Plan to Test ExxonMobil’s *In Situ* Oil Shale Technology on a Proposed RD&D Lease

31st Oil Shale Symposium, Colorado School of Mines


October 19, 2011
ExxonMobil Technology Development

• Developing *in situ* oil shale technology since 1999

• Colony Mine as a field laboratory since 2007

• 2nd Round Research, Development, and Demonstration (RD&D) Lease Nomination submitted in 2009 is currently under National Environmental Protection Act (NEPA) review

• Developing and progressing plans for RD&D Lease activities
ExxonMobil’s
*In Situ* Oil Shale Technology

- Oil shale is heated *in situ* by an electrically conductive material
- Electricity is conducted from one end of the heating element to the other
- Heat conducted into the formation, converting kerogen into oil and gas
- Oil and gas conventionally produced
- Potential for cost-effective recovery with less surface disturbance than
  - Mining and retorting
  - Competitive *in situ* processes
- Several years of continued research required to demonstrate technical, environmental, and economic feasibility
Location of RD&D Lease Nomination
• Parachute Creek member ~1500 ft thick
• Primarily organic rich dolostones, sandstone, and in lower parts, evaporites
• Dissolution surface not stratigraphic

• In place RD&D resource estimates
  – ~600 MBOE
  – Nahcolite ~ 87 MT
  – Dawsonite ~30 MT
Groundwater Protection

- Groundwater protection through hydraulic isolation of the converted oil shale resource below aquifers
  - Target “tight” saline zone below lower aquifer
  - Maintain unheated, impermeable seal around developed volume
Preservation of Sodium Mineral Value

1. Drill Wells, Build Heaters

2. Heat: Conversion, Porosity, Oil Production, Nahcolite to Natrite

3. Sodium Mineral Available For Future Recovery

Forms of Nahcolite in RD&D Lease Target Zone

- Nodular
- Bedded
- Coarse
- Dispersed
- Fine
Phased Technology Development
Phased Technology Development

Environmental and Appraisal Drilling
- Up to 50 wells; field office; permitting

Heating Element Construction
- Build two fractures at depth
- Small-scale Electrofrac Test
- Heat fractures for 6 months

Pilot Test
- Two full-scale fractures heated for 5 years

2nd Deep Pilot Test (optional)

- Appraisal drilling to define experiment locations
- Groundwater monitoring to obtain baseline data

- Build 2 or more small heating elements at depth
- Evaluate characteristics and confinement to target zone
- Make connections and drill production wells

- Heat for six months to demonstrate technology, assess groundwater protection
- Produce oil (up to 175 bpd), water (up to 80 bpd), and gas (up to 350 kscfd)

- Full-scale technology demonstration
- Construct two full-scale heating elements and heat for 2-5 years
- Produce oil (up to 700 bpd), water (up to 300 bpd), and gas (up to 6 Mcfd)
- Test sodium mineral recoverability

- Second full-scale pilot test is an option

ExxonMobil Oil Shale RD&D Lease
Schematic Layout of Wells and Facilities

Legend
- 500-ft Setback
- Lease Outline
- Appraisal Wells
- Groundwater Monitoring Wells
- Construction Hole
- Observation Hole
- Connector Hole
- Monitoring Hole
- Production Well
- Phase I – III Pads
- Production Facilities
- Heating Element

North
0 500 1,000 ft.
Commercial Outlook: Responsible Development

• Measured, protective path to development
• Reduced surface disturbance, water use, and CO₂ emissions
• Environmental elements are a prominent part of R&D program
• Energy Efficiency and CO₂ Emissions
  – Estimated > 3BOE energy produced for each BOE fuel input to power plant
  – Produced gas will fuel energy-efficient combined-cycle gas power plant
  – Opportunities to leverage promising EM CO₂ mitigation, capture, and injection technologies
• Reduced Freshwater Needs

Reduced Surface Disturbance

Planar Heaters

Wellbore Heaters

Reduction Freshwater Needs

<table>
<thead>
<tr>
<th>Industry Estimates</th>
<th>ExxonMobil’s In Situ Oil Shale Technology</th>
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<td>4-6</td>
<td>1-2</td>
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How Much Water?

<table>
<thead>
<tr>
<th>Scope</th>
<th>Oil Production bbl/day</th>
<th>Water Demand ac-ft/yr*</th>
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<tbody>
<tr>
<td>One Commercial Project</td>
<td>50,000</td>
<td>3,500</td>
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<tr>
<td>Industry (10 projects)</td>
<td>500,000</td>
<td>35,000</td>
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* 1 Acre-foot of water is equivalent to the planned annual use for one household
Closing Comments

- Oil shale comprises an important domestic resource to meet U.S. energy demand and diversify supply
- ExxonMobil’s *In Situ* Oil Shale process has significant potential for technical, environmental, and economic success
- Environmentally and socially responsible development
  - Reduced surface disturbance, water use, and CO$_2$ emissions
  - Groundwater protection
  - Multimineral development
- Going forward:
  - Careful, phased approach that allows for prudent technical, environmental, and social planning and execution
  - Work with all appropriate local, state, and federal agencies to develop viable options