

2022-2023 TPP High Electrification Load Sensitivity RESOLVE Modeling Results

July 1, 2022



California Public
Utilities Commission

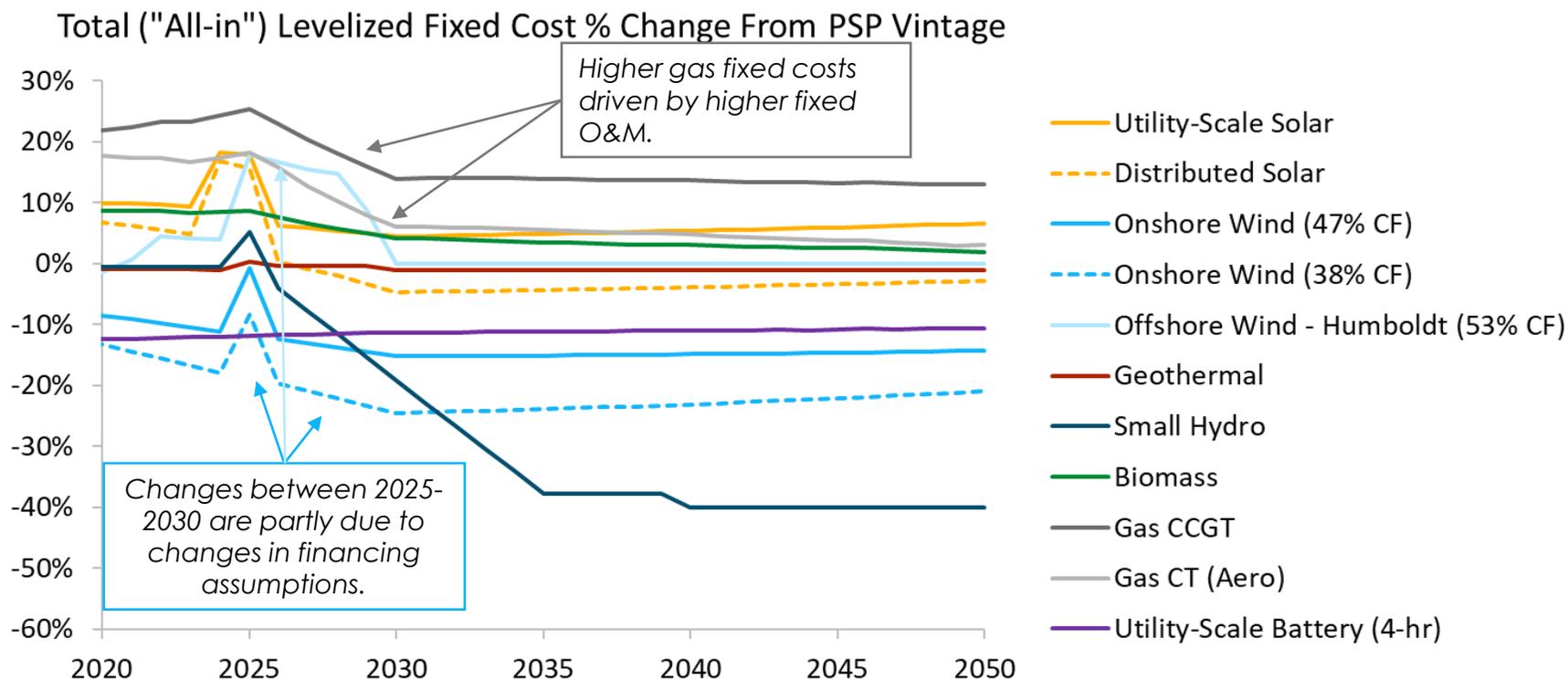
Contents

- RESOLVE Updates for LSE Plan Filing Requirements
- Detailed Results

Summary of RESOLVE Model Updates since February PSP Decision Release

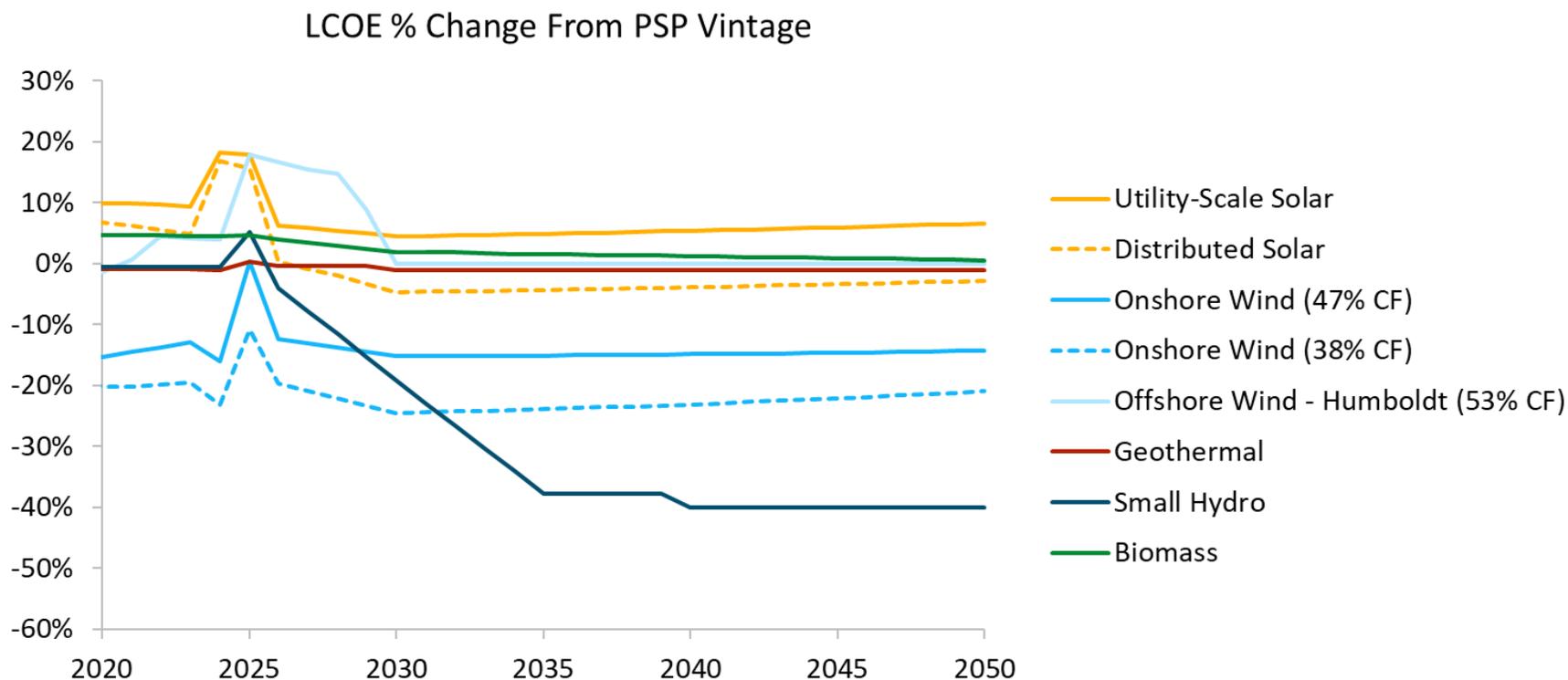
Update Category	Key Changes
Resource Costs and Potential	<ul style="list-style-type: none">Updated resource costs to NREL 2021 ATB and Lazard LCOS v7.0
Grid Planning Scenarios	<ul style="list-style-type: none">Updated the RESOLVE load forecast to the CEC 2021 IEPR including Mid, High, and Additional Transportation Electrification load scenario to capture high electrification future
Transmission Deliverability	<ul style="list-style-type: none">Updates to transmission deliverability – resource mappings, existing transmission deliverability capacity, transmission upgrades using the updated 2021 CAISO transmission whitepaper and the draft results of the CAISO analysis of the 2021-2022 TPP

Changes in total ("all-in") levelized fixed costs



Total levelized fixed costs are cost inputs into RESOLVE for candidate resources and impact resource build decisions.

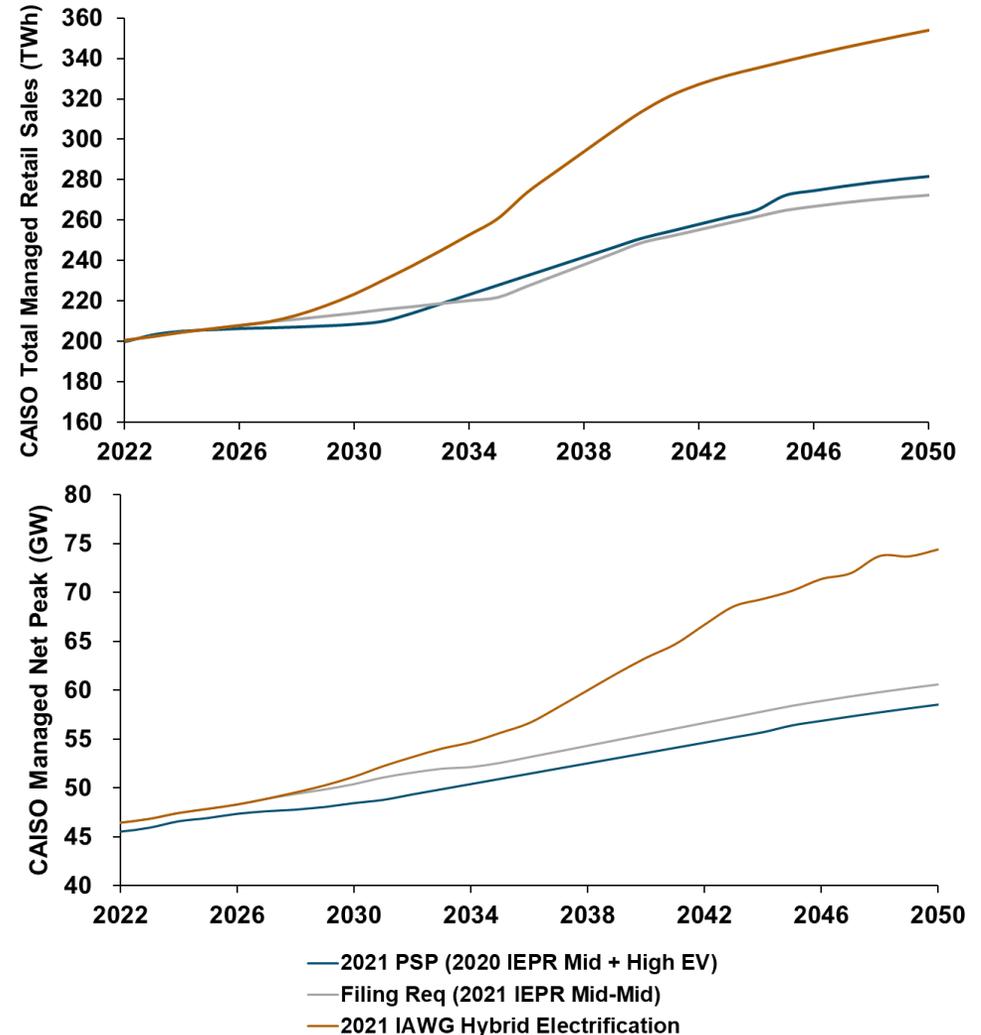
Changes in levelized cost of energy (LCOE)



Note: The LCOEs shown in this presentation are illustrative. All-in levelized costs are the primary cost inputs for new resources in RESOLVE. LCOEs are inferred from dispatch results.

Comparison of Load Forecast Scenarios

- By 2032 the 2021 IAWG Hybrid Electrification scenario has higher retail sales and slightly higher managed peaks than the 2021 IEPR Mid
- By 2045 the 2021 IAWG Hybrid Electrification has significantly higher retail sales compared to other scenarios
- The 2021 IAWG Hybrid Electrification scenario has similar managed net peak through 2027 as the 2021 IEPR Mid scenario.
- In 2028-2035, peak load is slightly higher in the 2021 Hybrid scenario compared to 2021 IEPR Mid due to additional transportation electrification
- Peak load grows significantly between 2036 and 2045 due to more aggressive transportation and building electrification assumptions in the Hybrid electrification scenario compared to 2021 IEPR Mid.

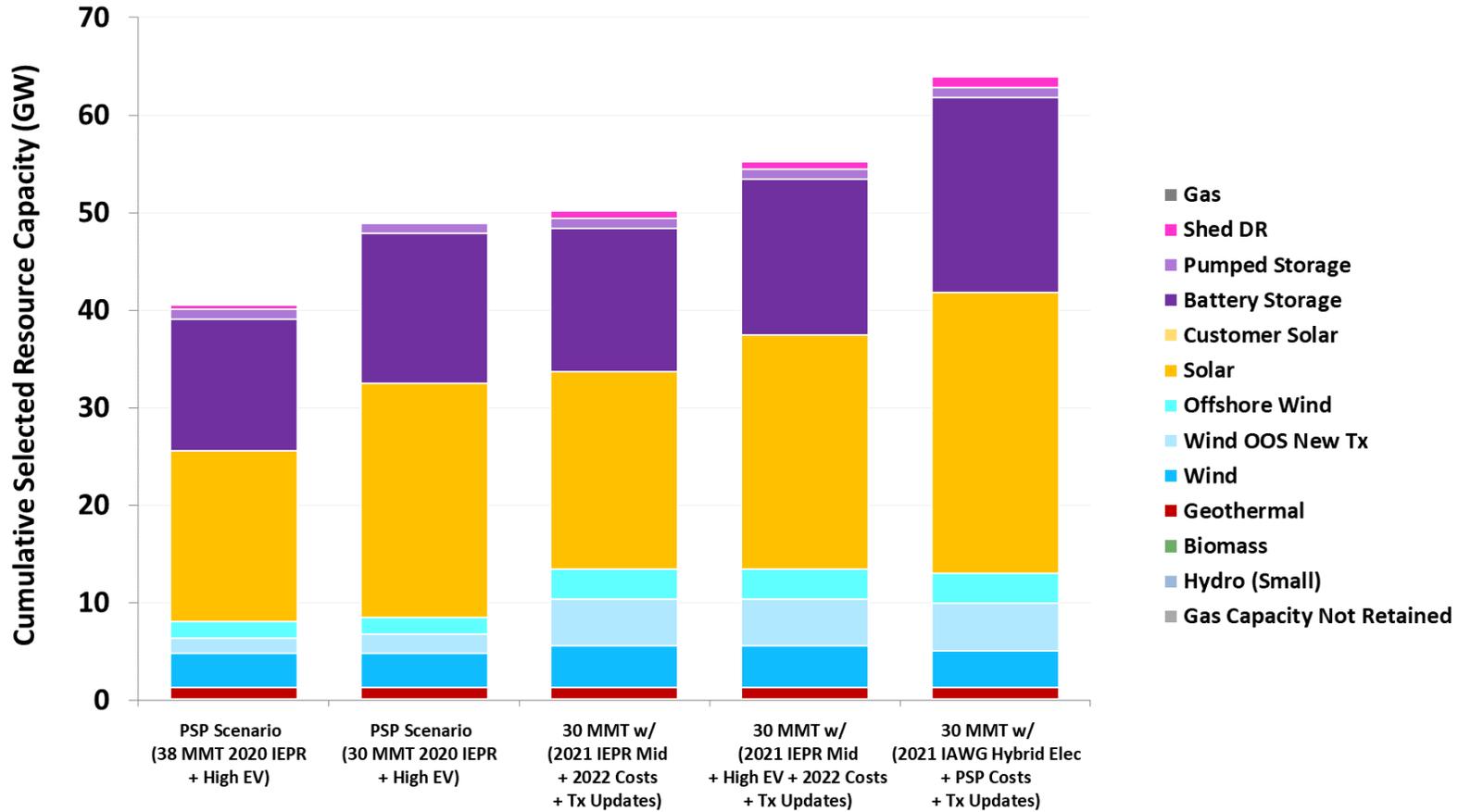


Transmission Deliverability Updates

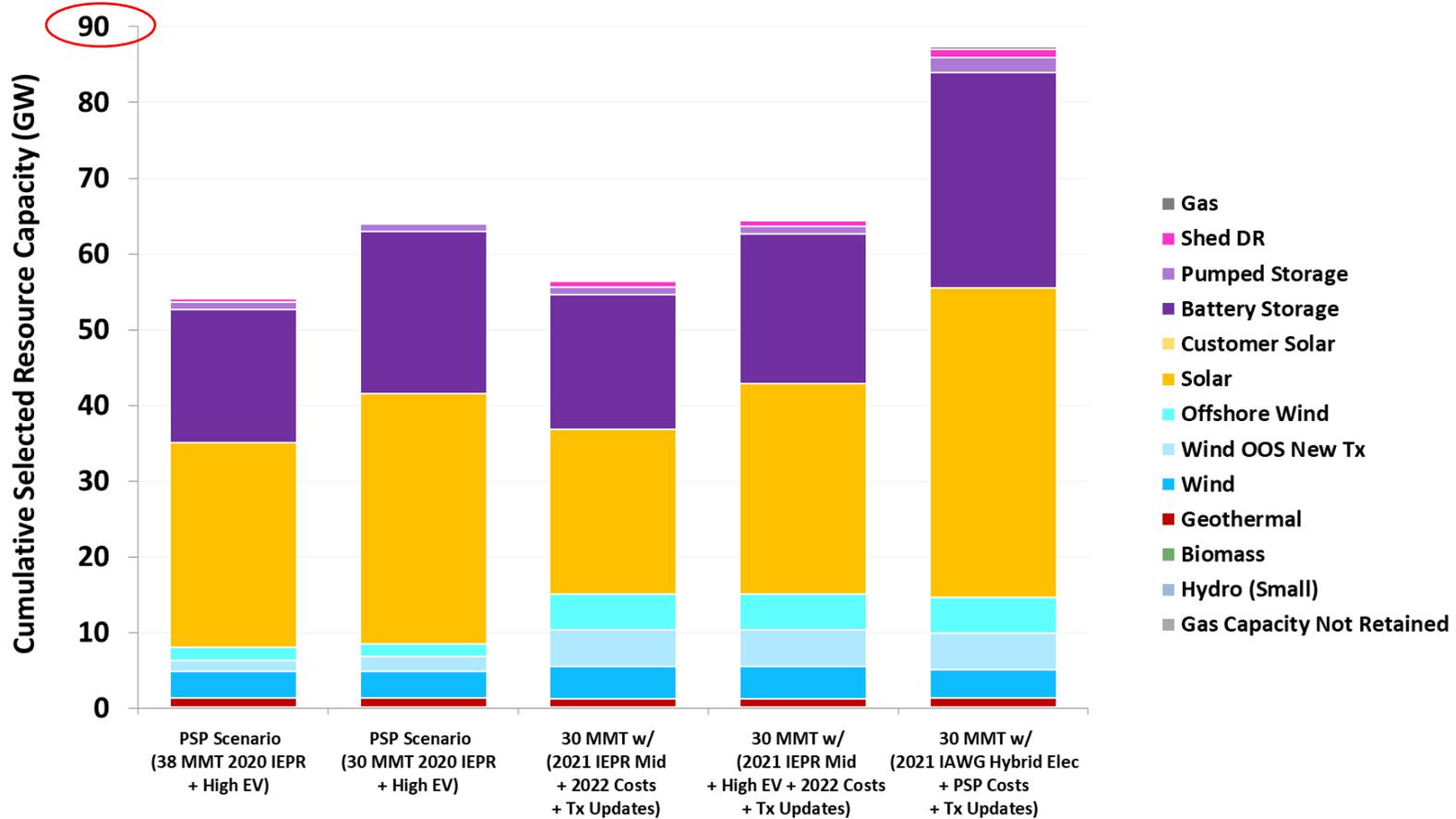
- Deliverability Updates
 - Adjustment of resources associated with the East of Miguel transmission constraint based on the updated CAISO Transmission Deliverability whitepaper
 - Updates to available transmission deliverability capacity to reflect reductions due to online resources and approved upgrades, from 2021-2022 TPP Base Case
 - Updates to transmission utilization factor for out-of-state wind resources, based on results from the 2021-2022 TPP Analysis
- Transmission Upgrade Updates
 - New transmission upgrades available for Morro Bay Offshore Wind and Humboldt Bay Offshore Wind, based on results from the 2021-2022 TPP Analysis

Scenario Results

Summary of Scenarios 2032 Snapshot Year



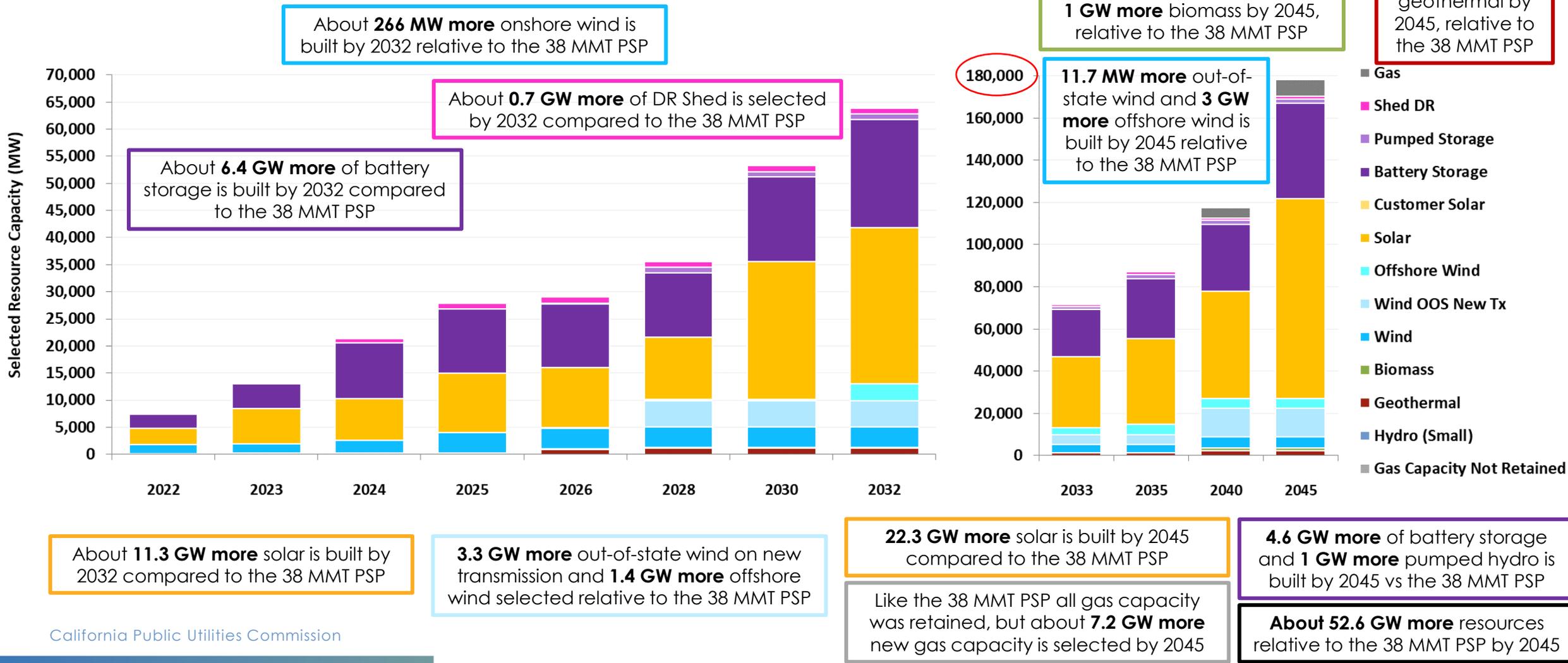
Summary of Scenarios 2035 Snapshot Year



30 MMT With 2021 IAWG Hybrid Electrification Load + 2022 Costs

With Transmission Updates

Selected resources – 30 MMT with 2021 IAWG Hybrid Elec + 2022 Costs + Tx Updates



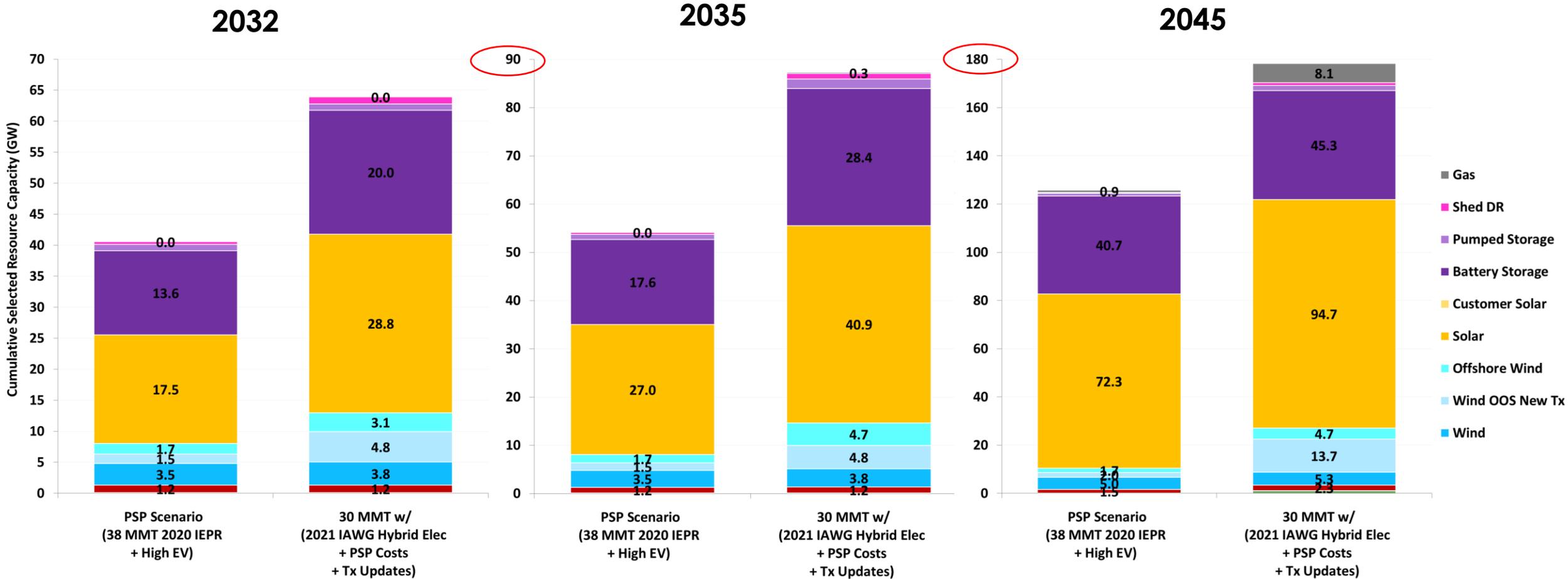
Selected resources – 30 MMT with 2021 IAWG Hybrid Elec + 2022 Costs + Tx Updates

	Unit	2022	2023	2024	2025	2026	2028	2030	2032	2033	2035	2040	2045
Gas	MW	-	-	-	-	-	-	-	-	-	256	4,742	8,135
Biomass	MW	34	65	83	107	107	134	134	134	134	134	1,147	1,147
Geothermal	MW	14	114	114	114	942	1,152	1,152	1,152	1,186	1,186	2,332	2,332
Hydro (Small)	MW	-	-	-	-	-	-	-	-	-	-	-	-
Wind	MW	1,697	1,719	2,347	3,797	3,797	3,797	3,797	3,797	3,797	3,797	5,297	5,297
Wind OOS New Tx	MW	-	-	-	-	-	4,828	4,828	4,828	4,828	4,828	13,660	13,660
Offshore Wind	MW	-	-	-	-	120	195	200	3,100	3,320	4,707	4,707	4,707
Solar	MW	3,094	6,549	7,750	11,000	11,000	11,539	25,414	28,779	33,480	40,879	50,620	94,681
Customer Solar	MW	-	-	-	-	-	-	-	-	-	-	-	-
Battery Storage	MW	2,565	4,603	10,222	11,771	11,771	11,860	15,613	19,993	22,437	28,402	31,780	45,323
Pumped Storage	MW	-	-	-	-	196	1,000	1,000	1,000	1,463	2,000	2,000	2,000
Shed DR	MW	151	151	893	1,115	1,115	1,115	1,115	1,115	1,115	1,115	1,115	1,115
Gas Capacity Not Retained	MW	-	-	-	-	-	-	-	-	-	-	-	-
Storage + DR	MW	2,716	4,755	11,115	12,886	13,082	13,976	17,729	22,108	25,015	31,518	34,895	48,439
Total Resources (Renewables + Storage + DR)	MW	7,555	13,202	21,410	27,905	29,049	35,622	53,254	63,898	71,761	87,306	117,400	178,397

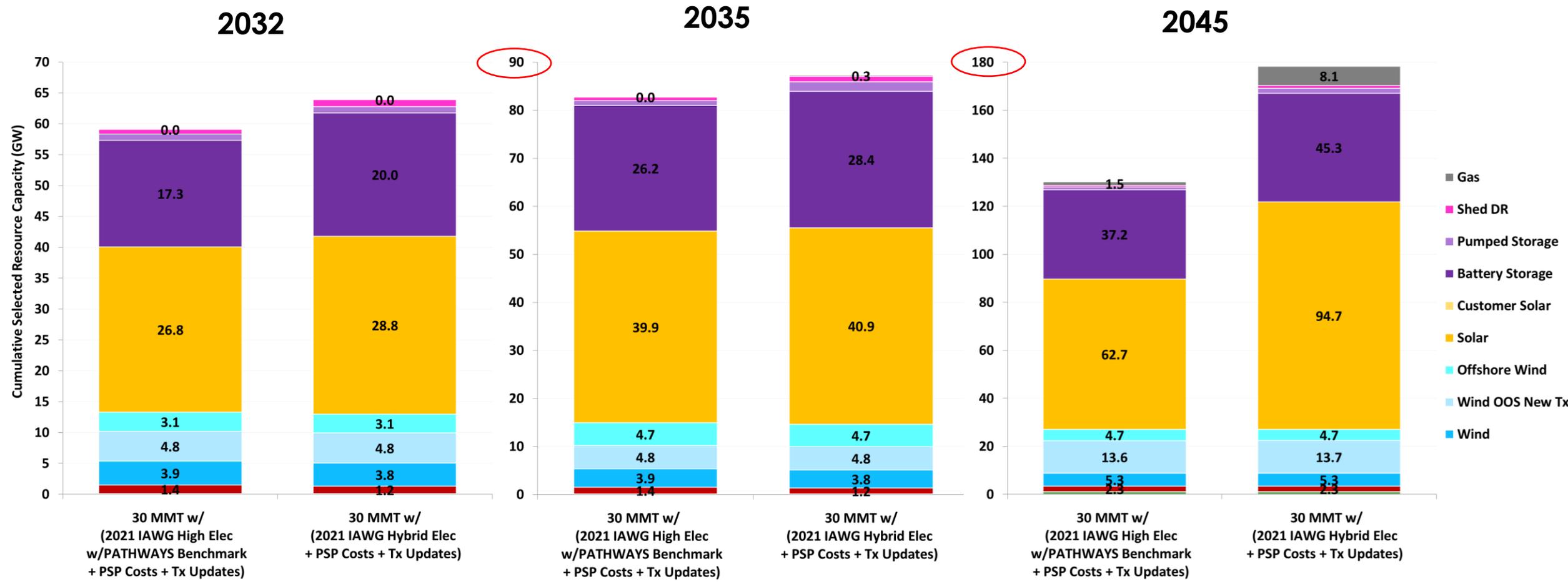
Relative to the 38 MMT PSP we find the following:

- By 2032 there is about 11.3 GW more solar PV resources, about 6.4 GW more battery storage resources, about 0.7 GW more DR, about 0.3 GW more onshore wind, about 3.3 GW more out-of-state wind, and about 1.4 GW more offshore wind.
- By 2035 there is about 13.9 GW more solar PV, about 10.8 GW more battery storage, 1 GW more pumped storage, about 0.7 GW more DR, about 0.3 GW more onshore wind, about 3.3 GW more out-of-state wind, and 3 GW more offshore wind, and 0.3 GW more gas.
- By 2045 there is about 22.3 GW more solar PV, 4.6 GW more battery storage, about 0.7 GW more DR, about 0.3 GW more onshore wind, about 11.7 GW more out-of-state wind, 3 GW more offshore wind, 0.8 GW more geothermal, 1 GW more biomass, and 7.2 GW more new gas.

PSP (38 MMT) vs 30 MMT with 2021 IAWG Hybrid Elec + 2022 Costs + Tx Updates



30 MMT with 2021 IAWG High Elec w PATHWAYS Benchmark vs 2021 IAWG Hybrid Elec + 2022 Costs + Tx Updates



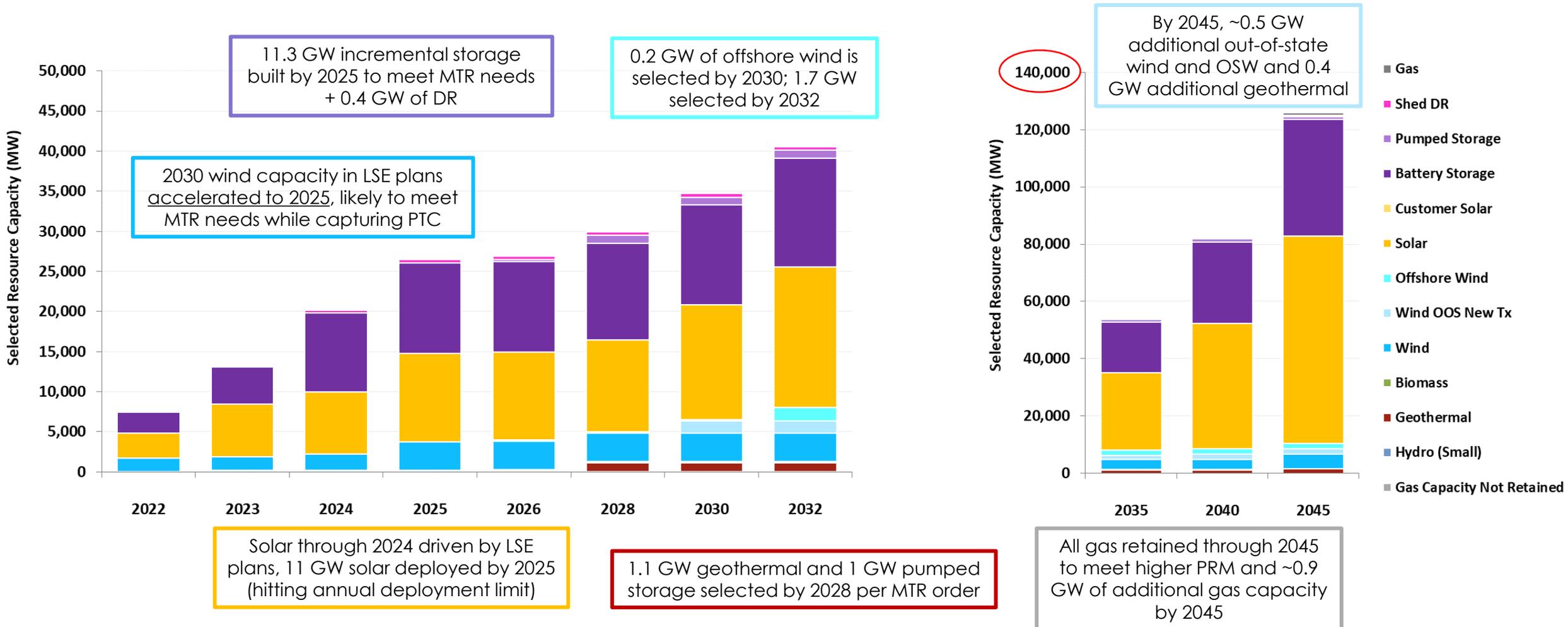
Key Highlights

- In the hybrid electrification scenario, there is a significant increase in the amounts of selected resources such that builds increase at an annual rate of 2.3, 2.6 and 2.3 GW through 2032, 2035, and 2045, respectively
- With the transmission updates we see significantly more out-of-state wind and offshore wind development throughout the modeling period
- Selected solar resources doubles in 2045 compared to 2032
- Additional gas capacities are needed as early as 2035, while firm thermal capacity needs increase in later years including from gas, biomass and geothermal resources
 - All the existing gas capacity is retained

38 MMT PSP Scenario – 38 MMT with 2020 IEPR + 2020 IEPR High EV

Voted in February

Selected resources – 38 MMT with 2020 IEPR + 2020 IEPR High EV



Selected resources – 38 MMT with 2020 IEPR + 2020 IEPR High EV

	Unit	2022	2023	2024	2025	2026	2028	2030	2032	2035	2040	2045
Gas	MW	-	-	-	-	-	0	0	0	0	0	926
Biomass	MW	34	65	83	107	107	134	134	134	134	134	134
Geothermal	MW	14	114	114	114	184	1,160	1,160	1,160	1,160	1,160	1,521
Hydro (Small)	MW	-	-	-	-	-	-	-	-	-	-	-
Wind	MW	1,697	1,719	2,049	3,531	3,531	3,531	3,531	3,531	3,531	3,531	5,031
Wind OOS New Tx	MW	-	-	-	-	0	0	1,500	1,500	1,500	1,970	1,970
Offshore Wind	MW	-	-	-	-	120	195	195	1,708	1,728	1,728	1,728
Solar	MW	3,094	6,549	7,750	11,000	11,000	11,397	14,342	17,506	26,977	43,716	72,340
Customer Solar	MW	-	-	-	-	-	-	-	-	-	-	-
Battery Storage	MW	2,565	4,604	9,811	11,317	11,317	12,078	12,395	13,571	17,648	28,528	40,706
Pumped Storage	MW	-	-	-	-	196	1,000	1,000	1,000	1,000	1,000	1,000
Shed DR	MW	151	151	353	441	441	441	441	441	441	441	441
Gas Capacity Not Retained	MW	-	-	-	-	-	-	-	-	-	-	-
Storage + DR	MW	2,716	4,755	10,164	11,758	11,954	13,519	13,835	15,012	19,089	29,969	42,147
Total Resources (Renewables + Storage + DR)	MW	7,555	13,202	20,161	26,511	26,897	29,937	34,698	40,551	54,120	82,210	125,799

- Resources selected by RESOLVE between 2030 and 2032, i.e., beyond the planning horizon of the current LSE plans:
 - ~3.2 GW solar PV, ~1.2 GW battery storage, ~1.5 GW offshore wind