

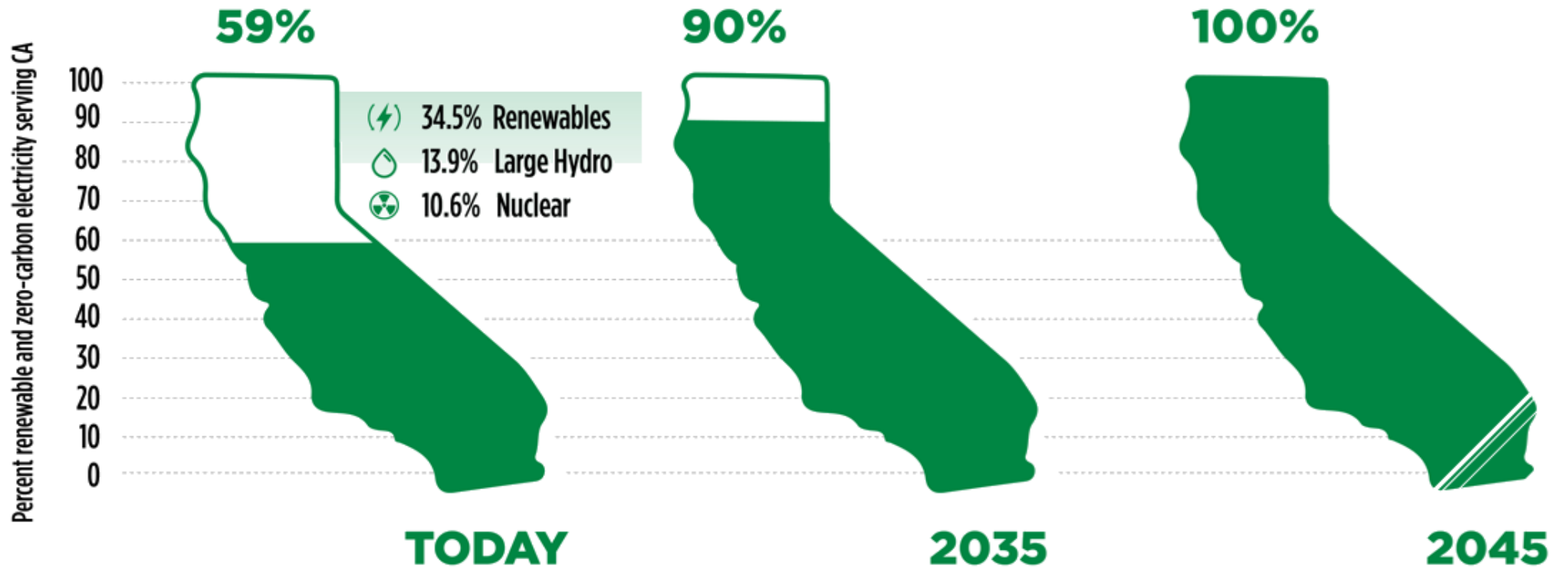


CEC Activities to Integrate Long Duration Energy Storage into the California Grid

**MIKE GRAVELY
ENERGY STORAGE TEAM LEAD
ADVISOR TO CHAIR HOCHSCHILD**



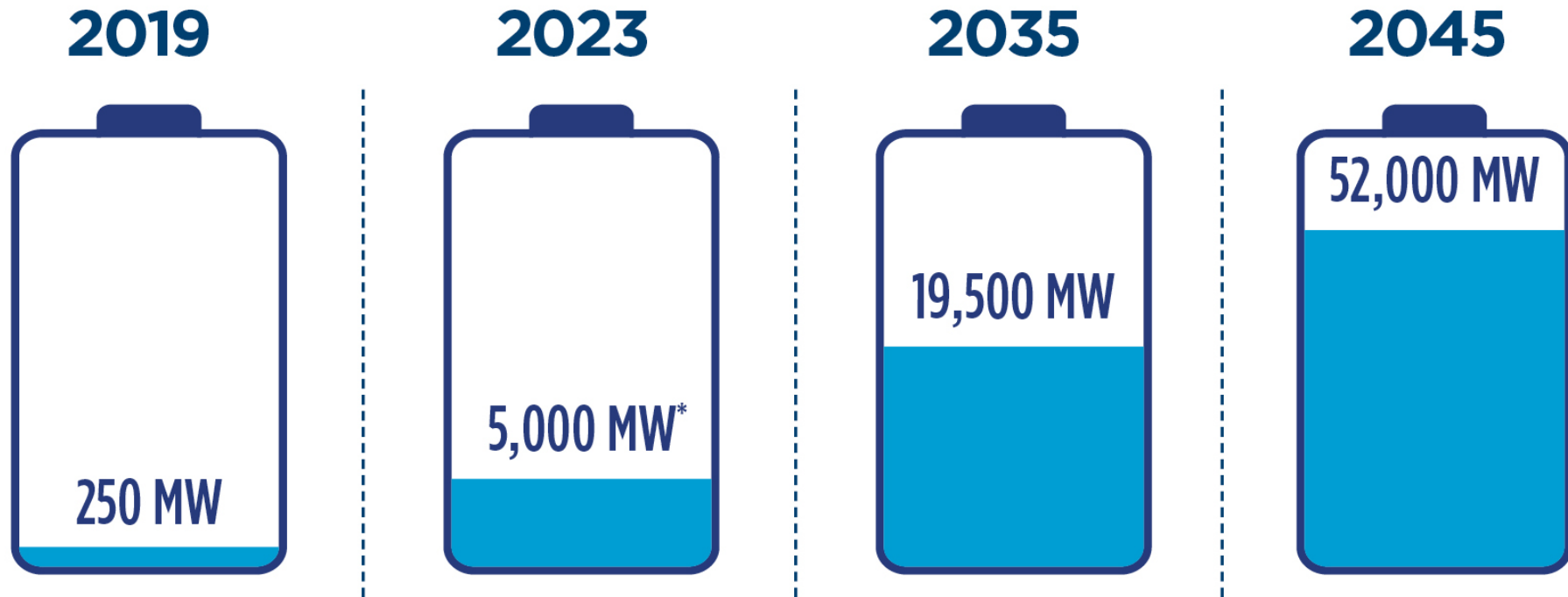
California Progress Toward 100% Clean Electricity by 2045





California's growing battery storage capacity

captures the state's abundant renewable resources



*Projected as of June 1, 2023 based on California ISO interconnection queue.



2020 WAS A PIVOTAL YEAR FOR LONG DURATION ENERGY STORAGE RESEARCH IN THE CEC EPIC PROGRAM

- Over \$100 million invested by CEC in energy storage in 2020
- Field demonstrations of non-lithium-ion long duration energy storage
 - 8 demonstrating 10+ hours of energy storage duration
 - 3 early-stage grants providing up to 100+ hours of energy storage duration



CA LDES PROGRAM APPROVED IN JULY 2022

- Approved Funding
 - \$140M in FY 2022-2023
 - \$190M in FY 2023-2024
- Provided execution team special capabilities



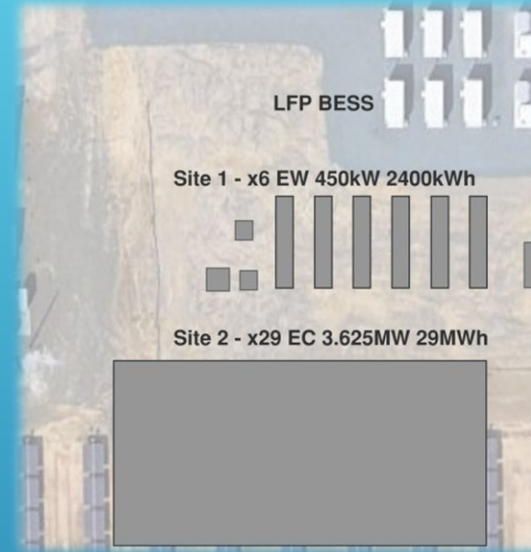
KEY TECHNOLOGY ADVANCEMENTS

- Six Different Non-Lithium-Ion technologies in different phases of initial field demonstrations
 - Zinc hybrid
 - Vanadium redox flow battery
 - Zinc bromine flow battery
 - Iron Flow battery
 - Iron air
 - Zinc Air
 - Future LDES program awards could add 1-3 additional technologies



JOINT SMUD-CEC LDES DEMONSTRATION

Site 1b & 1c will deploy the ESS Energy Center for a total of ~3.6 MW // 29 MWh (8-hour duration). Located adjacent to the site 1a installation at Hedge. 1b and 1c will be commissioned in 2026 and 2028, respectively.

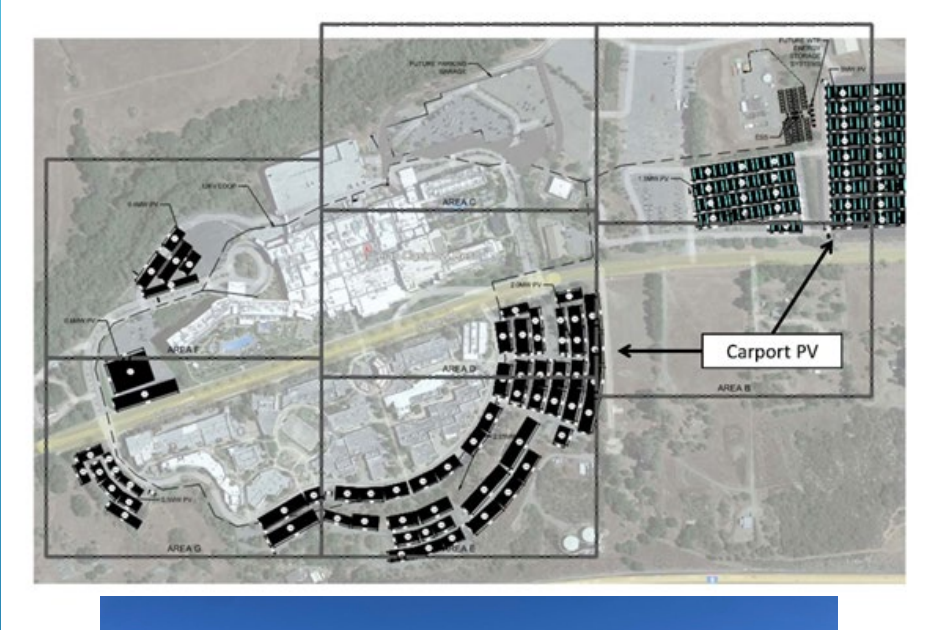


CEC and SMUD partnering to demonstrate ESS Inc. iron flow technology.

CEC/SMUD Team on schedule for CEC grant package award by July 2024.



VIEJAS BAND OF KUMEYAAY INDIANS MICROGRID IN SAN DIEGO

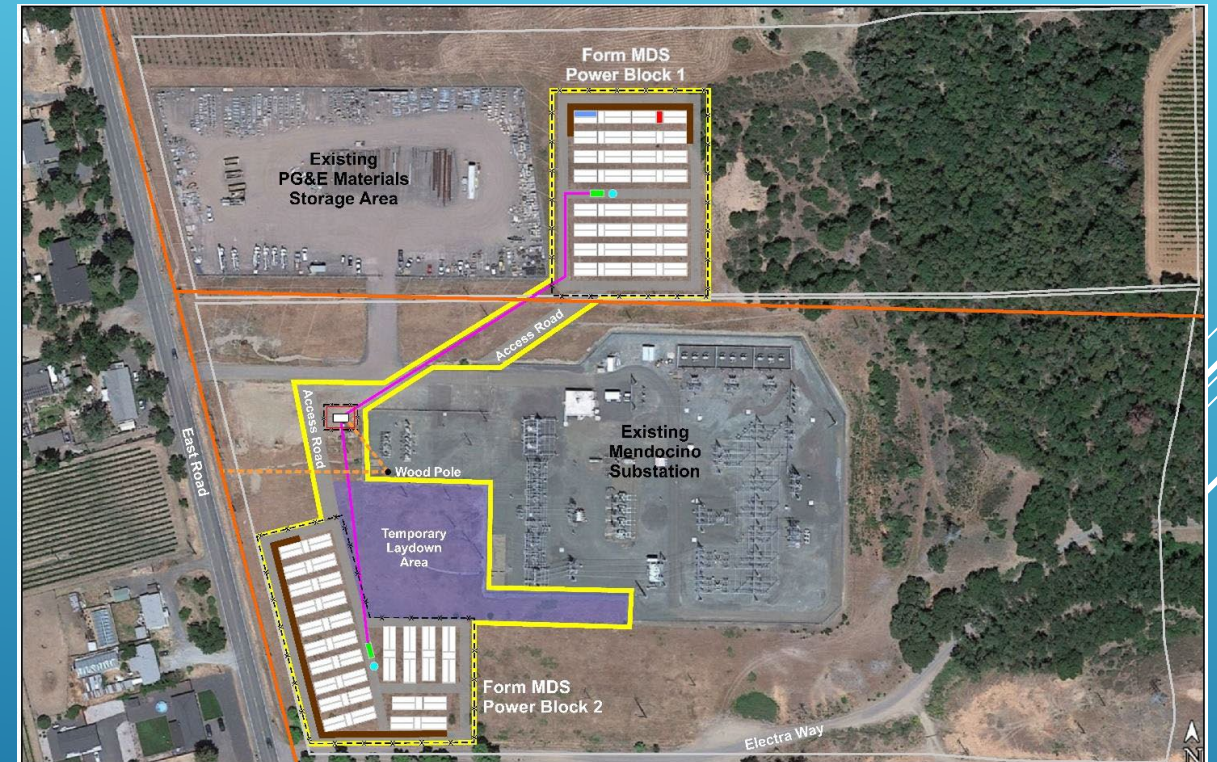




PROJECT OVERVIEW

Form Energy's Multi-day Storage System

- ▶ 100-hour duration, 5 MW, 500 MWh
- ▶ Front-of-the-meter grid application
- ▶ PG&E's substation at Redwood Valley, Mendocino County
- ▶ Use case and market application analysis
- ▶ Design, construction and operation of the multi-day storage system





PASKENTA BAND OF NOMLAKI INDIANS MICROGRID

- 15 MWH flow battery system with 4.5 MWs solar
- Zinc bromine flow battery technology
- Support extended tribal operations during grid outages
- Expanded emergency services operations
- Reduce tribal energy expenditure over 50%

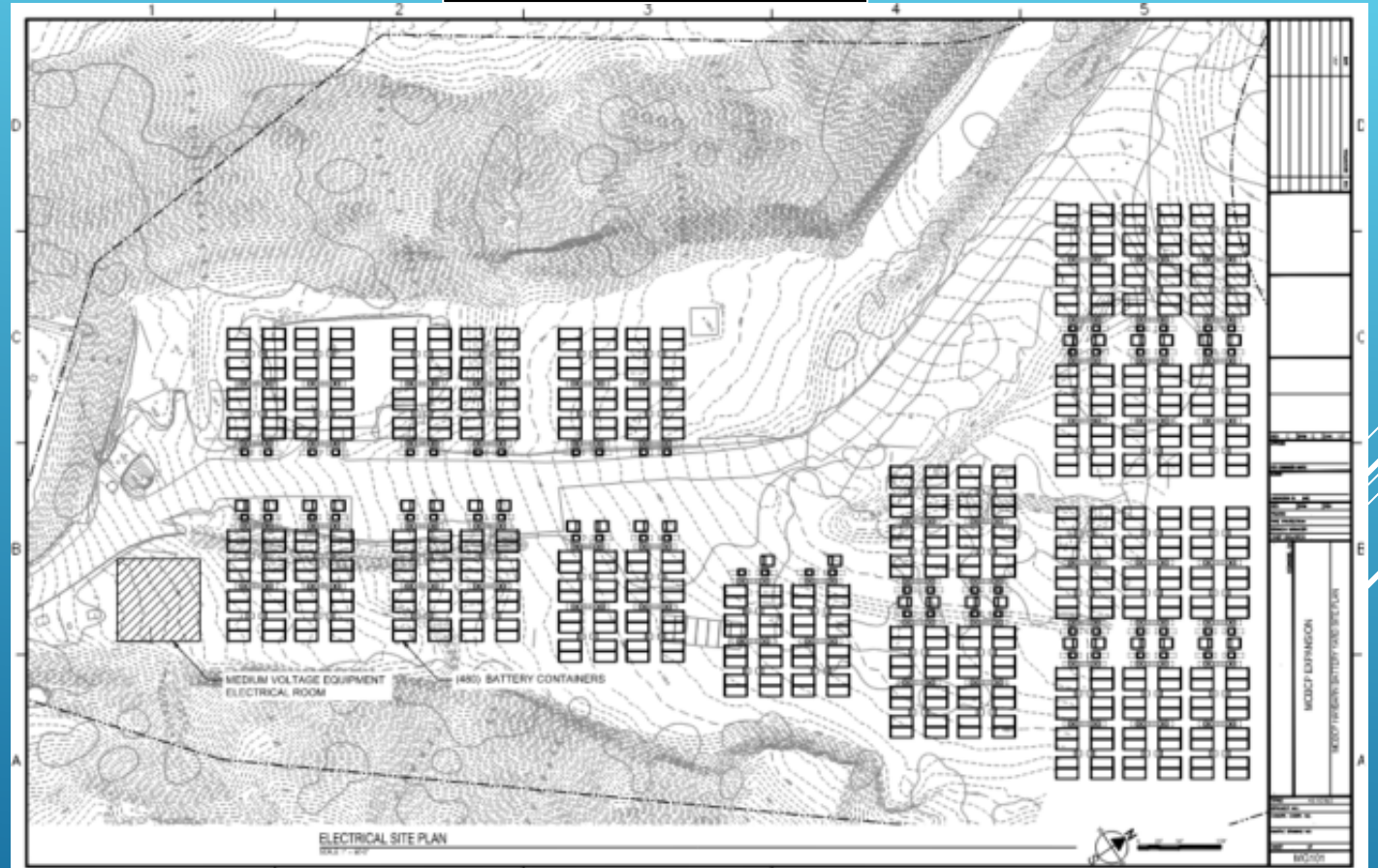




CAMP PENDLETON PROJECT

50MW/300MWh

- Military/commercial enterprise
- Third Party owned and operated with
- Military will have system for National Defense priorities
- System will participate in commercial market over 90% of the time





NAVY BASE SAN DIEGO PROJECT

- 1 MW 8 MWH LDES System
- Providing ability to integrate renewables and storage into critical military operations



Navy Microgrid Project Scope

CEC Grant Additions



RAPID INTEGRATION AND COMMERCIALIZATION UNIT PROVIDES CEC INDEPENDENT SYSTEM TESTING CAPABILITY





ADDITIONAL DOE AWARDS

- ▶ Awarded \$60M grant in DOE Grant solicitation (33MWH)
 - ▶ Valley Children's Hospital Microgrid Provides Critical Services to Disadvantaged Community
 - ▶ Demonstrate the effectiveness of LDES microgrids to eliminate the need for conventional generation resources (diesel generators)
- ▶ 2nd DOE Award--500KW / 12 MWH system (\$19M)
 - ▶ Zinc-Air technology (Company won prior EPIC award)
 - ▶ Technology considered an additional 100-hour LDES provider



FUNDING TECHNICAL ANALYSIS RESEARCH

- Defining what LDES energy storage duration mix is needed
 - 8hrs, 24hrs, 48hrs, 100hrs, seasonal energy storage
- Developing new proposed tariffs to ensure future financial stability
- Developing metrics on performance, safety and costs improvements

COMMERCIAL READINESS LEVEL (CRL)

		CRL Year												
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Technology	Li-ion batteries	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Flow: Vanadium	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Flow: Zinc Bromine	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Flow: Iron	Orange	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green
	CAES: dCAES	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	CAES: aCAES	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green
	CAES: aiCAES	Orange	Orange	Orange	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green
	NaS Battery	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Iron Air	Orange	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Zinc Battery	Red	Orange	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green

*Zinc batteries in this category refer to Zinc-air and Zinc hybrid cathode (Zinc bromine non-flow) technologies

Legend	Red	Orange	Yellow	Green
	CRL 5	CRL 6	CRL 7	CRL 9

- **CRL** evaluates the current and expected commercial viability and availability within the market from the commercial **viability hypothesis** of technology (1) to the **widespread deployment** of a technology in the market (9).



ADDRESSING FIRST RESPONDER TRAINING





LDES LESSONS LEARNED

- LDES size drives more complex projects
- CEQA is special challenge
- Venture capital investors increasing interest in LDES technologies but project financing investors still hard to find

OPEN DISCUSSION

