

A nighttime photograph of a city skyline, likely New York City, featuring a large suspension bridge in the foreground and numerous illuminated skyscrapers in the background. The sky is dark blue, and the city lights are reflected in the water. Two decorative lines, one blue and one pink, cross in the upper right corner.

# Liquid Air Energy Storage

TMCES Workshop, Feb 4, 2020  
Pittsburgh, PA



# Highview Power

## Solution

Liquid Air Energy Storage

## Company Role

Designer, developer, licensor

## Deployment Philosophy

Use proven equipment, suppliers & EPC

## Contracting

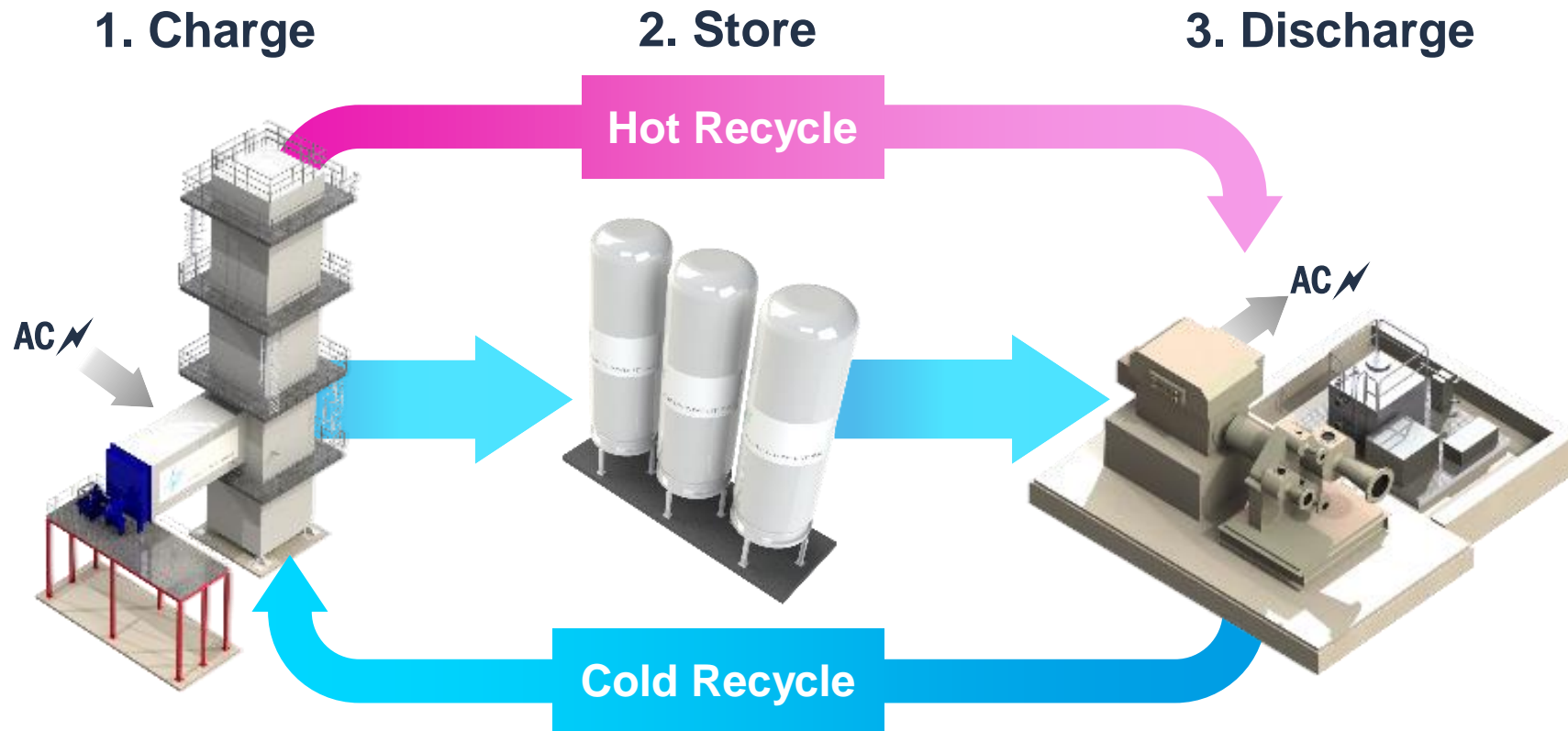
Build Own Transfer – PPA – Turnkey & wrap

## Facilities

5.5 MW built  
200 MW under development



# How Liquid Air Energy Storage works



Additional **hot** and **cold** thermal recycling increases efficiency

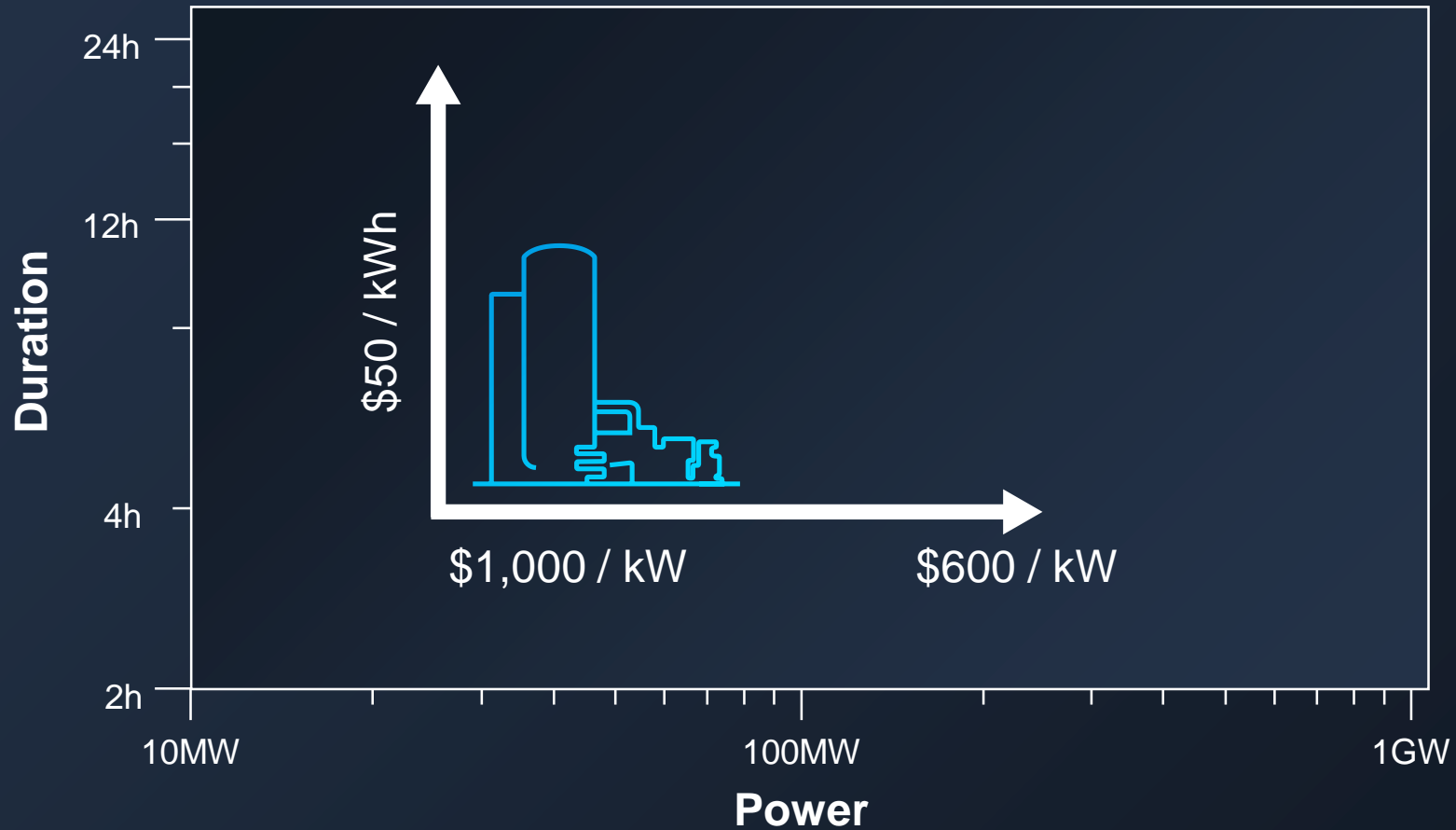




# Modular deployment



# Cost dynamics favorable to long duration



# Key characteristics

- ✓ Low cost for long duration
- ✓ No degradation
- ✓ Low standing losses
- ✓ Fast response capability
- ✓ Synchronous generation
- ✓ Safe and environmentally friendly

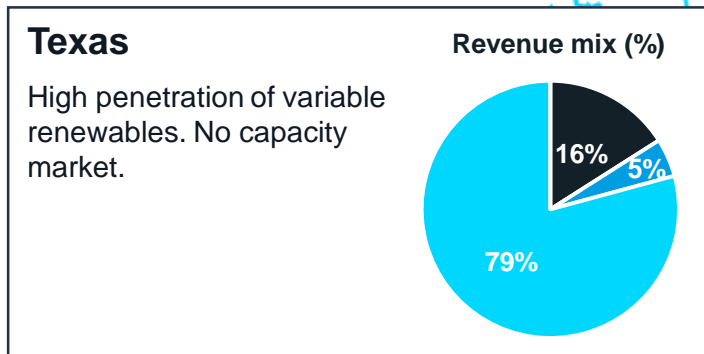
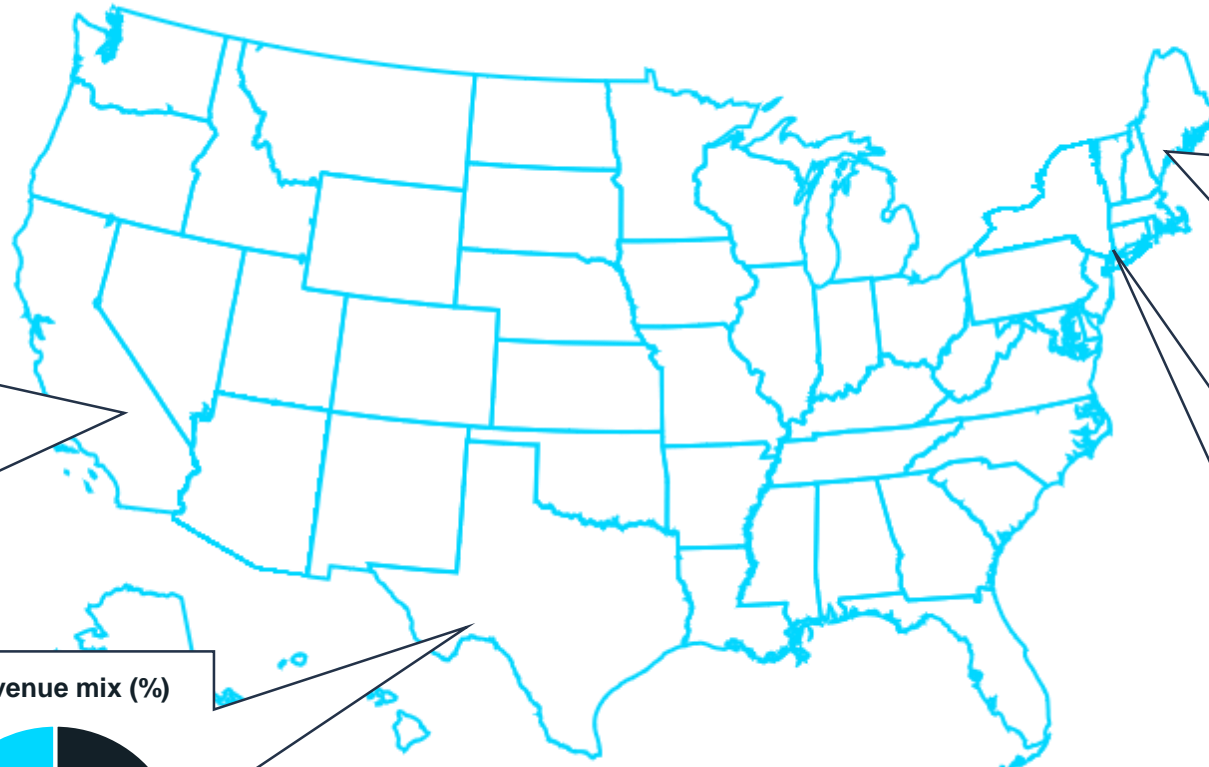
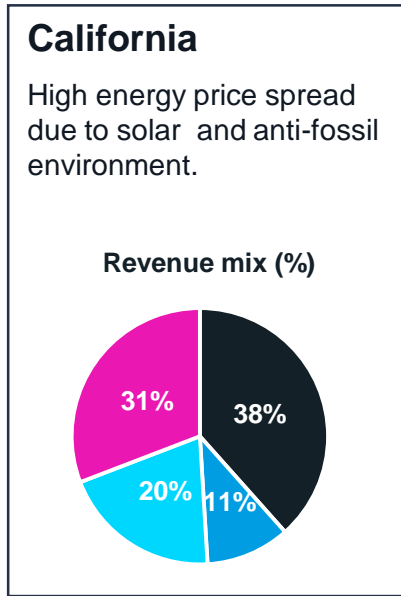
Characteristics	
Installed energy cost	\$50 / kWh
Installed power cost	\$1,000 / kW at 50 MW
Usable energy degradation	None
Roundtrip efficiency	60%
Standing losses	0.1% per day
Min. response time	< 1 minute
Synchronous services	Inertia and VARs
Chemical hazard	None
Fire hazard	Low
Environmental impact	Low



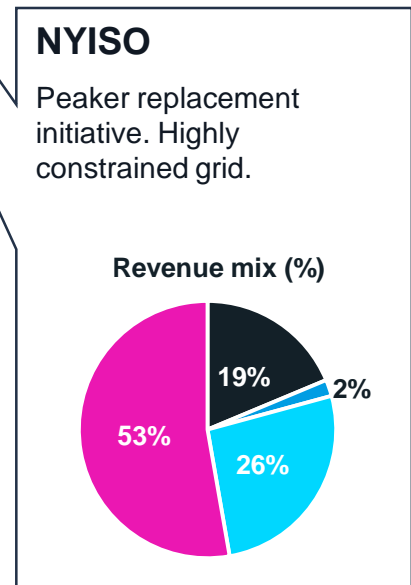
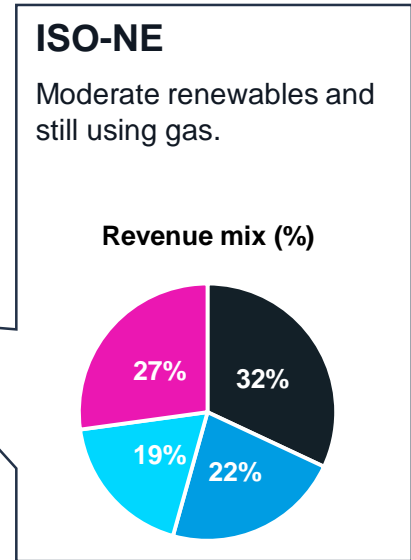
# Some value cases

Revenue source legend:

■ Energy ■ Regulation ■ Spinning Reserve ■ Capacity



Prevailing capacity price and best-location Day-Ahead wholesale revenue.



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# Economic sensitivities

Characteristic	Economic Sensitivity			
	CA case	TX case	NE Case	NY case
Capital cost	★ ★ ★	★ ★ ★	★ ★ ★	★ ★ ★
Degradation	★ ★	★	★ ★ ★	★
Roundtrip efficiency	★	★	★ ★	★
Standing losses		★		★
Min. response time		★ ★ ★		
Synchronous services			★ ★	





**Thank you!**



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