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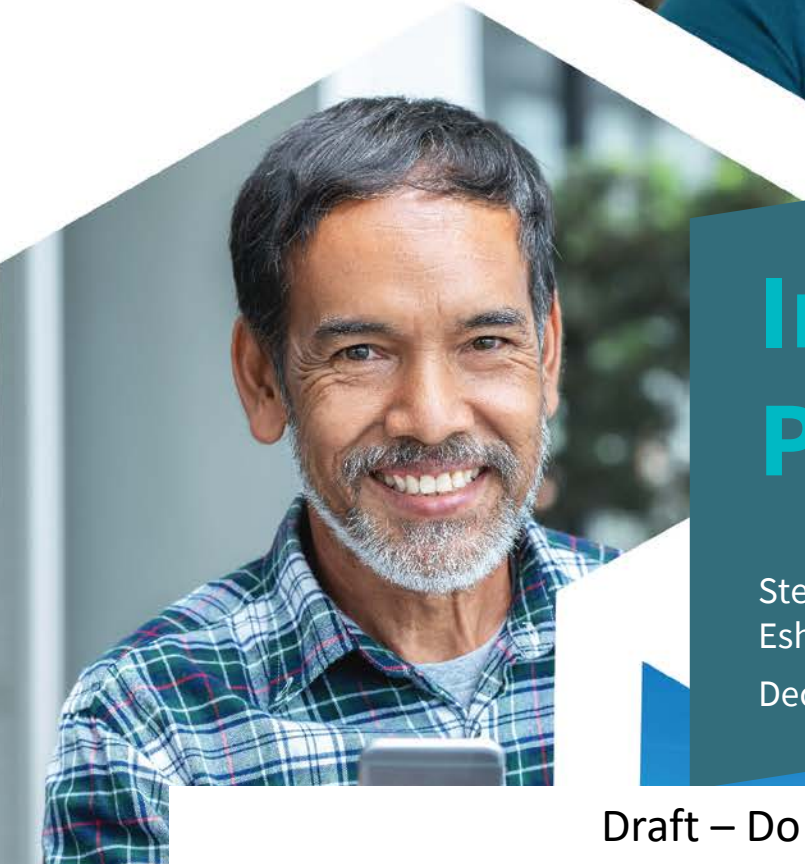

Integrated Resource Plan Results

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December 10, 2020

Draft – Do not distribute

Agenda

- IRP Overview and Objectives
- Modeling Approach
- Initial Results
- Summary & Next Steps

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Overview of EBCE IRP Process

- Phased approach to meet compliance obligations and evaluate portfolios to meet a range of greenhouse gas (GHG) emissions targets for EBCE
- Phase 1: CPUC IRP Filing
  - Includes two GHG target scenarios that represent EBCE's share of a 46 million metric ton (MMT) and 38 MMT statewide electric sector target
  - Phase 1 deliverables submitted to CPUC in September
- Phase 2: EBCE IRP Analysis
  - Includes GHG target scenario that represents EBCE's share of a 30 MMT statewide electric sector target and explores cost of achieving net zero GHG emissions
  - Revises CPUC 46 and 38 MMT scenarios to align with EBCE assumptions
  - Phase 2 deliverables will provide EBCE Board of Directors with a set of options to create a 2030 Clean Energy Goal

Objectives

- Analyze range of GHG targets
- Meet CPUC compliance requirements
- Identify reliability needs of different portfolios
- Define trade-offs between organizational objectives
- Inform procurement recommendations
- Develop path to expedited GHG reduction

Summary of Select Scenario Results

Key Evaluation Metrics	Scenario 1: EBCE 46 MMT i.e. 1.22 MMT	Scenario 2: EBCE 38 MMT i.e. 0.98 MMT	Scenario 3: EBCE 30 MMT i.e. 0.73 MMT	Scenario 4: EBCE net 0 MMT
Carbon Free (by 2030)	64%	72%	80%	100%
Affordability (2030 cost in 2020$)	$608 MM (2020$)	+3% (+$17 MM)	+6% (+$34 MM)	+14% (+$85 MM)
Resource Mix (2030) (incl. New build vs existing)	1.2 GW new RE PPAs (includes 100 MW BTM S+S) 1.5 GW/ 6 GWh new energy storage 100 MW existing NW hydro			
Risk Mgmt: Short-term vs Long-term Contracts	62% long-term in 2030 (~50% by 2025; ~55% avg. 2021-2030), remaining short-term			
Reliability	~70% of RA need met by long-term portfolio			

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MODELING APPROACH

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Modeling Approach

1. Develop portfolio of resources under long-term contracts
   - Optimized buildout of resources over time
   - Constraints applied to energy, resource specific availability and capacity limits
2. Perform production cost modeling on portfolios, which includes:
   - Short-term contracts
   - Emissions
   - Hourly spot purchases and sales
   - Ancillary services value

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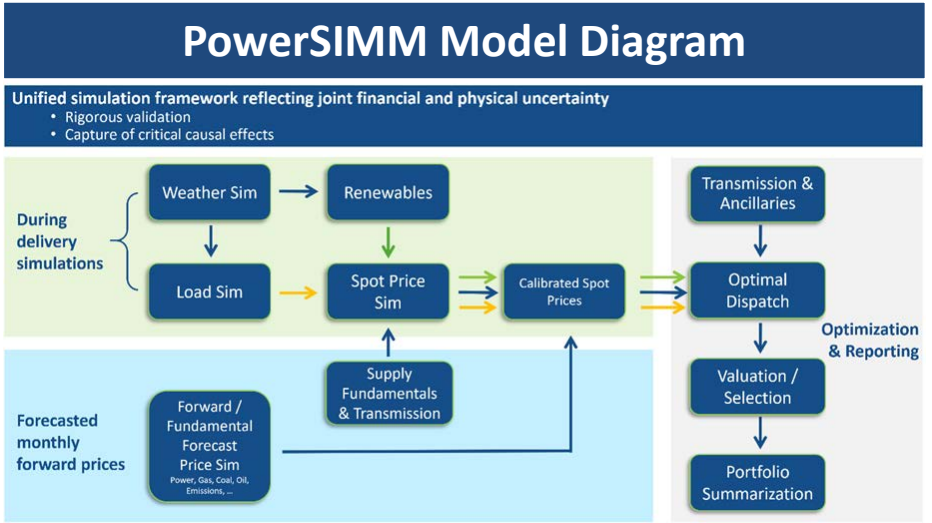
Modeling Tools

- EBCE contracted with Ascend analytics to perform portfolio optimization and production cost modeling using PowerSIMM
- PowerSIMM uses market data and long-term fundamentals to simulate load, renewables, and the CAISO spot market prices against which resources are dispatched and valued



EBCE Optimized Buildout Constraints

Optimization Constraints	• Selects long-term PPA resources up to target of ~60% of total delivered energy • Yearly Long-Term RPS targets • Meets yearly RA requirements, optimizing between PPA resources and market RA purchases

Resource Constraints	• No new resources until 2022
	• No 8hr storage before 2026
	• No in-state hydro available for long-term contracting
	• Annual build limits for each resource
	• Max capacity limits:
	  • Standalone Storage <4 hours – 800 MW
	  • Geothermal – 300 MW
	  • Imported Hydro – 100 MW

Other Notes	• Storage was given a $50/kw-yr credit for sub-hourly dispatch value • Short-term purchases layered on top of selected PPAs to achieve RPS, emissions, and spot exposure targets

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Inputs & Assumptions

	CPUC	EBCE
Load	• CEC IEPR annual load forecast • Modified C&I to Res split • CEC IEPR hourly load modifiers	• EBCE annual load forecast • ~1TWh higher by 2030 (~13%) due to EBCE electrification goals • EBCE hourly load shape
Resource Costs	• CPUC assumptions	• Ascend assumptions
Candidate Resource Types, Availability and Characteristics	• CPUC assumptions w/ EBCE-specific adjustments	• Includes hybrid solar + storage • Fixed storage durations • Custom RE profiles • Annual and total build limits • Modified ELCC/QC assumptions
Risk Mgmt: Short-Term vs Long-Term Contracts	• 62% long-term (46 MMT), remaining short-term (mix of existing renewables, carbon free and system power)	• 62% long-term, remaining short-term

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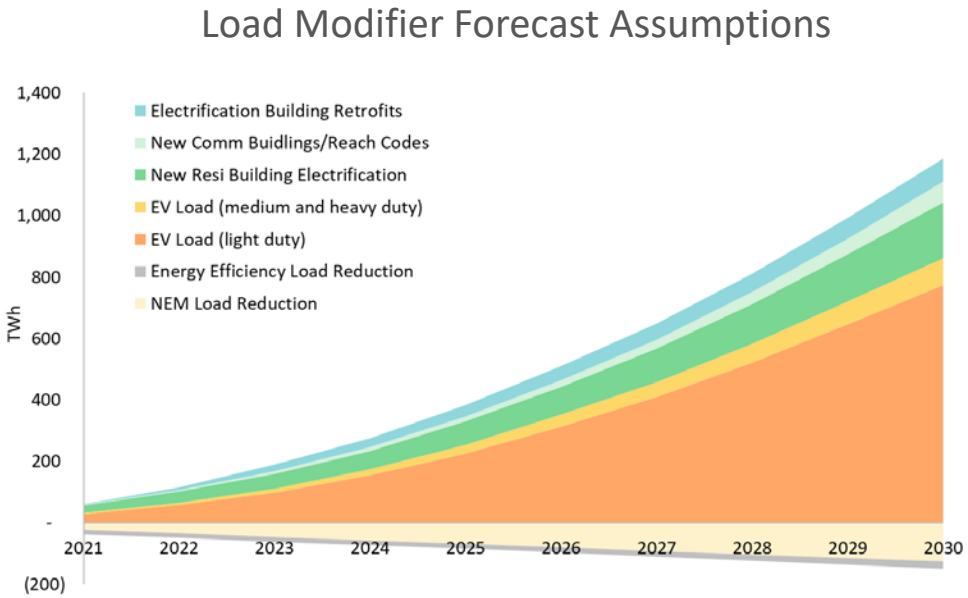
Load Assumptions

- Electrification growth (cumulative by 2030, approx.):
  - 190,000 light-duty EVs
  - 6,000 med and heavy-duty
  - 38,000 new residential and 900 new commercial all electric buildings
- Electrification growth offset somewhat by EE load reduction and NEM production



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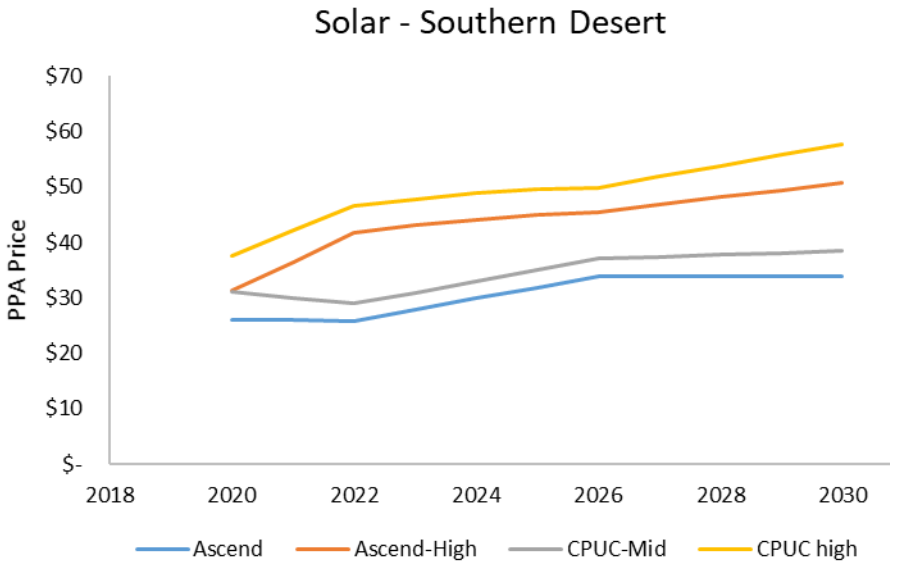
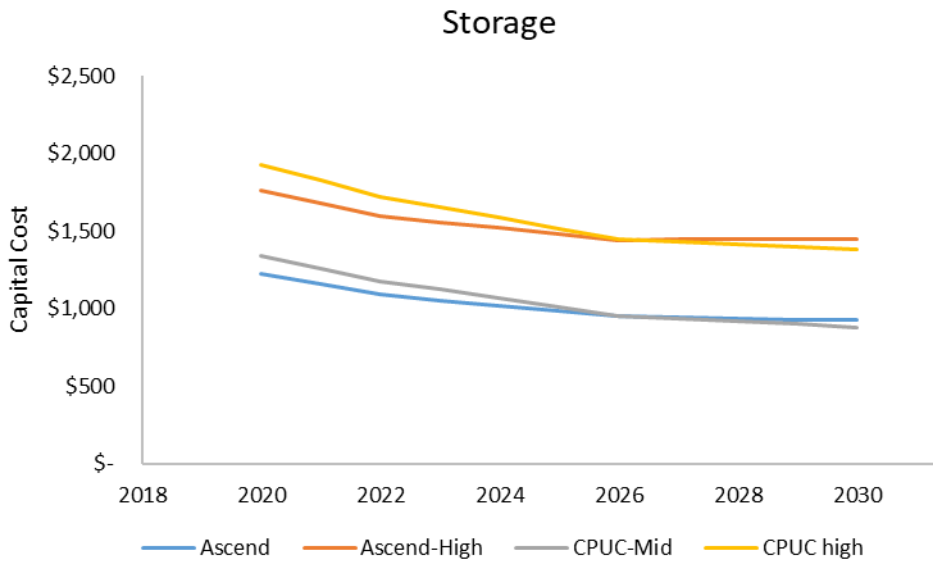
Resource Cost Assumptions





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RESULTS

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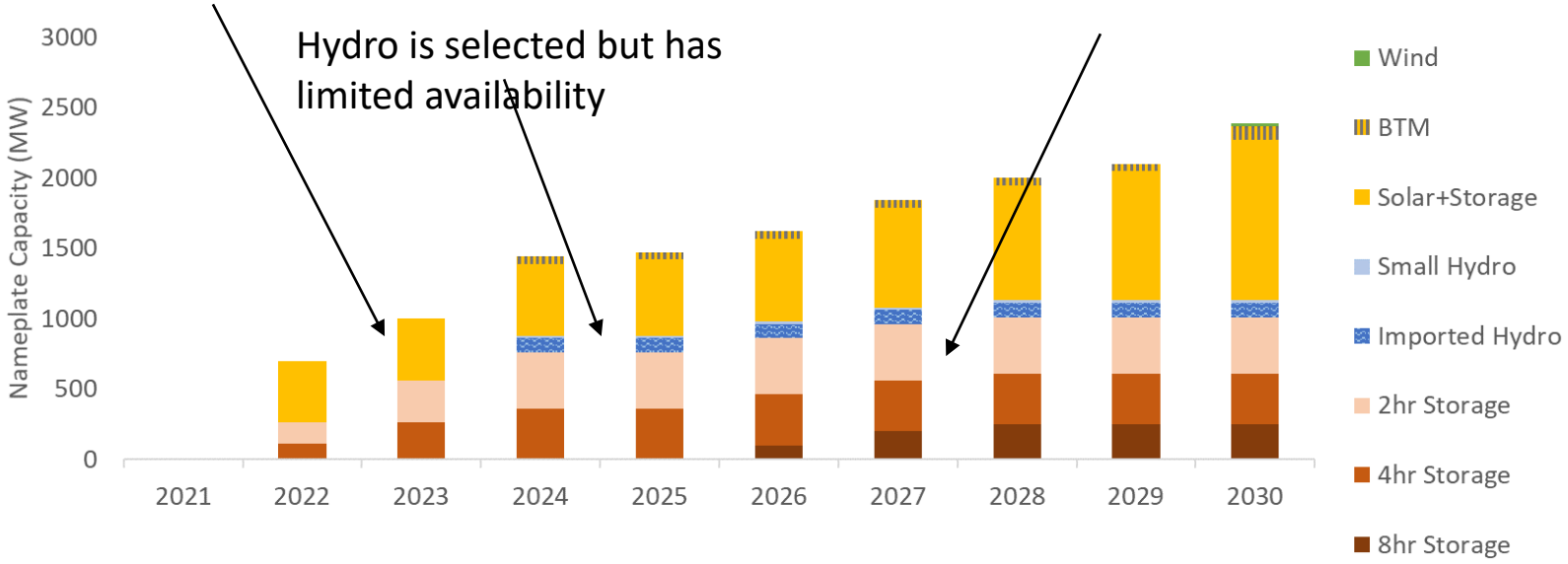
Resource Build (new)

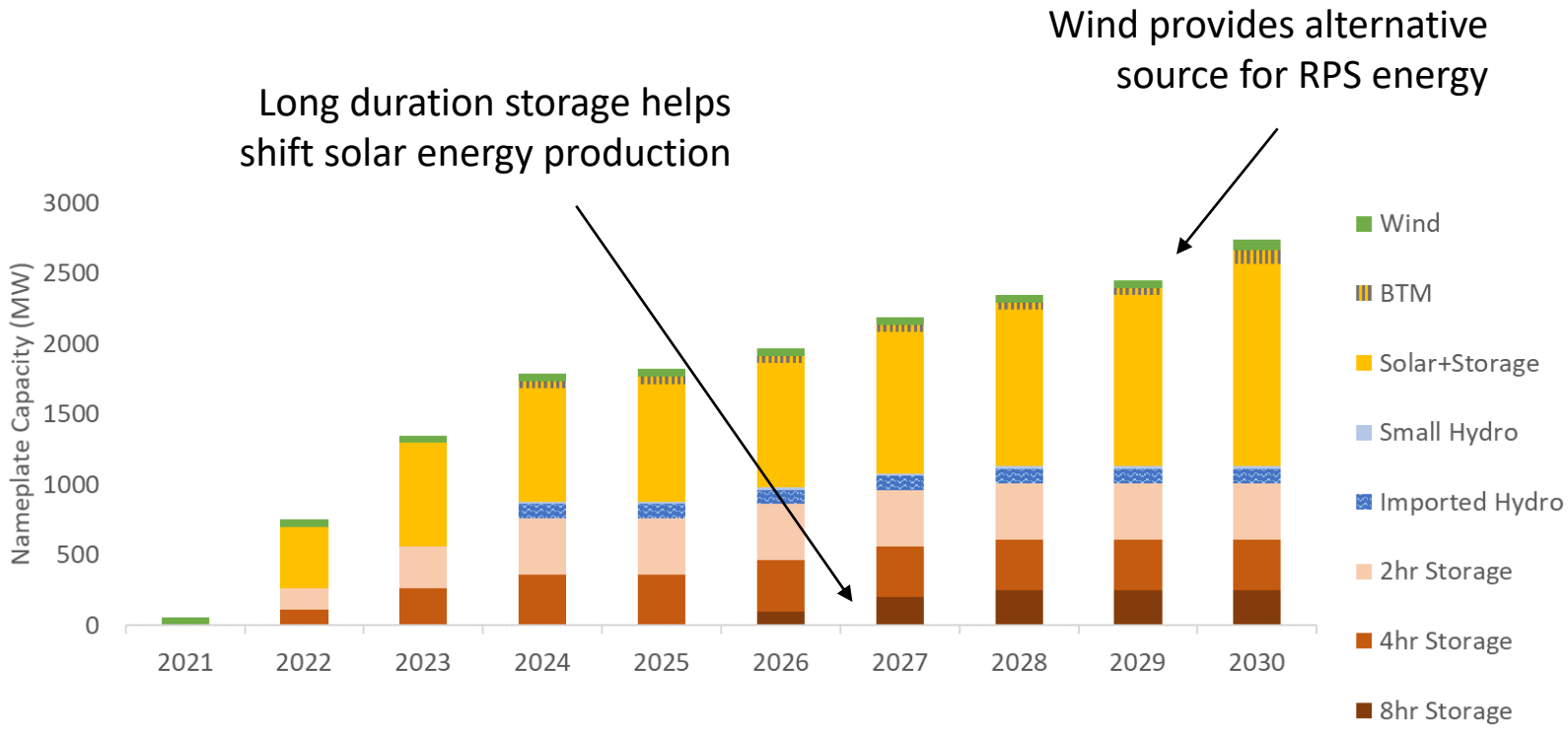
Solar+ storage provides economical energy paired with RA value

Standalone storage provides RA and energy arbitrage value



Solar + storage shown as solar nameplate capacity. Storage assumed to be 40% of solar nameplate

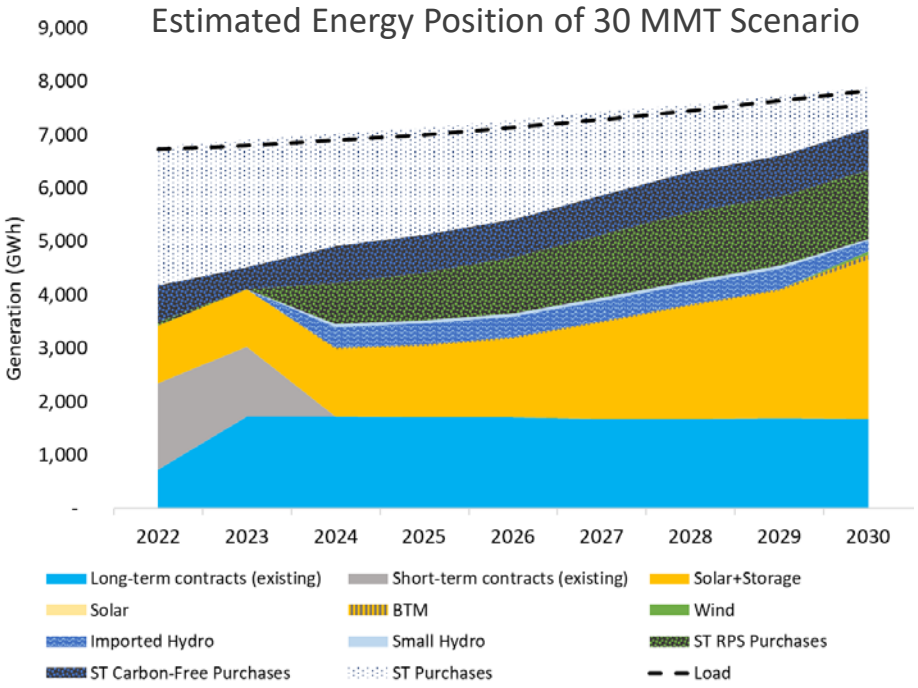
Resource Build (total)



Solar + storage shown as solar nameplate capacity. Storage assumed to be 40% of solar nameplate

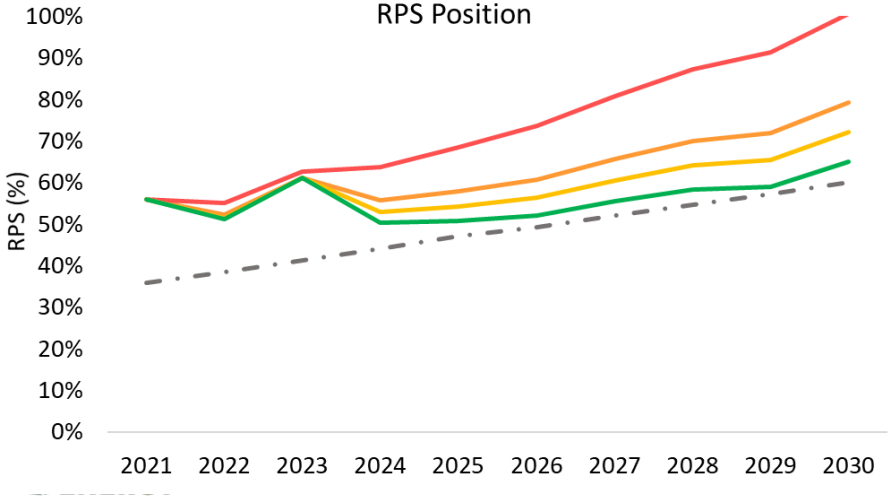
Energy Position

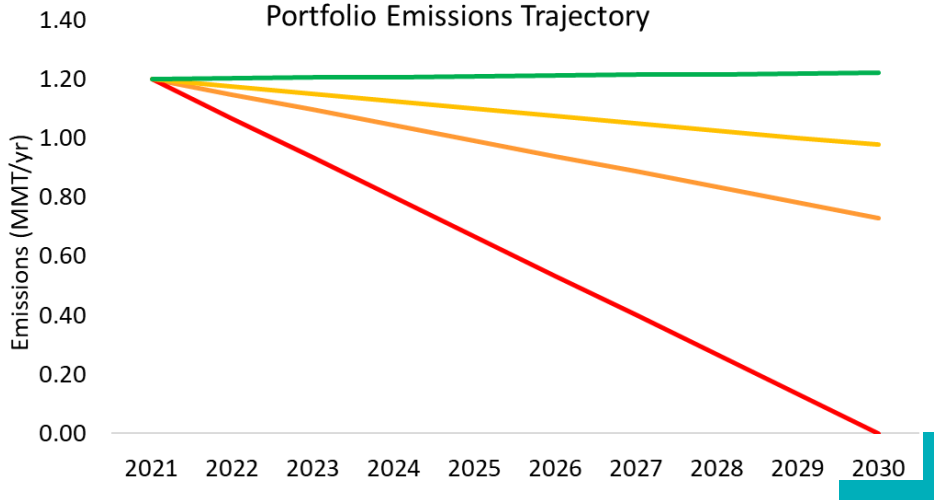
- Existing resources and solar + storage provide majority of long-term PPA energy
  - Long-term PPA energy sufficient to exceed RPS requirement in each year
- Short-term purchases are illustrative
  - Short-term carbon-free purchases assumed to fill remaining emissions requirements, up to 10% of load
  - Short-term RPS purchases assumed to fill remaining emissions requirements
  - Short-term brown purchases assumed to fill remaining need



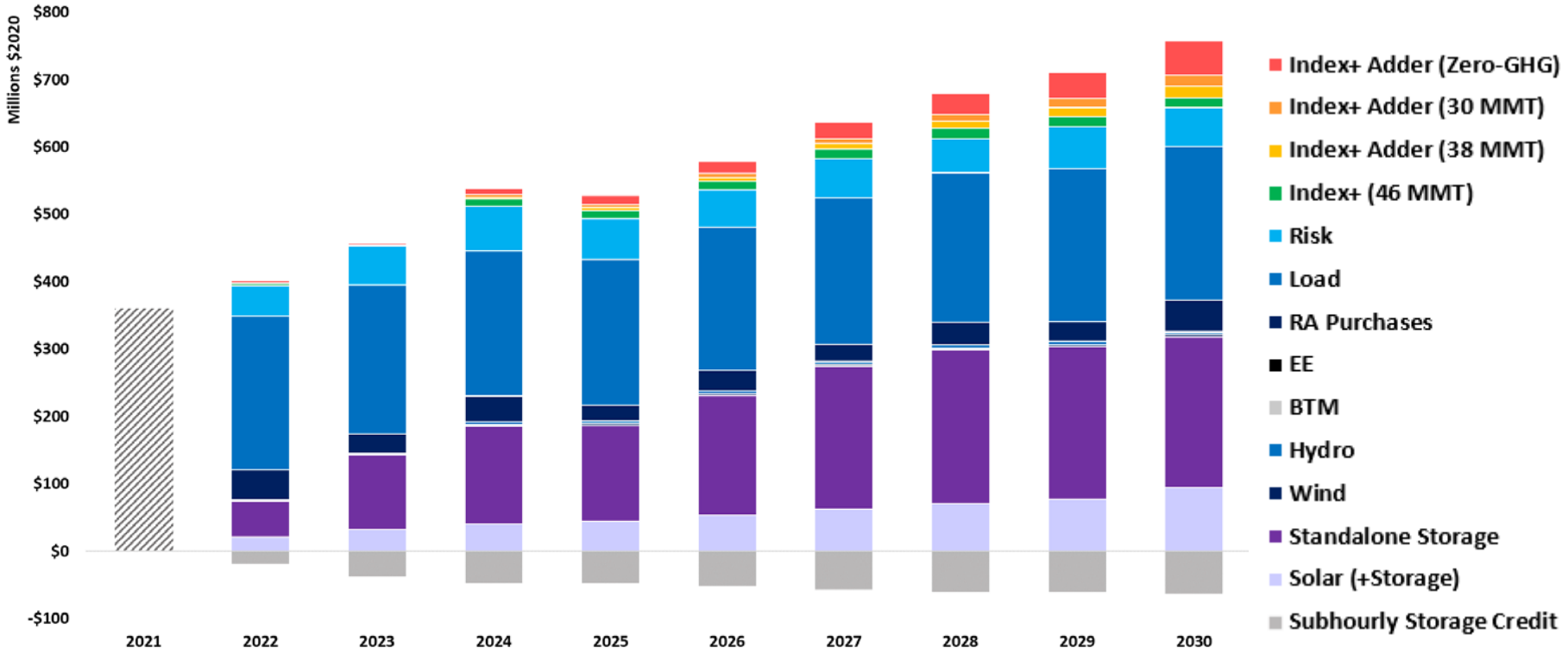
RPS and GHG Position

- Overall RPS and long-term requirements surpassed by PPAs
- Portfolio GHG emissions come from spot purchases + short-term brown energy purchases
- Emissions follow target trajectories





Total Costs of Conforming Portfolios



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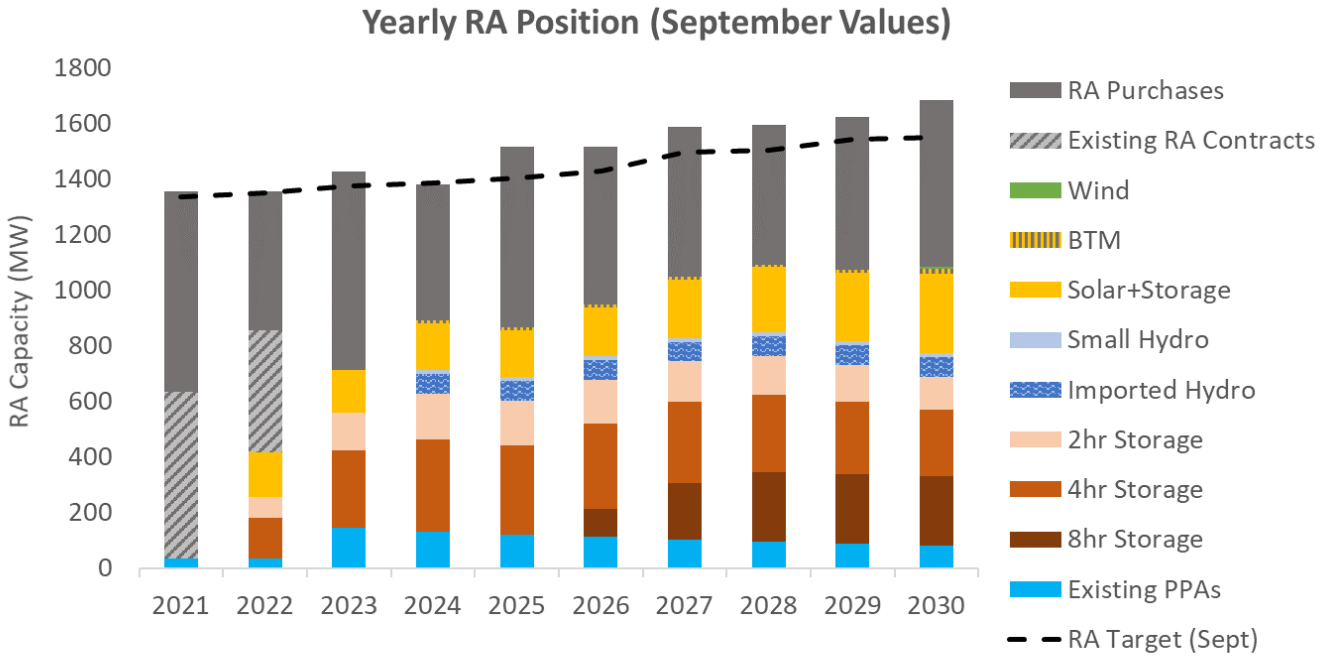
Annual RA Position (September)



Summary

- Hybrid solar & storage and standalone storage make up majority of selected resources
  - Solar and storage primarily selected based on current price forecasts
  - Standalone storage provides RA value
  - Wind and geothermal become competitive if S+S prices are higher than expected
- Resource portfolio needs may change as a result of state policy or procurement requirements, storage performance and reliability value, or approaches to risk management
- The magnitude of increased costs to achieve more ambitious GHG reductions depends on risk management strategy, market dynamics, regulatory requirements and technology costs

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APPENDIX

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Assumptions: Resource Costs

- Solar/wind/storage resource costs are based on Level10 reports and Ascend knowledge of PPA current prices, followed by escalation with NREL ATB
  - Includes phaseout of ITC and PTC
- Geothermal is based on Ascend knowledge of current PPA prices, followed by CPUC escalation
- Hydro is based on Ascend knowledge of current PPA prices, followed by inflation
- Biogas assumed equivalent to biomass, following CPUC values

	Solar (South)	Solar (North)	Hybrid Solar	Wind	Geothermal	Small Hydro	Large Hydro	Biogas	Hybrid 4hr Storage	2hr Storage	4hr Storage	8hr Storage	RA
2021	$25.95	$21.96	$ 25.95	$47.88	$ 71.27	$ 50.00	$ 39.14	$120.91	$ 7.08	$ 8.03	$ 11.81	$ 20.66	$6.72
2022	$25.90	$21.91	$ 25.90	$47.85	$ 72.54	$ 51.00	$ 40.05	$122.75	$ 6.67	$ 7.56	$ 11.11	$ 19.45	$6.39
2023	$27.87	$23.58	$ 27.87	$51.50	$ 75.88	$ 52.02	$ 40.77	$126.20	$ 6.87	$ 7.32	$ 10.76	$ 18.83	$5.96
2024	$29.84	$25.25	$ 29.84	$55.14	$ 79.21	$ 53.06	$ 41.15	$129.64	$ 7.08	$ 7.08	$ 10.41	$ 18.22	$5.54
2025	$31.81	$26.91	$ 31.81	$58.79	$ 82.54	$ 54.12	$ 41.56	$133.08	$ 7.28	$ 6.84	$ 10.06	$ 17.60	$5.17
2026	$33.78	$28.58	$ 33.78	$62.44	$ 85.88	$ 55.20	$ 41.94	$136.53	$ 7.49	$ 6.60	$ 9.71	$ 16.99	$5.00
2027	$33.78	$28.59	$ 33.78	$62.24	$ 88.18	$ 56.31	$ 42.29	$139.67	$ 7.43	$ 6.55	$ 9.64	$ 16.86	$4.99
2028	$33.79	$28.59	$ 33.79	$62.04	$ 90.48	$ 57.43	$ 44.76	$142.81	$ 7.38	$ 6.50	$ 9.56	$ 16.74	$5.41
2029	$33.79	$28.60	$ 33.79	$61.84	$ 92.78	$ 58.58	$ 45.11	$145.96	$ 7.32	$ 6.45	$ 9.49	$ 16.61	$5.90
2030	$33.80	$28.60	$ 33.80	$61.64	$ 95.08	$ 59.75	$ 45.71	$149.10	$ 7.27	$ 6.40	$ 9.42	$ 16.48	$6.62

($/MWh)

($/kW*mo)

Assumptions: Yearly RA (ELCC) Values by Resource

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Solar	14%	14%	14%	12%	10%	8%	8%	7%	6%	5%
Wind	15%	15%	15%	17%	20%	22%	22%	22%	22%	22%
2hr Storage	50%	49%	46%	41%	40%	39%	37%	35%	33%	30%
4hr Storage	100%	99%	92%	83%	80%	77%	73%	69%	65%	60%
8hr Storage	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Solar+Storage	54%	54%	51%	45%	42%	39%	37%	34%	32%	29%
Large Hydro	71%	71%	71%	71%	71%	71%	71%	71%	71%	71%
Small Hydro	71%	71%	71%	71%	71%	71%	71%	71%	71%	71%
Geothermal	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%
Biogas	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%

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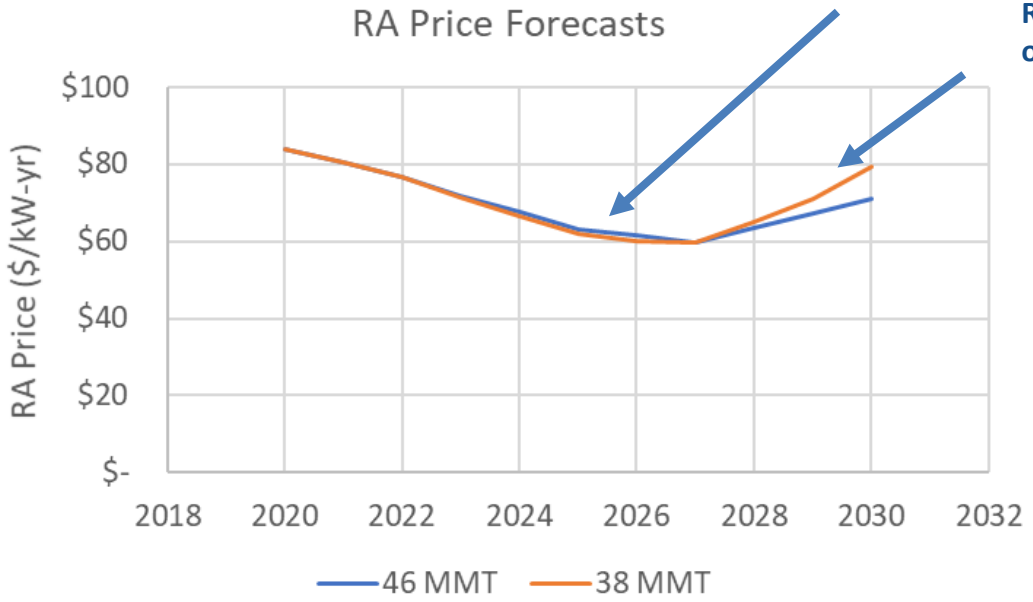
Assumptions: RA Price Forecasts

Decline due to falling cost of storage

Rise due to declining ELCC of storage



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Scenario Sensitivities- Key Takeaways

- Variations to annual and total resource build limits high-light trade-offs under different availability assumptions
  - If solar + storage is more limited, geothermal desirable in early years to provide RA value
  - If solar + storage is more limited, wind provides RPS energy
  - If large hydro is available, it displaces solar + storage procurement
- Sensitivities around load departure, market exposure and resource costs
  - Portfolio compositions are generally similar across sensitivities
  - Lower energy needs (due to load departure or high market exposure) reduce solar + storage and wind, delay hydro procurement
  - If solar + storage costs are high, wind is primary substitute to provide RPS energy

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