

COMPRESSED AIR ENERGY STORAGE IN CALIFORNIA

Michael Medeiros, Pacific Gas and Electric Company, San Francisco, CA
 Robert Booth, Booth & Associates International, San Francisco, CA

Introduction

The purpose of this presentation is to provide an overview of Pacific Gas and Electric Company's (PG&E) initiative in evaluating the technical and economic feasibility of compressed air energy storage (CAES) using porous rock reservoirs in California. PG&E was awarded funding from the U.S. Department of Energy (DOE), the California Energy Commission (CEC), and the California Public Utilities Commission (CPUC) to determine the feasibility of a 300 MW CAES facility utilizing up to 10 hours of storage in a porous rock reservoir. Currently, there are two utility scale CAES facilities operating in the world, and both utilize salt domes for their storage reservoir. Due to the geology in California and many other locations in the U.S., such underground storage features are not available. The identification, evaluation and testing of a reservoir, including preliminary engineering, environmental studies, and economic analysis, will take place over our 4 ½ year study period, which began in February 2011. Should the results of that testing and evaluation appear viable, and the appropriate approvals / funding is secured to move forward to construct a full CAES facility, it is anticipated such a facility would become commercially operational in 2021. The information provided in this presentation provides greater detail on the project status and reservoir selection and testing process, which is focused solely on evaluation of depleted gas reservoirs.

Initial Methodology

The map below (Figure 1) shows a sample of abandoned or idle gas reservoirs in northern California, a number of which have undergone preliminary evaluation by the PG&E team. The criteria developed to evaluate the potential reservoir fields is presented in Figure 2 below based on preliminary engineering studies, lessons learned from other subsurface investigations, and PG&E's experience with natural gas storage.

Figure 1: Abandoned or idle gas reservoirs in northern CA

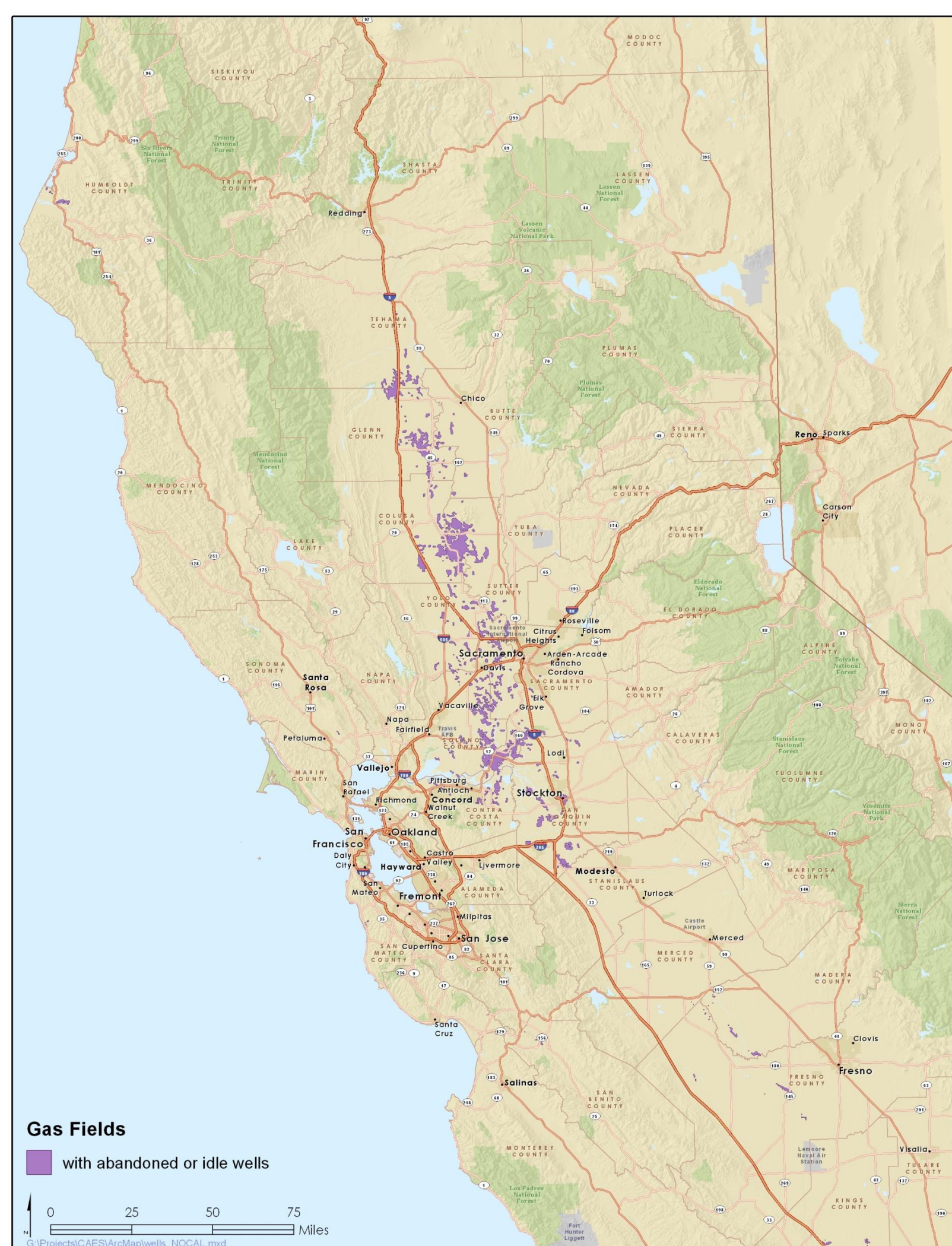
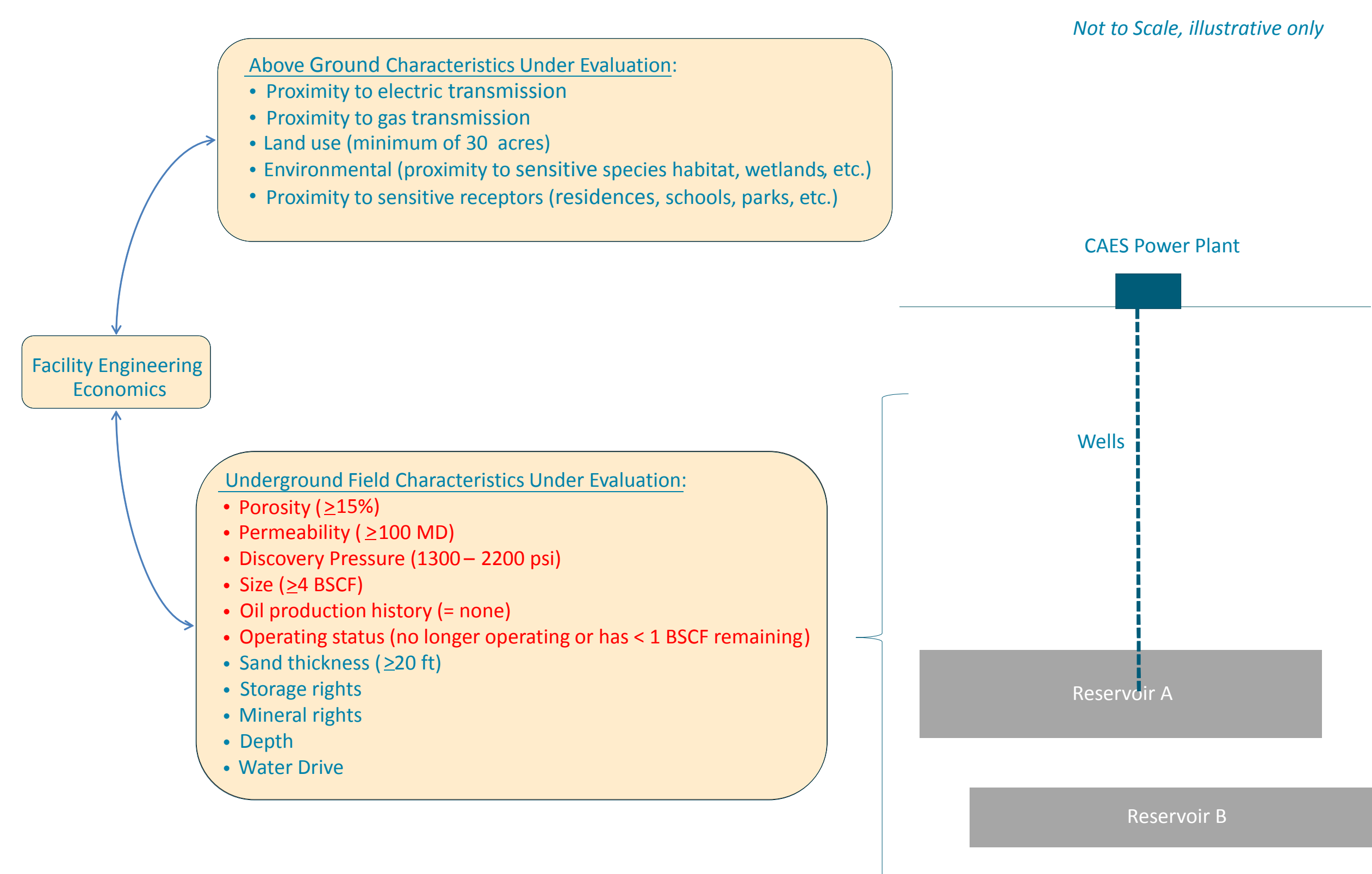


Figure 2: Initial Criteria Used to Evaluate Reservoir Fields



Notes:
 Items in red text are considered "go / no-go" criteria for the initial evaluation

Preliminary Results and Current Status

- more than 120 gas fields evaluated
- 14 gas fields passed the "go / no go" threshold → conducted further environmental & more detailed reservoir analysis
- further technical evaluation on 37 gas fields
- detailed cost and environmental/site screening conducted on 12 sites
- 3 sites short-listed with several back-up sites identified

Lessons Learned

1. **Major Reasons for Site Elimination**
 - a) Field cumulative production is too small, or
 - b) Field is in production with significant number of active wells, or
 - c) Field is too shallow → too low pressure
 - d) Environmental (proximity to vernal pools, waterfowl refuge, conservation easements)
 - e) Ownership complexity
2. **Optimal Hours of Storage Assumption**
 Preliminary economic analysis indicates that 4 to 6 hours of storage may be optimal (vs. the original assumption of 10 hours of storage). This will be further evaluated throughout the selection process.
3. Environmental and public policy siting considerations are a large factor in the selection process
4. Accurate sources of GIS and public data are critical

Next Steps

- 2012: Obtain site control for top 3 sites & environmental permits for drilling
- 2013: Complete core well drilling and sample analysis
- 2014: Complete compression testing (top site)
- 2015: Issue plant RFP and complete Final Phase I DOE report

Acknowledgements & References

Acknowledgements:

We'd like to acknowledge the Department of Energy, the California Public Utilities Commission, and the California Energy Commission for their support for this initiative. Additionally, thank you to team members Joe Sutton, Joe Chan, and Trent Holsey for their contributions to this presentation.

References:

- Final Report on CAES Siting in Northeastern Colorado, University of Colorado - Boulder, October 2008
- Lessons Learned for PG&E Adv. CAES Demo Plant Using Porous Rock Air Store, EPRI, January 2011 (draft)
- Conceptual Study for PG&E CAES Project Cost and Performance, Worley Parsons, December 2010
- Factors Affecting Storage of Compressed Air in Porous Rock Reservoirs, Pacific Northwest Laboratory, May 1983