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Docket Number:	15-MISC-05
Project Title:	2015 Bulk Storage Workshop
TN #:	206693
Document Title:	Burbank Water and Power Presentation on Pathfinder CAES I LLC
Description:	Bulk Storage Workshop Presentation
Filer:	Collin Doughty
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	11/19/2015 10:15:32 AM
Docketed Date:	11/19/2015

Burbank Water and Power Presentation on Pathfinder CAES I LLC

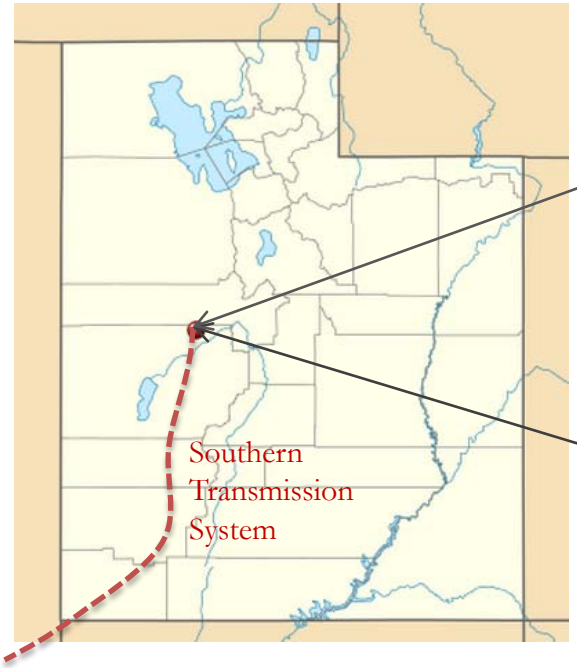
Joint California Energy Commission and California Public Utilities Commission Bulk Storage Workshop
November 20, 2015

Background

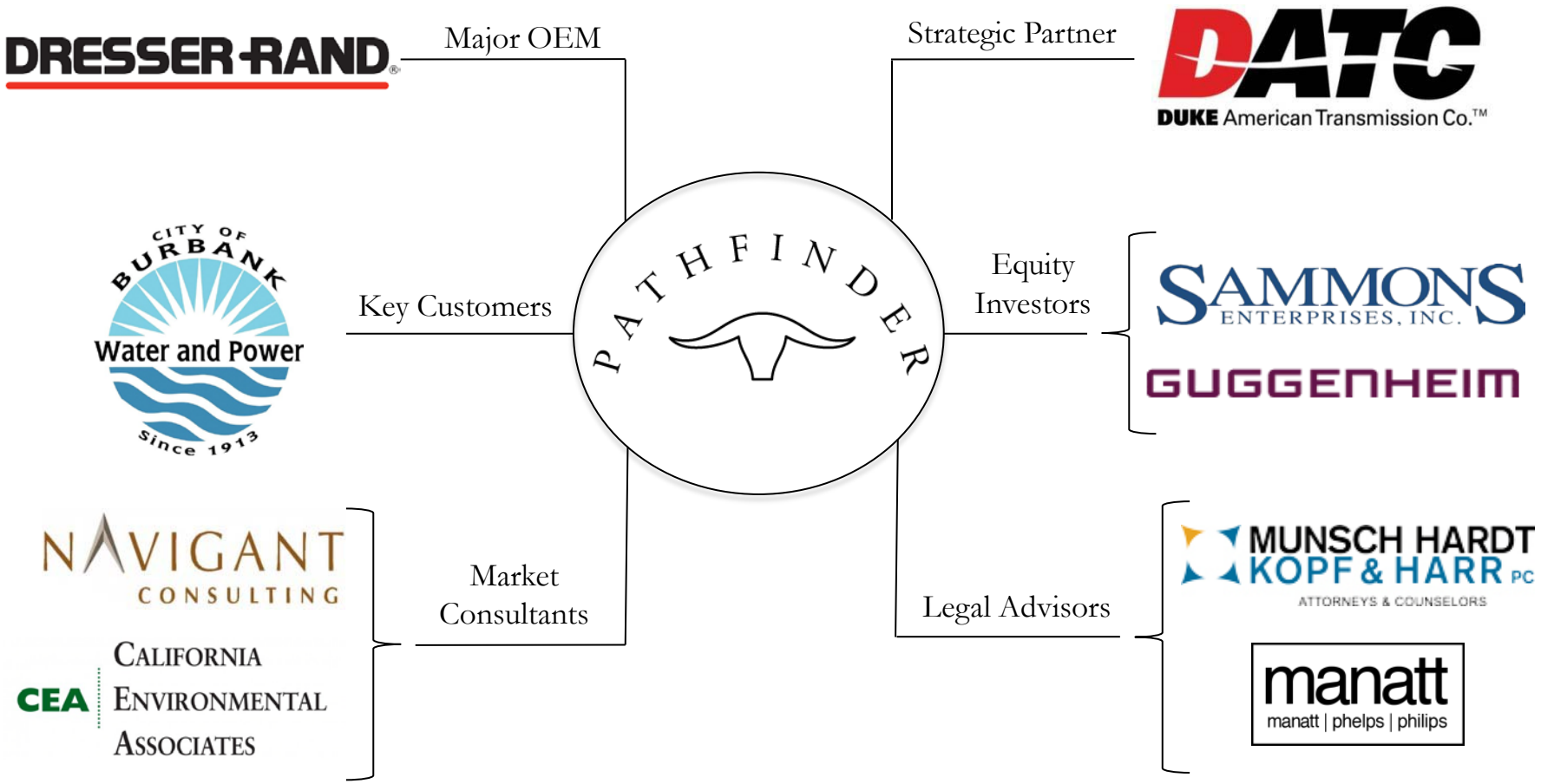
- **Pathfinder CAES I LLC** intends to construct, own and operate a 320 MW CAES project located in Milford County, Utah.
- This Project is the first of several phases ("**Phase I**") and is designed to support grid-level integration of California renewables.
- The success of this project will provide a foundation for California's 50% renewable future, enabling development of larger, future CAES projects which support both distributed and utility-scale renewable energy at significant scale.

Unique Project Attributes

- Geologically rare salt dome located at site of existing Intermountain Power Project, which will be retired in 2025
- Largest, strongest, most efficient CAES cavern of those studied in the U.S.
- Capable of housing at least 90 salt caverns, at 320 MW each.



Pathfinder Project: Key Participants Summary



BWP Operates Power Assets

Source: SCPPA

- Tieton Hydropower located in Washington
- Operated by BWP
- Other participants include City of Glendale, CA

Source: SCPPA

- Magnolia Power, a 310MW CCGT located in Burbank, CA
- Developed, construction-managed and operated by BWP (COD 2005)
- Other participants include the cities of Anaheim, Cerritos, Colton, Glendale and Pasadena

BWP & CA's Power Resources: A Regional Focus

The BWP and CA electrical system is diverse in terms of:

- Geography
- Facility
- Technology
- Fuel
- Transmission

BWP 1,200 MW CAES & 3,000 MW Wind Study: GridView Model Results

Year 2024, with Look-Ahead

Parameter (Year 2024)	1200 MW CAES / 3000 MW Wind	1200 MW CCGT / 2200 MW Wind	CAES & Wind Better Worse
Added Wind (GWh)	15,034	11,012	4,022
Regional Prod Cost ($M)	$23,615	$23,783	$168
Regional CO_2 (k tons)	391,984	393,238	2,254
Wind curtailment (MWh)	42,306 (0.3%)	68,218 (0.6%)	25,912
Solar curtailment (MWh)	31,873 (0.1%)	59,709 (0.19%)	26,836
STS load factor (%)	73%	66%	7 pct. pts.

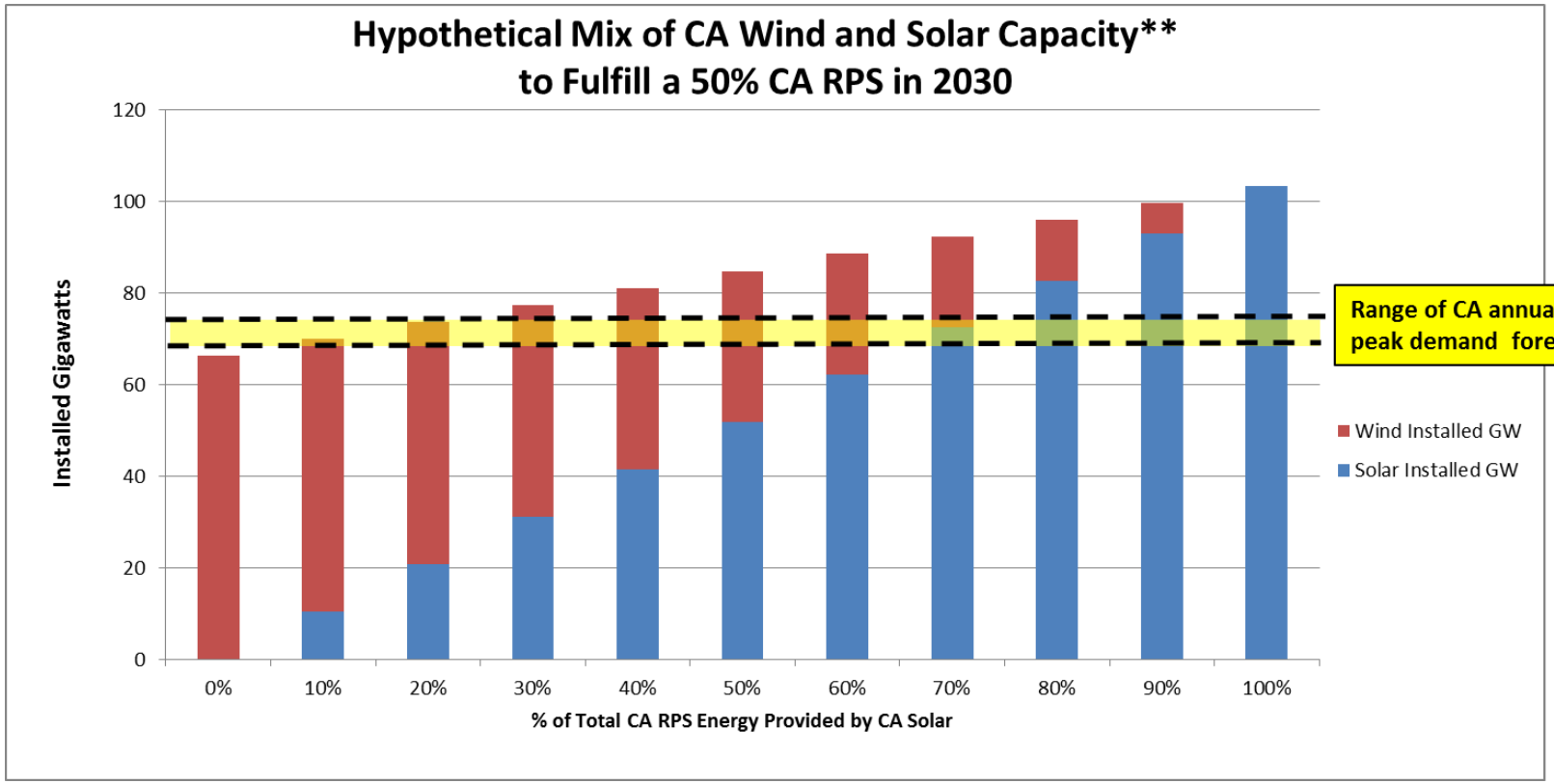
CAES & Wind is better in every key operating parameter than CCGT & Wind.

CAES vs. CCGT Comparison

	CCGT	CAES	CAES is
Technology Status	Mature	Mature	**Similar**
Capital Cost ($/kW for 2018 COD)	$1,375	$1,380	**Similar**
Fixed O&M Cost (2010$)	$19.80/kW-yr	$16.60/kW-yr	**Similar**
Roundtrip efficiency (%)	~50%	~50%	**Similar**
Ramp Rate (MW/minute)	13	60	**Better**
Minimum load (% of maximum)	55%	10%	**Better**
O&M increases with cycling?	Yes	No	**Better**
Operational start-up cost ($)	$Large	$Small	**Better**
Ability to integrate renewables	1MW:1MW	2MW:1MW	**Better**
Ability to store?	No	Yes	**Better**
CO_2 emissions (Ton/MWh generated)	0.5	0.3*	**Better**

*utilizing renewables

BWP 1,200 MW CAES & 3,000 MW Wind Study: The 50% RPS Capacity Challenge



Issue: The new California 50% RPS, based on energy, creates a capacity overgeneration situation that will require significant, grid-level storage.

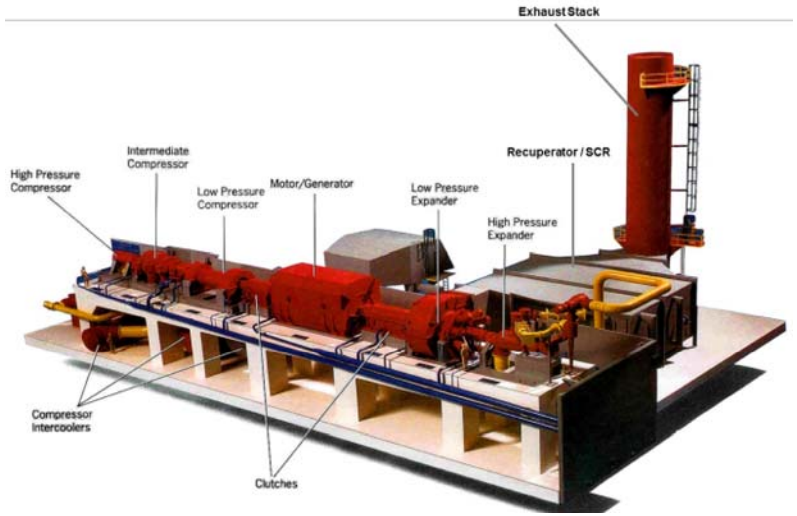
BWP 1,200 MW CAES & 3,000 MW Wind Study: Conclusions

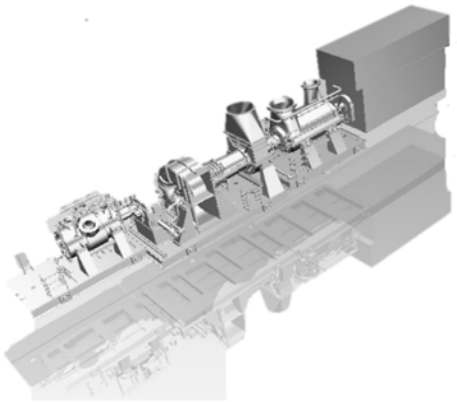
- **CAES storage as modeled can effectively integrate more than 3000 MW of Wyoming wind at Delta (with minimal curtailment).**
- **Economics:**
  - Ratepayer Perspective: CAES+3000 MW wind is far better than CCGT+2200 MW wind.
- **90% of the energy stored would be wind energy.**
- **There is also clear evidence that the "Duck Curve" of solar PV over-generation is occurring in Southern California.**
  - WECC GridView model assumed a 33% RPS in California in 2024; there is potential to supply storage to manage significant California renewable over-generation due to SB 350 and solar PV.

The 1,200 MW CAES project is dependent on the initial, 320 MW Phase I Project.

CAES Technology Improvements vs. McIntosh

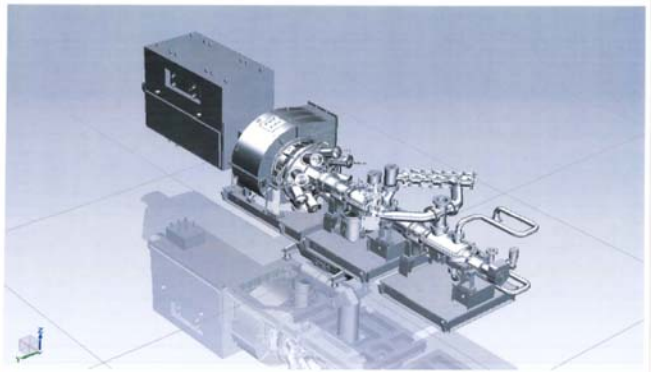
(Partial List Only0





New System Designs Driven to Meet Market Demands

- Separate Trains for Compression and Expansion (Split Train) for Simultaneous Train Operation
- 2835 Maximum Delivery Pressure from 1150 PSIA, While being 3% to 5% more efficient
- 19% increase in Power Generation (135MW to 160MW)
- 20% Increase in Recuperator Effectiveness (75% to 90%)
- >60% Reduction in NO_X & CO Emissions (5PPM to <2PPM)



Expander Train

Making CAES Happen For California

Challenges

1) CAES is generally not part of policy discussions, studies and mandates.
2) Regulatory treatment of storage is uncertain, esp. out-of-state resources.
3) Market treatment of storage is incomplete/uncertain.

General Solutions

A. Coordination among CPUC, CEC, CAISO
B. Level playing field for storage solutions
C. Clear regulatory guidance on out-of-state resources, focused on maximizing renewables into California
D. Full understanding of storage benefits, reflected in market mechanisms