lugo 2nd 500kV	SCE EOP	$33.67	✗	✓	0	579
Vincent-Lugo Area Deliverability Constraint	Vincent Lugo 500kV	SCE Northern	$3.98	✗	✓	0	1093

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case (2042)

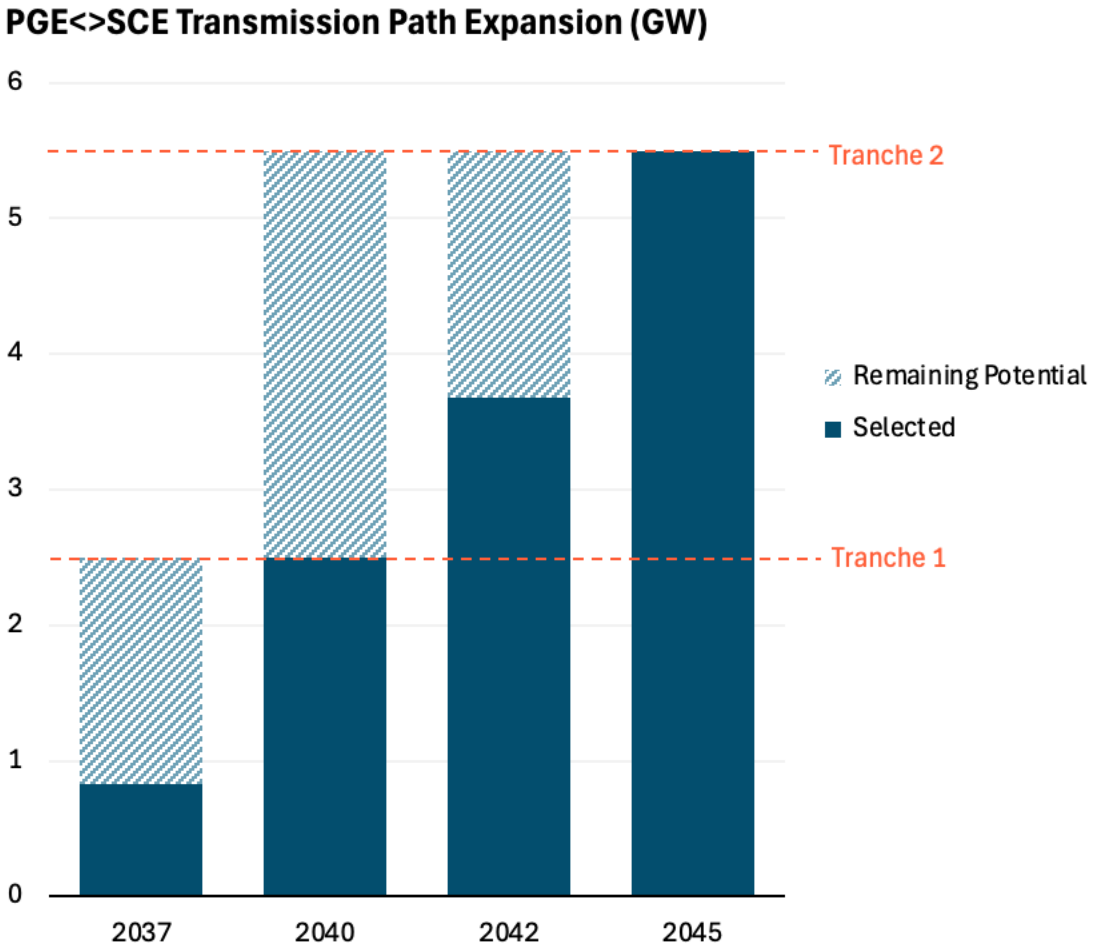
- ~0.3 GW net fewer transmission upgrades selected by 2042, with a net cost reduction of less than $0.1 Billion (~$3 Million/yr), driven by lower load
- **This result indicates the majority of upgrades selected by 2042 in the recommended base case are robust to lower load**

Constraint	Upgrade	Study Area	Cost ($/kW-yr)	2025 IEPR	Recommended Base Case	2025 IEPR MW	Recommended Base Case MW
Diablo-Gates 500 kV line	Diablo Midway 500kV	PG&E Fresno	$18.65	✗	✓	0	48
	Generic SCE EOP 500		$41.20	✗	✓	0	39
Metcalf-Mosslanding 500kV	Metcalf Mosslanding 500kV	PG&E Fresno	$3.05	✗	✓	0	190

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

PG&E-SCE Transmission Path Expansion

- Path 26/Path 15 expansion(s) are selected primarily to increase import capacity into PG&E
- Path expansion is selected by RESOLVE as soon as it becomes available in 2037, with the full first tranche built by 2040
- The second tranche selected in full by 2045, more than doubling the transmission capacity



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE Results: 27-28 TPP Recommended Sensitivity Case

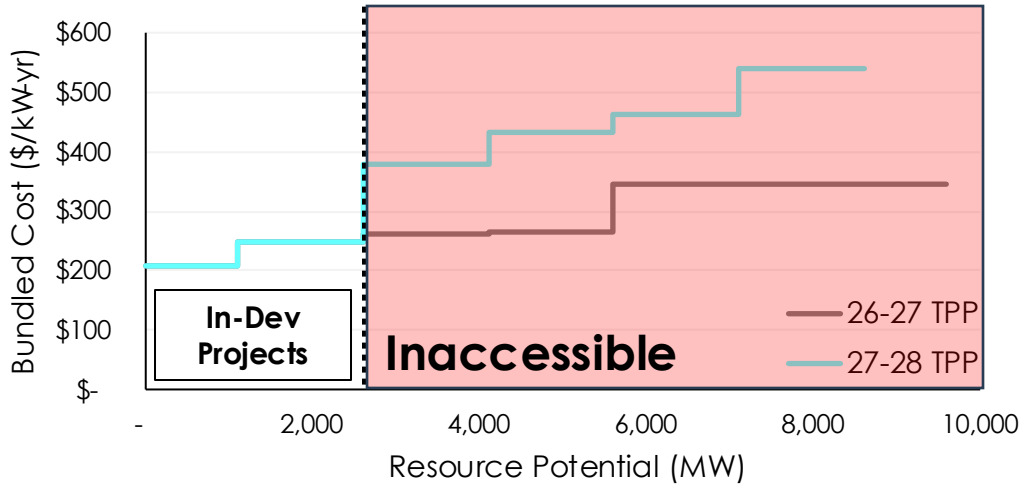
Limited Out-of-State (OOS) Resource Sensitivity

38 MMT by 2030, 30 MMT by 2035, No Offshore Wind

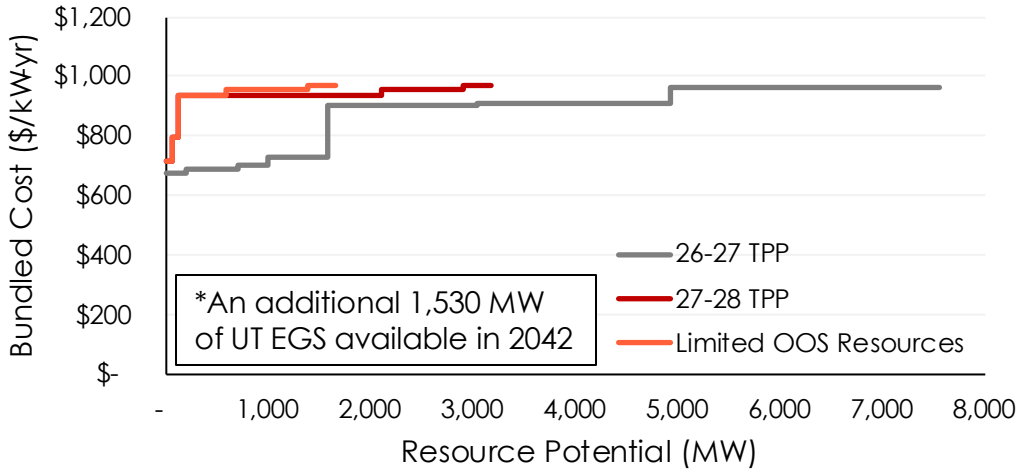
Limited OOS Resources Case Overview

- **Generic transmission lines that could deliver non-CAISO resources are assumed to be unavailable**
  - Out-of-state wind options are limited to SWIP-N and TransWest Express
  - Out-of-state geothermal options are limited to NV and UT geothermal contracts from LSE filings, projects identified in the NEVP interconnection queue, and 1,070 MW of NV EGS that could utilize capacity on SWIP-N or Greenlink West
  - High West (up to 2 GW of UT EGS) is made available in 2042 only
  - Transmission solutions to deliver in-state wind and geothermal resources in the Hilltop area are not modeled

Out-of-State Wind Supply Curve, 2037



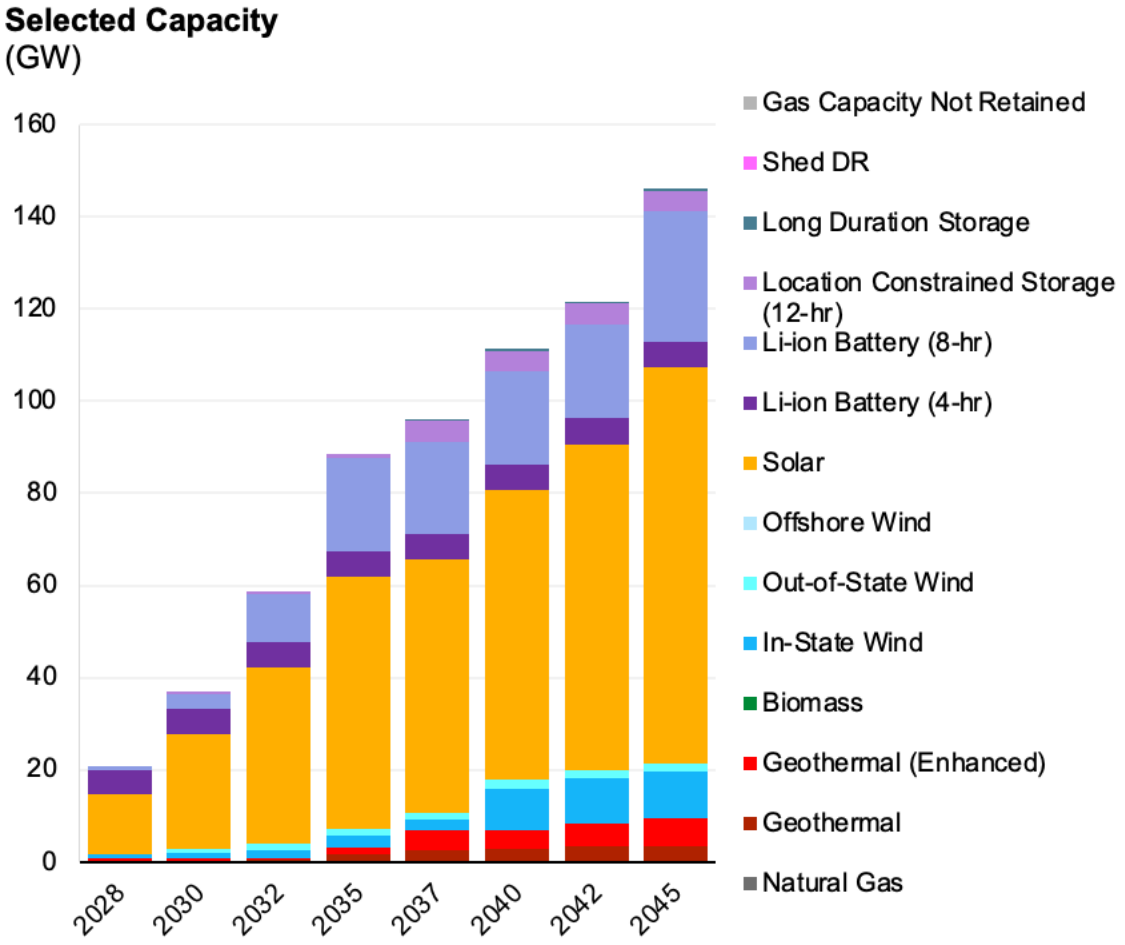
Out-of-State Geothermal and EGS Supply Curve, 2032



Limited OOS Sensitivity

Portfolio Summary

- Similar to the recommended base case, geothermal (both conventional and enhanced) is selected for reliability value and high-capacity factor, GHG-free energy
  - Most geothermal potential is selected by 2037 to capture tax credits before they expire
- Relatively small amounts of onshore wind are selected by the mid-2030s, then scale up rapidly in the 2040s
  - Transmission constraints limit in-state wind selection in the mid-2030s
- Solar and storage (especially 8-hr) are the scalable resources to meet GHG reduction and reliability, especially through 2035
  - As alternative resources become available starting in the mid-2030s, storage build rates slow until 2045
  - Solar continues to scale rapidly though 2045 in the absence of most out-of-state resources, even as it becomes heavily saturated
- No offshore wind is optimally selected, as lower-cost GHG-free resources are available in-state
- All gas capacity is retained
- **Greatly reduced amounts of out-of-state wind and geothermal resources are selected for the portfolio**



Limited OOS Sensitivity

Selected Builds

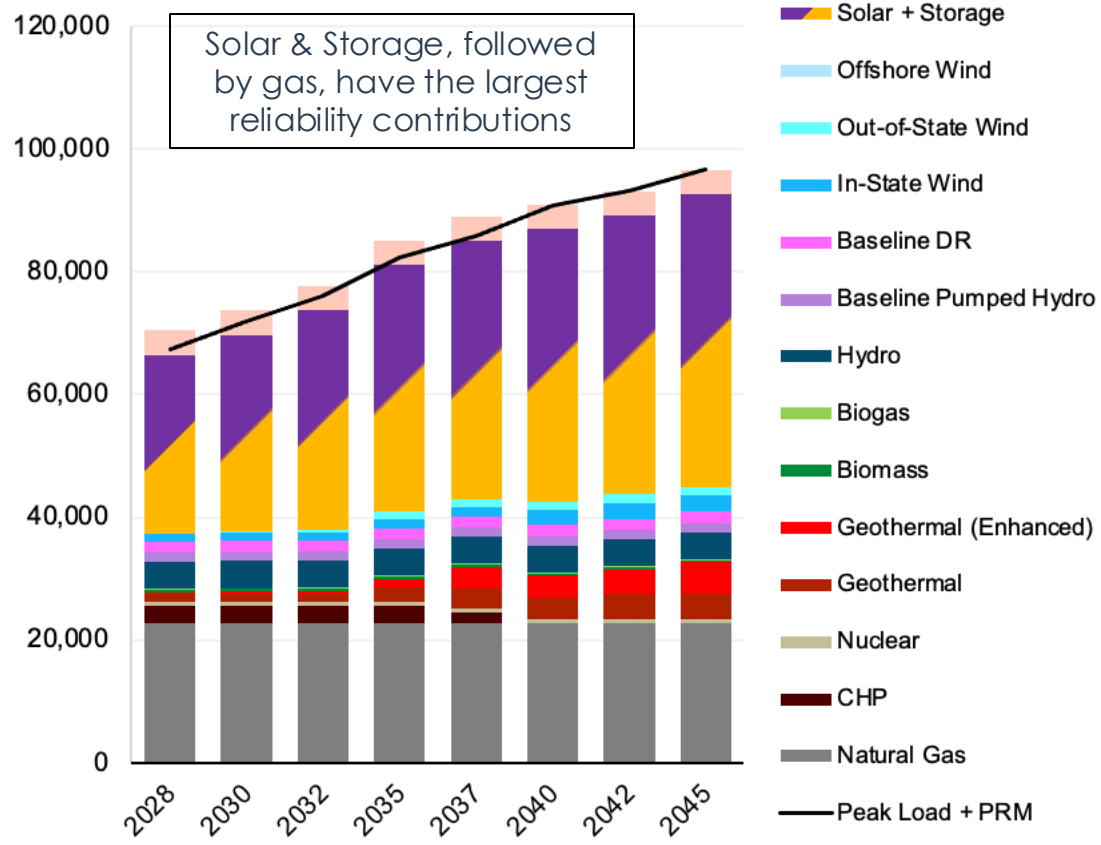
Resource Type (cumulative GW)	2028	2030	2032	2035	2037	2040	2042	2045
Natural Gas	-	-	-	-	-	-	-	-
Geothermal	0.2	0.3	0.3	1.5	2.5	2.8	3.5	3.5
Geothermal (Enhanced)	0.4	0.4	0.5	1.5	4.2	4.2	4.7	6.1
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-State Wind	1.2	1.2	1.6	2.5	2.5	9.0	10.0	10.0
Out-of-State Wind	-	0.9	1.5	1.5	1.5	1.8	1.8	1.8
Offshore Wind	-	-	-	-	-	-	-	-
Solar	13.0	24.9	38.2	54.8	54.8	63.0	70.7	85.9
Li-ion Battery (4-hr)	5.1	5.5	5.6	5.6	5.6	5.6	5.6	5.6
Li-ion Battery (8-hr)	0.8	3.0	10.5	20.1	20.1	20.1	20.4	28.4
Location Constrained Storage (12-hr)	-	0.5	0.5	0.9	4.4	4.4	4.4	4.4
Generic Storage (12-hr)	-	-	-	-	-	-	-	-
Generic Storage (24-hr)	-	-	-	-	-	-	-	-
Generic Storage (100-hr)	-	-	-	-	0.5	0.5	0.5	0.5
Shed DR	-	-	-	-	-	-	-	-
Gas Capacity Not Retained	-	-	-	-	-	-	-	-

Represents new resources (nameplate GW), both LSE planned and RESOLVE selected, above the IRP modeling resource baseline; Note: RESOLVE build exceeds AB 1373 amounts of geothermal and location-constrained (12-hr) storage

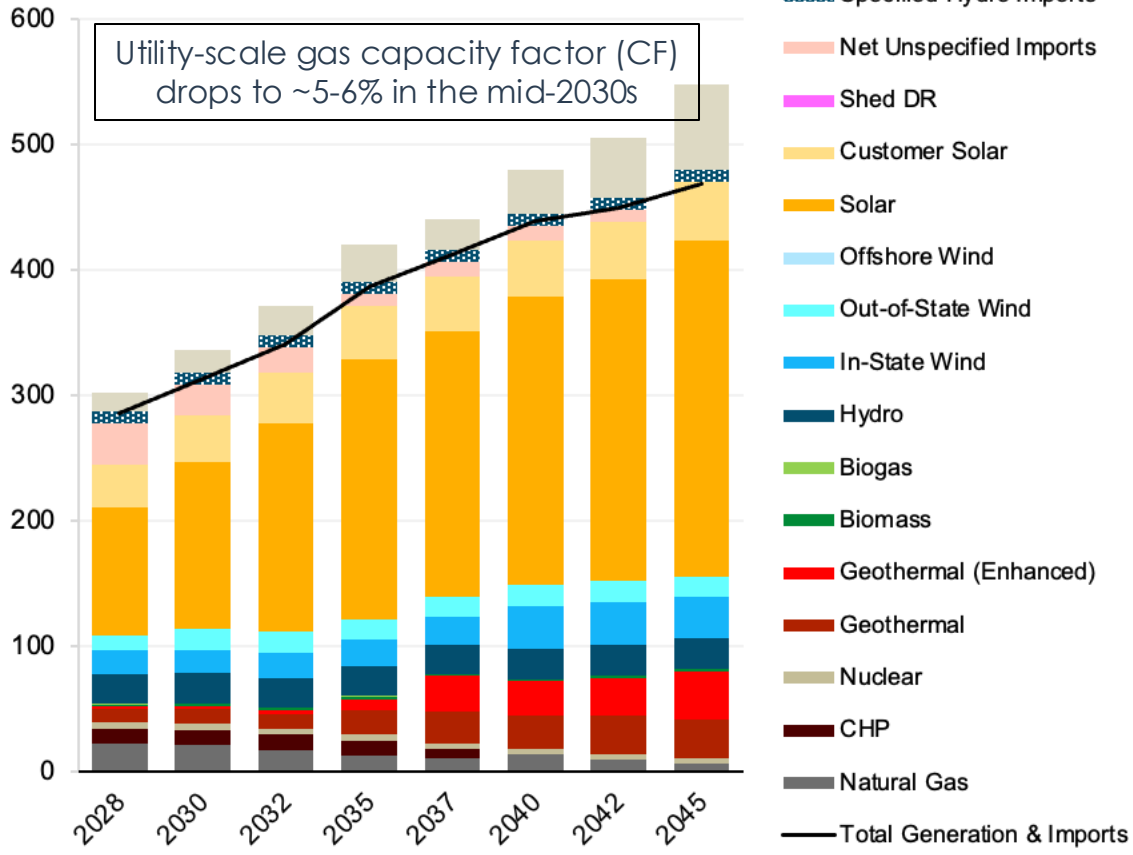
Limited OOS Sensitivity

Reliability and Energy Mix

PCAP PRM Contribution
(ELCC MW)



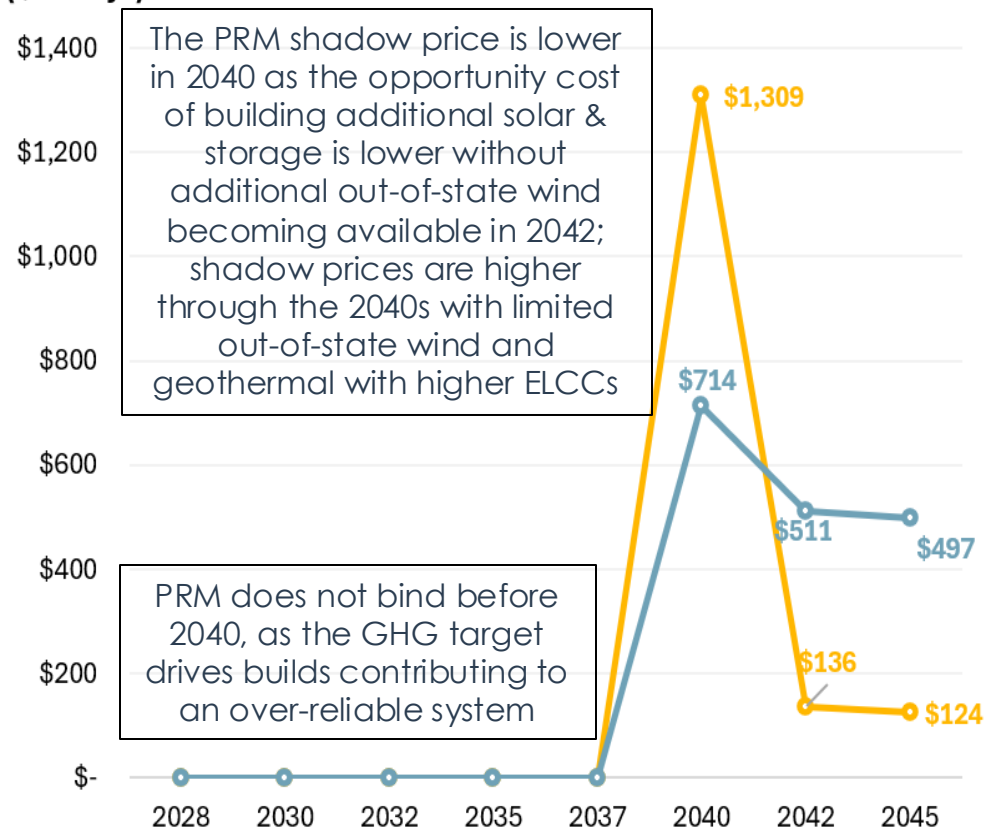
Annual Generation and Net Imports
(TWh)



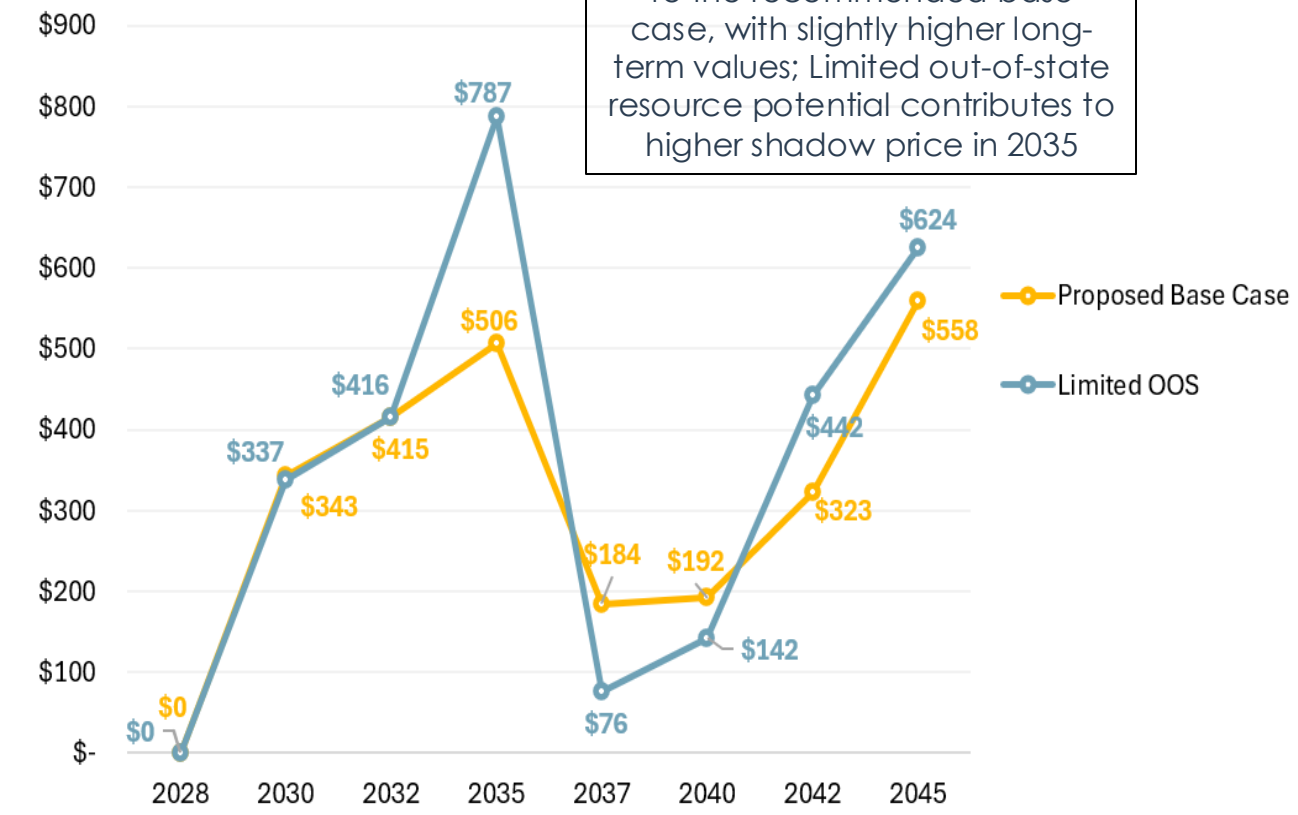
Planning Reserve Margin (PRM) and GHG Constraints

- Shadow prices represent the cost of meeting a constraint, i.e. the cost of the last kW of firm capacity or the last ton of GHG emissions reduction

Planning Reserve Margin Shadow Price ($/kW-yr)



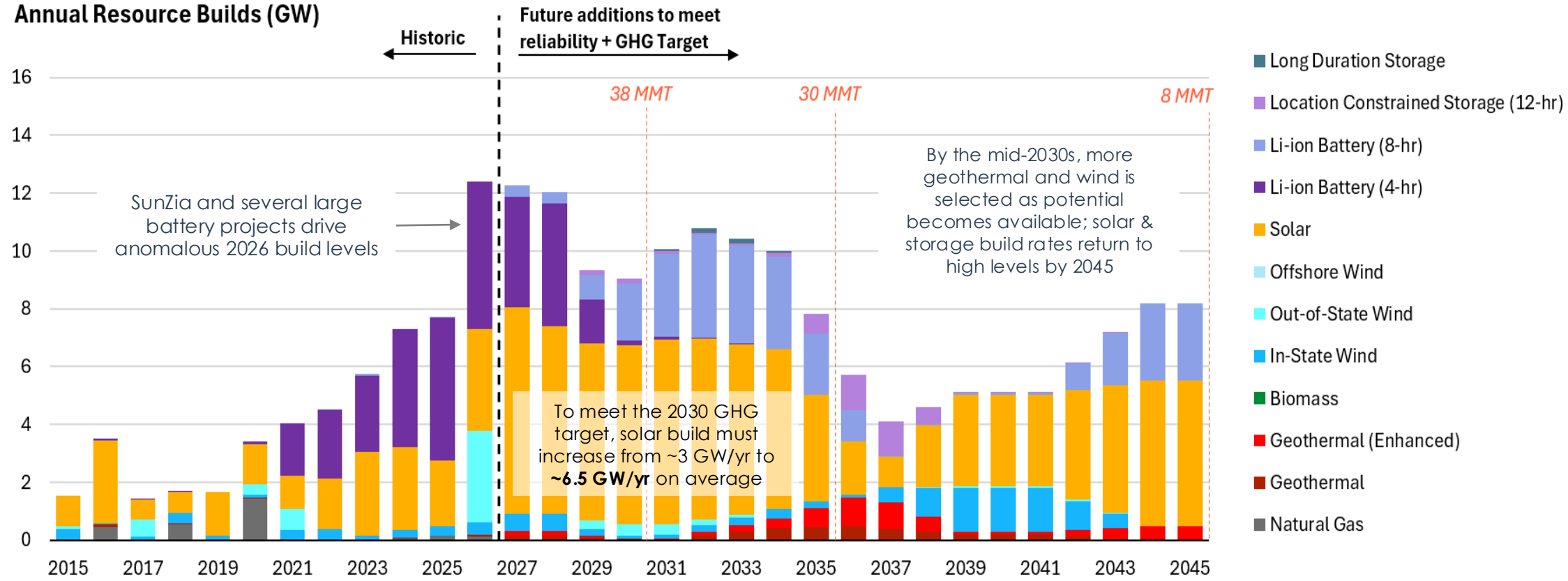
GHG Target Shadow Price ($/ton CO_2)



Limited OOS Sensitivity

Resource Build Rate

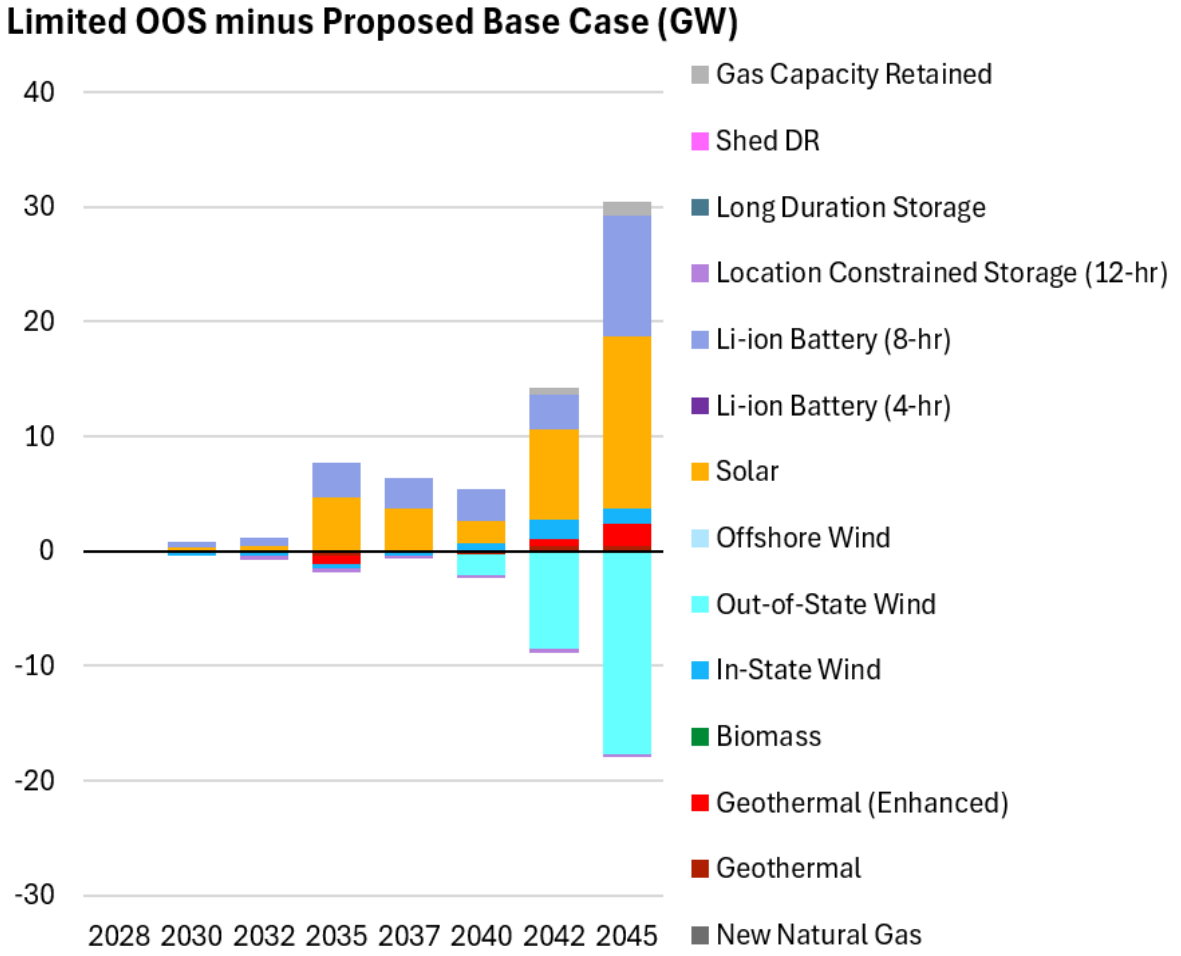
- The 2030 and 2035 GHG targets, combined with limited geothermal and wind availability through the mid-2030s, drive high solar and storage build rates in the near-term; limited out-of-state resource potential drives continued high build rates in the long-term



Builds are interpolated and smoothed between model years; 2026 build is a combination of resources already online this year and resources with high-confidence online dates later in the year provided by CAISO

Total Capacity Comparison with Recommended Base Case

- Differences grow starting in 2035, when out-of-state resources become available in the recommended base case
- Out-of-state resources are primarily replaced by solar and storage, plus smaller amounts in-state wind and EGS
  - An additional ~15 GW of solar and ~10 GW of storage are needed by 2045
- Although out-of-state EGS is limited, more than enough in-state EGS is selected to replace it
- All gas capacity is retained



System Cost Comparison with Recommended Base Case

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Case	2028	2030	2032	2035	2037	2040	2042	2045	NPV
Recommended Base Case	$13,316	$16,667	$20,080	$25,190	$27,746	$30,420	$32,378	$40,287	*$421,454*
Limited OOS Sensitivity	$13,322 + 6 (<0.1%)	$16,663 -4 (<0.1%)	$20,086 + 6 (<0.1%)	$25,529 + 339 (1.3%)	$28,389 + 643 (2.3%)	$30,654 + 234 (0.8%)	$33,328 + 950 (2.9%)	$42,176 + 1,889 (4.7%)	*$433,652* *+ 12,198* *(2.9%)*

- Limited out-of-state resource availability results in **increased costs of ~$1Billion/yr by 2042**, and growing thereafter

RESOLVE-optimized costs account for ~15-30% of total system costs (increasing over time); non-optimized baseline generation, transmission, and distribution make up the rest of the revenue requirement

Limited OOS Sensitivity

Selected Builds by Study Area (2037)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	-	-	500	-	-
PGE_Fresno	-	-	-	6,722	1,176	5,742	-	-	-	-	-	274
PGE_GBA	247	-	-	3,859	344	59	186	-	-	-	-	632
PGE_Kern	183	-	-	9,413	345	107	-	-	-	-	-	5
PGE_NGBA	744	-	-	1,693	-	-	-	668	60	125	-	507
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	5,508	493	-	-	-	-	-	-	-
SCE_Eastern	-	-	-	8,534	240	85	-	567	-	7	-	-
SCE_EOP	255	1,500	-	12,343	593	1,444	500	-	703	-	1,540	5
SCE_Metro	-	-	-	502	1,405	11,589	-	-	-	-	-	-
SCE_NOL	-	-	-	799	-	6	373	-	-	-	-	-
SCE_Northern	700	-	-	3,430	590	600	3,170	-	-	-	-	-
SDGE (Generic)	-	-	-	-	-	-	176	262	-	-	-	-
SDGE_Arizona	-	-	-	-	-	8	-	-	-	-	-	72
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	396	-	-	1,991	39	461	-	267	-	529	-	3

Plus 500 MW total 100-hr storage in SCE

Selected Builds by Study Area (2037) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	-	- 25	-	500	-	-
PGE_Fresno	-	-	-	- 1,115	-	- 386	-	-	-	-	-	5
PGE_GBA	-	-	-	1,690	-	-	186	-	-	-	-	67
PGE_Kern	181	-	-	- 294	-	- 305	- 47	-	-	-	-	-
PGE_NGBA	- 18	-	-	74	-	-	-	25	- 228	- 141	- 297	507
PGE_Northeast_CA	-	-	-	-	-	-	-	- 178	-	- 178	-	-
SCE_Arizona	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Eastern	- 467	-	-	-	-	-	- 365	535	-	7	-	-
SCE_EOP	-	-	-	2,446	-	840	-	-	- 80	-	- 789	5
SCE_Metro	-	-	-	-	-	4,020	-	-	-	-	-	-
SCE_NOL	-	-	-	277	-	-	- 113	-	-	-	-	-
SCE_Northern	-	-	-	240	-	- 1,147	- 47	-	-	-	-	-
SDGE (Generic)	-	-	-	-	-	-	176	262	-	-	-	-
SDGE_Arizona	-	-	-	- 1,075	-	- 320	-	-	-	-	-	72
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	- 60	-	-	1,348	-	-	- 100	- 262	-	290	-	3

Shifts in solar between locations

Shift in Location-Constrained Storage locations

Replacement for out-of-state (and Northeast CA) geothermal spread between locations

Limited OOS Sensitivity

Selected Builds by Study Area (2042)

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	18	926	-	500	-	-
PGE_Fresno	-	-	-	7,731	1,176	5,742	-	-	-	-	-	274
PGE_GBA	247	-	-	3,859	344	59	186	-	-	-	-	632
PGE_Kern	245	-	-	9,419	345	107	-	-	-	-	-	5
PGE_NGBA	1,893	-	-	3,878	393	-	-	668	60	673	-	507
PGE_Northeast_CA	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Arizona	-	-	-	5,508	493	-	-	-	-	-	-	-
SCE_Eastern	819	-	-	9,012	240	85	-	567	-	7	-	-
SCE_EOP	255	1,800	-	14,482	593	1,444	500	-	703	-	1,540	5
SCE_Metro	-	-	-	544	1,405	11,589	-	-	-	-	-	-
SCE_NOL	1,243	-	-	862	-	6	373	-	-	-	-	-
SCE_Northern	2,434	-	-	6,859	590	600	3,170	-	-	-	-	-
SDGE (Generic)	-	-	-	-	-	-	176	262	-	-	-	-
SDGE_Arizona	-	-	-	6,057	-	328	-	-	-	-	-	72
SDGE_Baja_California	1,958	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	923	-	-	2,099	39	461	69	267	-	238	-	3

Plus 500 MW total 100-hr storage in SCE

Selected Builds by Study Area (2042) – Change from Recommended Base Case

Region (MW)	In-State Wind	Out-of-State Wind	Offshore Wind	Solar	Li-ion Battery (4-hr)	Li-ion Battery (8-hr)	Location-Constrained Storage (12-hr)	In-State Geothermal	Out-of-State Geothermal	In-State EGS - Near Field	Out-of-State EGS - Near Field	EGS - Deep
PGE (Generic)	-	-	-	-	-	-	1	902	-	500	-	-
PGE_Fresno	-	-	-	- 106	-	- 386	-	-	-	-	-	5
PGE_GBA	-	- 951	-	1,690	-	-	186	-	-	-	-	67
PGE_Kern	-	-	-	- 311	-	- 305	- 47	-	-	-	-	-
PGE_NGBA	-	-	-	- 506	-	-	-	25	- 748	344	- 297	507
PGE_Northeast_CA	- 1,015	-	-	-	-	-	-	- 178	-	- 178	-	-
SCE_Arizona	-	-	-	-	-	-	-	-	-	-	-	-
SCE_Eastern	352	-	-	477	-	-	- 365	535	-	7	-	-
SCE_EOP	-	- 6,559	-	1,402	-	840	-	-	- 80	-	- 789	5
SCE_Metro	-	-	-	-	-	4,020	-	-	-	-	-	-
SCE_NOL	1,231	-	-	339	-	-	- 113	-	-	-	-	-
SCE_Northern	95	-	-	1,240	-	- 1,147	- 47	-	-	-	-	-
SDGE (Generic)	-	-	-	-	-	-	176	262	-	-	-	-
SDGE_Arizona	-	-	-	2,286	-	-	-	-	-	-	-	72
SDGE_Baja_California	-	-	-	-	-	-	-	-	-	-	-	-
SDGE_Imperial	- 60	-	-	1,348	-	-	- 100	- 262	-	290	-	3

Incremental in-state wind concentrated SCE NOL; Northeast CA wind new out-of-state wind not available

Incremental solar spread between several study areas

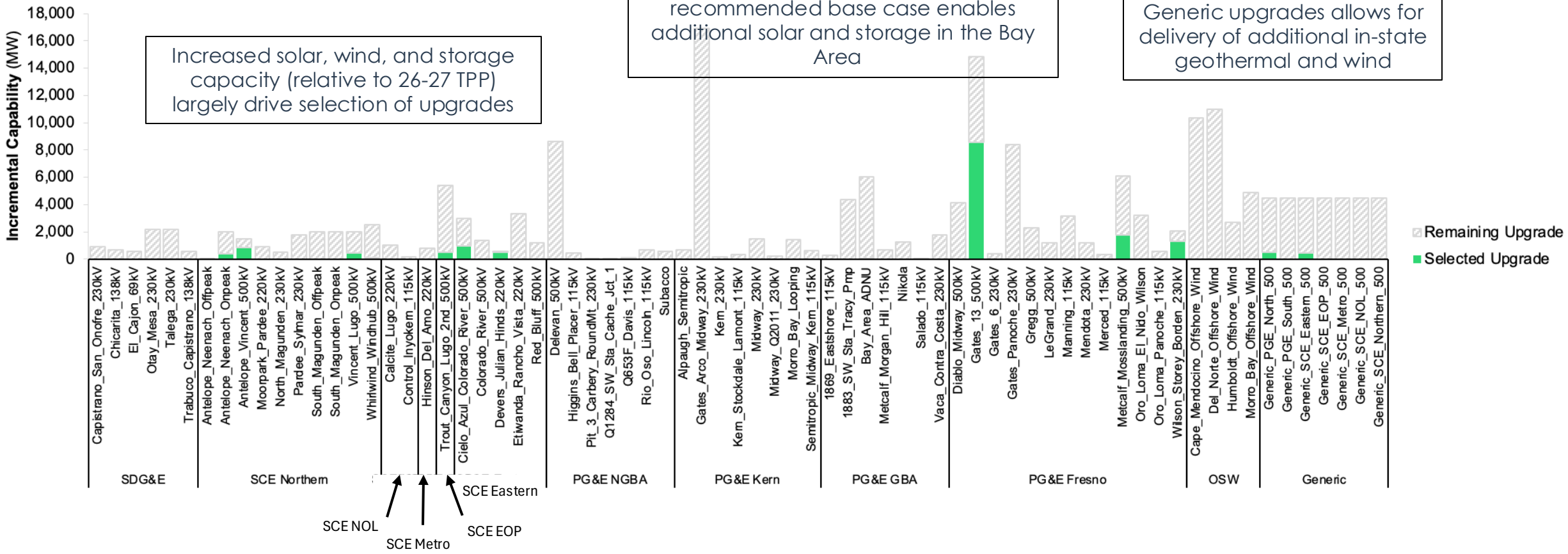
Shift in Location-Constrained Storage locations

Additional in-state geothermal by 2042 is primarily concentrated in PG&E

Limited OOS Sensitivity

RESOLVE-Selected Transmission Upgrades (2037)

Selected Transmission Upgrades by Study Area, 2037
(MW)



Increased solar, wind, and storage capacity (relative to 26-27 TPP) largely drive selection of upgrades

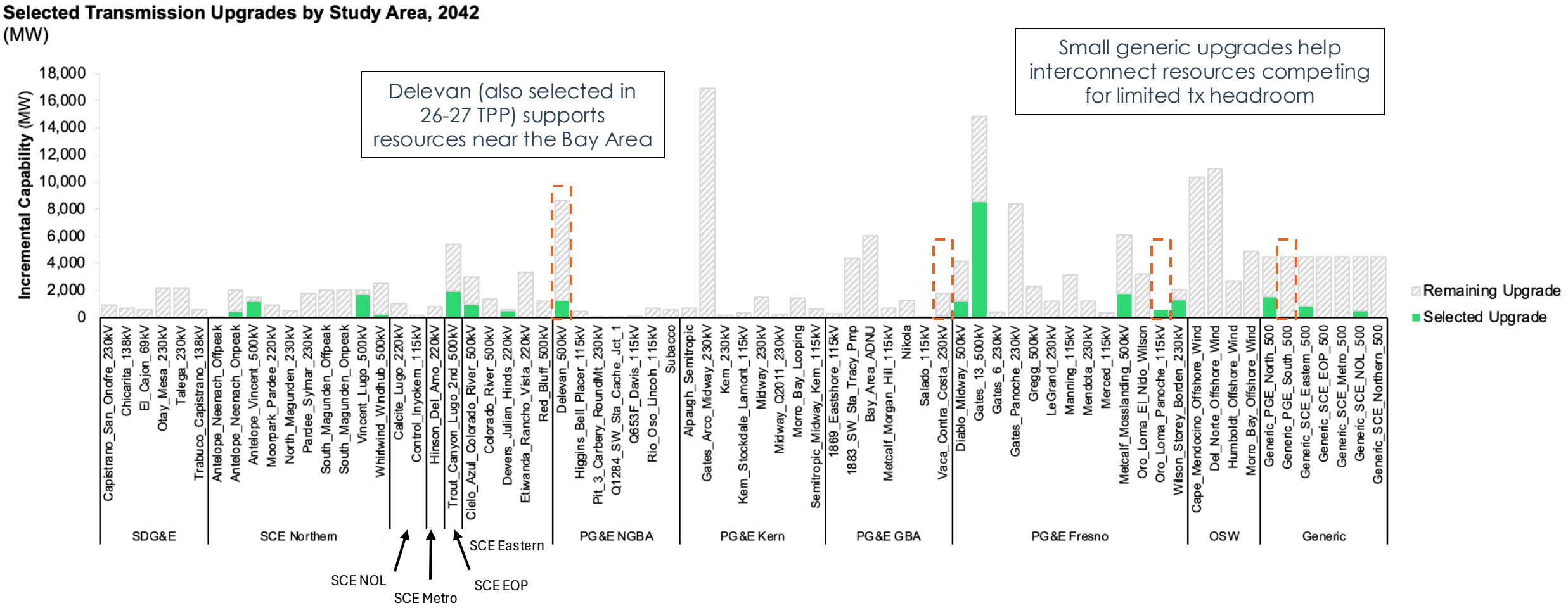
Increased Metcalf-Mosslanding selection compared to recommended base case enables additional solar and storage in the Bay Area

Generic upgrades allows for delivery of additional in-state geothermal and wind

Officially selected transmission upgrades are determined by the CAISO Transmission Plan

Limited OOS Sensitivity

RESOLVE-Selected Transmission Upgrades (2042)



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case (2037)

- **~1 GW net additional transmission upgrades are selected to accommodate in-state resources** by 2037, with a net cost increase of ~$1.3 Billion (~$125 Million/yr)

Constraint	Upgrade	Study Area	Cost ($/kW-yr)	Limited OOS	Recommended Base Case	Limited OOS MW	Recommended Base Case MW
Eagle Mountain Area Deliverability Constraint	Devers Julian Hinds 220kV	SCE Eastern	$182.62	✓	✗	535	0
	Generic SCE Eastern 500		$61.80	✓	✗	437	0

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

RESOLVE-Selected Transmission Upgrades – Changes from Recommended Base Case (2042)

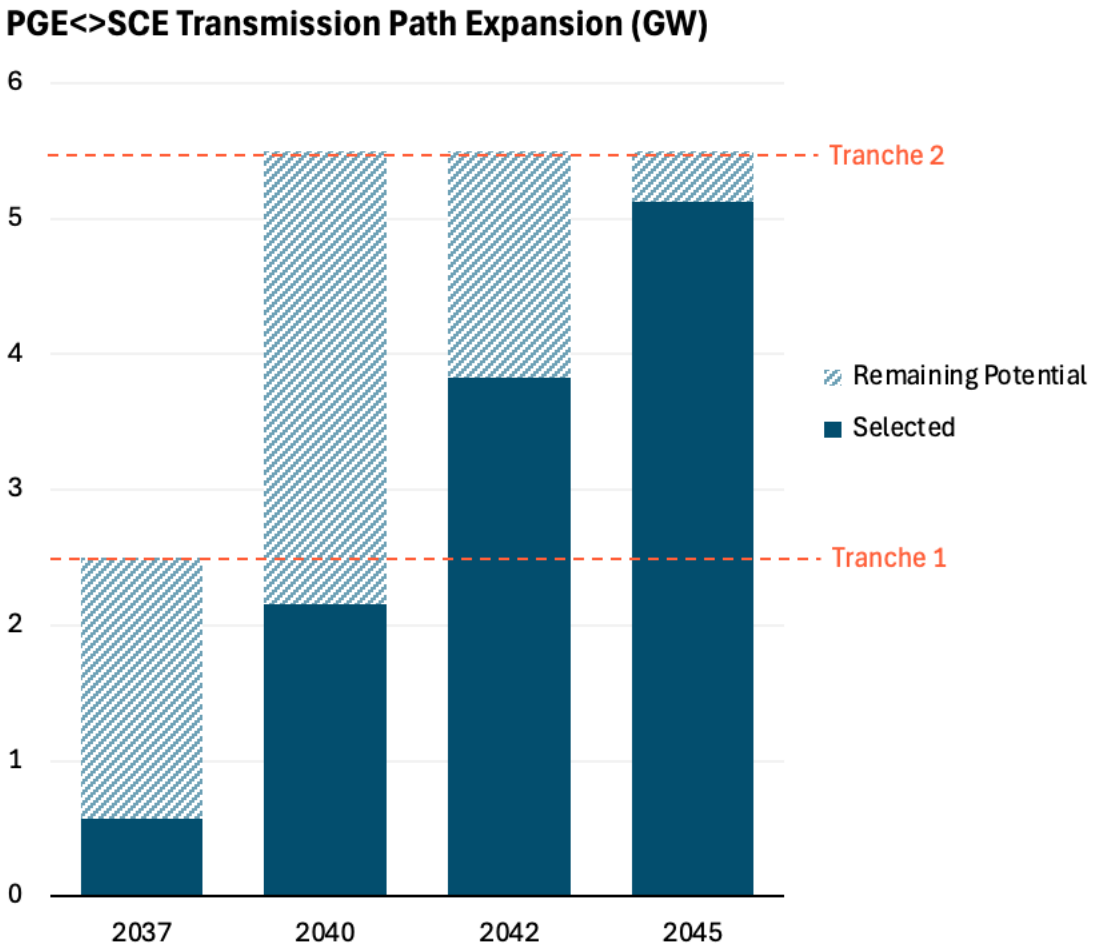
- **~2 GW net additional transmission upgrades** selected by 2042, at an additional cost of ~$1.9Billion (~$175 Million/yr) to accommodate additional in-state resources

Constraint	Upgrade	Study Area	Cost ($/kW-yr)	Limited OOS	Recommended Base Case	Limited OOS MW	Recommended Base Case MW
Eagle Mountain Area Deliverability Constraint	Devers Julian Hinds 220kV	SCE Eastern	$182.62	✓	✗	535	0
	Generic SCE Eastern 500		$61.80	✓	✗	862	0
	Generic SCE NOL 500		$41.20	✓	✗	489	0
Birds Landing-Contra Costa 230kV Line	Vaca Contra Costa 230kV	PG&E GBA	$36.74	✓	✗	134	0
	Generic SCE EOP 500		$41.20	✗	✓	0	39

Officially selected transmission upgrades are determined by the CAISO Transmission Plan;
Only upgrades selected in one case and not the other are shown; upgrades selected in different MW amounts omitted

PG&E-SCE Transmission Path Expansion

- Path 26/Path 15 expansion(s) are selected primarily to increase import capacity into PG&E
- Path expansion is selected by RESOLVE as soon as it becomes available in 2037, with the full first tranche built by 2042
  - Limited out-of-state resources drives ~1 GW additional selection by 2042, though other years remain similar to the recommended base case
- Most of the second tranche is selected by 2045, more than doubling the transmission capacity



Officially selected transmission upgrades are determined by the CAISO Transmission Plan

Appendix

Marginal GHG Abatement Costs in RESOLVE

- **Calculated marginal GHG abatement costs represent the marginal cost of reducing electric sector GHG emissions**
- In RESOLVE, the marginal GHG abatement cost is made up of two components: (1) the CARB Cap-and-Invest Program floor carbon price, and (2) the GHG emissions target shadow price, both provided in $/ton
  - The CARB floor price is forecasted by the CEC IEPR forecast and assigned to all in-state emitting generators and unspecified imports in RESOLVE
  - In RESOLVE's linear programming optimization, the GHG emissions target shadow price represents how much the portfolio cost (i.e., the modeled fixed and variable costs in RESOLVE's objective function) would change if the GHG target was relaxed by one ton
  - The GHG shadow price is incremental to the CARB floor price; total electric marginal GHG abatement costs are the sum of the two
- Calculating the electric sector marginal GHG abatement cost is useful for comparing the $/ton of electric GHG reductions to other sectors and to the social cost of carbon (SCC)
  - The SCC represents an estimate of the damages-based social cost of emissions, which can be either higher or lower than policy-driven abatement costs