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SB 423 Firm Zero-carbon Resources Update

Presenter: Chie Hong Yee Yang

July 29, 2025

SB 423 Background

- Requires the CEC to assess firm zero-carbon resources
- First Report – published 3/21/2025
- Requires the CEC to update the assessment in each IEPR

Firm Zero-Carbon Resource Definition

- **Provides steady electricity output**
  - No stand-alone wind or solar resources
  - Zero-carbon fuels storage (e.g., hydrogen storage, reservoirs)
  - Natural gas pairing with CCUS allowable (100% capture rate or partial counting for less than 100%)
  - Flex fuel acceptable
- **Enables multi-day operations**
  - Able to operate during subsequent days of an extreme event
  - Systems must be dispatchable or baseload – not necessarily 24/7

Framework for IEPR update

Technology maturity

- **Evaluate market readiness** of each resource

Recent innovations

- **Highlight advancements** that improve performance, reduce costs, or enhance scalability

Policy support

- **Examine** the regulatory and incentive **landscape that** promote deployment

Challenges and barriers

- **Evaluate** the economic, technical, and regulatory hurdles that limit adoption

Opportunities

- **Explore** pathways for scaling technologies, achieving cost reductions

Overview of Firm Zero-carbon Resources

Resources Reviewed	Technologies
Long-Duration Energy Storage	Flow, Iron Air, Zinc, thermal storage, Compressed Air Energy Storage – must be charged with clean energy
Hydropower	Pumped Storage Hydro, Large Hydro, Small Hydro
Geothermal	Conventional Hydrothermal, Enhanced Geothermal Systems
Bioenergy	Thermochemical (Gasification and Pyrolysis), Anaerobic Digestion, and Landfills
Hydrogen	Fuel Cells, Combustion Turbines, Reciprocating Engines, Non-Combustion and Non-Fuel Cell Gas Fueled Generators, Hydrogen Storage
Generation with Carbon Capture	Point Source Capture
Fission	Small Modular Reactors
Fusion	Inertial Confinement Fusion, Magnetic Confinement Fusion

Long-Duration Energy Storage

- Early commercial; pilot scale (1-10 MW)
- Iron-air, zinc hybrid cathode, flow batteries, thermal storage
- AB 209, CPUC Central Procurement, DOE LDES Earthshot
- High capital costs, limited bankability
- high potential during multi-day net-peak events or low renewables

Geothermal

- Conventional – commercial; enhanced geothermal – demonstration
- EGS innovations - FORGE project, horizontal drilling, reservoir monitoring
- CPUC long-term procurement order, POU decarbonization mandates, DOE Geothermal Earthshot
- Site geology, resource characterization and high upfront costs, long lead times (7–10 years), transmission access limits
- EGS could unlock 100+ GW nationwide; significant potential in Imperial Valley

Bioenergy

- RNG-steam methane reformation and landfill gas; gasification; methane pyrolysis
- Biochar production, modular biomass gasifiers, co-firing potential with CCS
- RPS eligibility, Cap-and-Trade, LCFS pathways, potential CCS stacking
- Feedstock supply chain, air quality impacts, other uses
- Net-negative carbon with CCS, flexible siting, forest and ag waste utilization

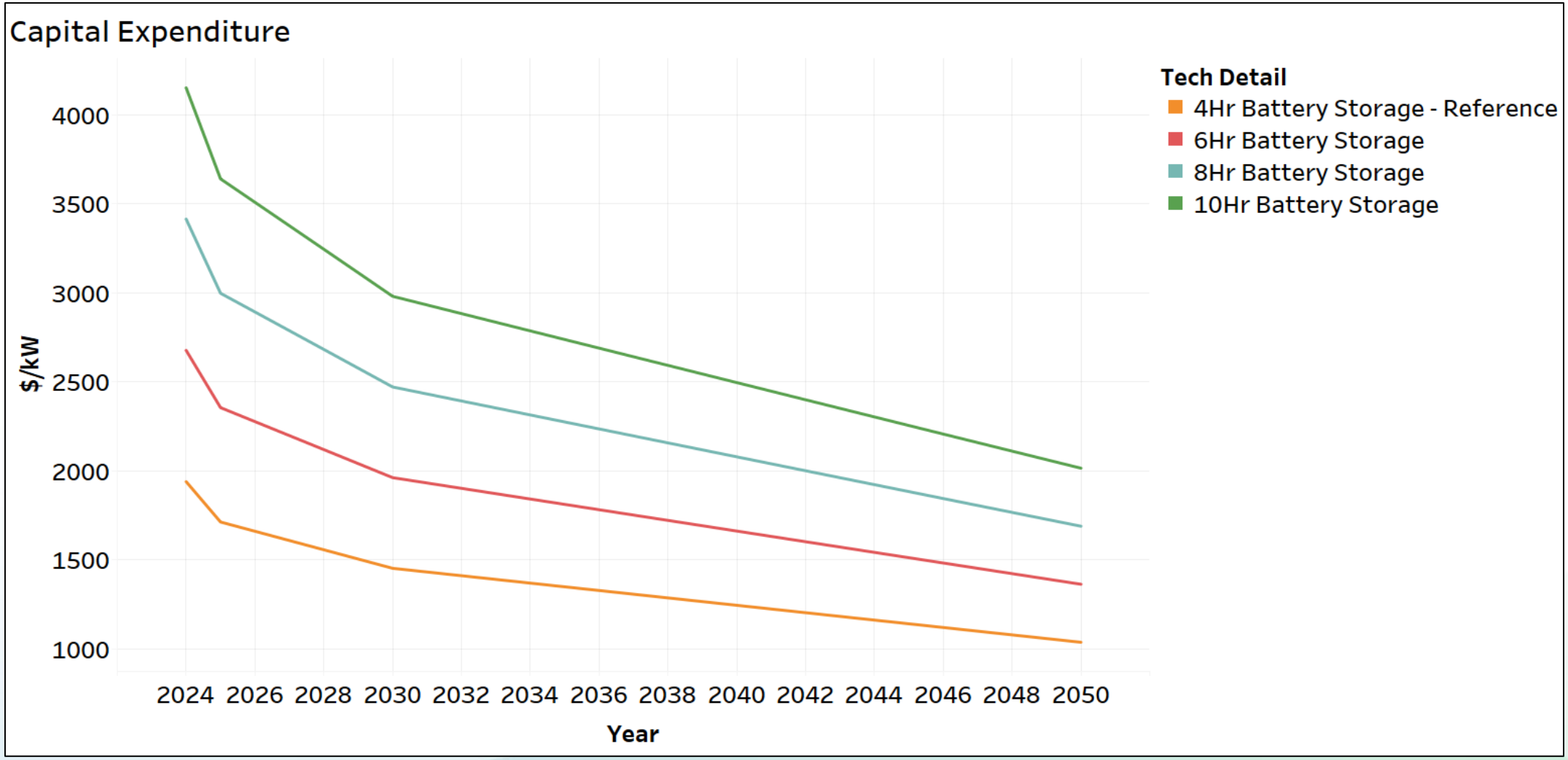
Generation with Carbon Capture

- Post-combustion combined-cycle - commercial
- Absorption, adsorption, membranes, cryogenic
- Federal 45Q tax credits, LCFS credits, SB 1314 (capture limits), DOE CCS hubs
- High cost, siting risk, public acceptance, infrastructure needs (CO_2 transport)
- CCS for industrial & power sectors; potential synergy with bioenergy for net-negative emissions

Small Modular Reactors

- Pre-commercial; licensing or demonstration stage.
- Natrium sodium-cooled design, pressurized light water SMRs
- DOE ARDP funding, NRC pre-licensing pathway, federal loan support
- California nuclear moratorium, waste handling, public acceptance
- Modular scalability, hydrogen co-production, co-location with renewables or industry

Costs – Utility-Scale Battery Storage



Source: 2024 NREL ATB

Preliminary Takeaways

- Continue Investment in Demonstration and Early Deployment
- Certain Technologies Require Broader Coordination
- Coordinate with Permitting Authorities on Emerging Technologies

Thank you!