

POLAR Project in Healy, AK

Grid-Scale Long Duration Energy Storage with Unmatched Application Flexibility

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4th Annual DOE Energy Storage Grand Challenge Summit

Tim Held: Chief Technical Officer, Echogen Power Systems

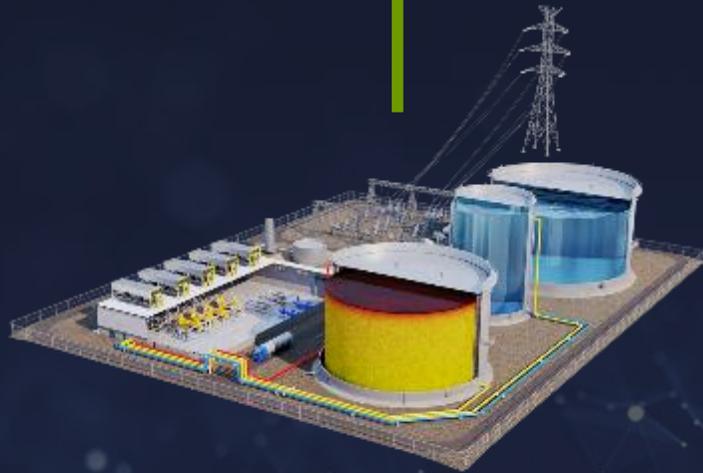
Cory Stansbury: Energy Storage Chief Technologist, Westinghouse

How It Works

Storing electrical energy as a differential of temperature.

Charging

sCO₂ heat pump cycle consumes grid power to move heat from freezing of water in LTR to heating oil/media in HTR.

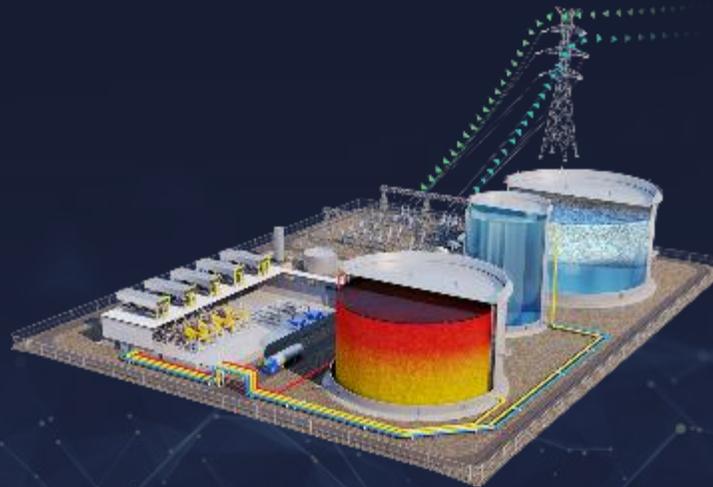


Zero Charge

System at a fully discharged state where LTR has chilled water and HTR has warm oil/media.

Discharging

sCO₂ heat engine cycle utilizes stored temperature difference to produce electricity, melting ice & cooling the oil/media.



Full Charge

System at a fully charged state where LTR has ice and HTR has hot oil/media.

Proven Technology

Balancing innovation with proven components to deliver a reliable system

Systems

Generation

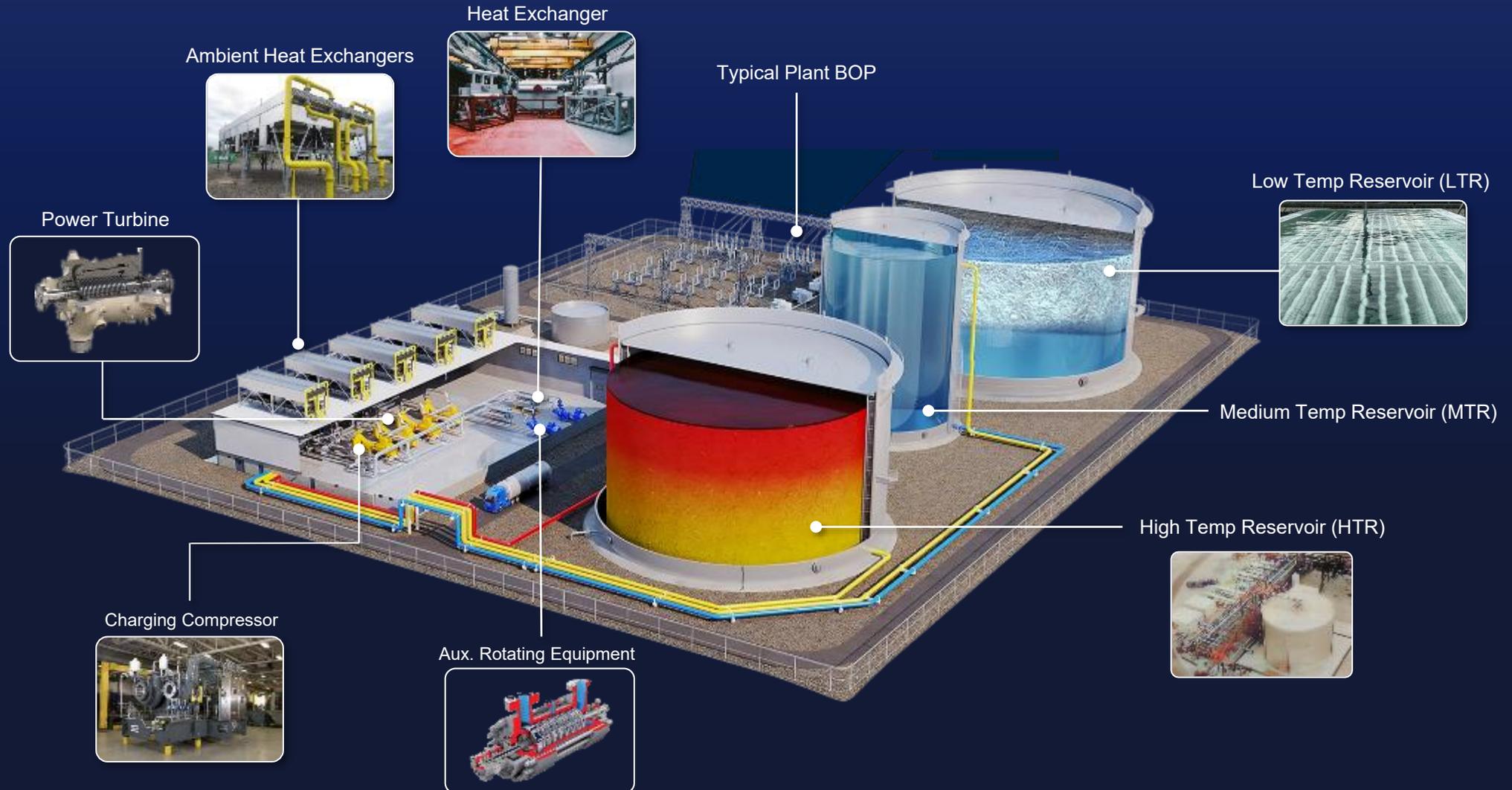


The EPS100 is a commercially available generating system with over 330 hours of operation

Heat Pump



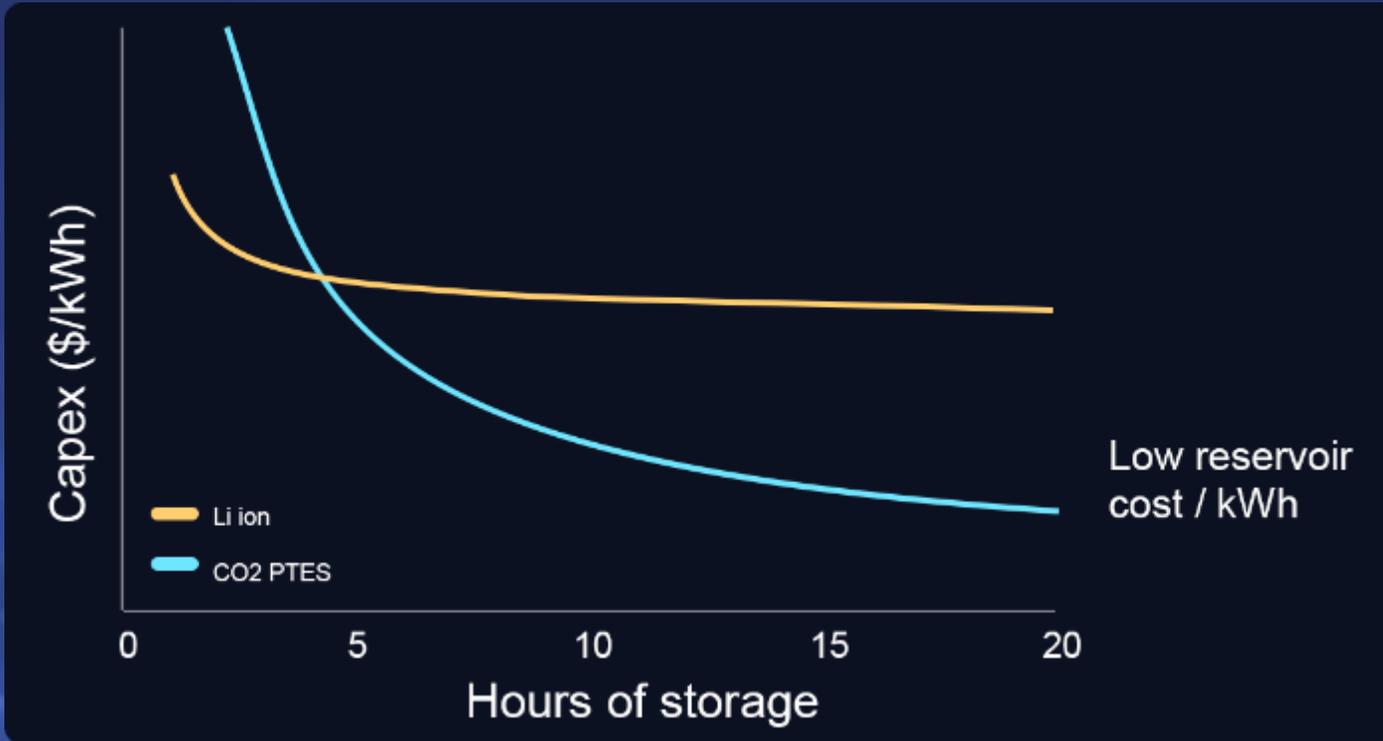
Large pilot scale system used to validate models



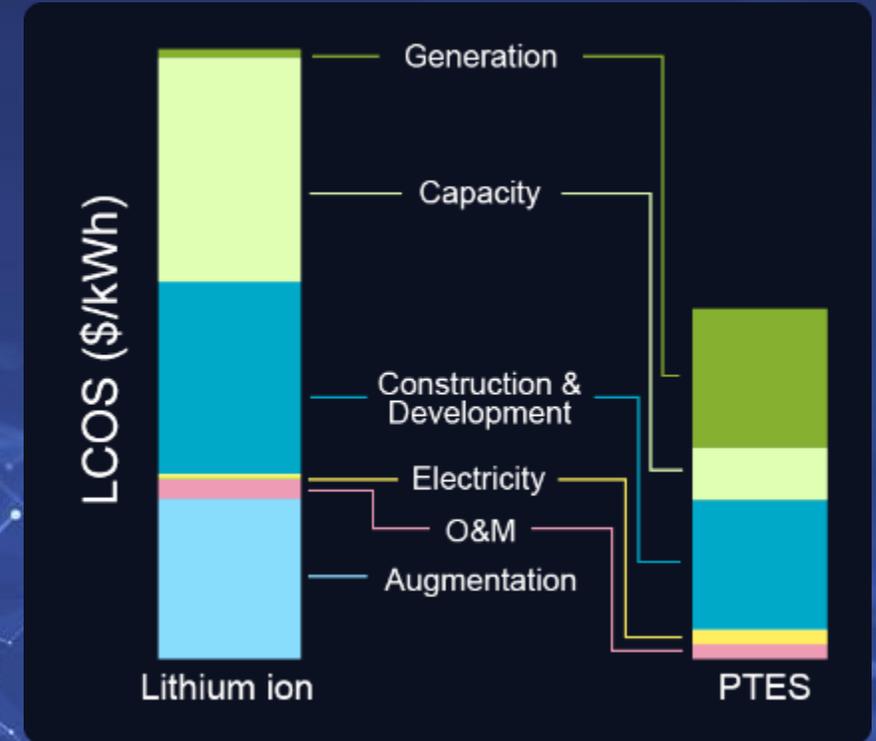
Cost-Effective Storage

Lower Capex, no augmentation costs => Lower LCOS

Capital cost / kWh, 100 MW scale

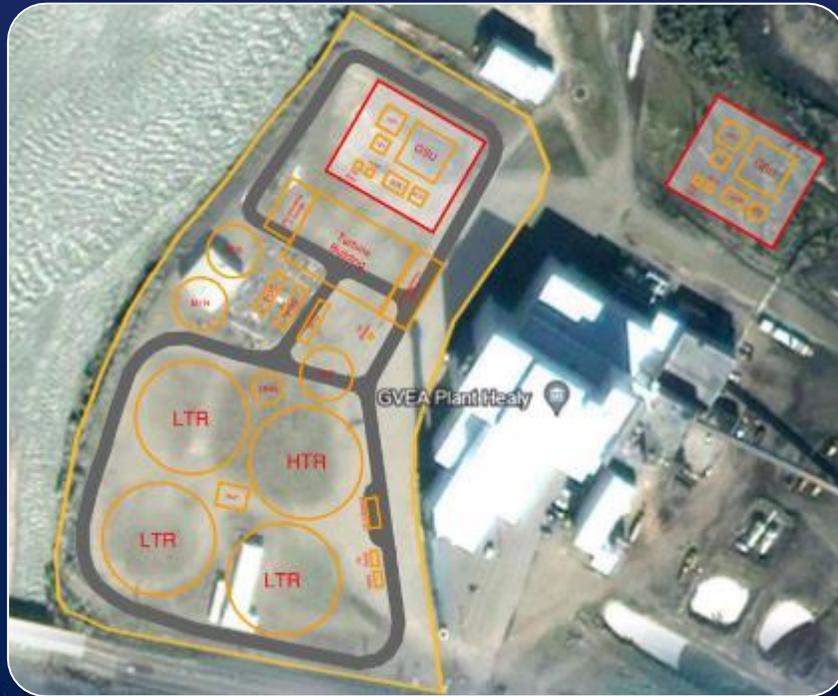


Levelized cost of storage, 100 MW/10 hrs



POLAR Project in Healy, AK

One of the largest, planned installations of long-duration energy storage in the United States



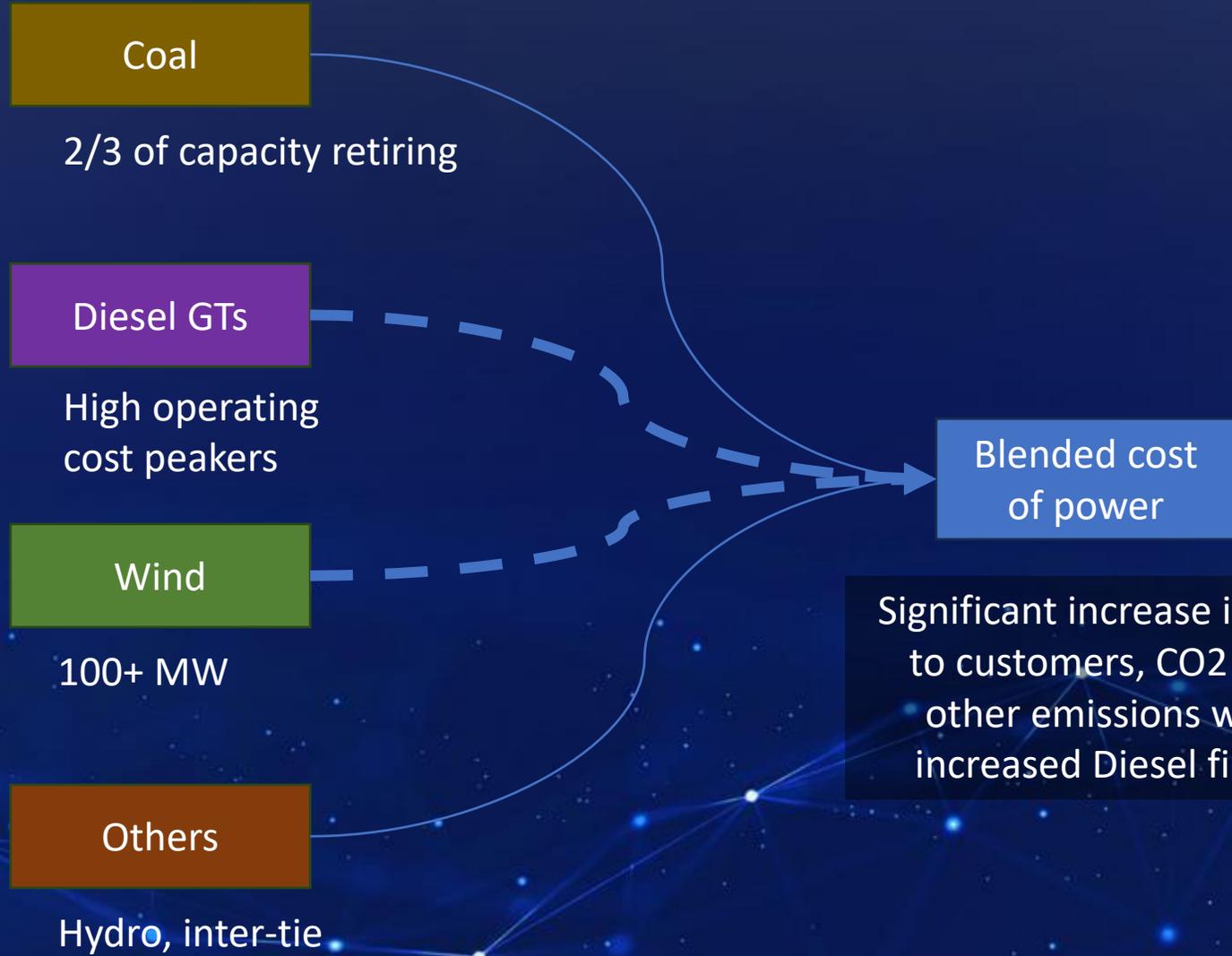
- US Department of Energy awards project to deploy 50MW, 1.2 GWh utility-scale long-duration energy storage
- Built to support new deployment wind to replace a baseload coal asset
- Minimizes challenges associated with transmission limitation & low-sulfur distillate fuel costs
- Provides significant benefits to local community in air quality and utility pricing



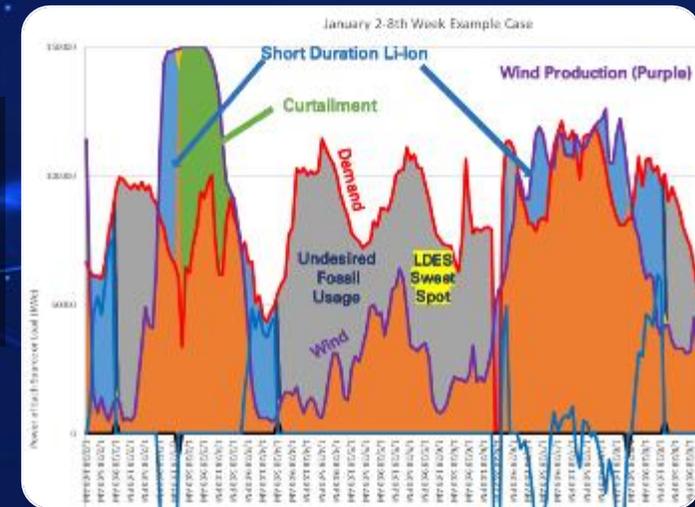
Current Generation Mix



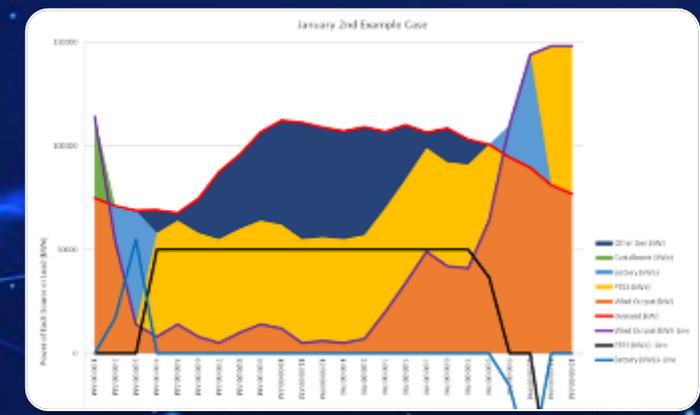
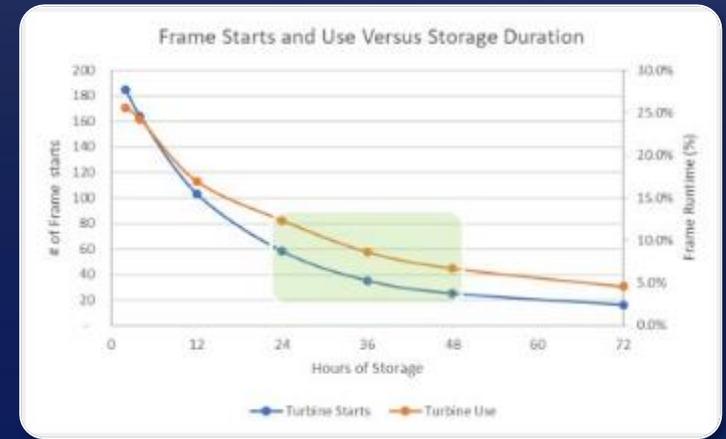
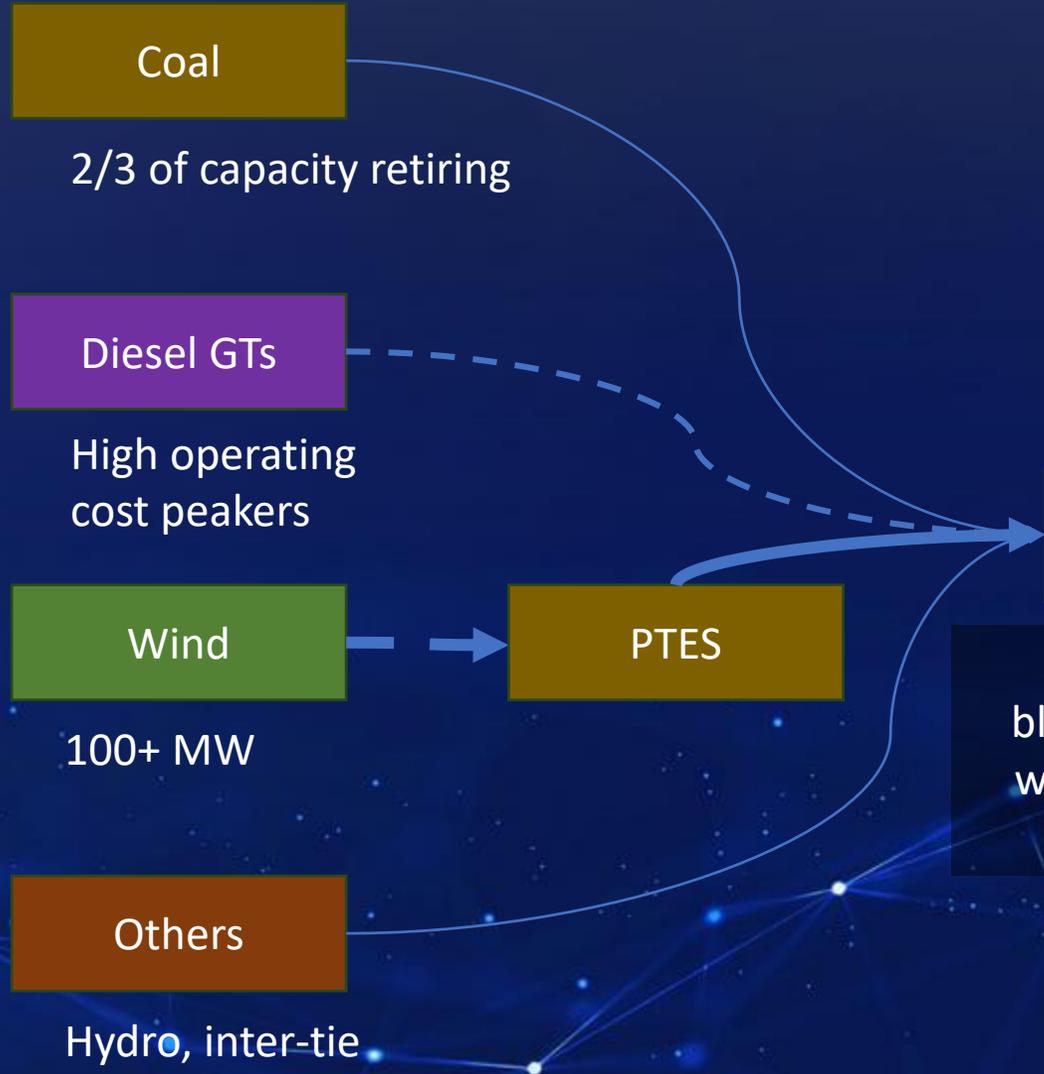
Future Without LDES



Significant increase in cost to customers, CO2 and other emissions with increased Diesel firing



Future With POLAR Project



Westinghouse & Echogen LDES

Grid-Scale Long Duration Energy Storage with unmatched application flexibility



Cost-Effective

~65% LCOS compared to li-ion batteries

Low cost of capacity across longer duration applications



Ultra Long-Life

Targeting **60** years of technology lifespan with the capability for unlimited cycles

Maintains capacity over time without augmentation.



Safe & Sustainable

100% non-toxic with no hazardous materials in an inherently safer design

Low carbon footprint and fully recyclable end of life



Back-up

Westinghouse & Echogen Team



Elias Gedeon
SVP, Commercial Operations
Energy Systems



Luca Oriani
SVP, Global Chief
Engineering Services



Phil Brennan
CEO



Daniel Lipman
Commercial Consultant



S. Shen Fong
Director, Mech & Chem Process
Engineering Services



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CTO



John Battaglini
VP, Sales & BD, Americas
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Jeremy Ward
Project Engineering Manager
Engineering Services



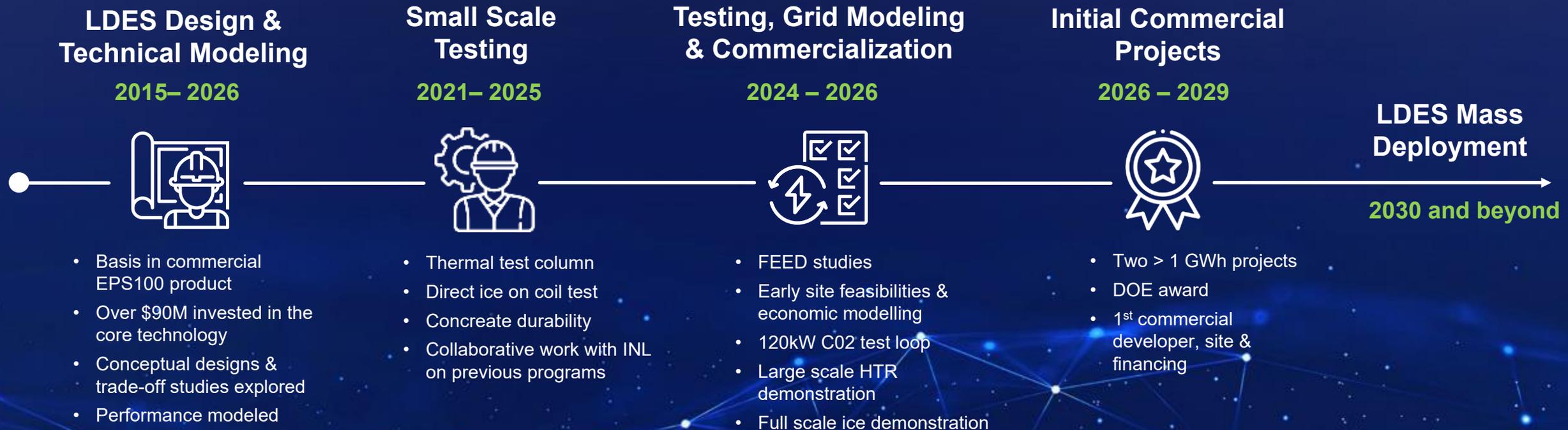
Jason Miller
Project Engineering Manager



Cory Stansbury
SME, Hot Storage Development

LDES Roadmap

Grid-Scale Long Duration Energy Storage with unmatched application flexibility

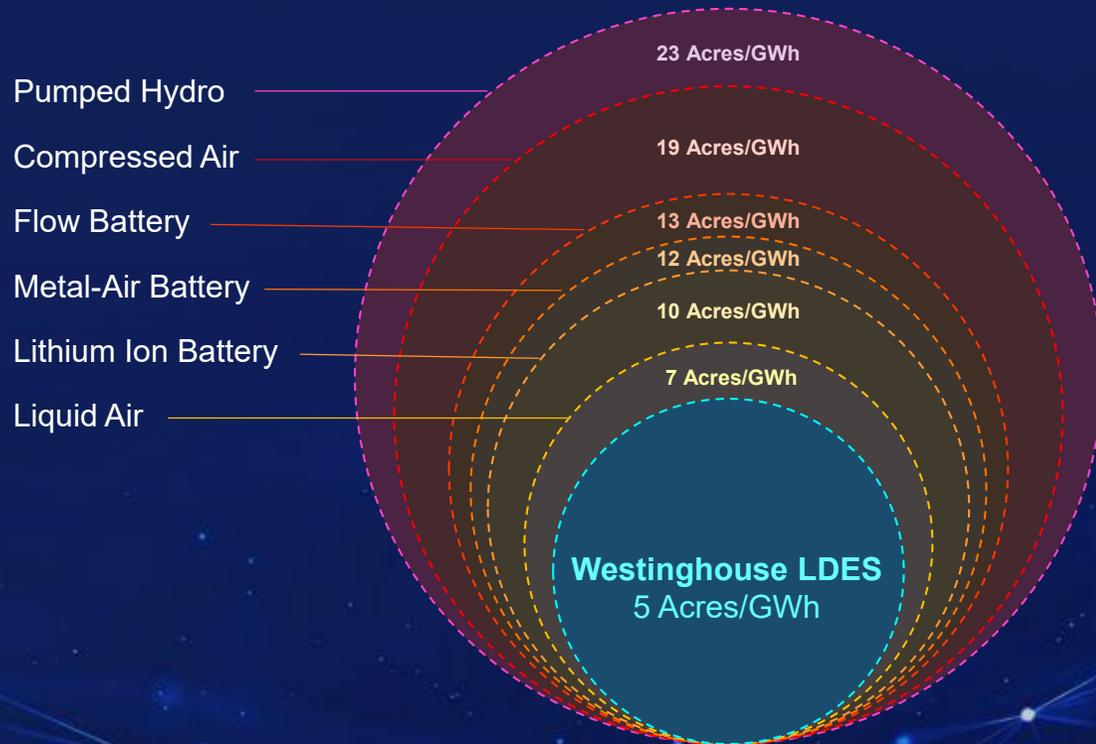


Siting & Sustainability

One of the most compact LDES footprints at ~5 acres for +GWh

Storage Technology Comparison

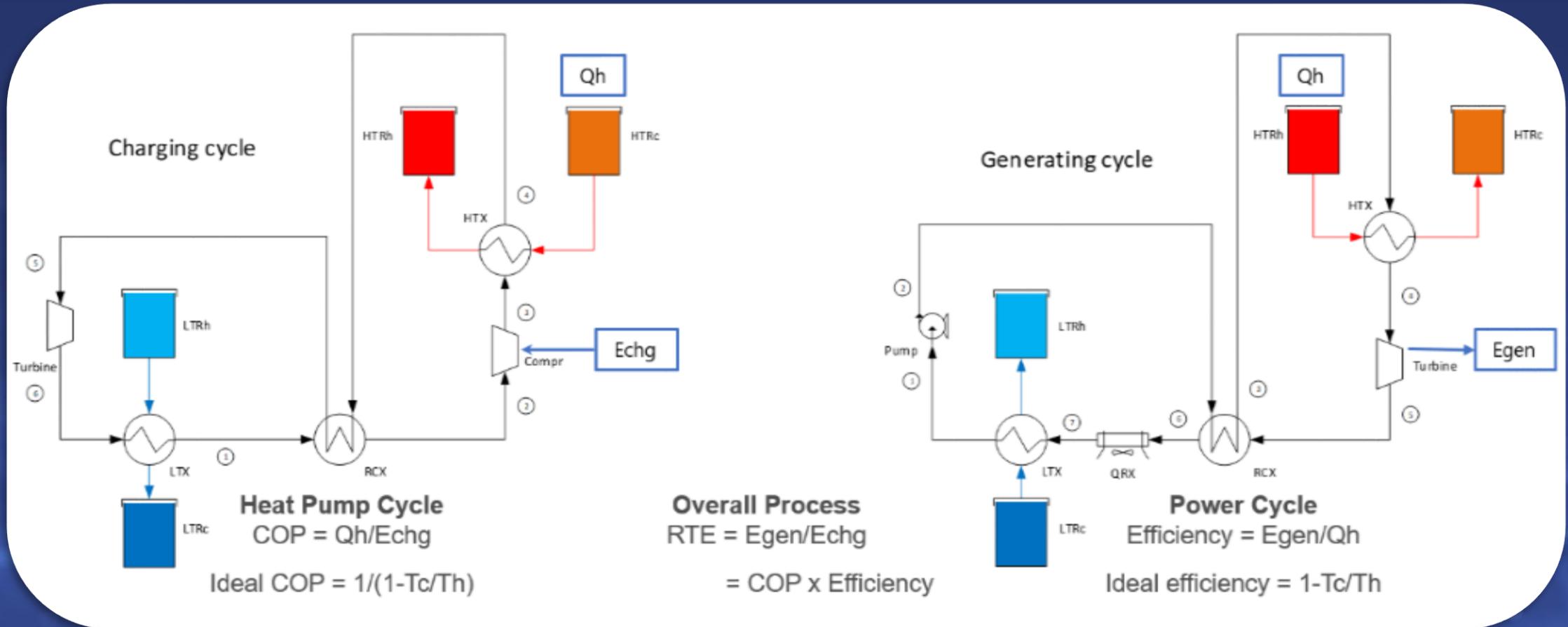
OVERALL FOOTPRINTS



Unmatched Sustainability

- No topographical or geologic dependencies
- Can be built anywhere with a fully domestic supply chain
- Non-toxic, non-hazardous materials, low chemical, fire and safety risks
- Low carbon footprint, fully recyclable end of life
- Established & Existing Supply Chain

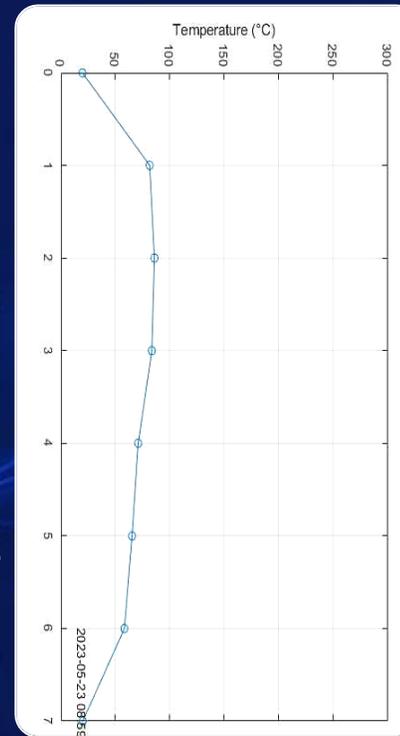
Simplified Cycle Diagrams



Hot and Cold Storage Testing

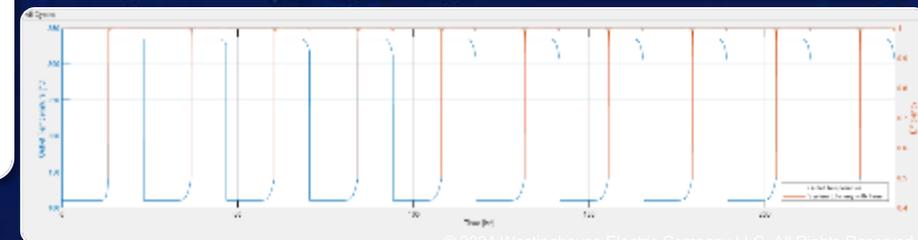
~400 kWh-t Packed Bed Test Column

- 6-hour cycle time
- 14 cycles have been completed
- Presently using gravel as a stand-in to gather early test data and as risk mitigation if issues arise with the development and manufacturer of the concrete forms.
- Testing of concrete and validation against code in 2024



Direct Ice-on-Coil Cold Storage Validation

- Ice-on-coil technology is well proven, but had never been done directly with sCO₂
- Have both demonstrated and worked to optimize this design for large scale deployment



Outperforming LDES Alternatives

		PTES (sCO ₂)	PTES (Brayton)	Li-ion	Pumped Hydro	Liquid Air	CAES	Gravity	Flow Battery
Economics	LCOS - Capex, opex, end of life	✓							
Scalability	Flexible capacity and duration, add storage later								
Footprint	Energy density per acre	✓							
Location	Ability to be located anywhere	✓							
Sustainability	Environmental impact, domestic supply chain	✓							
Safety	Risk to people and community	✓							
Complexity	Daily cycling, maintenance								
Ancillary Services	Inertia / Synchronous Condenser	✓							

Comparisons made at 10-hr discharge duration



Grid Level Support

From 8 hours to multiple days of stored capacity & other ancillary services to enable Net Zero Goals

