Helms Pumped Storage Plant
Northwest Wind Integration Forum Workshop

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Pacific Gas and Electric Company - Overview

Headquarters Location
San Francisco, CA

Service Area
70,000 square miles in northern and central California

Service Area Population
15 million people (or about 1 of every 20 Americans)

Distribution Customer Accounts
5.1 million electric, 4.3 million gas

Employees
Approximately 20,000

System
- 159,364 miles of electric transmission and distribution lines
- 48,198 miles of natural gas T&D pipelines
- 6,271 megawatts of generation, including
  Diablo Canyon nuclear power plant,
  Helms pumped storage plant, and
  one of the largest hydroelectric systems in the country
On average, More than 50% of PG&E’s Portfolio is Carbon-Free

PG&E’s 2007 Electric Delivery Mix

Note: Delivery mix includes all of PG&E’s owned generation plus all of PG&E’s power purchases. PG&E’s direct purchases of coal have not increased and remain at 1.6%. The higher number on the chart is due to state regulations that assume a higher mix of coal in market purchases. Also, 2007 was a below normal hydro year.
Helms Pumped Storage Plant is in its 25th Operating Year

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<thead>
<tr>
<th>Location</th>
<th>Central California, about 50 miles east of the City of Fresno</th>
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<tr>
<td>Commission</td>
<td>June 30, 1984</td>
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<td>Upper Reservoir</td>
<td>Courtright Lake 123,000 Acre Feet</td>
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<tr>
<td>Lower Reservoir</td>
<td>Lake Wishon 129,000 Acre Feet</td>
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<td>Installed Capacity</td>
<td>Three units; 1,212 MW generating; 930 MW pumping</td>
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<td>Average Energy</td>
<td>&lt;100 GWh per year (natural in-flow)</td>
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A-Courtright, B-Supply Tunnel, C-Turbine, D-Generator, E-Transformer, F-Wishon, G-Surge Chamber, H-Elevator
Helms Generates During Day Time and Pumps at Night

- Helms has three identical reversible pump-turbine motor-generator units
- 1,212 MW total in generation mode, and 930 MW total in pump mode
- Units are housed in a chamber about 1,000 feet underground
- In generating mode, water would
  - release from Courtright Lake
  - travel at 9,000 cubic feet per second
  - through a 22,000 feet long supply tunnel, and
  - drop 1,744 vertical feet before discharging into Lake Wishon
- In pumping mode, the units would reverse and pump water from Lake Wishon into storage at Courtright Lake
- Units have fast operating capability:
  - Dead stop to full generation in eight minutes
  - Dead stop to full pump in twenty minutes (single speed)
  - Generating ramp rate of 80 MW per minute per unit
Helms Provides PG&E Customers with Many Benefits

- Storage of economy energy, or surplus or lower cost energy that is sometimes available at night for daily cycling or during Spring runoff conditions for seasonal storage
- A large amount of fast acting spinning reserve and regulation capability, or generating capacity that is immediately available to meet fluctuations in electric demand
- Revenues from CAISO’s energy and ancillary markets (regulation, spin and non-spin)
- Helps alleviate over-generation or minimum load condition by using excess energy to pump water into storage
- Allows operation of thermal plants at a more steady output level, resulting in higher efficiencies
- Reduces dependence on fossil fuels and greenhouse gas emissions (environmental benefits)
Helms Operation – Typical Summer Week

Unit 1

Unit 2

Unit 3
Helms' Production Substantially Exceeds its Natural Inflow
Demand Increase has Consumed Transmission for Pumping

- Over the past 25 years, electric demand in central California has increased and has consumed some transmission capacity for pumping at Helms during off-peak hours.
- PG&E has plans to construct a new 150 mile long 500 kV transmission line to, among other things, restore Helms' pumping flexibility.

Illustrative Demand vs. Transmission Capability for Pumping

- Electric Demand 25 year ago
- Today's Local Area Electric Demand
- Transmission Limit
- Hour
Future Changes to Helms PSP Operation --- Unclear

Potential drivers are:

• Electric transmission constraints
• Intermittent renewable generation
• CAISO’s Market Redesign and Technology Upgrade initiative and its Nodal and Locational Marginal Pricing
• Western Electricity Coordination Council’s draft Frequency Response Reserve criteria in additional to the current spinning reserve requirement
PG&E is Evaluating New Pumped Storage Opportunities

- More pumped storage plants is good for power system operation
- In 2008, PG&E has sought and received FERC permits to evaluate potential pumped storage hydro facilities at Mokelumne River and Kings River
- PG&E is currently evaluating several potential pumped storage sites based on using a number of existing or new reservoirs
In Summary

- PG&E’s Helms Pumped Storage Plant has provided positive economic, reliability, operational and environmental values to PG&E’s customers for almost 25 years, with many more to come
- Helms can facilitate storage of economy energy on both a daily and a seasonal basis
- Helms is an effective means to resolve over-generation and minimum load issues
- Helms, with its fast operating characteristics, is a valuable tool for system operators to meet changing demand and system conditions
- Helms is very valuable in the ancillary market as well as the energy market
- Helms can also be an effective tool to accommodate and integrate intermittent renewable resources

QUESTIONS???