Overview of Emerging Oil Shale Technologies

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INTEK, INC.

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Introduction

- Key Oil Shale Processes
- History of Oil Shale Technologies
- Lessons Learned and New Challenges
- Current Technologies, and Industry RD&D Activities
Key Oil Shale Processes

**Surface Process**

1. Resource → Ore Mining
2. Ore Mining → Retorting
3. Retorting → Oil Upgrading
4. Oil Upgrading → Premium Refinery Feed

**In-Situ Process**

1. Resource → In-Situ Conversion
   - True In-Situ
   - Modified In-Situ
2. In-Situ Conversion → Oil Upgrading
3. Oil Upgrading → Premium Refinery Feed
History of Oil Shale Technologies

Abandoned Oil Shale Retort
Utah, circa 1900

UNOCAL’s Demonstration Plant
Parachute Creek, circa 1990

Millennium Synfuels
Vernal Utah, circa 2006
# Lessons Learned and New Challenges Drive Technology Development

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<th>Technology Challenges</th>
<th>Approaches Considered</th>
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<td>Scalability</td>
<td>Smaller units, scaled modularly</td>
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<td>Reliability</td>
<td>Redundancy to improve uptime</td>
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<td>Efficiency</td>
<td>New retort / heater technologies</td>
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<td>-- Energy Use / Balance</td>
<td>Advanced controls</td>
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<td>-- Resource Recovery</td>
<td>Temperature / residence time</td>
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<td>Drilling and spacing configurations</td>
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<td>Water Use</td>
<td>Low water-use processes</td>
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<td>Connate water use</td>
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<td>Capture, clean-up, and re-use</td>
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<td>Groundwater Protection</td>
<td>Impermeable barriers</td>
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<td>Freeze walls</td>
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<td>Emissions &amp; Carbon Management</td>
<td>State of the art emissions controls</td>
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<td>Processes that reduce CO$_2$ creation</td>
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<td>CO$_2$ capture, use, and sequestration strategies</td>
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Department of Interior has established an Oil Shale Leasing Program

Department of Energy profiled oil shale companies

Industry is moving forward with mature and novel technologies on public and private lands
### Companies and Current Technologies

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<th>In-Situ</th>
<th>Surface</th>
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<td><strong>Companies</strong></td>
<td><strong>Current Technologies</strong></td>
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<td>Chevron USA</td>
<td>Brent Fryer, Sc.D.</td>
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<td>E.G.L. Resources</td>
<td>Chattanooga Corporation</td>
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<tr>
<td>Earth Search Sciences / Petro-Probe, Inc.</td>
<td>Closed Loop In-Situ</td>
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<td>Electro-Petroleum</td>
<td>J.W. Bungar and Associates, Inc.</td>
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<td>ExxonMobil Corporation</td>
<td>Millennium Synthetic Fuels, Inc.</td>
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<tr>
<td>Independent Energy Partners</td>
<td>ExxonMobil Corporation</td>
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<tr>
<td>James A. Maguire, Inc.</td>
<td>Oil Shale Exploration Corporation (OSEC)</td>
</tr>
<tr>
<td>Mountain West Energy Company</td>
<td>Syntec, Inc.</td>
</tr>
<tr>
<td>Phoenix-Wyoming, Inc.</td>
<td>Western Energy Partners</td>
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<tr>
<td>Raytheon Corporation</td>
<td>Imperial Petroleum Recovery Corp.</td>
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<tr>
<td>Shell Frontier Oil and Gas, Inc.</td>
<td>Red Leaf Resources</td>
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<td>Global Resource Corporation</td>
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<th>Upgrading</th>
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<td>Imperial Petroleum Recovery Corp.</td>
<td>Microwave Separation</td>
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<tr>
<td>Global Resource Corporation</td>
<td>Gasification/Purification</td>
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Phases of Oil Shale Technology Maturation

I. Laboratory Phase
- Basic Research
- Applied Research
- Bench Scale Plants

II. Field Testing Phase
- Pilot Plants
- Semi Works (Scale Up)

III. Commercial Phase
- Demo Plants
- Commercial Plants

Time:
- 25/20 yrs
- 20/10 yrs
- 10/5 yrs
- 0 yrs

Cost:
- $10^5
- $10^6
- $10^7
- $10^8

Source: Lukens, 2004
Surface Retort Technology Today

Alberta Taciuk Processor (ATP)

- Initially designed for extracting bitumen from tar sands
- Applied for oil shale conversion in Australia (SPP)
- OSEC evaluating ATP for its RD&D efforts in Utah

- Originally developed by
  - Cameron Engineering
  - Bureau of Mines
- Most successful
  - High thermal efficiency
  - High retort efficiency
- Variations of GCR
  - Petrosix operating in Brazil
  - Paraho Process / Pilot in CO
  - Variations being tested considered for other projects
In-Situ Conversion Technology Today

Pilot tests under development in Colorado

Shell’s ICP Process

- Naphtha
- Jet
- Diesel
- Nat. Gas
- Hydrogen
- Chem. Feed
- Heat

- Developed by Shell Frontier Oil & Gas Inc.
- Currently in “pilot” phase in north-western Colorado
- Shell to apply technology at three other sites in Colorado
In-Situ Conversion Technology Today

Pilot tests under development in Colorado

Chevron Process
In-Situ Conversion Technology Today

Pilot tests under development in Colorado

EGL Resources Process
Raytheon & CF Technology’s patent-pending extraction methodology
- Radio frequency energy is used to heat the shale
- Super critical carbon dioxide is pumped in to extract oil

- Imperial Petroleum Recovery Corporation’s patented Microwave Separation Technology
- Add on system to separate emulsions into usable products
- Improves the processing of shale oil

Radio Frequency/Critical Fluid Oil Extraction Technology

Emulsion Breaking System
- microwave generator
- microwave applicator
- stable emulsion feed
- emulsion receiving tank

Emulsion Separation System
- destablized emulsion feed
- settling tank 1
- settling tank 2
DOE’s Report on Oil Shale Companies

- Department of Energy’s Naval Petroleum and Oil Shale Reserves Produced a Profile of 27 Companies

- Report is available for download on website at:

http://www.fossil.energy.gov/programs/reserves/npr/NPR_Oil_Shale_Program.html
Conclusions

- Oil Shale technologies continue to advance
- RD&D is addressing lessons learned and new challenges
- BLM lease program facilitates development and demonstration
- Numerous other technologies offer significant promise and potential
- The development timeline requires investment now to meet energy supply, security, and environmental challenges