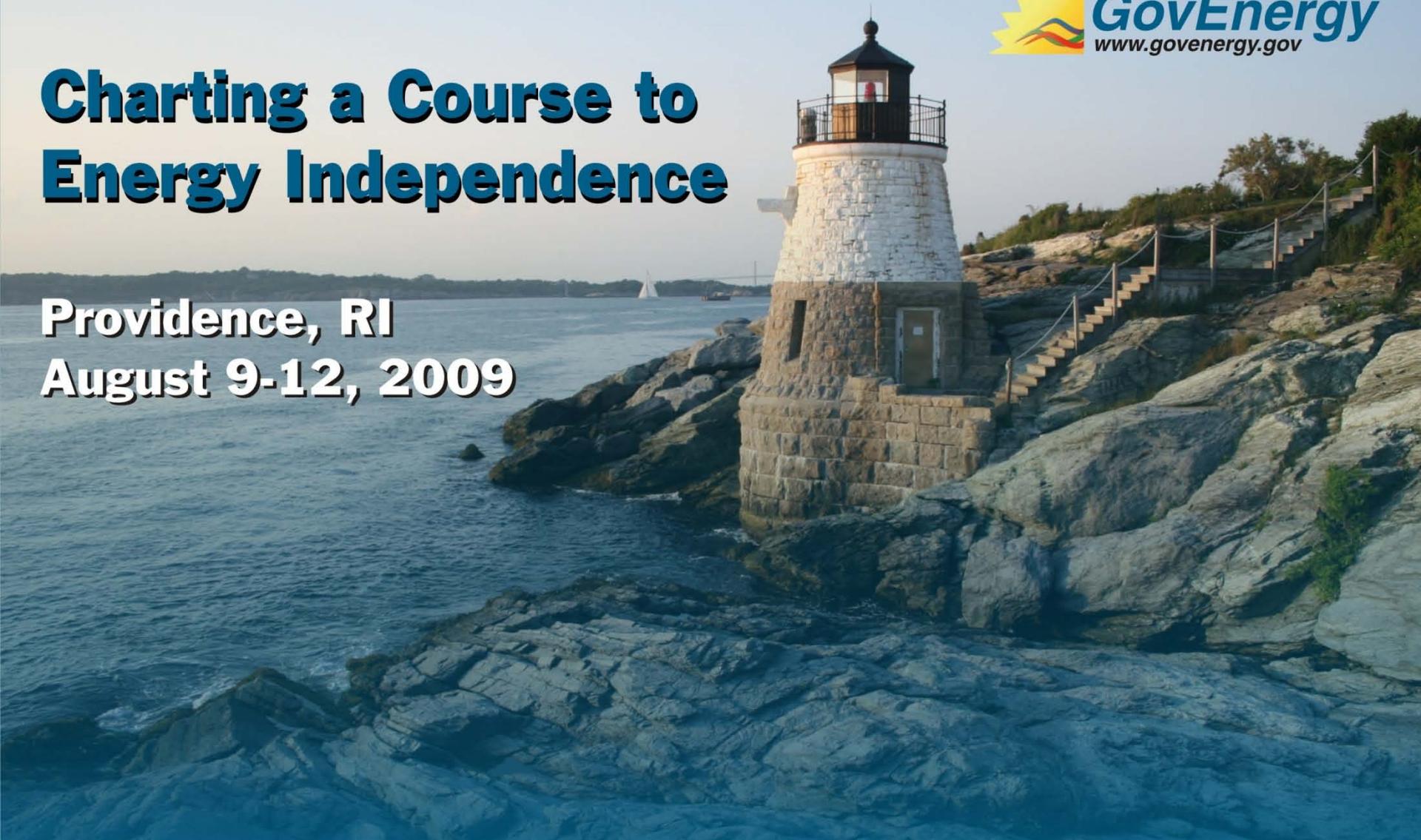




Charting a Course to Energy Independence

Providence, RI
August 9-12, 2009





LOW TEMPERATURE GEOTHERMAL : OIL FIELD CO-PRODUCTION AT DOE / RMOTC

10/2/2009

Dr. Carl N. Nett
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BUSINESS FOCUS

- Geothermal & Recovered Energy Generation (REG)
 - Design, supply, installation, service and operation since 1965
 - Supplied approximately 1,200 MW in 23 countries
 - More than 16 million total operating hours
 - Own / operate more than 500 MW
 - ~ 70% of U.S. geothermal capacity installed since 2000

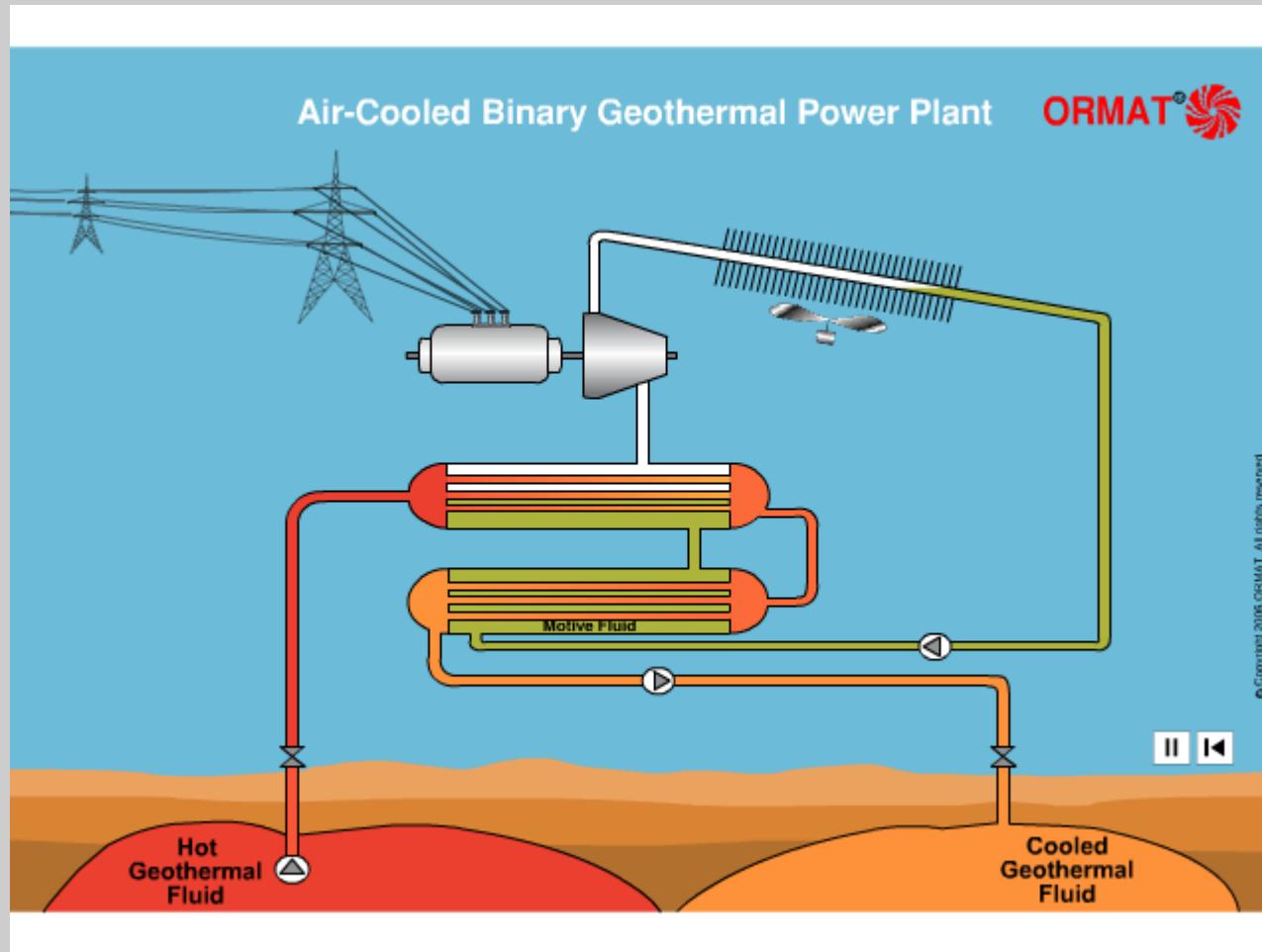


TECHNOLOGY

- Energy Converter
 - Proprietary Organic Rankine Cycle (ORC) implementation
 - Used in both Geothermal & REG applications
 - Technology leadership for over 4 decades



OPERATION - ANIMATION





PIONEERING INNOVATION

Solar Powered ORC Water Pump – Mali 1966



High Reliability ORC Power Unit - Alyeska P/L, 1976



5 MW Solar Pond Collects and Stores Energy - 1982



1 MW ORC Solar Thermal Project –Arizona 2006





CO-PRODUCTION - AN EMERGING OPPORTUNITY

- Generating power from co-produced water
- Fuel & emission free energy production
- Reduced oil field operating costs
- Potential green energy tax incentives



LOW TEMP RESOURCE – 1979

- 1979, Manley Hot Springs, AK
- 2.0 kW gross output
- 120°F brine inlet temperature, 18 gpm
- 39°F cooling water inlet, 79 gpm





LOW TEMP RESOURCE – 1986

- Collaborative R&D project with Bureau of Reclamation & UTEP
- 70 kW Solar Pond
- ORC Power Unit at El Paso, TX
- In operation from 1986 to 2002
- Temperatures of 154°F to 190°F





LOW TEMP RESOURCE – 2001

- 2001, Rogner Hotel and Spa, Bad Blumau, Austria
- 210°F Geothermal Fluid, 250 kW





CO-PRODUCTION – NEW CHALLENGES

- Resource chemistry / reliability
 - Major factor is heat exchanger lifespan
 - Fouling and corrosion will reduce HEX life
 - Increased O&M costs will reduce economic benefits
 - Every resource is different
- Cooling
 - Water cooling requires tower, make-up water, & pumps
 - Air cooling (dry cooling) can be utilized anywhere

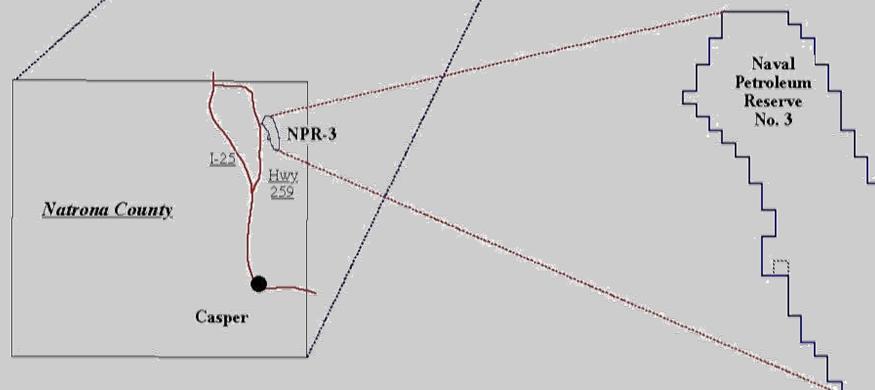
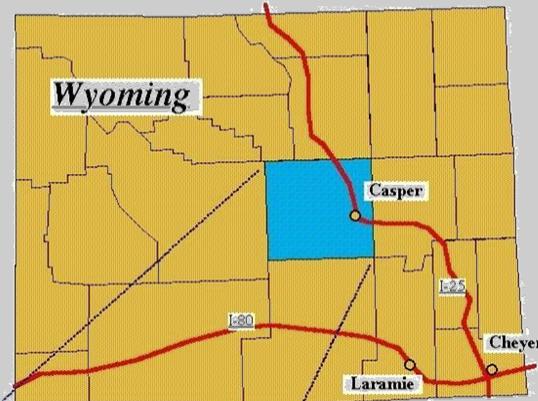


RMOTC CASE STUDY





RMOTC CASE STUDY – LOCATION



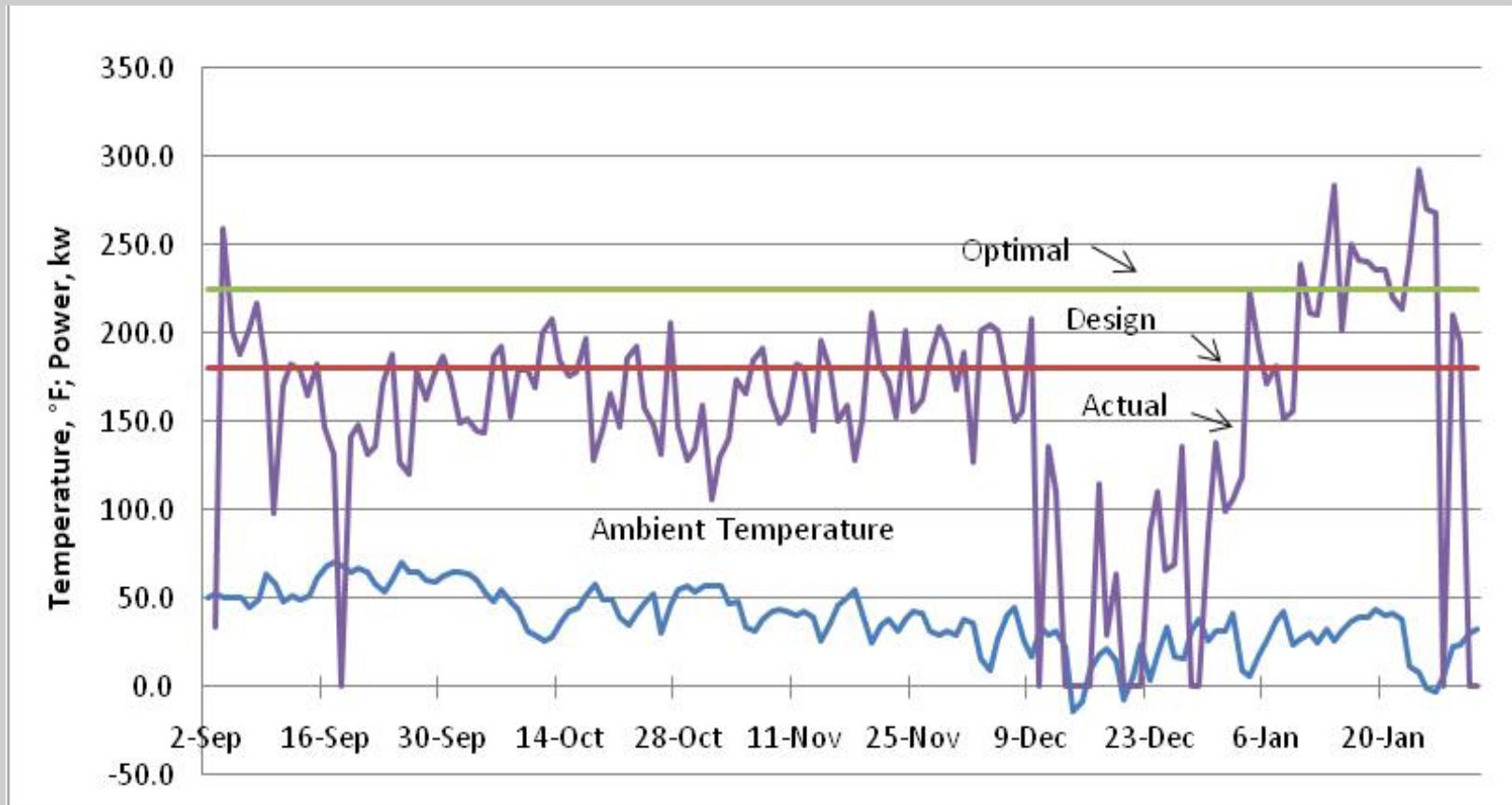


RMOTC CASE STUDY – DESIGN POINT

Flow Rate:	40,000 BWPD (1167 gpm)
Inlet Temperature:	170°F
Outlet Temperature:	152°F
Ambient Temperature:	50°F
Generator Gross Power:	180 kW
Net Power Output:	132 kW

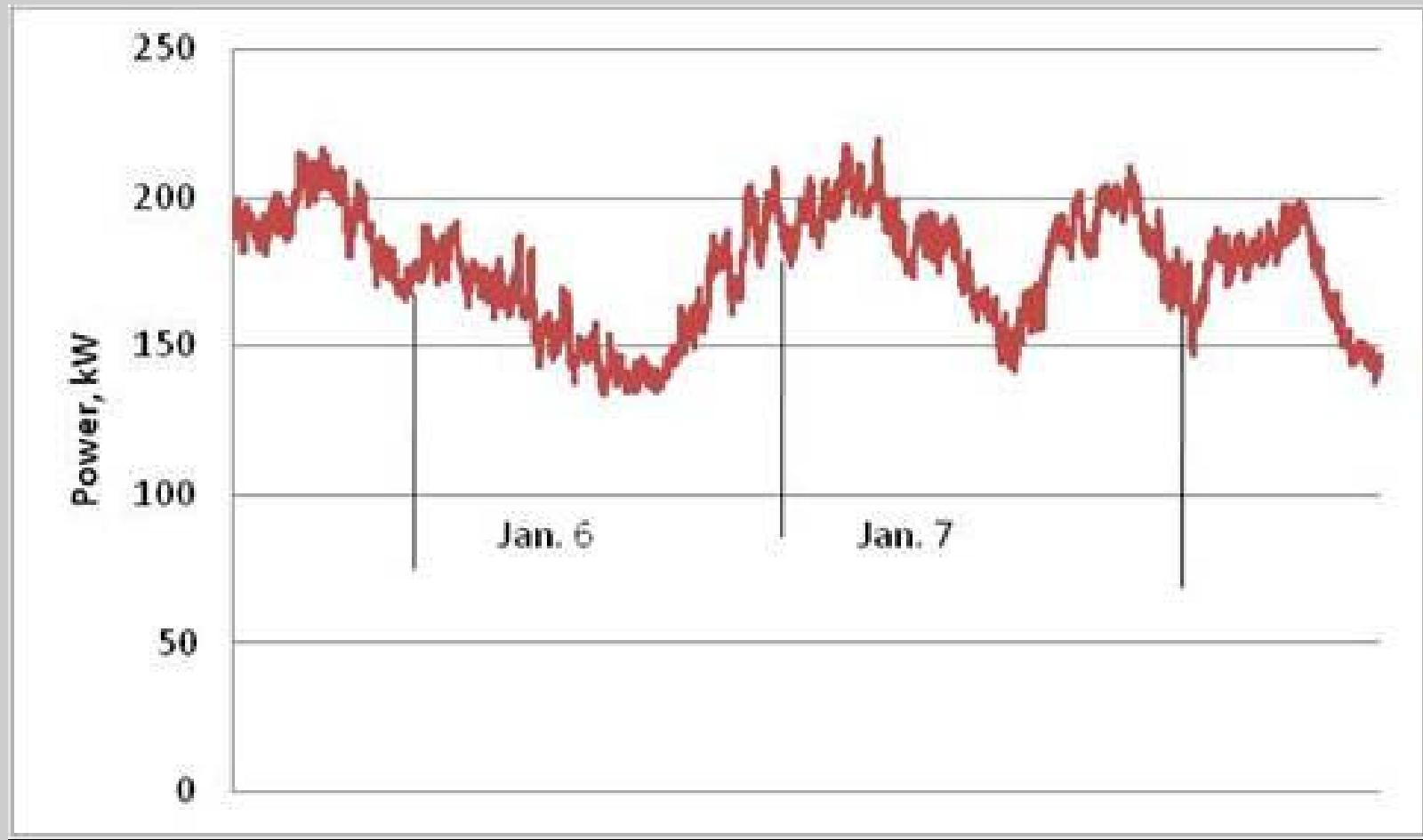


RMOTC CASE STUDY – FIELD PERFORMANCE





RMOTC CASE STUDY – AMBIENT TEMP EFFECTS





RMOTC CASE STUDY – FIELD PERFORMANCE

Operating Interval (days)	151
Inlet Brine Temperature (°F)	195-198
Inlet Brine Volume (Barrels)	2,867,180
Net Power Produced (kWh)	550,553
Overall	
On line percentage (%)	89
Average net power (kW)	152
Overall w/o Field Downtime	
On line percentage (%)	96
Average net power (kW)	164
Avg. Net January 2009 (kW)	208



CO-PRODUCTION – COMMON CHALLENGES

- Installed Costs
- Operating Costs
- Reservoir Management
- Environmental Considerations



RMOTC CASE STUDY





CO-PRODUCTION – SUMMARY

- Pioneering low temp geothermal for 30 yrs
- Co-produced water
 - Attraction : Abundant resource
 - Challenge : Long-term reliability
- RMOTC OEC pioneers co-produced generation



CONTACT INFORMATION

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