Electric Power Generation Using Geothermal Fluid Coproduced from Oil and/or Gas Wells

Project Officer: Eric Hass
Total Project Funding: $724,000
April 22, 2013

PI – Bernie Karl
Chena Hot Springs Resort
Track 1
Relevance/Impact of Research

Project Objectives

• Design, build, and operate low temperature, mobile, geothermal power plant capable of co-producing off oil/gas wells
• Quick installation and removal of power plant on site
• Portability reduces permitting requirements
• Generate 220 kW of electrical power
• Project originally to operate in Jay, FL at Quantum Resource’s oil field
• Increase low temperature and co-generation capacity by 220kW
Scientific/Technical Approach

- Use PureCycle ORC manufactured by Pratt & Whitney Power Systems
- Chena Hot Springs Resort has experience in operating PureCycle
- Unit to provide own cooling by means of three evaporative cooling towers
- On board communications via Hughes net or cellular signal for remote operations
- Designed for 24 hour set up and removal
- Designed to self replenish cooling water lost from evaporative cooling
Scientific/Technical Approach

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10&quot; PIPE</td>
</tr>
<tr>
<td>2</td>
<td>8&quot; PIPE</td>
</tr>
<tr>
<td>3</td>
<td>6&quot; PIPE</td>
</tr>
<tr>
<td>4</td>
<td>2&quot; PIPE</td>
</tr>
<tr>
<td>5</td>
<td>1&quot; PIPE w/ COOLING FINS</td>
</tr>
<tr>
<td>6</td>
<td>ULTRACEPT OIL/WATER SEPARATOR model# 8625-03</td>
</tr>
<tr>
<td>7</td>
<td>BAC VTL-227 COOLING TOWER</td>
</tr>
<tr>
<td>8</td>
<td>UTC PURE CYCLE SYSTEM 280kW ORC model# 280</td>
</tr>
<tr>
<td>9</td>
<td>GUSHER PUMP 15hp model# PCL6x8-11SEH-CBM-A</td>
</tr>
<tr>
<td>ALL FLANGES 150# SLIP ON</td>
<td></td>
</tr>
</tbody>
</table>
Scientific/Technical Approach

Water/Oil from well

Evaporator

Turbine

Condenser

25 gpm oil/water separator

Make-up Water

280 KW Generator

Evaporative Cooling Tower

Pump

R-134a

170 F Resource

Cooling Water

Water/Oil to processing
Accomplishments, Results and Progress

- Describe Accomplishments/Progress to date.
  - Completed building mobile ORC power plant
  - Successfully commissioned plant at Chena Hot Springs
    - Plant operated on 160F geothermal water
  - Tested plant after 65 mile transportation at the Aurora Energy power plant in Fairbanks, AK
  - Operated plant at the Peppermill Resort and Casino in Reno, NV using hotel’s boiler water as a heat source
  - Quantum Energy backed out of partnership to host power plant
  - Installed in Utah and has been operating since 11/12
    - Generating 220kW off 600gpm of water at 210°F

<table>
<thead>
<tr>
<th>Original Planned Milestone/Technical Accomplishment</th>
<th>Actual Milestone/Technical Accomplishment</th>
<th>Date Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct mobile power plant</td>
<td>Well completed as planned</td>
<td>8/09</td>
</tr>
<tr>
<td>Commission power plant on low temp water source</td>
<td>Power plant successfully produced power on 160F water</td>
<td>8/09</td>
</tr>
<tr>
<td>Install power plant on test site</td>
<td>Power plant installed and operating</td>
<td>11/12</td>
</tr>
</tbody>
</table>
Accomplishments, Results and Progress
Future Directions

- Work with Pratt & Whitney Power Systems to configure power plant to compile operational data
- Operate plant at Utah site until 12-31-14
- Continue to gauge interest of oil/gas companies to produce geothermal power
- Work out long term agreement with operator after grant expires

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Status &amp; Expected Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate plant for 2 years</td>
<td>On schedule, expected completion 12-31-14</td>
</tr>
<tr>
<td>Complete reservoir modeling</td>
<td>To be completed by 5/31/13</td>
</tr>
</tbody>
</table>
Summary

- Designed and built mobile geothermal power plant to co-produce off low temperature oil/gas wells
- All encompassing power plant that comes with cooling system
- Power plant successfully operational after 1,000+ transportation
- Power plant is currently generating 220kW in southwest Utah off 210°F water
- Geothermal projects struggle to compete for capital against other oil/gas related projects
- Permitting not required for any location the power plant operated at
- Successfully operated on 4 different utility grids
- Contribute ~220kW to the installed low temperature capacity goal of the GTO
### Timeline:

<table>
<thead>
<tr>
<th>Planned Start Date</th>
<th>Planned End Date</th>
<th>Actual Start Date</th>
<th>Current End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/1/08</td>
<td>4/30/2010</td>
<td>7/1/08</td>
<td>12/31/14</td>
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</table>

### Budget:

<table>
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<tr>
<th>Federal Share</th>
<th>Cost Share</th>
<th>Planned Expenses to Date</th>
<th>Actual Expenses to Date</th>
<th>Value of Work Completed to Date</th>
<th>Funding needed to Complete Work</th>
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</thead>
<tbody>
<tr>
<td>$723,982</td>
<td>$1,021,879</td>
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<td>$1,021,879</td>
<td>$0</td>
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</tbody>
</table>

- Chena Hot Springs Resort is the grant recipient
  - Pratt & Whitney Power Systems is a sub-contractor
- Project extended to 12/31/14 and is on schedule to meet end date
- Project delayed due to Quantum Resources backing out and lack of interest from oil/gas industry