Environmental Challenges and R&D Needs

Perspectives on Oil Shale Development

U.S. Department of Energy
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Golden, Colorado

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National Energy Technology Laboratory
National Energy Technology Laboratory

- Only U.S. DOE national lab dedicated to fossil energy
  - Fossil fuels provide 85% of U.S. energy supply
  - 96% of U.S. transportation fuels
- One lab, five locations, one management structure
- 1,200 Federal and support-contractor employees
- Research spans fundamental science to technology demonstrations

Alaska

Oklahoma

Oregon

Pennsylvania

West Virginia

Strategic Center for Natural Gas & Oil
Accomplishing Our Mission

**Onsite Research and Development**

**Systems, Analysis, and Planning**

**Extramural Research and Collaboration**

More Than 1,800 Activities in the United States and 40+ Other Countries

Strategic Center for Natural Gas & Oil
Strategic Center for Natural Gas & Oil

Implement science and technology programs that resolve the environmental, supply and reliability constraints of oil and natural gas resources and enhance our energy security.

• Create public benefits by investing in research that industry would not take on itself.

• Deliver a balanced portfolio of technology to:
  – Enable Independents to efficiently produce discovered resources.
  – Conduct Long-term/High risk R&D with high potential payoff for the Nation - develop entirely new sources of supply.
  – Minimize environmental impact.

A Multi-discipline, Long-Term, High-Risk, and High-Reward endeavor that will only occur through Federal involvement.
Western Oil Shale – A Strategic Domestic Resource

- Green River Formation (CO, UT, WY) - estimated 1.5 trillion barrels
- Initial development - high-grade oil shale yielding 25 or more gallons per ton; estimated between 400 and 750 billion barrels
- More than 80% of the resource of this richness located in a remarkably small area of the Piceance Creek Basin
- Some portions of the Piceance Basin have oil shale deposits in excess of 2000 feet thick with the potential to yield over 2.5 million barrels per acre
Federal Government is Largest Landowner

80% of Oil Shale Resource is on Federal land
Colorado, Utah and Wyoming Hydrocarbon Resources

- **Green River Basin**
  - Gas, Oil, CBM and Kerogen
- **Uinta Basin**
  - Gas, Oil, CBM, Bitumen and Kerogen
- **Washakie Basin**
  - Gas, Oil and CBM
- **Piceance Creek Basin**
  - Gas, Oil, CBM, Kerogen and Coal

Sources: EIA Website 20060724
Technologies to Economically Develop Oil Shale Resource will be Different and Have Different Environmental Impacts

- The shale resources are distributed differently
  - Colorado has richest zones below 1200’
  - Utah has richest zones above 700’
- Best suited – economic production technologies of each will likely be different
- Environmental challenges similar but different
- Cumulative effect on the area – total impact
- Competing interests
Federal Role in Oil Shale Environmental R&D

- 80% of the resource is on Federal lands
- Government driven by broader societal interests – not just compliance
- Unbiased, objective source of scientific data for policy-makers and regulators
- Opportunity to coordinate with other Government research programs to maximize R&D impacts
  - CO₂ Partnerships
  - Ongoing produced water research
  - Coal mine reclamation
- Diverse nature of issues requires coordination
  - Multiple resources (oil, gas, kerogen, coal, minerals, water, land)
  - Multiple land uses (resource recovery, recreation, ranching and agriculture)
Although Resource is Very Different, Lessons Can Be Learned from Canadian Oil Sands Development

- Water requirements in oil sands processing have dropped
- CO₂ emissions per barrel have been reduced

Source: NRCan
Technology Has Also Lowered Production Costs …

Source: NRCan

$ Cdn./barrel

- Mining and upgrading
- In situ bitumen

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Payoff of Oil Sands R&D in Canada
Cumulative Benefits over 1971-2004

R&D Investment of $2 Billion over 20 years

$200 Billion GDP
$78 Billion labor income
$19 Billion Provincial Gov’t. Revenue
1.6 million person-years employment

Figures in 2005 $

10 to 20% of Private/Public Oil Sands R&D Currently Spent on Environmental Issues

Strategic Center for Natural Gas & Oil

• One-day Workshop hosted by U.S. Department of Energy - NETL, Colorado Energy Research Institute and Colorado School of Mines

• Breakout Sessions analyzed challenges and provided recommended actions in four areas:
  – Water Quality and Quantity
  – Air Quality
  – Surface and Ecosystem Impact
  – Social and Economic Impact

• **Groups were asked to classify challenges as:**
  – Near-term (needing to be addressed by 2010)
  – Mid-term (by 2015)
  – Long-term (beyond 2020)

• **Groups asked to identify who should pursue**
Challenges and Recommended Actions
Air Quality

• **Challenges**
  – Need for long-term, basin/regional air quality monitoring & measurement
  – Insufficient process-specific emissions data; e.g., no data for CO₂
  – Need for a coordinated strategy for addressing CO₂ emissions, capture and use/storage

• **R&D Needs**
  – Develop a protocol for basin/regional emissions monitoring
  – Develop accurate, predictive regional models for release, fate and transport of emissions
  – Conduct process-/resource-specific emissions research and evaluate best available cleanup technology (BACT)
  – Identify gaps, and conduct R&D to develop innovative technologies for reducing (high efficiency) or controlling (capture/separation) emissions at any point; pre-process through post-process
  – Integrate and coordinate with CO₂ regional partnerships (CO₂ sources and sinks/markets) for development of a CO₂ Management Plan
  – Assess life-cycle emissions under various development scenarios, including full suite of infrastructure requirements
Challenges and Recommended Actions
Water Quality & Availability

- **Challenges**
  - Cumulative impacts on surface and groundwater quality and availability unknown
  - Data needed for process-specific water use/consumption and waste water contaminants
  - Need for coordinated strategy for addressing water needs and produced waters from multi-resource/alternative land use development efforts

- **R&D Needs**
  - Develop integrated basin/regional baseline for surface and groundwater data (quality and quantity) and GIS-based analytical tool
  - Conduct process-specific research to evaluate generated contaminants and water consumption; evaluate BACT
  - Conduct R&D to develop new, low water consumption processes; cost-effective water treatment and improved recycle/reuse options
  - Conduct R&D to characterize and assess solutions to potential spent shale leachate
  - Assess water requirements and potential effluents for multi-site oil shale development in conjunction with other regional water use planning efforts for the development of a Water Resource Management Plan
Challenges and Recommended Actions
Surface Impacts

• Challenges
  – Need process-specific data on solid and liquid wastes (waste constituents and volumes)
  – Cumulative impacts on land, habitats and ecosystems unknown
  – Information on land requirements (spatial/temporal) for oil shale development and associated infrastructure needed
  – Need for of integrated multi-resource land use planning

• R&D Needs
  – Spent shale characterization and R&D for alternative by-products
  – Conduct research and analysis to reduce process/development foot print
  – Conduct research on subsidence and potential mitigation strategies
  – Coordinate infrastructure evaluation using GIS-based analysis tools; oil shale and alternative land use development scenarios (trade-off analysis) for the development of a Land Use Plan
Challenges and Recommended Actions
Social and Economic Impacts

- **Challenges/Observations**
  - Critical component in all energy production scenarios
  - Local impact often not adequately addressed by the royalty and bonus paid by energy companies as funds collected are diverted to other issues in many states
  - Upfront impact not adequately addressed in communities
  - Oil Shale development is high risk investment
  - Many conflicting land use alternatives
  - Many factors have changed since the 1970’s
  - Today is a more challenging environment to operate than the 1970’s
The 2006 Workshop Identified These Major Needs

- Basin/regional models to evaluate oil shale development and infrastructure requirements in conjunction with other natural resource development and alternative land uses
- A better understanding of water requirements and the environmental impacts of development alternatives on local/regional surface and groundwater quality and availability
- A better understanding of the nature and impacts of air emissions (including CO$_2$ and other GHGs), and better ways to control these emissions at any point pre-process through post-process
- Alternatives for mitigating impact of surface disposal of spent shale (e.g. recycle/reuse or commercial product)
- Development of cost-effective technologies to minimize water and energy requirements, and to prevent, reduce and mitigate environmental impacts to air, water, and land
Cross-cutting Workshop Themes

• Loss of institutional knowledge from 1970/80s R&D era
• Need for central repository of past and ongoing research and development efforts
• Multiple competing interests for best use of federal lands
• Multiple layers of oversight at all levels; federal, state and local
• Need for a coordinated approach to addressing environmental challenges
Progress Since Last Workshop

- **EPACT Sect 369**
  - Created the Strategic Unconventional Fuels Task Force

- **EPACT Sect 999**
  - Supports $12.5 million for DOE/NETL-led complementary research, including unconventional oil resources (includes oil shale)

- **Environmental Assessments by Companies Operating BLM RD&D Leases**
  - Generally acknowledge that cumulative environmental impacts of long-term, expanded development in the region may occur

- **Groups have made progress on working with consortia and other affiliations to address environmental issues**

- **BLM developing Resource Management Plan(s) schedules in Green River oil shale areas**
2007 Oil Shale Environmental Issues and Research Needs Workshop

- Build upon last year’s workshop results and the findings of the Strategic Unconventional Fuels Task Force

- Develop the framework for an oil shale environmental R&D roadmap
  - Major environmental challenges
  - R&D needs to address challenges
  - Actions necessary to achieve R&D success

- Identify next steps
Workshop Framework

- Two parallel breakout sessions on environmental challenges and research needs
- Each session will address:
  - Major environmental challenges
  - Ongoing efforts to address these challenges at a technology, basin or regional level
  - Additional R&D needs
  - Timeframe for completing R&D actions
  - Required next steps for implementation of an oil shale environmental R&D Roadmap

- Summarize Results
- Plan Next Steps

Welcome to participate!