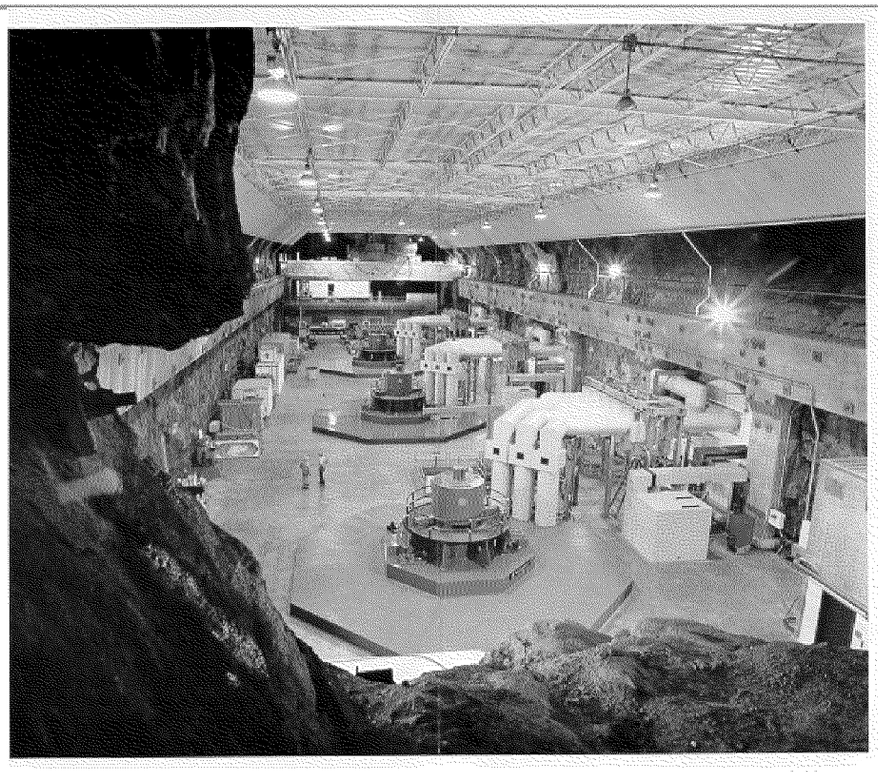

Pumped Storage Project Development

PG&E Photo: Helms Pumped Storage Project

Pacific Gas and Electric Company

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Agenda

- Why Energy Storage?
- Why Pumped Storage?
- Pumped Storage Overview
- PG&E's Pumped Storage Project Development
- Potential Regulatory Path

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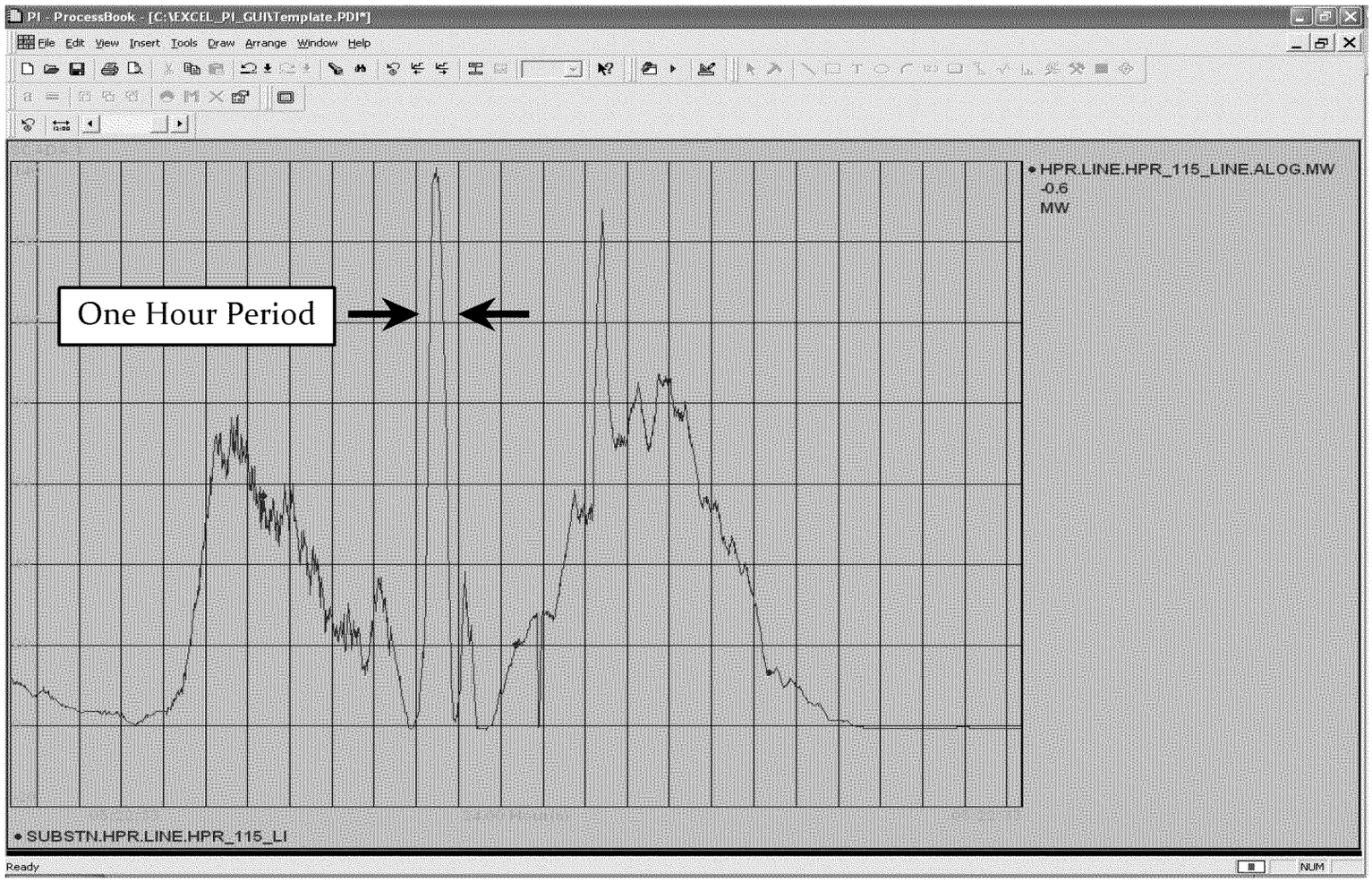

Example of extreme wind variability from a conference presentation by HDR/DTA

Why Energy Storage?
Activity Addressing Integration of Intermittent Resources

- FERC Notice of Inquiry, Variable Energy Resources
- CAISO 33% Renewable Integration Study, Assesses the incremental integration requirements of different 33% RPS portfolios
  - Calculates the flexible resources required to address the variability and forecast uncertainty of variable renewables
  - The study results are intended to provide a perspective of integration requirements and serve as benchmarks against which integration alternatives can be evaluated
  - Mitigation alternatives include energy storage and intermittent generation curtailment
- PG&E is conducting a parallel analysis, using CAISO assumptions when possible, intended to support and help validate CAISO's study

- Storage of economy energy, (surplus energy) that is sometimes available at night for daily cycling or during Spring snowmelt runoff conditions for seasonal storage.
- A large amount of fast acting spinning reserve and electric system regulation capability, or generating capacity that is immediately available to meet fluctuations in electric demand and provide grid stability.
- Helps alleviate over-generation or minimum load condition by using excess energy to pump water into storage
- Reduces dependence on fossil fueled technologies and their associated greenhouse gas emissions otherwise needed to firm variable resources.
- Provides all of these functions with a very small footprint when compared to a similarly sized conventional hydro project.

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Why Pumped Storage?
Multiple Storage Solutions

- Pumped storage is an established and widely deployed bulk energy storage alternative and can provide significant ancillary services functionality for electric system stability and control.
- However, it takes time to develop, permit, license, and construct pumped storage projects.
- There are multiple storage technologies in development. Incentives can help ongoing development of several technologies to maintain optionality of storage solutions.

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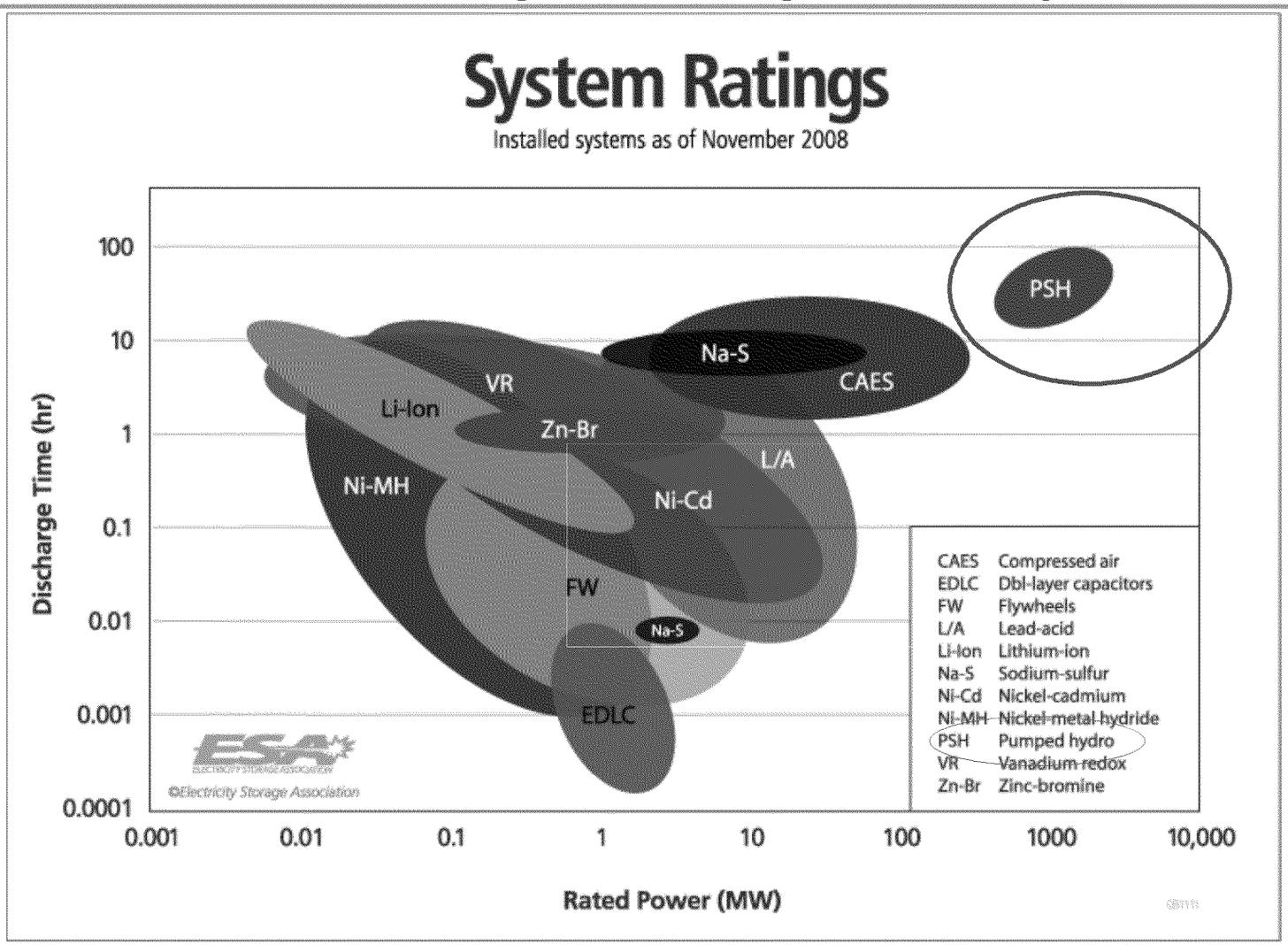
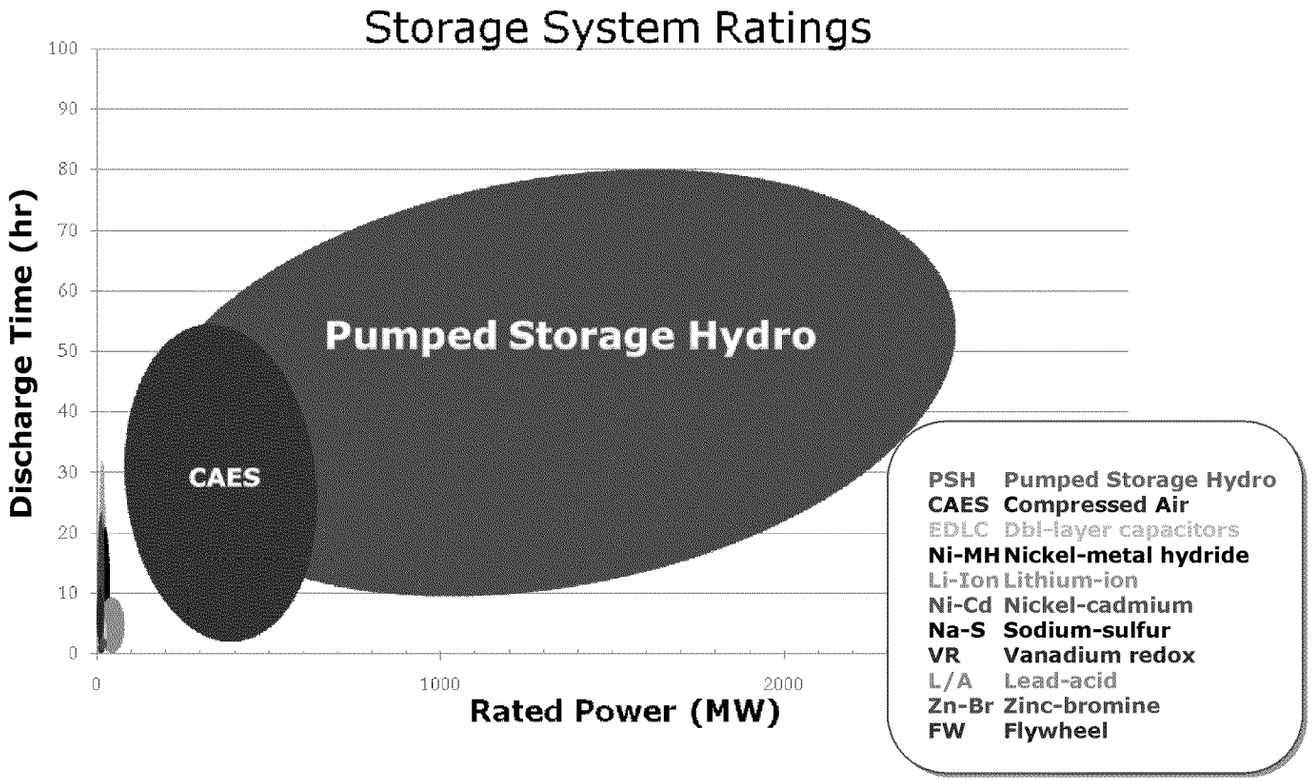
Why Pumped Storage?
Different Storage Technologies Can Play Different Roles



http://electricitystorage.org/tech/technologies_comparisons_ratings.htm (logarithmic scale)

Energy Storage Technologies



Same as prior graph by Electricity Storage Association (converted to normal scale by Rick Miller, HDR | DTA)

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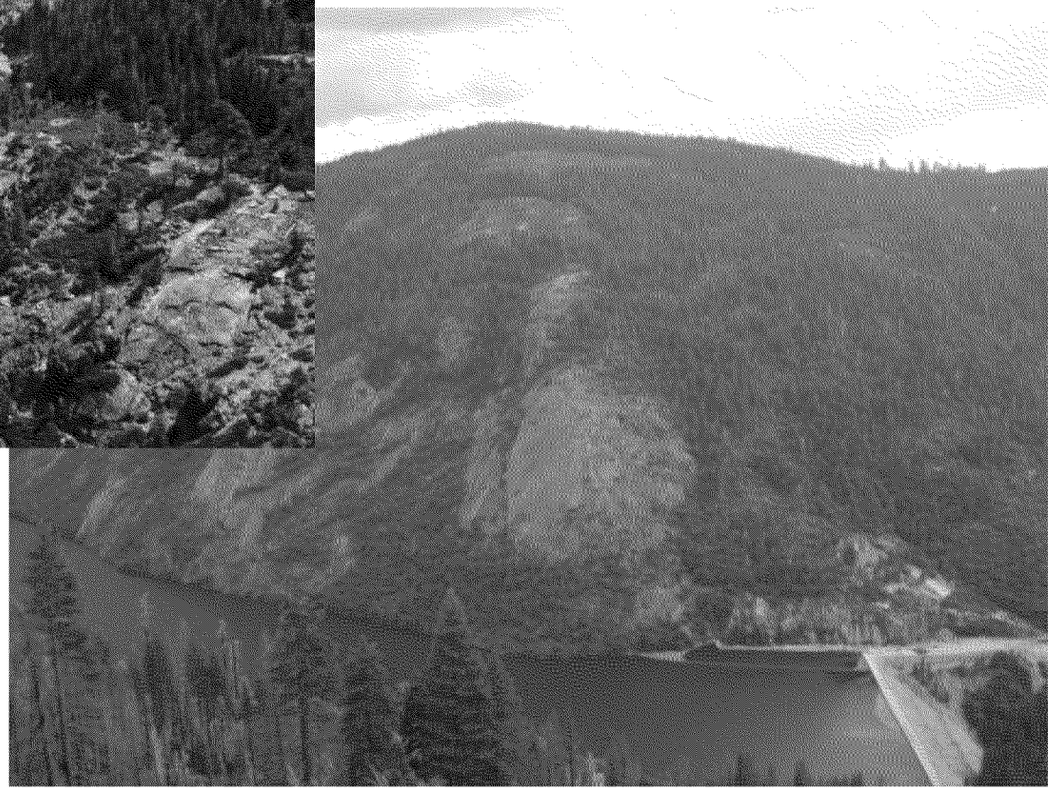
Pumped Storage Overview

- Minimize cost – good geology, maximize use of existing infrastructure.
- Maximize value – greatest benefit to power supply portfolio and grid reliability.

Redacted

Pumped Storage Overview
Mokelumne

Lower Bear River Reservoir



Salt Springs Reservoir

PG&E Pumped Storage Project Development

- Timing
  - Start FERC Licensing – 2011
  - Complete FERC Licensing and CPUC approval – 2016-2017
  - Construction – 2017-2021
- Cumulative Costs (approximate)
  - $12 million to get to start of FERC licensing
  - $50 million to get to completion of FERC licensing and CPUC approval
  - $5 billion (2021 dollars) to get to commercial operation

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- Energy Policy Act, 2005:
  "**Advanced transmission technologies**" defined as … including … energy storage devices (including **pumped hydro** …"
- FERC Order 679:
  - Available Incentives include:
    1. **Abandoned plant cost recovery**
    2. ROE enhancements
    3. Current recovery of construction work in progress (CWIP)
    4. Imputed debt-equity structures
    5. Accelerated depreciation
    6. Other incentives that a project proponent might request
  - Must Demonstrate that Project will either:
    7. **Ensure reliability**; or
    8. Reduce the cost of delivered power by reducing transmission congestion