



To Tri Lu, Senior Director – Hydrostor

From Caitlin Liotiris, Principal – Energy Strategies

Re RESOLVE Portfolio Comparison – CPUC 2026–27 TPP Base Case vs. No Long Duration Storage Sensitivity

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1. Introduction & Study Purpose

In January 2026, Energy Strategies conducted a comparative analysis of two RESOLVE modeling portfolios. This assessment was performed to provide Hydrostor with insights on the impacts associated with not procuring Long-Duration Storage (LDS) to meet the needs of utilities included in the California Public Utilities Commission’s (CPUC) planning processes.

This comparison assessed two different RESOLVE portfolios. The base case for this analysis was the publicly posted 2026–27 Transmission Planning Process (TPP) RESOLVE Base Case. The “No LDS Builds” sensitivity case prevented RESOLVE from selecting all LDS by making those resources unavailable as candidate resources in the model, while maintaining all other assumptions and inputs consistent with the CPUC baseline.¹ Specifically, the following resources were eliminated as candidate resources in the No LDS Builds sensitivity case:

- Li-ion Battery (8-hour)
- Location-Constrained Storage (12-hour)
- Generic LDES (12-hour, 24-hour, and 100-hour)

This “No LDS Builds” case provides insight into how the RESOLVE model substitutes alternative resources when long-duration storage is unavailable, and how these substitutions affect the CPUC’s anticipated portfolio cost and resource composition.

¹ Note that, in addition to making LDS resources unavailable, Energy Strategies removed the Mid-Term Reliability LDS procurement constraint from the RESOLVE No LDS Builds sensitivity case in order to avoid model constraint violations and develop a portfolio without LDS included.

2. Total System Cost Impacts of No Long-Duration Storage

Energy Strategies compared the total system cost impacts of the Base Case and No LDS Builds case from our RESOLVE runs. The results show that the removal of LDS resources from RESOLVE produces a meaningful increase in total modeled system costs over the planning horizon.

The RESOLVE results show that eliminating LDS resources increases total system cost relative to the Base Case by approximately **\$9.7 billion NPV (2022\$)**. The cost increase is largely attributable to an increase in resource investment costs, which are primarily made up of new renewable fixed costs and reflect the model's increased reliance on both firm renewable technologies and increased in-state wind buildout when LDS is unavailable. The case with no LDS also resulted in a NPV with higher adjusted production costs and slightly higher transmission investment than the Base Case, as illustrated in Table 1 below.

Table 1

NPV	Base Case	No LDS Storage	Case - Base
Total System Cost (\$B)	1,633.7	1,643.4	9.7
Tx Investment Cost (\$B)	4.7	4.9	0.2
Resource Investment Cost (\$B)	351.7	359.1	7.4
Adjusted Production Cost (\$B)	94.0	95.7	1.7
GHG Costs (\$B)	10.5	10.4	-0.1

Table 2 provides a more in-depth break down of the difference in the costs of various line items in RESOLVE between the two cases.

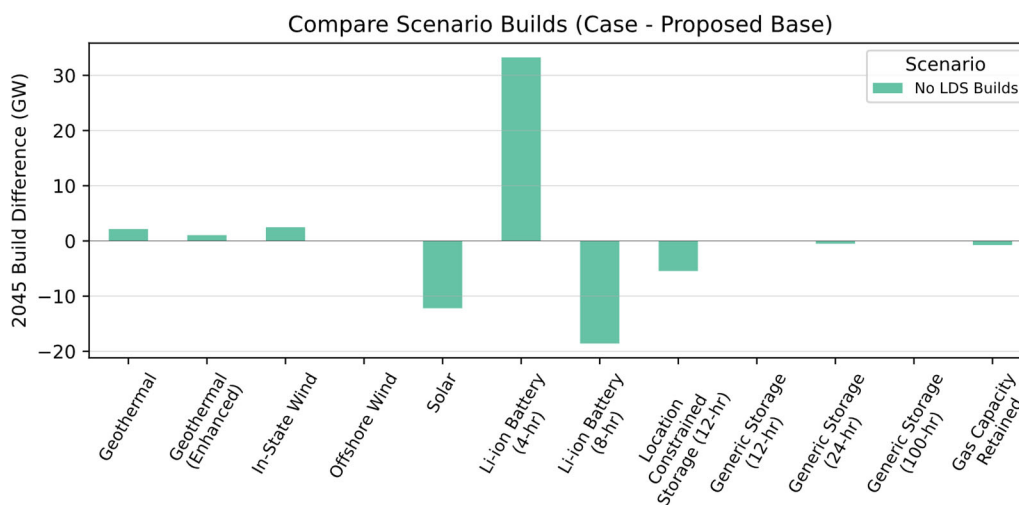
Table 2

Total Optimized Costs (\$ Million): No LDS Builds - Proposed Base						
	2026	2028	2031	2036	2041	2045
Thermal Fleet Fixed Costs	6	(31)	(31)	(39)	(51)	(74)
New Renewables Fixed Costs	2	183	138	891	987	2,114
New Storage Fixed Costs (excludes BTM)	(67)	(388)	318	(356)	(353)	(1,178)
DR Fixed Costs	-	-	-	-	-	-
Variable O&M Costs	1	7	6	3	(0)	4
Fuel Costs	(2)	(74)	(0)	2	(98)	(10)
New CAISO Transmission Fixed Costs	-	-	0	(2)	3	(40)
Generic CAISO Transmission Fixed Costs	-	-	-	-	69	101
New Zonal Transmission Expansion Costs	-	-	-	-	-	(43)
Carbon Costs	(0)	(8)	1	(4)	(12)	(3)
Market Purchases	(5)	246	5	267	145	117
Market Revenues	4	(8)	(34)	94	29	(45)
Total Generation, Storage, and DR Costs (excluding BTM)	(60)	(303)	431	502	484	855
Total Transmission Upgrade Costs	-	-	0	(2)	72	18
Total & Carbon Market Costs	(1)	230	(28)	357	162	69
Total Optimized Costs	(61)	(73)	404	857	718	943

3. Portfolio Comparison

In addition to observing different costs between the 2026-27 Base Case and No LDS Builds portfolios, there are also differences in the underlying resource composition of the portfolios. The most significant portfolio shifts in the No LDS Builds sensitivity case occur in the renewable and storage build decisions. In the absence of LDS as a candidate resource, RESOLVE replaces LDS capacity through a combination of shorter-duration batteries and additional renewable builds. Figure 1 below illustrates the difference in energy builds between the two cases.

Figure 1



Removing LDS candidates results in a heavy shift toward 4-hour lithium-ion battery deployment, with the No LDS Builds sensitivity resulting in an additional 33 GW of 4-hour storage (which is offset by a loss of roughly 25 GW of LDS resources). Despite the greater storage capacity, the No LDS Builds case includes 93 GWh **less** of total storage energy capability than the 2026-27 Base Case. This indicates that while capacity (GW) can be replaced with short-duration batteries, the overall energy duration value (GWh) of LDS is not fully replicated.

Additionally, to compensate for reduced storage flexibility, RESOLVE builds additional firm renewable resources, particularly geothermal and enhanced geothermal resources. These technologies appear as key substitutes likely because they provide flat, must-run capacity and contribute firm planning value to meeting RESOLVE's planning reserve margin/reliability metrics.

In addition to geothermal expansion, RESOLVE adjusts renewable composition in California, by increasing in-state wind and by decreasing CAISO solar (by ~12 GW). The reduction in solar may reflect interactions between solar + storage Effective Load Carrying Capability (ELCC) assumptions

contained in RESOLVE.² In short, it is possible this decrease in solar resources selected occurs because, without long-duration storage to shift daytime output, additional solar becomes less valuable.

Finally, we note that the No LDS Builds case also retires an additional 2.4 GW of natural gas capacity over the model horizon relative to the 2026-27 Base Case. While the No LDS Builds sensitivity sees reduced in-state natural gas generation, these reductions are offset by increased reliance on unspecified imports with their own GHG profile.

4. Conclusion

The RESOLVE case comparison demonstrates that removing LDS resources leads to:

1. **Higher total system costs (+\$9.7B NPV)**, driven primarily by higher renewable investment needs
2. **Substitution of LDS with extensive 4-hour storage builds**, though total storage *energy* capability declines
3. **Increased geothermal and enhanced geothermal deployment**, raising renewable fixed costs
4. **Reduced California solar buildout (~12 GW decline)** and increased in-state wind additions
5. **Additional natural gas retirements**, with greater reliance on imports for system balancing

² For additional information on these impacts, see slides 118-129 of the following presentation <https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2024-2026-irp-cycle-events-and-materials/presentation-slides-2025-ia-workshop.pdf>.