



# GridStar<sup>®</sup> Flow

**LDES National Consortium  
Annual Workshop**

September 2024



**THE NATIONAL CONSORTIUM FOR THE  
ADVANCEMENT OF LONG DURATION  
ENERGY STORAGE TECHNOLOGIES**



# About Lockheed Martin Energy

Lockheed Martin is a global security and aerospace company engaged in the development, manufacture and integration of advanced technology systems. 116,000 employees in >30 countries.

Aero



MFC



RMS



Space



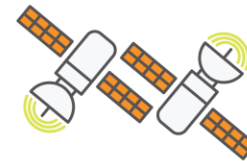
Advanced Batteries for over **60** YEARS

OVER **90** Energy Patents

First Energy Patent in **1933**

Expertise In...

Systems Integration & Advanced Manufacturing



Scale & Stability



Challenging & Secure Environments



...Led To



Advanced Batteries

# Lockheed Martin in California

## Impact by Numbers

**9,700+** working employees and  
**9,900+** retired employees in California

**2,100+** Californiabased suppliers  
spending **\$16.9B** with those suppliers.

**100+** facilities located in California  
housing the development and production of  
several key mission portfolios.



From a church “factory” in Santa Ana to a small garage in San Francisco, Lockheed Martin’s founders developed their aerial innovations and continued throughout the years to grow in the state helping to establish the robust Aerospace industry in California today.



**1910**

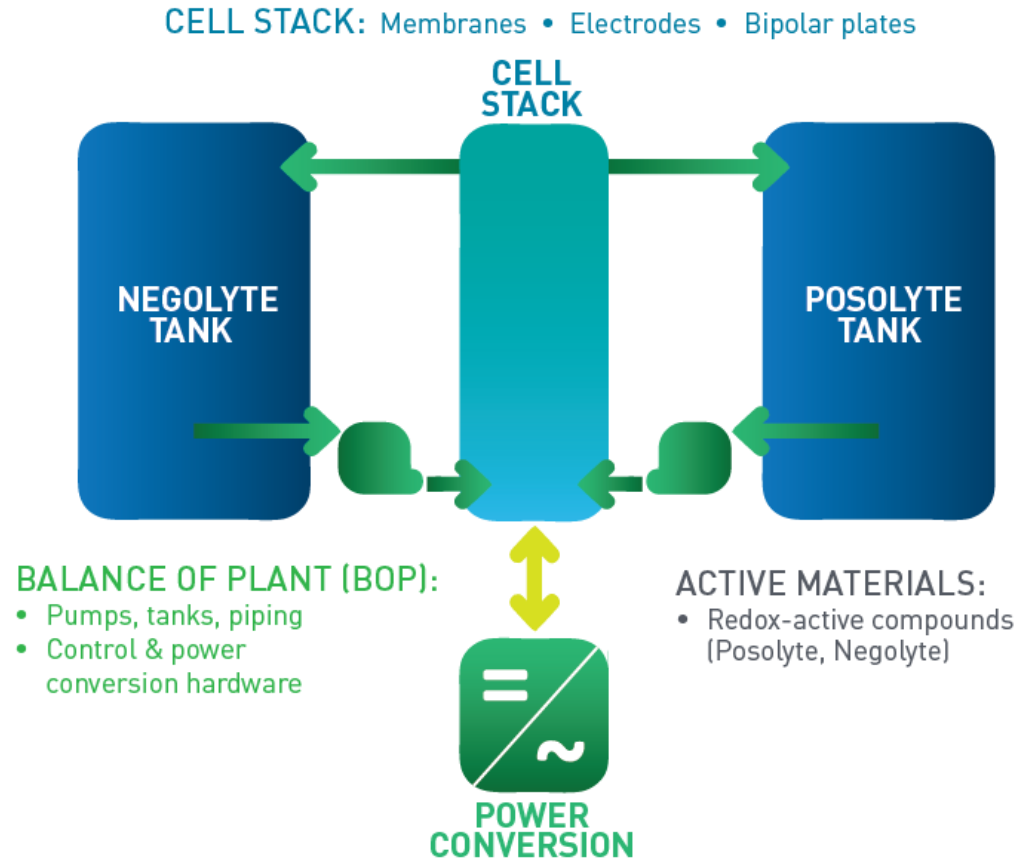
Glenn L. Martin takes flight  
in Santa Ana and opens his  
Los Angeles Factory in 1912

**1913**

Allan and Malcom  
Lockheed Model G  
takes flight in the San  
Francisco Bay



# Flow Battery Architecture and Opportunity



## Architectural advantages

- **Decoupling of power and energy** enables low cost long-duration storage
- **Energy capacity insensitivity** to duty-cycle affords operational flexibility (e.g., deep or frequent cycling, storage at high states-of-charge)
- **Straightforward expansion**
- **Safety** (e.g., water-based electrolytes)



# Energy Storage Applications

## ENERGY STORAGE APPLICATIONS

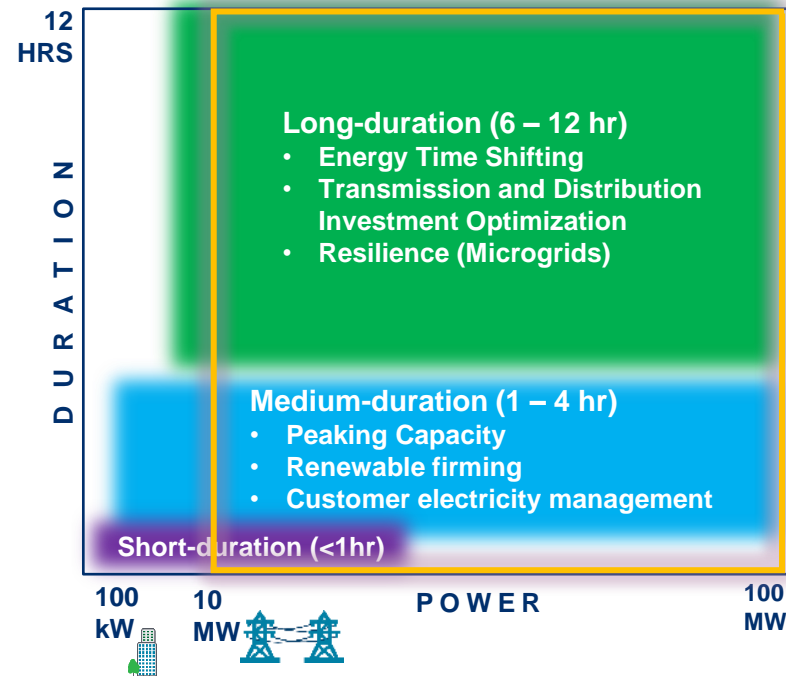
For the 20+ services energy storage can provide...

Wholesale Energy Markets	End User / Customer
Price Arbitrage	Demand Response
Portfolio Optimization	Demand Charge Management
Grid Systems	Transmission Rate Management
T&D Upgrade Deferral	Capacity Rate Management
T&D Congestion Relief	Energy Rate Management
Substation On-site Power	
Microgrids	Electric Service Reliability
Islanded Microgrids	Electric Power Quality
Grid-Connected Smart Microgrids	Ancillary Services
Renewables	Frequency Regulation
Solar Energy Time-shifting	Load Following
Wind Energy Time-shifting	Reserve Products – Spinning / Primary
Solar Smoothing / Firming	
Wind Smoothing / Firming	Voltage / VAR Support

■ Short-duration
 ■ Medium-duration
 ■ Long-duration

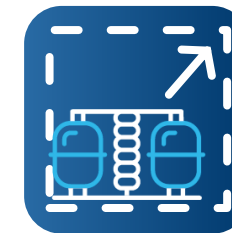
## APPLICATION REQUIREMENTS

...various size, duration, cycling and response characteristics are required.



## GRIDSTAR FLOW OPTIONALITY

Optimized for Long-duration...



... but can flex among applications across durations.

--- GSF Addressable Applications



# GridStar Flow

10 MW<sub>AC</sub> / 100 MWh Configuration

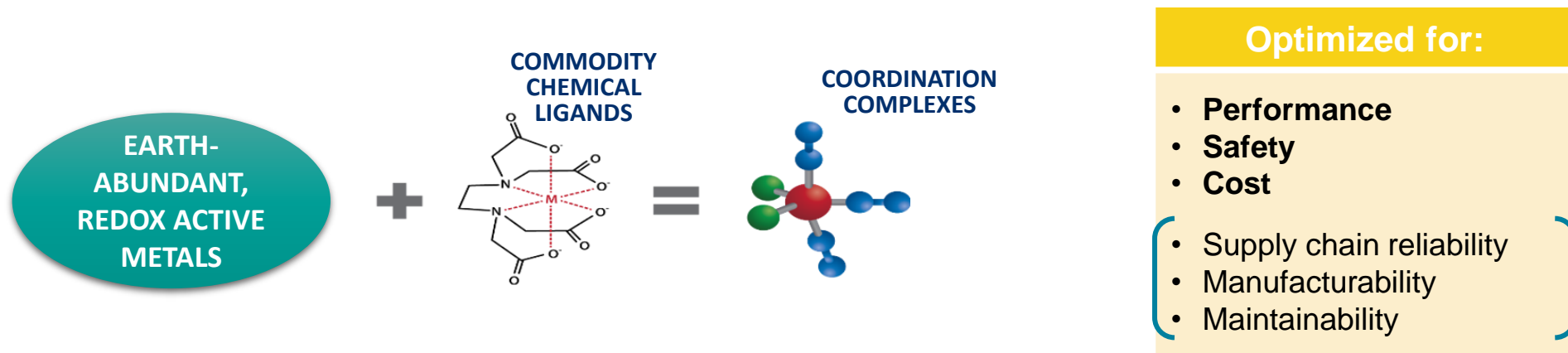
Power (MW)  $\propto$  cell stack count  
Energy (MWh)  $\propto$  electrolyte volumes  
( & tank capacity)



Pioneering utility-scale flow battery  
utilizing earth-abundant metals  
and commodity chemicals.



# Engineered Electrolytes as Differentiators



- Optimized for:**
- Performance
  - Safety
  - Cost
- ( Supply chain reliability  
Manufacturability  
Maintainability )

ELECTROLYTES ARE COMPOSED OF...	Incumbent Flow Technologies	GridStar Flow	Why change?
<i>Electroactive materials</i> <b>-charge carriers-</b>	Metal ions	<b>Earth-abundant metals</b> and <b>commodity chemical ligands</b>	<ul style="list-style-type: none"> <li>• Use <b>affordable raw materials</b>, established supply chains, and reliable partners.</li> <li>• Complexes are larger, <b>reducing crossover</b>.</li> <li>• Complexes and membrane are negatively charged, <b>reducing crossover</b>.</li> </ul>
<i>Liquid solvents</i> <b>-material transport-</b>	<b>Strong acids</b> (pH <2)	<b>Water</b> (pH 10-11)	<ul style="list-style-type: none"> <li>• <b>More affordable</b> balance of plant.</li> <li>• <b>Non-flammable, non-corrosive</b> with modest pH</li> </ul>

Patented and Proprietary Chemistry

# GridStar Flow System Prototypes



## ALPHA Unit:

**Power:** 250 kW<sub>AC</sub>  
**Energy:** 500 kWh (2 hr)

2017-18: ~1 year of testing



## BETA Unit:

**Power:** 250 kW<sub>AC</sub>  
**Energy:** 1500 kWh (6 hr)

2018-20: ~ 1 year of testing



## GridStar Flow S/N01:

**Power:** 250 - 500 kW<sub>AC</sub>  
**Energy:** 2.5 MWh (5 -10 hr)

2020-24+: 3+ years of testing



# First Commercial Scale GridStar Flow

## GridStar Flow S/N01

- Located at 95,000 square foot Andover, Mass. facility
- 250 - 500 kW<sub>AC</sub> , 2.5 MWh (5 -10 hr) system
- Commissioned Oct. 2020
- Design basis for customer-sited projects.



*\*GridStar Flow S/N01 pictured above shown without insulated tanks*



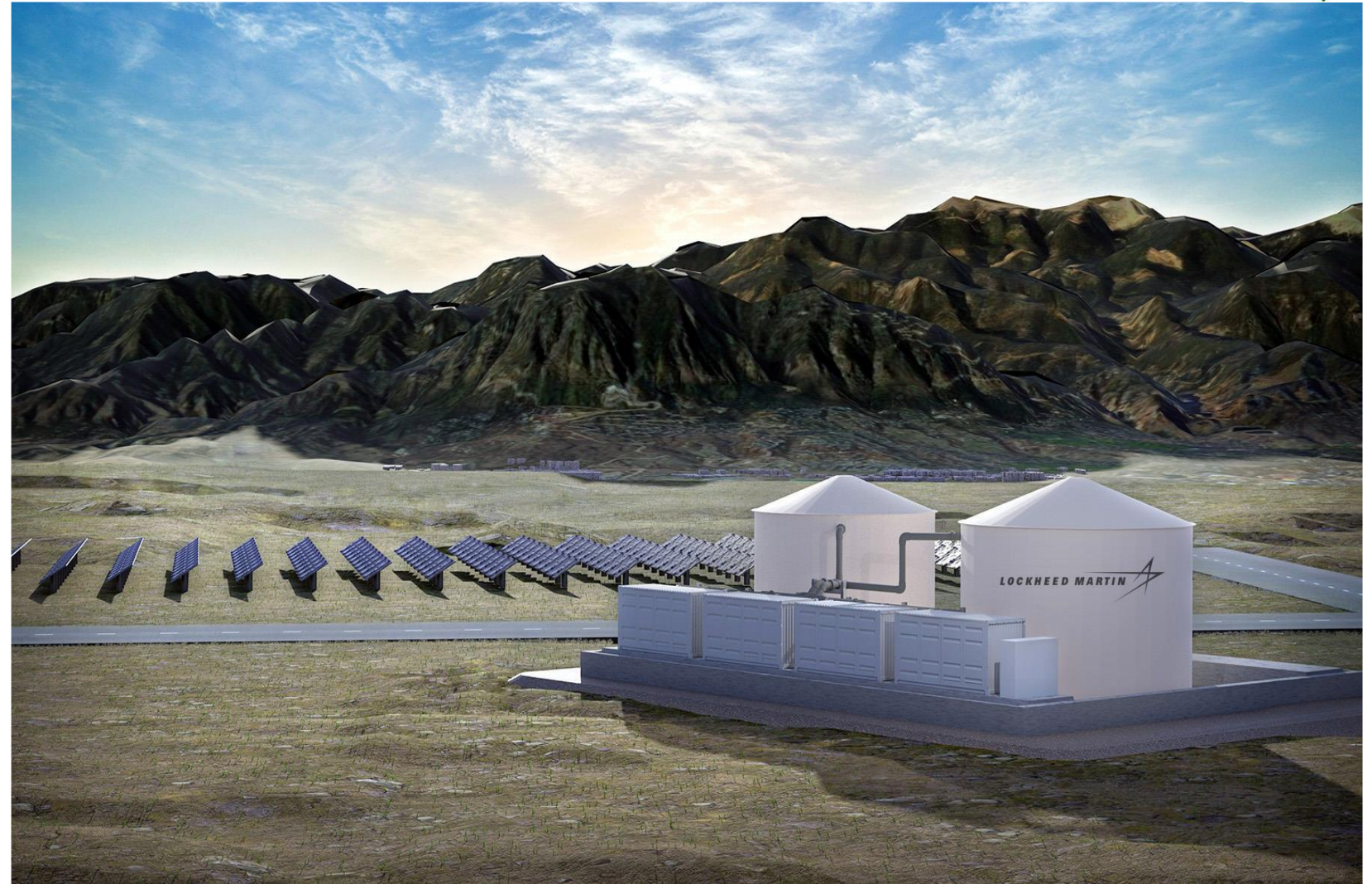
# First Customer Sited Project



US Army Corps  
of Engineers®



- Pilot project with U.S. Army at Fort Carson, Colorado
- 1 MW | 10-hour (10 MWh) GSF demonstration to enhance grid resiliency
- Two-year test period using PNNL protocols for resilience and grid support
- Construction began in June 2023, estimated completion by EOY 2024

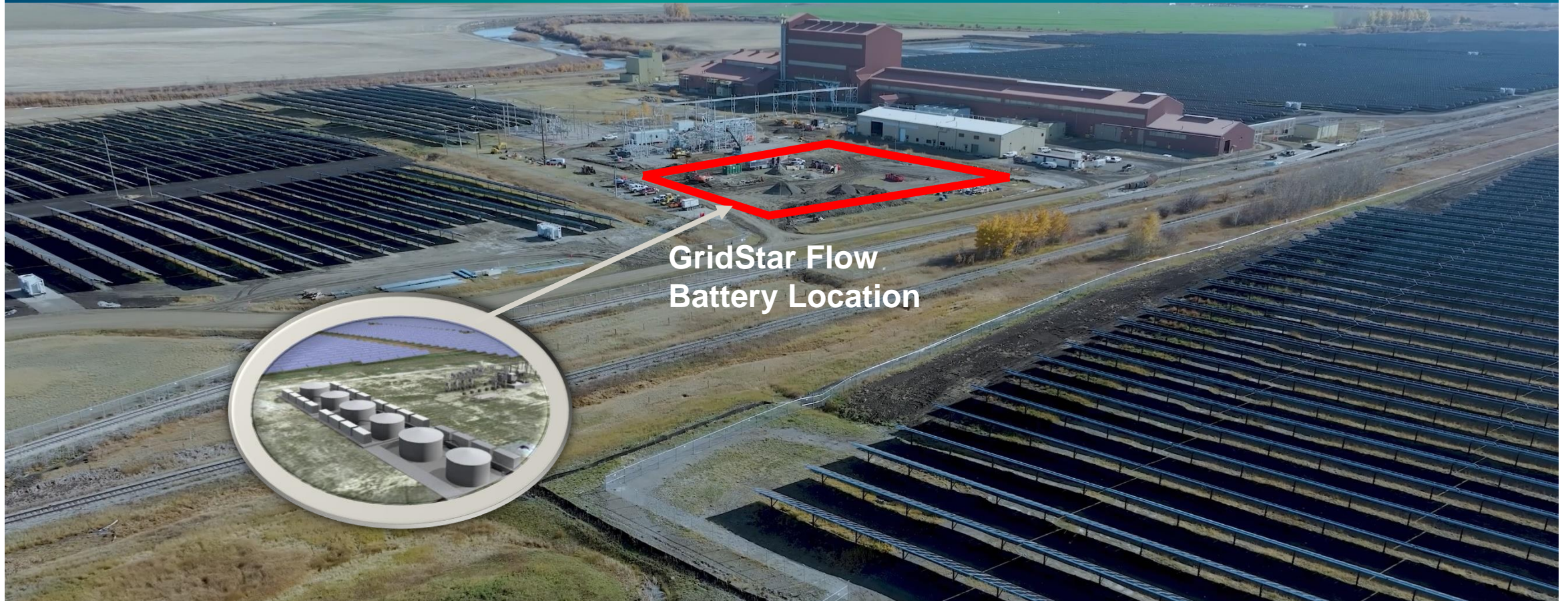




# First International Project



- Teaming agreement with TC Energy for Saddlebrook Solar + Storage Project in Alberta, Canada
- 5 MW/25 MWh GridStar Flow energy storage system



GridStar Flow  
Battery Location



# Thank You



[www.lockheedmartin.com/energystorage](http://www.lockheedmartin.com/energystorage)  
([video](#))

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