Review of Load Curtailments at the GEO Facility
Considerations for GEO Load Curtailments

Advantages

• Higher revenue – Avoid negative pricing

• Preserve steam for future use when Day Ahead Market prices are higher
  • No significant puff of the reservoir is expected when returning from curtailment period

• Expected to curtail only during hydro run off
  ~ 3 to 4 months
Considerations for GEO Load Curtailments

Disadvantages

- No immediate return for curtailing production
  - Loss of REC’s

- Some steam may be captured by nearby operator
- Turbine is less efficient at reduced loads

- Plant Equipment
  - Potential incidental Seasonal O&M costs ~ $10,000 to $20,000
    - Increased water disposal costs
    - Increased abatement costs
    - Increased manpower costs

- Steam Field
  - Increased workover risk to steam wells
  - Increased level of steam condensate in pipelines
NCPA Geo Facility
Steam Usage vs. Flowrate

Only 80% of the curtailed steam will be banked.
NCPA Geo Facility Gross Generation and Superheat Levels
March 15 - May 15, 2016

- Generation Reduced to 65% of Normal
- 75% of Wells Have Some Superheat
- 56% of Wells Have Some Superheat

Level of Superheated Temperature, Deg. F
Gross Generation Level, MW

- Lower Risk
- Higher Risk

March 15, 2016
April 1, 2016
April 18, 2016
May 5, 2016

Red: Gross Generation Level, MW
Blue: Level of Superheat
Considerations for GEO Load Curtailments

• **Mid-1990’s Daily Curtailment**
  - Daily cycling of plants during hydro run off season to 30% to 50% of capacity
  - Probability of well bridging after curtailing following hydro run off season ~ 2%

• **Competent rock but risk of 1 to 2 wells bridging off**

• **Estimated current cost of well workover ~$3.5 million**

• **Premium for potential well damage $5.00/mwh (breakeven point)**
  - (2% x $3.5 million)/(45 mw curtailment x 4 hours/day x 90 days)

• **Premium for increased O&M $1.25/mwh**
  - ($20,000 increased O&M / (45 mw curtailment x 4 hours/day x 90 days)
Considerations for GEO Load Curtailments

- Recommend 45 MW Max. Curtailment
  - Curtailment to be spread over three units, approximately 50% of normal generation
    - May need to adjust the curtailment level depending upon the steam field response

- Curtailment duration
  - Only Cycle when the daily prices are expected to be at the negative price above for 4 hours or more
  - Limit cycling to once per day
# Fiscal Impact of Curtailing 45 MW

<table>
<thead>
<tr>
<th>Energy Price</th>
<th>Assumed REC Value</th>
<th>Royalty Cost</th>
<th>O&amp;M Costs Cost</th>
<th>Well Work Over Risk Cost</th>
<th>Net Cost of Curtailment Cost</th>
<th>MW Curtailed</th>
<th>Fiscal Impact per MWhr</th>
<th>4 hr Daily Curtailment for 45 MWhr $/Day</th>
<th>Seasonal Value 90 Days $</th>
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<tbody>
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<td>$/MWhr</td>
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Three methods to Curtail Geysers Output

• Day Ahead Scheduling/bidding
  • Self schedule minimum load and bid agreed to negative price for remainder of generation
    • Receive Day Ahead energy price for final schedule
    • Need to guess at forward prices self schedule minimum load

• Future Possible Options
  • Fifteen minute market (FMM) (Gain experience with curtailment and resolve compliance equation)
    • Self schedule plant for full output
      • Receive Day Ahead Energy Price for full output
    • Bid negative pricing into FMM
      • Buy or sell changes in output at FMM clearing price

• Regulation Service (Gain experience with curtailment-plant not certified today)
  • Bid/self schedule plant into market
  • Bid regulation up/down into market
    • Receive “capacity payment” for regulation service
    • Buy or sell regulation energy at real time market price
Recommendations

• Recommend that the GEO facility not be curtailed unless
  • Power prices are a negative price of $19.07/MWhr or lower
    • (breakeven point covering risk exposure of well damage, increased O&M, and loss or REC).
  • Recommend additional margin be added to the minimum price to ensure a positive benefit (ie $5 to 10/mwh resulting in a negative price of $24.07-29.07/mwh used for curtailment)

• Curtailment level
  • Maximum of 45 MW
    • The amount of curtailment may need to be adjusted based upon steam field response
  • Only Cycle when the daily prices are expected to be at the negative price above for 4 hours or more
  • Limit cycling to once per day