CALPINE®
NYSE CPN

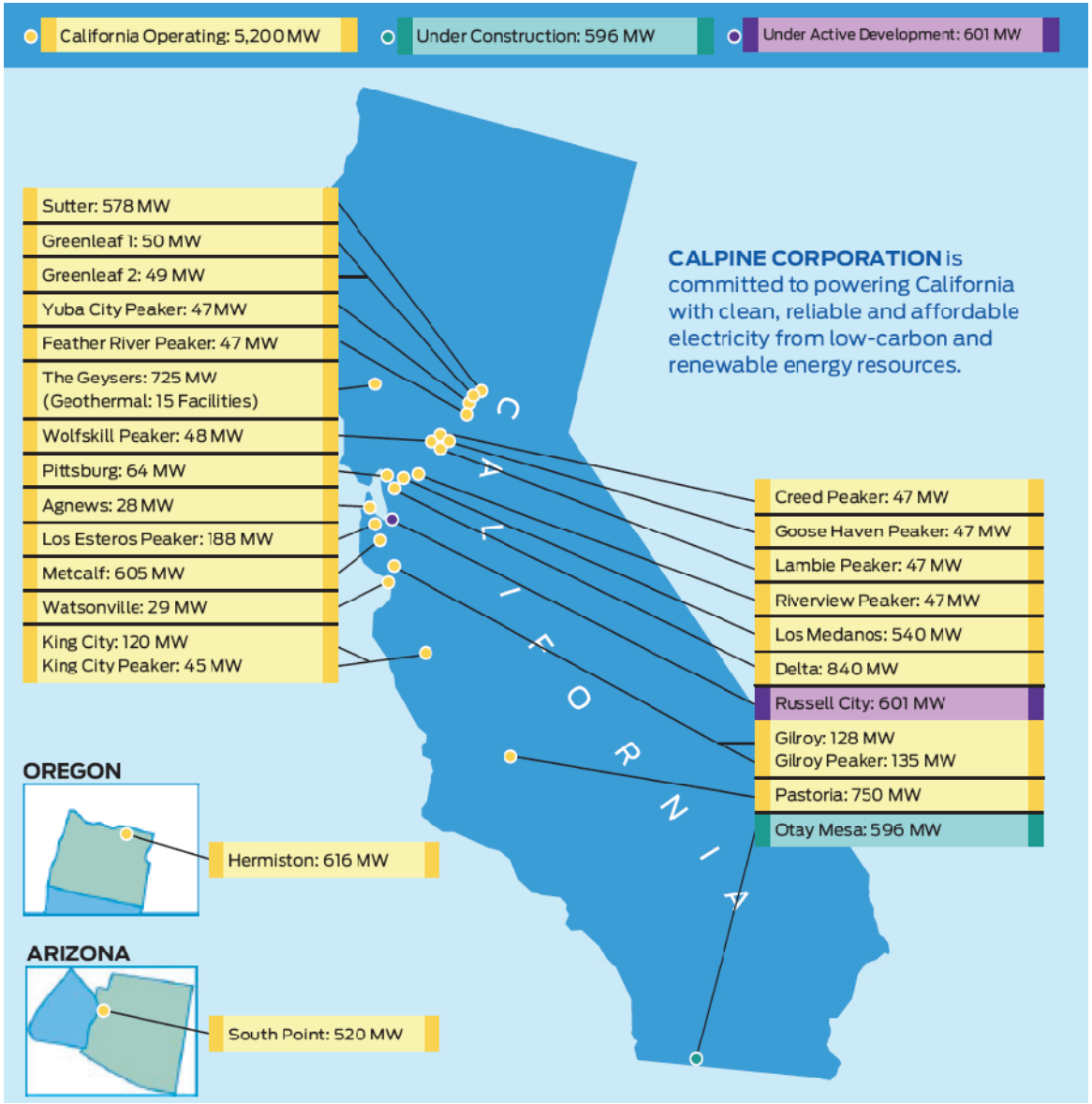
A GENERATION AHEAD, *today*

GHG BACT Analysis Case Study
Russell City Energy Center

May 2010

Donald Neal
Vice President, EHS

Calpine In California



Project Description

- 612 megawatt natural gas fired combined cycle power plant in Hayward, CA
- GHG emission sources
  - 2 Siemens Westinghouse 501FD3 combustion turbines – natural gas fired
  - 2 Heat Recovery Steam Generators with supplemental firing – natural gas fired
  - 1 Emergency Fire Pump – diesel fired
  - 5 Circuit breakers – SF6
- Emission controls
  - Dry Low NOx combustors
  - Selective Catalytic Reduction
  - Oxidation catalyst
- Power purchase agreement with PG&E
- Permits required from California Energy Commission and Bay Area Air Quality Management District

Air Permit History

- **Bay Area Air Quality Management District issued combined Authority to Construct and PSD Permit on November 1, 2007**
  - Appeal to Air District Hearing Board denied
  - Petition to EAB resulted in remand of PSD Permit on July 29, 2008
- **Draft PSD Permit issued December 8, 2008**
  - Public hearing held January 21, 2009
  - Public comment period extended until February 6, 2009
  - EPA approved Petition for Reconsideration February 19, 2009
- **Revised Draft PSD Permit and Additional Statement of Basis Issued August 3, 2009**
  - Included GHG BACT and voluntary GHG limits
  - Public hearing held September 2, 2009
  - Public comment period closed September 16, 2009
- **Final PSD Permit Issued February 3, 2010**
- **Petitions for Review Due to EAB March 22, 2010**
- **Several parties appealed to EAB**
- **Oral arguments August 17, 2010 – BAAQMD and Calpine seeking dismissal**

General Approach to BACT

- Followed the 5 Step Approach
- Initial BACT Analysis in December 2008
- BACT Analysis modified in August 2009 in response to comments
- Resulted in voluntary federally-enforceable GHG limits

BACT Process

- Step 1 – Identify Control Technologies
  - Thermal efficiency was the only combustion control identified
  - Carbon capture and storage identified as the only post-combustion controls
  - Evaluation of non-fossil electricity generation
    - BAAQMD sympathetic but deferred to California Energy Commission
    - BAAQMD states "… the federal BACT framework is clear that it does not require consideration … of non-fossil-fuel-fired alternatives …"

- Step 2 - Eliminate Technically Infeasible Options
  - Energy efficiency is feasible and proven
  - CCS not commercially available

- Conclusion that high-efficiency power generation technology is the only available and feasible control technology

- Since top control technology chosen no further analysis required per EPA top-down BACT approach

BACT Emission Limit Considerations

- BAAQMD determined CO2 emissions achievable for the level of efficiency
- CDC data showed CCGT power plants with emission rates ranging from 794 to 1058 lb/mwh
- BAAQMD cited EPA guidance that BACT limits should not necessarily reflect the maximum possible emissions control efficiency under the most favorable conditions but rather at levels that will allow facilities to achieve compliance consistently over time under all operating conditions
- Factors reducing CCGT efficiency:
  - Hot weather
  - Starting up or shutting down
  - Loads below 100 percent
  - Duct firing
  - Air cooling
- In December 2008 BAAQMD Proposed BACT Limit for CO2 of 1100 lb/mwh
  - Lowest regulatory limit at the time (CA SB 1368)
  - Enforced through heat input limit

GHG BACT Permit Conditions

- Mass limits measured continuously

Averaging Period	Heat Input Limit (MMBtu)	Greenhouse Gas Emissions Limits (metric tons CO_2E)			
		CO_2	CH_4	N_2O	CO_2E
1-Hour	4,477.2	242	0.08	0.14	242
24-Hour	107,452.0	5,797	2.03	3.33	5,802
Annual	35,708,858.0	1,926,399	675	1,107.48	1,928,182

- Efficiency limit of 7,730 Btu/kwh
  - Demonstrate compliance 90 days of commissioning and annually
  - BAAQMD concluded continuous monitoring not possible
  - Efficiency limit measured during baseload operation

- Fire pump BACT identified as limiting operation to testing and emergencies to achieve annual limit of 7.6 metric tons CO2e per year

- Circuit beakers BACT identified as SF6 leak detection and requirement to maintain emissions below 39.3 metric tons CO2e per year

Lessons Learned

- Project configuration will drive the efficiency determinations
  - Simple cycle vs. combined cycle
  - Turbine scale (larger is more efficient but not always marketable)
  - Customer defines project configuration
    - Size (megawatts)
    - Characteristics (ramp rate, peaking capacity)

- Companies should be amenable to reasonable GHG limits based on efficiency
  - Important to maintain realistic estimate of heat rate degradation
  - Vendor heat rate projections cover first 48K hours

- Difficult to define efficiency except where design bases and heat rate guarantees exist
  - Many factors degrade efficiency

CALPINE®

NYSE CPN