



Secure Fuels from Domestic Resources

The Continuing Evolution of America's Oil Shale and Tar Sands Industries

Profiles of Companies Engaged in Domestic Oil Shale and Tar Sands Resource and Technology Development

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Millennium Synfuels / Oil-Tech Retort Pilot Plant – Near Vernal, Utah (2006)





Foreword

A WORD FROM THE OFFICE OF PETROLEUM RESERVES

Energy Security Is Essential To Preserve America's Economic Strength and National Security.

Reducing our dependence on foreign imports of oil and refined products is essential to achieving the energy security objective.

Import reductions can be achieved in two fundamental ways – reducing our demand for oil through conservation and efficiency and increasing production of fuels from domestic resources, including alternatives, bio-fuels, and unconventional fuels resources.

Two Promising Domestic Unconventional Resources Are Oil Shale and Tar Sands.

America is endowed with more than two trillion barrels of Oil Shale resources, of which more than 1.2 trillion barrels is concentrated in Colorado, Wyoming and Utah.

Our nation is also endowed with more than 50 billion barrels of Tar Sands resources, with the largest deposits in Utah.

If commercially developed, shale oil and bitumen from tar sands could contribute nearly three million barrels per day to reduce oil imports, improve energy security, and fuel economic growth.

This Is Not A New Industry – But Rather An Evolving One...

Public and private investments in research and technology development since the early 1900's have established a solid foundation of science and technology to enable oil shale and tar sands development. The resources and their potential are well understood. When oil shale efforts began to decline in 1982 and were finally curtailed in 1991, numerous technologies approached readiness for demonstration at commercially-representative scale.

... And the Evolution Goes On

Much has happened in the United States and elsewhere in the world since Unocal shut down Parachute Creek in 1991. Early technologies are still viable, but many are being improved and adapted to take advantage of technical advances. New technologies are also emerging that build on the lessons of the past to respond to new technical, economic, and environmental challenges.

Numerous Companies Are Engaged In Technology And Resource Development Activities For Domestic Oil Shale And Tar Sands.

Over 30 private companies are now applying the technologies and lessons learned from prior domestic and foreign oil shale development activity, and ongoing Alberta oil

sands development to meet technical, economic, and environmental challenges and evolve a new domestic fuels industry.

This report documents the groundswell of activity of 27 companies that are currently investing private capital and human ingenuity to prove the viability of oil shale and tar sands resources and pilot technologies at commercially representative scale. Additional companies that are engaged in technology and resource development may be included in later editions of this document.

This Report Is Intended To Serve As An Information Resource.

Links and contacts are provided to help readers find more information about companies, projects, and emerging technologies and to facilitate the sharing of information among industry participants.

As this domestic unconventional fuels industry continues to grow, the Department of Energy will update and supplement these profiles. Other companies and entities interested in being included in this evolving suite of profiles should contact James.Killen@hq.doe.gov.

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Oil Shale Reserves



An Historical Perspective

SECURE FUELS FROM DOMESTIC RESOURCES

Oil shale has been recognized as a potentially valuable U.S. energy resource since as early as 1859, the same year Colonel Drake completed his first oil well in Titusville, Pennsylvania. Early products derived from shale oil included kerosene and lamp oil, paraffin, fuel oil, lubricating oil and grease, naphtha, illuminating gas, and ammonium sulfate fertilizer.

In the beginning of the 20th century, the U.S. Navy converted its ships from coal to fuel oil, and the nation's economy was transformed by gasoline fueled automobiles and diesel fueled trucks and trains, raising concerns about assuring adequate long-term supplies of liquid fuels at affordable prices to meet the needs of the nation.

America's abundant resources of oil shale were initially eyed as a major source for these fuels. Commercial entities sought to develop oil shale resources. The Mineral Leasing Act of 1920 made petroleum and oil shale resources on Federal lands available for development. Soon, however, discoveries of more economically producible and refinable liquid crude oil in commercial quantities caused interest in oil shale to plateau.

Interest resumed after World War II, when military fuel demand, fuel rationing and rising fuel prices made the economic and strategic importance of the oil shale resource more apparent. The booming post-war economy drove demand for fuels ever higher.

Public and private research and development efforts were commenced, including the 1946 U.S. Bureau of Mines Anvil Points, Colorado oil shale demonstration project. Significant investments were made to define and develop the resource and develop commercially viable technologies and processes to mine, produce, retort, and upgrade oil shale into viable refinery feedstocks and bi-products.

Once again, major crude oil discoveries in the lower-48 states, offshore, and in Alaska, and in other parts of the world reduced the need for shale oil and industry and government interest and activity again diminished.

Lower-48 U.S. crude oil reserves peaked in 1959 and lower-48 production peaked in 1970. By 1970, oil discoveries were slowing, demand was rising, and crude oil imports, largely from the Middle East, were rising to meet demand. Oil prices, while still relatively low, were also rising reflecting the changing market conditions. Oil shale research was re-energized and new projects were envisioned by energy companies seeking alternative fuel feedstocks.

These efforts were significantly amplified by the impacts of the 1973 *Arab Oil Embargo* which demonstrated the nation's vulnerability to oil import supply disruptions, and were underscored by a new supply disruption during the 1979 Iranian Revolution. Oil prices increased and remained high.

By 1982, technology advances and discoveries of offshore oil resources in the North Sea and elsewhere provided new and diverse sources for U.S. oil imports. The discoveries, surging production from OPEC, and falling demand dampened energy prices.

Global political shifts promised to open restricted provinces to exploration and led economists and experts to again predict a long future of low and stable oil prices.

Despite significant investments by energy companies and numerous advances in mining, retorting, and in-situ processes, the costs of oil shale production relative to expected low crude oil prices, made continuation of most commercial efforts impractical. Several projects failed for technical and design reasons. Federal research and development and leasing activities were curtailed, and most projects were abandoned.

Given today's high oil prices, a decline in global oil production, increasing U.S. and global demand, and resources increasingly controlled by parties unfriendly to the United States, our national attention has returned to the need for secure fuels from domestic resources such as oil shale and tar sands.

Industry is already working to move technologies that can meet our energy and environmental challenges to commercialization as documented in this report.



Table 1. Major Milestones in U.S. Western Oil Shale History

1912	U.S. Government creates U.S. Naval Oil Shale Reserve	1980	Exxon buys Arco's Colony interest and in 1981 begins Colony II construction, designed for 47,000 b/d using Tosco II retort process
1916	USGS estimates 40 B Bbls of shale oil in Green River formation in CO, WY, and UT	1980	Congress approves \$14 billion for synthetic fuels development
1917	First oil shale retort kiln in DeBecque, CO.	1980	Unocal plans Long Ridge 50,000 b/d plant applying "Union B" retort; begins construction in 1981
1918	First oil shale boom begins; over 30,000 mining claims; lasts until 1925	1980	Amoco Rio Blanco produces 1,900 bbls of oil at C-a tract
1920	Mineral Leasing Act requires shale lands be leased through the Secretary of Interior	1981	Exxon begins Battlement Mesa town for oil shale workers
1929	Test retort at Rulison CO stops at 3,600 bbls after oil discoveries in CA, TX, and OK	1981	2nd Rio Blanco in-situ demo produces 24,400 bbls of oil
1944	U.S. Synthetic Liquid Fuels Act provides \$18 million for experiments at Anvil Points	1982	Oil demand falls and crude oil prices collapse
1950s	Gulf and Shell purchase oil shale lands in Green River formation	1982	Exxon closes Colony II due to cost and lower demand
1956	Anvil Points operations cease after testing three experimental retort processes	1982	NPOSr suspends NOSR-1 Oil Shale Pre-Development Plan
1961	Unocal shuts down Parachute Creek "Union A" retort after 18 months and 800b/d due to cost	1982	Shell continues in-situ experiments at Red Pinnacle and labs
1964	Colorado School of Mines leases Anvil Points facility to conduct research on USBM Gas Combustion Retorts	1985	Congress abolishes Synthetic Liquid Fuels Program after 40 years and \$8 billion
1967	CER and AEC abandon "Project Bronco" atomic retort plan	1987	Shell purchases Ertl-Mahogany and Pacific tracts in CO
1972	Tosco, Sohio and Cleveland Cliffs halt Colony oil shale project begun in 1964 after 270,000 bbls of production	1987	Paraho reorganizes as New Paraho; begins production of SOMAT asphalt additive used in test strips in 5 States.
1972	Occidental conducts first of six in-situ tests at Logan Wash	1990	Exxon sells Battlement Mesa for retirement community
1972	Paraho formed as a consortium of 17 companies, leases Anvil Points facility, builds and operates 24 ton/day pilot plant and 240 ton/day semi-works plant.	1991	Occidental closes C-b project before first retort operates
1970s	Shell researches Piceance Creek in-situ steam injection process for oil shale and nahcolite	1991	Unocal closes Long Ridge after 5 MM bbls and 10 years for operational issues and losses
1973	DOI completes EIS for Prototype Leasing Program	1991	LLNL plans \$20 million experiment plant at Parachute; Congress halts test funds in 1993
1974	Four oil shale leases issued by Prototype Leasing Program	1991	New PARAHO reports successful tests of SOMAT shale oil asphalt additive
1974	Unocal develops "Union B" retort process; Shell and Ashland join Colony Project	1997	DOE transfers NPOSr to DOI/BLM
1976	Navy contracts Paraho to produce 100,000 Bbls of shale oil for testing as a military fuel	1997	Shell tests in-situ heating on Mahogany property; defers further work on economic basis
1977	Superior Oil abandons plan for Meeker oil shale plant	2000	DOE Establishes U.S. /Estonia Oil Shale R&D Program
1976	Unocal plans commercial scale plant to be built at Parachute Creek when economic; oil prices reach \$41/bbl	2000	BLM seeks comment on oil shale lands management
1979	Shell, Ashland, Cleveland Cliffs and Sohio sell interests in Colony to ARCO and Tosco; Shell sells leases to Occidental and Tenneco	2000	Shell returns to Mahogany with expanded in-situ heating technology research plan (on-going)
1979	Energy Security Act establishes U.S. Synthetic Fuels Corporation;	2004	DOE Office of Naval Petroleum & Oil Shale Reserves initiates study of the strategic significance of America's oil shale resources
1979	Congress authorizes up to \$88 Billion for synthetic fuels projects, including oil shale	2005	BLM initiates RD&D leasing program, solicits bids. Energy Policy Act directs development of PEIS and Commercial Leasing rules; Directs Energy Secretary to create Task Force to develop integrated unconventional fuels development program; oil prices exceed \$50/ Bbl
		2006	BLM selects RD&D lessees; Task Force prepares initial findings and initiates development of program plan for integrated unconventional fuels development; Oil prices exceed \$70/bbl then fall back



Resources

AMERICA'S OIL SHALE AND TAR SANDS RESOURCES

America's Oil Shale and Tar Sands Resources Have Been Characterized and Assessed - Their Potential is Well Documented

U.S. OIL SHALE RESOURCES

Oil shale is a hydrocarbon bearing rock that occurs in 27 countries around the world. Worldwide, the oil shale resource base is believed to contain about 2.6 trillion barrels, of which the vast majority (2 trillion barrels) is located in the United States.

The most concentrated U.S. oil shale deposits are located in Colorado, Utah, and Wyoming. Of the 1.2 trillion barrels contained in these three western states, the majority (80 percent) are located on Federal land managed by the Department of Interior (DOI). Access to the oil shale resources located on public lands is therefore a critical step in the future commercial development of this resource as discussed in this chapter.

Large areas of the United States contain oil shale deposits, but those in Colorado, Utah, and Wyoming contain the greatest promise for shale oil production in the immediate future (Figure 1). The oil shale deposits in these three states occur beneath 25,000 square miles (16 million acres). These deposits contain

approximately 1.2 trillion barrels of oil equivalent. Recovery of even a small fraction of this resource would represent a significant contribution to supplement the Nation's oil supply for many decades.

QUALITY AND GRADE

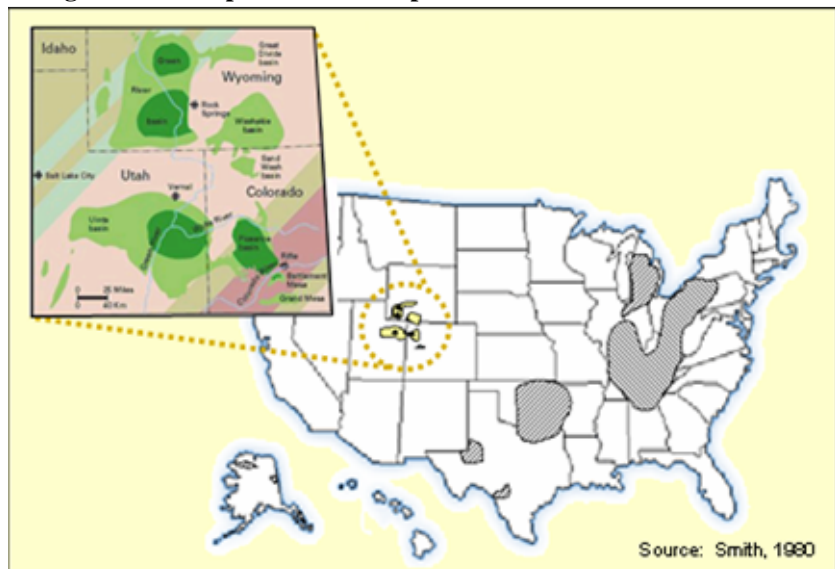
Oil shale resources of the United States have already been identified and been extensively characterized. Yields greater than 25 gallons per ton (gal/ton) are generally viewed as the most economically attractive,

and hence, the most favorable for initial development.

With experience, improved understanding, and technology innovation, this cut-off could be reduced, increasing the size of the estimated recoverable resource.

Table 2 from the U.S. Geological Survey¹ displays the richness of various oil shale deposits in three areas of the United States. The oil shale from each region of the United States has unique characteristics as summarized next.

Figure 1. Principal Oil Shale Deposits of the Western United States





WESTERN SHALE: The most economically attractive deposits, containing in excess of 1.2 trillion barrels, are found in the Green River Formation of Colorado (Piceance Creek Basin), Utah (Uinta Basin) and Wyoming (Green River and Washakie Basins).

More than a quarter million assays have been conducted on the Green River oil shale. In the richest zone, known as the Mahogany Zone, oil yields vary from 10 to 50 gal/ton and, for a few feet in the Mahogany zone, up to about 65 gal/ton.

According to Culbertson and Pittmanⁱⁱ, of the western resource, an estimated 418 billion barrels are in deposits that will yield at least 30 gal/ton and located in zones at least 100 feet thick. Donnellⁱⁱⁱ estimates resources of 750 billion barrels at 25 gal/ton in zones at least 10 feet thick (Figure 2).

EASTERN SHALES: Eastern oil shale deposits have been well characterized as to location, depth, and carbon content. The eastern shale is located among a number of states and is not as concentrated as the western shale.

Ninety-eight percent of these accessible deposits are in Kentucky, Ohio, Tennessee, and Indiana. With processing technology advances, for example the addition of hydrogen to the retorting process, potential oil yields could approach those of the western shale.

Eastern deposits have a different type of organic carbon than the western shale. As a result, conventional retorting of eastern shale yields less shale oil and a higher carbon residue as compared with the western shale.

Deposits	Richness (Gallons/ton)		
	5 - 10	10 - 25	25 - 100
Colorado, Wyoming & Utah (Green River)	4,000	2,800	1,200
Central & Eastern States	2,000	1,000	NA
Alaska	Large	200	250
Total	6,000+	4,000	2,000+

Source: Duncan, and others (1965)

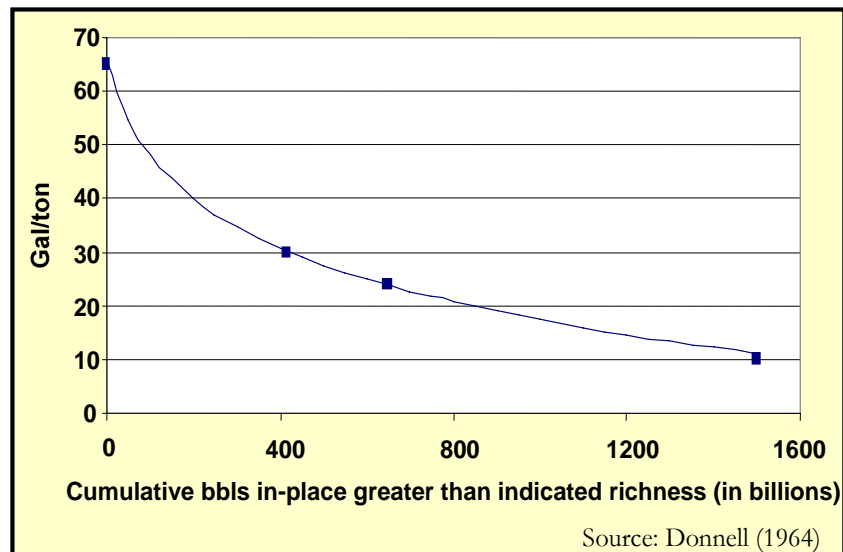
Because of these differences, industry interest in oil shale commercialization has focused on the rich, concentrated oil shale deposits of the western states.

Eastern shale has the potential to become an important addition to the nation's unconventional fuel supplies. The Kentucky Knobs region alone has resources of 16 billion barrels, at a minimum grade of 25 gal/ton. Near-surface mineable resources are estimated at 423 billion barrels^{iv}.

OTHER OIL SHALES: Numerous deposits of oil shale are found in the United States. The two most important deposits are the western and eastern areas described above.

However, oil shale deposits also occur in Nevada, Montana, Alaska, Kansas, and elsewhere, but these are either too small, too low-grade, or have not yet been well explored to be considered for near-term development.

Figure 2. Cumulative Resource Greater than Indicated Richness





U.S. TAR SANDS RESOURCES

Tar sands (referred to as oil sands in Canada) are a combination of clay, sand, water, and bitumen; a heavy, black, asphalt-like hydrocarbon. Tar sands can be mined and processed to extract the oil-rich bitumen, which is then upgraded and refined into synthetic crude oil.

Unlike oil, the bitumen in tar sands cannot be pumped from the ground in its natural state; instead tar sand deposits are mined, usually using open pit techniques, or produced in-situ by underground heating or other processes.

The U.S. tar sands resource in place is estimated to be 60 to 80 billion barrels of oil. The resource is substantial, but far smaller than Alberta's oil sands or U.S. oil shale resources (Figure 3). About 11 billion barrels of U.S. tar sands resources may ultimately be recoverable^v.

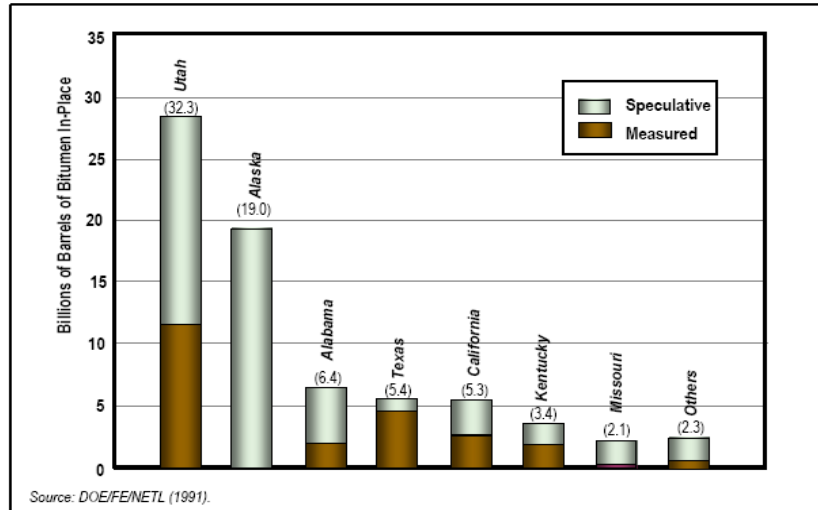
The rate of resource development and the potential volume of production are somewhat dependent on future oil prices. It also depends on industry access to resources on state and Federal lands and the availability of infrastructure for resource development and product upgrading.

With current price projections, the near term incremental U.S. tar sands production potential to 2025 will probably not exceed 250,000 Bbl/d. However, should very high oil prices persist, a greater portion of the resource will become economic, and leaner and more fragmented resources may become economically producible.

Quality and Grade

U.S. tar sands differ somewhat in quality and configuration from Canadian oil sands. They are generally leaner in grade, less uniform in quality, and have higher sulfur content.

Figure 3. Known and Speculative U.S. Tar Sand Resources



U.S. tar sands are typically found in layered sandstone and are often consolidated, or cemented. Unlike U.S. sands, Canadian oil sands are less consolidated and mixed with sand and water. While Canadian oil sands are water wet, U.S. tar sands are more typically hydrocarbon wet. New extraction technology approaches may be required.

Location and Availability

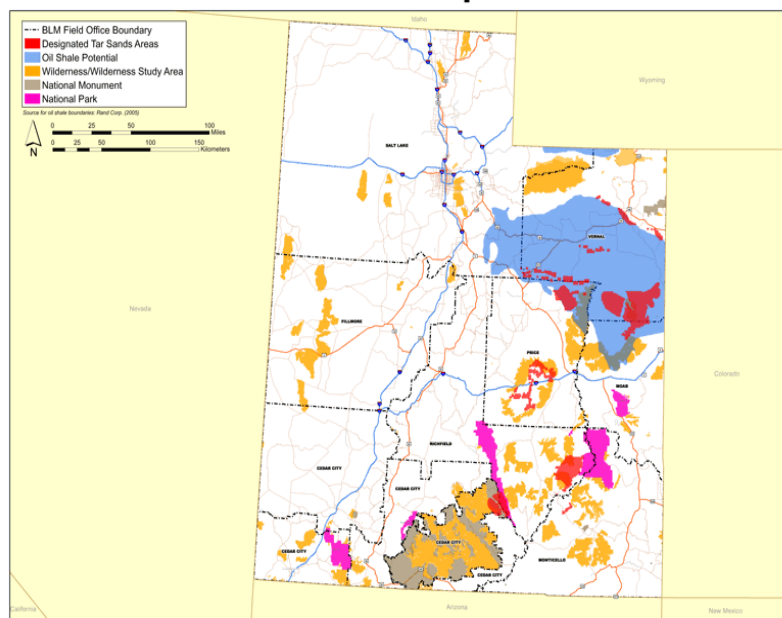
The United States' largest measured tar sands deposits are found in Utah. The rest is found in deposits in Alabama, Texas, California,

Kentucky, and other states. Utah has between 19 and 32 billion barrels of tar sands, about one-third of the domestic resource.

Utah's tar sands resource is concentrated in the eastern portion of the state, predominantly on public land. Approximately 19 billion barrels of speculative resources are thought to exist in Alaska.

Figure 4 displays the location of tar sands deposits in Utah.

Figure 4. Utah Oil Shale and Tar Sand Resources (Source U.S. BLM)





The known (measured) and potential additional (inferred) resource for each of the major Utah deposits are displayed in Table 3 and discussed below. The four largest Utah deposits are:

- **Sunnyside:** The Sunnyside deposit contains enough recoverable resource to support a 100,000 Bbl/d operation. Thermal or solvent treatment may be required as the ore is consolidated.
- **Tar Sand Triangle (TST):** The bitumen is characterized by high sulfur content, similar to Alberta oil sands but, unlike the Uinta Basin deposits described above, which are low in sulfur. TST is located near Canyon Lands National Park, and development is likely to meet with challenges. There appears to be interest in this deposit for in-situ recovery. The product could be transported by truck and rail in bitumen or diluted bitumen state.

Table 3. Major Tar Sands Deposits in Utah		
Deposit	Known Resource (MMBbl)	Additional Potential (MMBbl)
Sunnyside	4,400	1,700
Tar Sand Triangle	2,500	13,700
PR Spring	2,140	2,230
Asphalt Ridge	820	310
Circle Cliffs	590	1,140
Other	1,410	1,530
Total:	11,860	20,610

Source: DOE/FE/NETL (1991)

- **PR Springs:** This sizeable resource is close to the surface, but is fragmented by erosion and multiple beds. It is in a primitive area, which may slow development. A few rich zones could each support modest size operations on the order of 25 to 50 MBbl/d.
- **Asphalt Ridge:** Asphalt Ridge was characterized by SOHIO as holding about 1 billion barrels of recoverable oil with the potential to support a 50 MBbl/d facility. Since then,

growth of the community of Vernal has encumbered some of the resource. Two rich locations could produce significant yields of bitumen but in more modest quantities than contemplated by SOHIO. Alberta technology could be adaptable for use in the unconsolidated sands of the rich zones.

Tar sands in Alaska, Alabama, Texas, California, and Kentucky are deeper and thinner, so less economic to develop.

Figure 5. The Nevtah/Black Sands Closed-Loop Mobil Extraction Plant (Nevtah Photo)





The Evolution of Oil Shale and Tar Sands Technology

THE PATH TO TECHNOLOGY COMMERCIALIZATION

Energy technology development does not happen overnight. It can take decades, thousands of person-hours of effort, and billions of dollars of investment to advance major energy technologies from the conceptualization to successful demonstration at a commercially representative scale.

Figure 6 depicts the path of energy technology evolution and commercialization. To be deemed successful, a technology must be demonstrated to be effective in

producing desired products, energy efficient, economically competitive, scalable, and acceptable to the community.

The development path of a major energy technology from concept to demonstration and commercial scale operation can take as much as 15 to 25 years. This evolution process can be viewed as occurring in three major phases - a Laboratory Phase, a Field Testing Phase, and a Commercialization Phase. While confidence increases at each progressive phase, the level of project risk and required capital investment increases as well.

Failure at any point in the process can require taking a step back, rethinking the approach or the design, or starting over at step one.

By the 1990s, more than 20 technologies for oil shale processing had been conceived. Many had moved beyond basic research and progressed to bench scale plants, field pilots, semi-works scale, or demonstration-scale plants. Of those, at least nine are still considered viable and worthy of consideration for additional effort leading toward demonstration and commercial application.

Figure 6. Evolution of Major Oil Shale Technologies (Lukens, 2004)

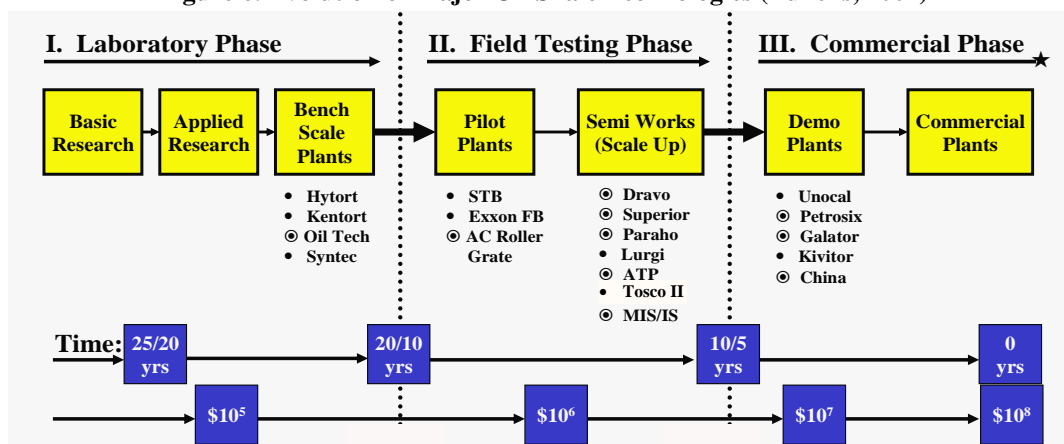




Figure 7. Early Retort, Bonanza, UT (Circa 1900)



THE CONTINUING EVOLUTION OF OIL SHALE AND TAR SANDS TECHNOLOGY

As our understanding of the location, extent, characteristics and potential of oil shale and tar sands resources has improved over time, the technology for accessing and converting these resources to fuels and byproducts has also improved.

Billions of dollars have been invested by private industry and by various governments to research, develop, test, and improve a range of approaches and technologies for oil shale and tar sands development.

The scope of these technology research, development and demonstration (RD&D) efforts embrace the full fuels development lifecycle, including:

- Resource access and extraction,
- Conversion of raw resources to hydrocarbons,
- Environmental protection,
- Upgrading, and
- Fuels manufacturing.

Alberta's Oil Sands Technology

One needs only to look to the Province of Alberta to view the demonstrated success of more than three decades of effort to develop technologies to produce bitumen from Alberta's massive oil sands resources.

Through the evolution of technology, the efficiency and performance of oil sands extraction, separation and bitumen upgrading technology has advanced while operating costs have fallen. In 2006, Alberta produced more than 1 million barrels per day of synthetic oil from oil sands.

Although U.S. tar sands resources are significantly smaller than the massive Alberta oil sands, and compositionally different in important ways. The evolution of Alberta's oil sands industry and technologies contributes both technology and lessons learned to guide development of U.S. tar sands resources.

Several U.S. companies have been active in the Alberta Oil Sands effort. Many are now applying knowledge and technology developed in Alberta and in other oil and energy resource development efforts to overcome challenges posed by America's own tar sands resources. The companies and technologies, described in a series of profiles that follow this discussion, demonstrate that much oil sands technology has moved from the lab, to the field, and on toward commercial stage

demonstration that could result in commercial-scale application within a decade.

U.S. Oil Shale Technology

Because of the abundance and geographic concentration of the nation's known resources, oil shale has been recognized as a valuable U.S. energy resource since as early as 1859, the same year Colonel Drake completed his first oil well in Titusville, Pennsylvania.

Early products derived from shale oil included kerosene and lamp oil, paraffin, fuel oil, lubricating oil and grease, naphtha, illuminating gas, and ammonium sulfate fertilizer.

Since then, energy companies and petroleum researchers have developed, tested, enhanced, and in many cases, demonstrated a variety of technologies for recovering oil and gas from oil shale and upgrading it to produce fuels and byproducts.

Both surface processing and in-situ technologies have been conceived, developed and tested in the laboratory, field tested at pilot and semi-works scale, or demonstrated at commercially representative scale in demonstration plants.

Figure 8. UNOCAL's Demonstration Plant at Parachute Creek (Circa 1990)





Generally, surface processing consists of three major steps: (1) oil shale mining and ore preparation (2) pyrolysis of oil shale to produce kerogen oil, and (3) processing kerogen oil to produce refinery feedstock and high-value chemicals

For deeper, thicker deposits, not as amenable to surface- or deep-mining methods, the kerogen oil can be produced by in-situ technology. In-situ processes minimize, or in the case of true in-situ, eliminate the need for mining and surface pyrolysis, by heating the resource in its natural depositional setting.

By as early as 1978, the U.S. Department of Energy had concluded that the development of a domestic oil shale industry was technically feasible and was ready for the next steps toward aggressive commercialization (Ref. 12).

- Surface and sub-surface mining technologies were deemed commercially proven and economic.
- Numerous surface retorting technologies were largely demonstrated, although additional process design improvements were deemed desirable to improve reliability and to reduce costs.
- In-situ technologies, although less costly than surface retorts, had been demonstrated to a more limited degree, but warranted additional public and private R&D investment and testing.
- Environmental impacts, though significant at the time, appeared to be controllable to meet existing and anticipated regulatory standards with available technologies. A programmatic environmental impact statement was prepared in 1973 to support the Department of Interior's

Prototype Oil Shale Leasing Program.

- Upgrading and processing technologies to convert kerogen oil to quality fuels and chemical byproducts were also considered proven, although on-site processing and new commercial refineries would be required to support a full-scale industry.
- First-generation commercial-scale plants were expected to be economically competitive, based on oil price forecasts that followed the Arab Oil Embargo of 1973 and the supply disruptions and price shocks associated with the 1979 Iranian Revolution.

By 1984, reduced tensions in the Middle East, the availability of new petroleum supplies from non-OPEC sources, including the North Sea, and decreases in world petroleum demand, caused prices to fall from \$31/ Bbl to as low as \$10 / Bbl.

Public and private sector decisions to terminate investments in R&D and large-scale demonstration projects were made largely based on evolving economic uncertainties associated with the supply and price of conventional petroleum, as well as oil shale plant design issues. For example, design issues in the Unocal retort created production bottlenecks that played a major role in Unocal's decision to shut down rather than retrofit its pilot plant.

Investment uncertainty was further compounded by regulatory and policy uncertainty. These uncertainties are now being resolved as petroleum prices firm, the regulatory environment matures, and the need for additional, diverse energy supplies brings renewed focus to government policy.

In many cases, the technologies developed to produce and process

Perceptions that oil shale projects in the 1980s and 1990s were terminated due to the quality of the resource are incorrect. In fact, it was the abundance, concentration, and high quality of the oil shale resources of the Green River Formation that attracted the billion+ dollars of investment in the first place.

oil from shale were not abandoned, but rather "mothballed" for adaptation and application at a future date when market demand for shale oil would increase, oil price risk would attenuate, and major capital investments for oil shale projects could be justified.

Many of the companies involved in earlier oil shale projects still retain their oil shale technology and resource assets.

Current U.S. Oil Shale Development Activity

Today, with oil prices in excess of \$60 per barrel, domestic oil shale and tar sands are now attractive resources for the production of secure, domestically sourced transportation fuels.

Fortunately, the body of knowledge and understanding established by past efforts exists to provide the foundation for emerging advances in oil shale mining, retort, and processing and supports the growing interest in oil shale.

Public and private interest and activity in oil shale resources and technology development continues, both in the United States and elsewhere in the world, despite the fact that major U.S. efforts to commercialize oil shale were terminated with the closure of the Unocal effort in 1991.



At that time, many technologies had advanced well beyond proof of concept in the lab to engineering, design and field-testing at pilot or semi-works scale.

New Technologies are Emerging; New Challenges Being Addressed

These efforts are – and must be – clearly focused not only on overcoming the technical challenges of the past, but also on meeting new challenges that face 21st century producers of domestic energy resources.

New Technologies That Address Past and Present Oil Shale Challenges

- Indirect heating for in situ – instead of direct combustion (several variations)
- Direct current heating
- RF Microwave heating for in-situ
- Oil Tech Vertical Retort
- Freezwall barriers for groundwater protection in in-situ
- Impermeable barriers to prevent leaching and protect ground water
- Solvent-based liquefaction versus pyrolysis
- Hot gas recycle and solid-to-solid heat transfer for surface processes (Alberta Taciuk Processor and Gas Combustion Retort)

Major New Industry Challenges and Objectives

- Efficient production to maximize recovery and conserve resource
- Conservation of water supplies
- Preservation of air quality
- Net carbon emissions equal to or less than conventional petroleum (wells to wheels)
- Protection of groundwater quality from in-situ processes
- Protection of ground water from surface operations

This continuing interest and effort has enabled the art and science of oil shale mining, conversion of oil shale to hydrocarbon liquids and gases, and shale oil processing to advance in several very significant ways:

- Technology performance and efficiency are significantly improved – more barrels of oil equivalent can be produced from a given resource per unit of energy expended.
- Capital and operating costs per barrel of production capacity are falling to the point where

they are likely to be economically competitive with conventional crude oil at current and expected market prices.

- Environmental monitoring, control, and remediation technologies have become more effective, reliable, and less costly.
- More efficient in-situ and surface retorting processes leave less residual carbon behind, both increasing product yield and improving the environmental safety of the spent shale or residual subsurface formations.
- Technologies to reduce water requirements, to use previously unsuitable water resources, and to capture, clean-up, and re-use water have improved dramatically, reducing water demand estimates significantly.
- Technologies to capture, concentrate and use or store produced carbon dioxide are advancing and the locations, opportunities, and strategies for storing produced carbon dioxide are far better understood.

Today, building on the lessons learned and technologies developed in past efforts, more than 30 companies are moving technologies

forward toward commercial scale development. Research and development interest and activity is intensifying. Renewed interest in commercial-scale oil shale development is evident.

Several technologies are sufficiently developed and field-tested to approach readiness to enter Phase III – Demonstration efforts at commercially-representative scale. The current efforts include both surface and in-situ technologies

COMPANY PROFILES

The 27 Company Profiles that follow describe companies that are currently and actively engaged in domestic oil shale and heavy oil resource and technology development. Each profile describes the company, its role in oil shale or tar sands development, the nature and features of its process technology (if any), the location of its resource holdings or leases (if any), the status of technology or project development efforts, and plans for further efforts.

The information provided in the company profiles was provided by the subject companies or garnered from information in the public domain found on company websites or in public filings. The Department of Energy makes no representation as to the accuracy of this information.



OIL SHALE AND TAR SANDS COMPANY PROFILES

Companies Investing Today to Advance Technology to Provide Clean
Secure Fuels for Tomorrow

Profiled Companies Active in Oil Shale and Tar Sands Development

1. Anadarko Petroleum Corporation
2. Chattanooga Corporation
3. Chevron USA
4. Commonwealth Raw Materials
5. E.G.L. Resources
6. Electro-Petroleum
7. Earth Search Sciences / Petro-Probe, Inc.
8. ExxonMobil Corporation
9. Brent Fryer, Sc.D.
10. Global Resource Corporation
11. Imperial Petroleum Recovery Corp.
12. Independent Energy Partners
13. J. W. Bunger and Associates, Inc.
14. James A. Maguire, Inc.
15. Millennium Synthetic Fuels, Inc.
16. Mountain West Energy Company
17. Natural Soda, Inc.
18. Nevtah Capital Management, Inc.
19. Oil Shale Exploration Corporation
20. Phoenix-Wyoming, Inc.
21. Raytheon Corporation
22. Red Leaf Resources
23. Shell Frontier Oil and Gas, Inc.
24. Syntec, Inc.
25. Temple Mountain Energy, Inc.
26. Western Energy Partners
27. Great Western Energy Corporation



OIL SHALE AND TAR SANDS COMPANY PROFILES SUMMARY

Company	Resource*	Project Developer	Technology Developer	Technology Type	Resource Holder			Page
					BLM	State	Private	
Anadarko Petroleum Corporation	S						√	14
Chattanooga Corporation	S/T		√	Surface				16
Chevron USA	S	√	√	In-Situ	√			18
Commonwealth Raw Materials	T/H	√	√			√	√	20
E.G.L. Resources	S	√	√	In-Situ	√			22
Electro-Petroleum	S/H		√	In-Situ				24
Earth Search Sciences / Petro-Probe, Inc.	S	√		In-Situ				26
ExxonMobil Corporation	S	√	√	In-Situ			√	28
Brent Fryer, Sc.D.	S	√	√	Surf/In-Situ				30
Global Resource Corporation	S/T/H		√	In-Situ				32
Imperial Petroleum Recovery Corp.	S		√	Upgrading				34
Independent Energy Partners	S	√	√	In-Situ			√	36
J.W. Bunger and Associates, Inc.	S/T		√	Surface		√		38
James A. Maguire, Inc.	S		√	In-Situ				40
Millennium Synthetic Fuels, Inc.	S/C	√	√	Surface			√	42
Mountain West Energy Company	S	√	√	In-Situ		√		44
Natural Soda, Inc.	S						√	46
Nevtah Capital Management, Inc.	T	√	√	Surface		√		48
Oil Shale Exploration Corporation (OSEC)	S	√		Surface	√			50
Phoenix-Wyoming, Inc.	S	√	√	In-Situ				52
Red Leaf Resources	S	√	√	Surface		√		54
Raytheon Corporation	S		√	In-Situ				56
Shell Frontier Oil and Gas, Inc.	S	√	√	In-Situ	√		√	58
Syntec, Inc.	S			Surface				60
Temple Mountain Energy, Inc.	T	√	√	Surface		√		62
Western Energy Partners	S	√	√	Surface				64
Great Western Energy Corporation	S					√		66

*Oil Shale = S, Tar Sands = T, Heavy Oil = H, Coal = C



Anadarko Petroleum Corporation

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COMPANY DESCRIPTION

Anadarko Petroleum Corporation is among the largest independent oil and gas exploration and production companies in the world, with 3.01 billion barrels of oil equivalent (BOE) of proved reserves as of December 31, 2006.

The Company's major areas of operation are located onshore in the United States, the deepwater of the Gulf of Mexico and Algeria. Anadarko also has production in China, Venezuela and Qatar, a development project in Brazil and is executing strategic exploration programs in several other countries. The Company actively markets natural gas, oil and natural gas liquids (NGLs) and owns and operates gas gathering and processing systems.

In addition, the Company engages in the hard minerals business through non-operated joint ventures and royalty arrangements in several coal, trona (natural soda ash) and industrial mineral mines located on lands within and adjacent to its Land Grant holdings - an 8 million acre strip running through portions of Colorado, Wyoming and Utah where the Company owns most of its fee mineral rights.

Anadarko is committed to minimizing the environmental impact of exploration and production activities in its worldwide operations through programs such as carbon dioxide (CO₂) sequestration and the reduction of surface area used for production facilities.

OIL SHALE INDUSTRY ROLE

Anadarko's current role in the U.S. oil shale industry is that of a resource owner.

DESCRIPTION OF TECHNOLOGY

Anadarko is not developing technology for oil shale processing.

TYPE / LOCATION OF RESOURCE HOLDINGS

- Anadarko engages in the hard minerals business through non-operated joint ventures and royalty arrangements in several coal, trona (natural soda ash) and industrial mineral mines located on lands within and adjacent to its Land Grant holdings.
- The Land Grant is an 8 million acre strip running through portions of Colorado, Wyoming and Utah where the Company owns most of its fee mineral rights. (See opposite page).

PROJECT STATUS / STATE OF DEVELOPMENT

- In 2006 Anadarko drilled 22 core holes and shipped a 500 ton bulk sample to Calgary to be tested in the Alberta Taciuk Processor.
- The bulk sampling program was successful and Anadarko expects to have the core analyses completed in late 2007.

Oil Shale and Tar Sands Industry Profiles

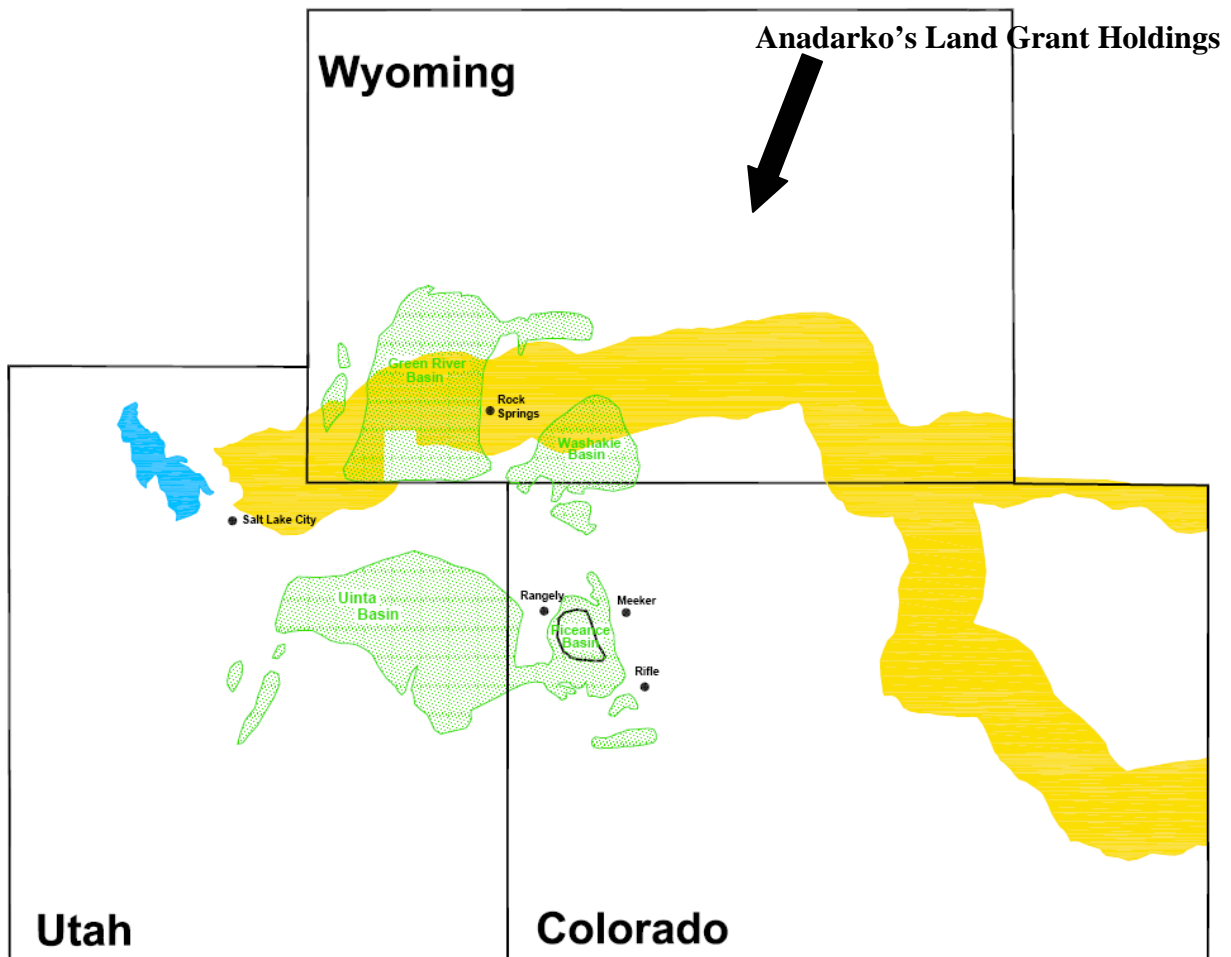
RELEVANT EXPERIENCE

Anadarko and its predecessor companies have participated in and funded many of the numerous studies of the Land Grant oil shales which have included several coring programs.

OUTLOOK / FUTURE PLANS

Anadarko is currently interested in leasing its oil shale lands. Anadarko will make available all studies and the results of all drilling programs to qualified prospective lessees.

Area of Anadarko's Land Grant Holdings Relative to Western Oil Shale Deposits



Oil Shale and Tar Sands Industry Profiles



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COMPANY DESCRIPTION

Chattanooga Corp is a technology development company that focuses on processes for converting unconventional oil resources into synthetic crude oil. Chattanooga has developed, patented and demonstrated a new process to directly convert unconventional oil resources into light, high grade, synthetic crude oil.

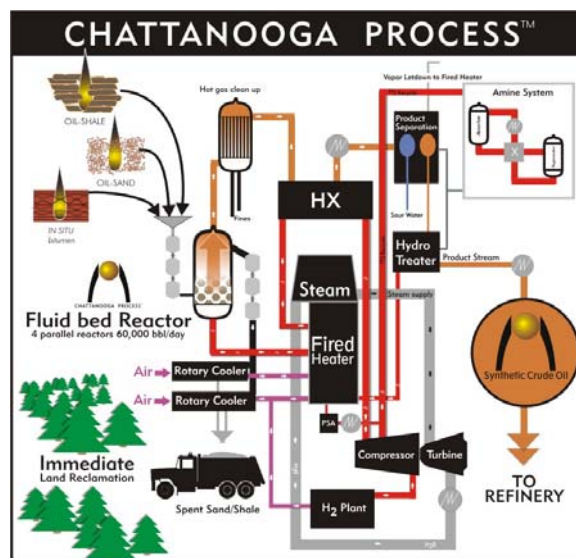
OIL SHALE INDUSTRY ROLE

Chattanooga Corp is a technology developer. Chattanooga Corp is expanding partnerships with leading energy producers, government agencies, banks and investors for the purpose of establishing a demonstration facility to be followed by multiple commercial operations.

DESCRIPTION OF TECHNOLOGY

Central to the Chattanooga Process is the pressurized fluid bed reactor and associated fired hydrogen heater. Conversion reaction occurs in a relatively low temperature (sub 537°C/1000°F) non-combustion environment. With modifications only to its feed system, the reactor can convert oil bearing material such as oil sand, oil shale and liquid bitumen via thermal cracking and hydrogenation into hydrocarbon vapors and spent solids.

Hydrogen is used as the heat conveyor to the reactor, reactor bed fluidizing gas, and reactant. Hydrogen is heated in an adjacent fired heater fueled by process off-gases and either supplemental gas or product oil, depending upon economic conditions. This flexibility minimizes or eliminates natural gas requirements. Combustion air for the heater and the associated hydrogen plant reformer is preheated by cooling the spent sand or shale discharged from the reactor.



Reactor overhead gases are cleaned of particulate solids in a hot gas filter, cooled and hydrocarbon products condensed and separated from the gas stream. The liquid product produced at this stage may be lightly hydro-treated to produce a very low sulfur high grade synthetic crude oil.

The excess hydrogen, light hydrocarbon (HC) and acid gases are passed through an amine scrubbing system to remove hydrogen sulfide which is converted to elemental sulfur. Excess hydrogen and light HC gases, stripped of the acid gases, together with new make-up hydrogen are admitted to a turbine-driven centrifugal compressor for recompression and recycling. Steam for the turbine is generated by recovering waste heat from the fired heater. Compressor power requirements are minimized by maintaining a low pressure drop around the process loop.

A slip stream of recycle gases is taken from the compressor discharge and passed through a purification system to remove light HC gases produced in the reactor. The purified hydrogen gas stream is returned to the compressor inlet. The light HC gases may be used as feedstock to the integrated hydrogen plant thus again minimizing the requirement for purchased natural gas.

Oil Shale and Tar Sands Industry Profiles

Efficiency: Use of hydrogen in the initial phase of the process greatly enhances the quality of the product and reduces the need for extreme hydrotreating in downstream operations. Recovery of waste heat, power co-generation and the utilization of the light HC gases produced in the reactor as feedstock for the hydrogen plant make the Chattanooga Process virtually self sufficient by obtaining its energy requirements from the primary plant feedstock.

Environmental Benefits common to all feedstock: Dry processing of resource material eliminates water pollution and greatly reduces water usage. Greenhouse gas emissions are substantially reduced. The majority of the CO₂ produced in the hydrogen reformer can be sequestered. Spent shale or sand is immediately available for land reclamation. Process has the ability to remove 99.8% of all sulfur.

Bitumen : Upgrading of bitumen by the Chattanooga Process produces a high-value, low-sulfur synthetic crude oil, compared to a low-value, raw bitumen that is difficult to transport.

Oil Sand: The Chattanooga Process provides a simplified extraction and upgrading technology for processing oil sands, resulting in significant benefits to the industry, including reduced greenhouse gas emissions, elimination of tailing ponds and reduced natural gas consumption.

RESOURCE HOLDINGS

Chattanooga Corporation does not have direct holdings in oil shale or tar sands resources or land.

PROJECT STATUS / STATE OF DEVELOPMENT

- Pilot plant tests have demonstrated that the Chattanooga Process has produced yields of 51.5 gal/ton from Colorado shale (with a Fischer Assay of 28.4 gal/ton), and 15.4 gal/ton from Kentucky shale (with a Fischer Assay of 7.7 gal/ton). Tests demonstrated effective fluidization using hydrogen with extremely high extraction efficiency results.
- Pilot plant tests on bitumen/sand demonstrated production of a 28°-30° API product in the reactor with extremely high extraction efficiency results. Hydrotreating would increase this material to a product in the range of 38°-40° API.
- Pilot plant tests are performed at the National Centre for Upgrading Technology (NCUT) in Devon, Alberta, Canada
- Contract engineering companies have been commissioned to design, engineer and cost-estimate a 60,000 bbl/day commercial plant and mining operation. All sub-processes employed downstream of the fluid bed reactor are commercially proven, time tested and readily available.
- The Chattanooga team has created a complete field operation model for integrating the Process into SAGD operations.

RELEVANT EXPERIENCE

Chattanooga Corp is a technology company founded by an experienced team of energy industry professionals to create processes for converting oil resources into synthetic crude oil. The company also utilizes a team of industry experts as consultants and advisors for various aspects of its process and business development.

OUTLOOK / FUTURE PLANS

Having proven the efficacy of the Chattanooga Process for producing synthetic crude oil from oil shale and bitumen/sand in its pilot plant, Chattanooga Corp is planning to design, construct and operate a demonstration facility as the next step in the commercialization process. In parallel, Chattanooga will expand its relationships with targeted energy producers, government agencies, financial institutions and investors for the purpose of promoting and establishing commercial-scale facilities and creating licensing and royalty agreements.



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COMPANY DESCRIPTION

Chevron U.S.A. Inc. is one of the largest integrated energy companies in the world. Headquartered in San Ramon, California, and conducting business in approximately 180 countries, the company is engaged in every aspect of the oil and natural gas industry.

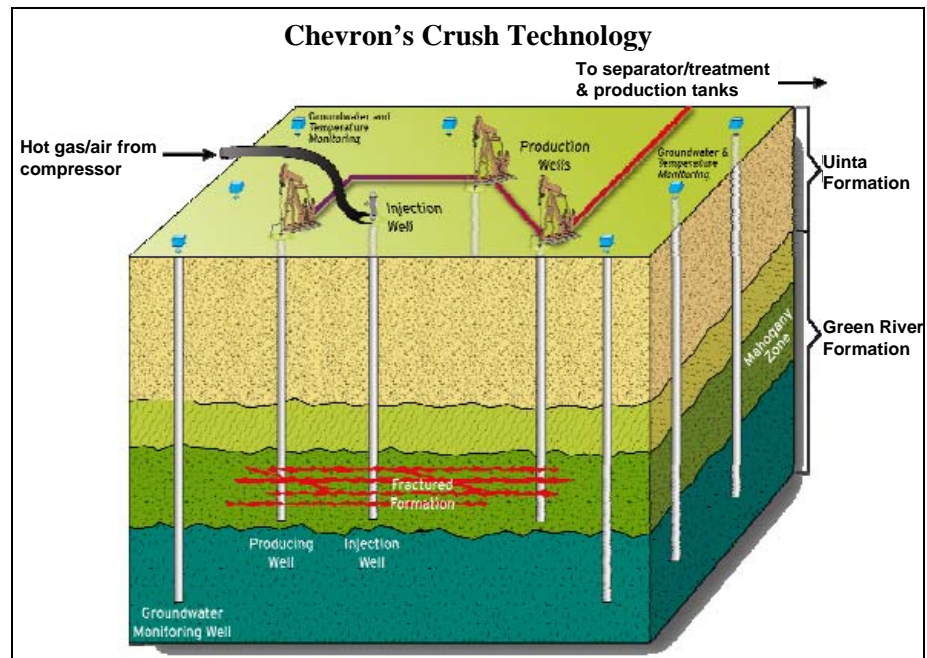
Chevron Shale Oil Company, a part of Chevron U.S.A. Inc, is leading the way in oil shale development. Chevron has secured a leasing tract -T3S R97W Sec5 - in Rio Blanco County, Colorado. There the company will conduct research, development, and demonstration of their oil shale extraction technology.

OIL SHALE INDUSTRY ROLE

Chevron USA is engaged in the oil shale industry as a resource owner, technology developer, and project developer. The company has been developing an in-situ process that it intends to test on a BLM RD&D lease. The project could be expanded to commercial scale production depending on a finding of technical, economic feasibility and other investment criteria.

DESCRIPTION OF CHEVRON'S CRUSH TECHNOLOGY

- Chevron's Technology for the Recovery and Upgrading of Oil from Shale (CRUSH) process is an in-situ conversion process.
- It involves the application of a series of fracturing technologies to rubblized the formation to enhance the surface area of the exposed kerogen.
- The exposed kerogen in the fractured formation is then converted through chemistry resulting in the kerogen changing from a solid material to a liquid and gas.
- The hydrocarbon fluids are recovered and upgraded to refinery feedstock specs.



LOCATION OF RESOURCE HOLDINGS

- Chevron was awarded a 160 acres RD&D lease by the U.S. Bureau of Land Management.
- If efforts are successful, Chevron will have the right to convert the RD&D to a 5,120 commercial lease.
- The RD&D lease is located at -T3S R97W Sec5 - in Rio Blanco County, Colorado.

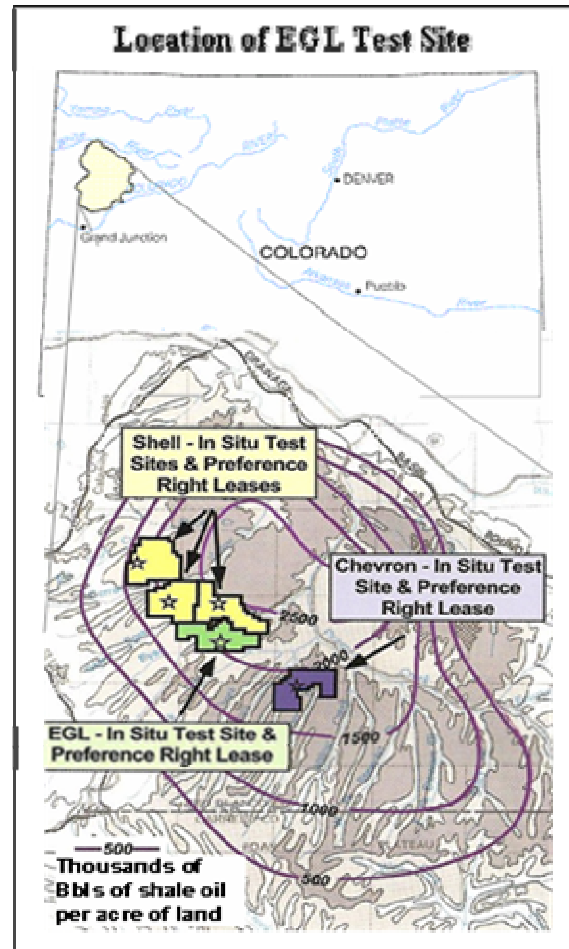
PROJECT STATUS / STATE OF DEVELOPMENT

- Chevron plans to test its technology in several laboratory, bench, and small field tests.
- They successfully proposed a research, development, and demonstration (RD&D) lease to the Department of Interior, Bureau of Land Management (BLM).

OUTLOOK / FUTURE PLANS

Chevron proposed a pilot test to BLM consisting of a minimum of 2-5 spot patterns (4 injectors and 1 producer per pattern) in Rio Blanco County, Colorado. The project schedule includes:

- An unspecified period of time for research, development, and demonstration lease acquisition, for BLM completion of the Environmental Impact Statement, and for Chevron development and BLM approval of a plan of operations;
- A three-plus year period of time to fracture, treat, and produce the first pattern;
- Another 2 plus years to repeat the process for the second pattern; and
- An unspecified period of time for analyzing test results and planning next steps.





Commonwealth Raw Materials

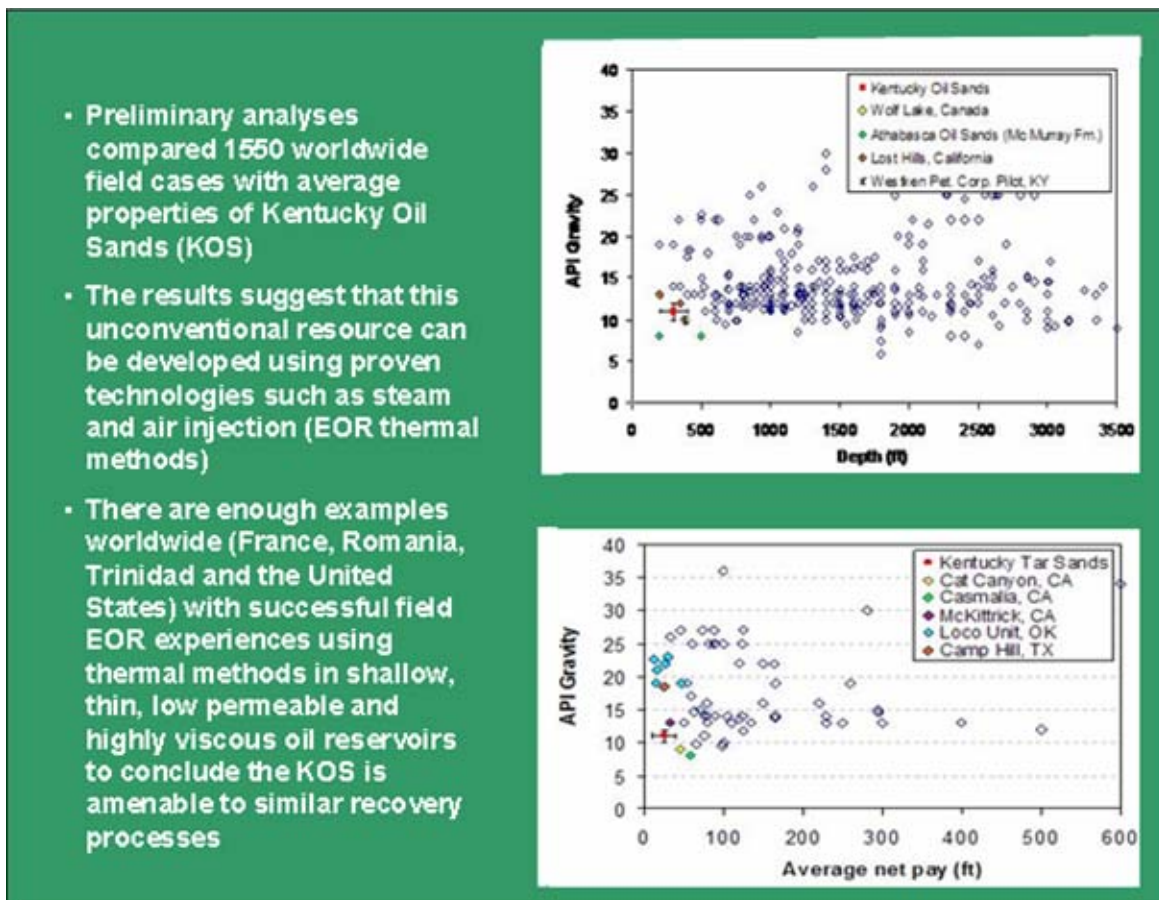
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COMPANY DESCRIPTION

Commonwealth Raw Materials is engaged in the natural resource sector as a resource owner. It owns over 50,000 acres of Mineral deeds in Kentucky. The acreage is estimated to contain over 1.5 BBL of heavy oil deposited within a sandstone matrix. The entire resource is estimated to be more than 5 BBL within a 3 county area. This represents the largest heavy oil/tar sand resource east of the Mississippi.

DESCRIPTION OF TECHNOLOGY

- CRM is in the preliminary process of a pilot program to evaluate the heavy oil resource.
- The CRM pilot process involves the use of proven EOR technologies to recover the oil from the resource.
- The pilot program will be the fourth to be undertaken on the resource all of which were successful. A



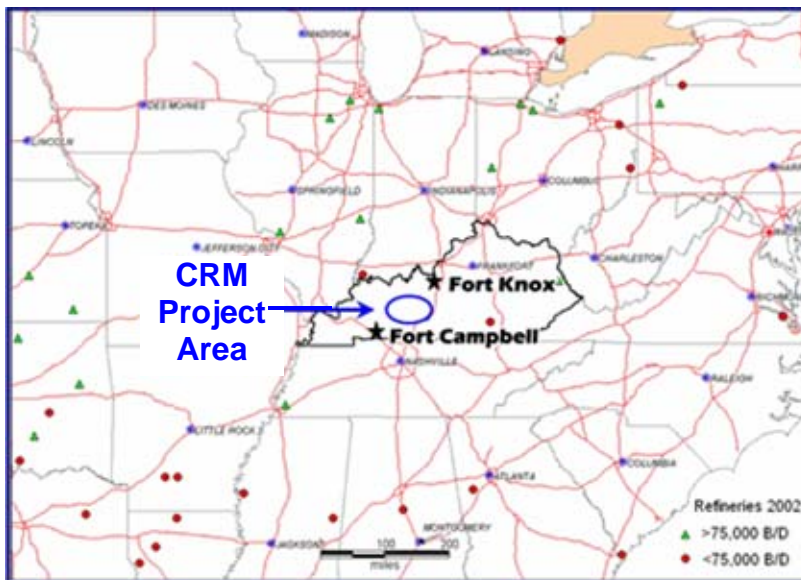
Oil Shale and Tar Sands Industry Profiles

1961 Gulf Pilot Program showed 54% recovery. The technology being used in the CRM pilot should improve that number dramatically.

- The pilot program will use multiple state of the art technologies and should be operating by the fall 2008.
- Recent testing has revealed that historic EOR recovery values were underestimated and by applying recent advances in heavy oil recovery, total recoveries are anticipated to be dramatically higher.

TYPE / LOCATION OF RESOURCE HOLDINGS

- CRM owns several thousand acres of fee and over 50,000 acres of mineral deeds in Kentucky. The properties contain an estimated 1.54 billion barrels of heavy oil/ tar sand.
- The evaluation program includes both a pilot facility and core drilling. There have been over two hundred cores holes drilled on the property in recent years.
- The CRM resource is located in a very strategic area (just 65 miles southwest of Fort Knox and 60 miles northeast of Fort Campbell) close to major refineries, large markets, navigable rivers, rail, and major highways.



PROJECT STATUS / STATE OF DEVELOPMENT

- CRM anticipates the pilot facility to be in production by fall of 2008.

RELEVANT EXPERIENCE

- The philosophy of CRM is to bring together the most knowledgeable teams of experts utilizing the latest EOR technology available in the oil and gas industry today.
- CRM has retained the services of one of the oil and gas industries most respected Reservoir engineering firms in Norwest Questa Engineering out of Denver and Calgary.
- The Pilot facility is being designed by another major engineering firm in Processes Unlimited International out of Bakersfield, California.



E.G.L. Oil Shale, L.L.C.

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COMPANY DESCRIPTION

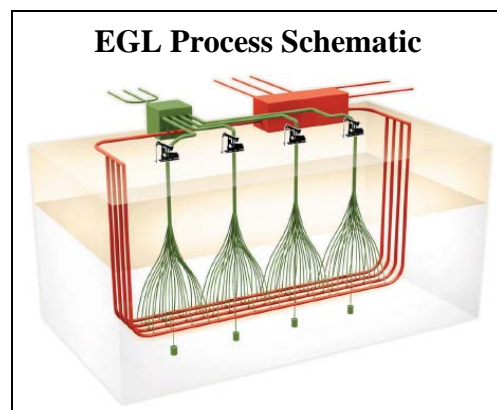
E.G.L. Oil Shale, L.L.C. (EGL) is a wholly owned subsidiary of E.G.L. Resources, Inc. a privately owned independent oil company based in Midland Texas with offices in Glenwood Springs and Rifle, Colorado.

OIL SHALE INDUSTRY ROLE

EGL is engaged in the oil shale industry as a technology developer and holder of a BLM oil shale RD&D lease in Rio Blanco County Colorado. The company is developing an innovative in-situ oil shale recovery process and is proposing an Oil Shale Research Consortium to validate the economic, technical, and environmental viability of shale oil production. It is seeking partners that will have input on research direction; have individual rights to research results and licensed technology; and will contribute monetarily to the research. The consortium will focus on computer modeling; hydrologic studies; solutions to environmental challenges such as carbon management and mitigation of water impacts; the application and control of heat to shale in-situ; and provide access to its accumulated knowledge and document base.

DESCRIPTION OF TECHNOLOGY

- EGL has been developing a new process for in-situ retorting of Green River oil shale.
- The EGL Oil Shale Process (patent applied for) involves the use of proven oil field drilling and completion practices coupled with EGL's unique heating and recovery technology.
- The EGL approach is a closed loop in-situ retorting process with advantages of energy efficiency and manageable environmental impacts. The oil shale is heated with superheated steam or other heat transfer medium through a series of pipes placed below the oil shale bed to be retorted. Shale oil and gas are produced through wells drilled vertically from the surface and "spidered" to provide a connection between the heating wells and production system.
- Convection and refluxing are mechanisms that improve heat transfer to retort the oil shale. After initial start-up, the process uses the gas produced from retorting to supply all the heat required to liberate shale oil and gas from the deposit. By heating through lateral piping the process minimizes surface disturbance. Energy efficiency is optimized by recovery of heat from the shale rock after retorting is completed.



Oil Shale and Tar Sands Industry Profiles

- Mitigation of subsurface water impacts will be a focus of testing and research. Conventional dewatering is contemplated prior to and during retorting operations. Clean up of water after processing is completed will involve existing pump and treat technologies plus down-hole techniques under development by EGL.

TYPE / LOCATION OF RESOURCE HOLDINGS

- EGL holds a 160-acre BLM RD&D oil shale lease in the Piceance Basin in Rio Blanco County, CO.
- The lease was secured from BLM after EGL and some 19 other firms proposed innovative technologies to be tested on the research, development and demonstration leases.
- The rich oil shales under the EGL lease are about 1000-ft thick and are covered by overburden of about 1000-ft.
- When EGL proves its technology is economically viable and environmentally acceptable, it may expand its lease to 5,120 acres for commercialization. In that event EGL's lease has a 5-billion barrel recoverable reserve expectation.

PROJECT STATUS / STATE OF DEVELOPMENT

EGL has based its technology on the use of modern but conventional oil and gas recovery techniques, the study of past successes and failures in in-situ retorting, and calculations of heat and mass transfer. EGL is now proposing a research consortium as described above to improve the prospects for success of field testing on the lease. The current schedule includes completing site characterization and research activities in order to commence field testing in late 2009.

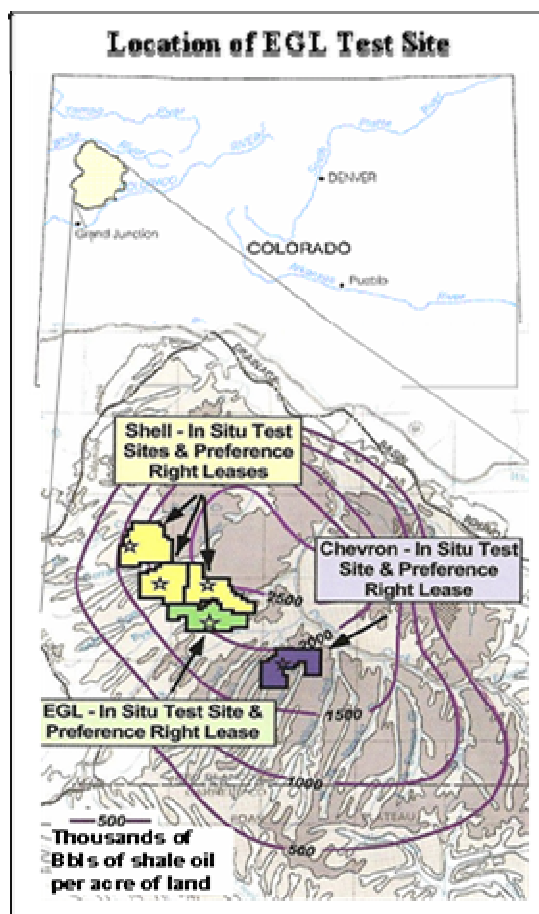
RELEVANT EXPERIENCE

EGL has a team of experts with extensive experience in oil and gas drilling, completion and production practices; oil shale technology; and project development. Team members include managers, engineers and scientists that have been active in oil shale for decades. Three of its members were active participants in oil shale development efforts in western Colorado and Wyoming in the 1970's and 80's. Its Midland, Texas group is involved directly in oil and gas operations on a day to day basis. The company is currently engaged in working with regional universities, national labs and the USGS to provide research expertise.

OUTLOOK / FUTURE PLANS

The mission of EGL is to prove that petroleum products can be produced from oil shale in an economic, environmentally acceptable and socially sustainable fashion, and to secure a property upon which commercial production can be achieved. EGL's vision is driven by the strong belief that oil shale is a viable domestic energy source needed by the nation.

EGL intends to continue research, development, and demonstration efforts on the EGL Oil Shale Process, to determine its technical, economic, environmental and socioeconomic feasibility for commercial scale application. When a positive decision is reached that these goals have been met EGL will apply to BLM to expand its lease to 5,120 acres for commercialization.





Electro-Petroleum, Inc.

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COMPANY DESCRIPTION

Electro-Petroleum Inc. (EPI) is a small business established with a mission to apply Direct Current (DC) Technologies for the solution of energy and environmental problems. The company was founded in 1973 by Mr. Christy Bell. EPI has used DC technology for oil recovery, mud drying and soil remediation. A sister company, Electro-Pyrolysis, Inc., has developed a high temperature vitrification technology utilizing direct current.

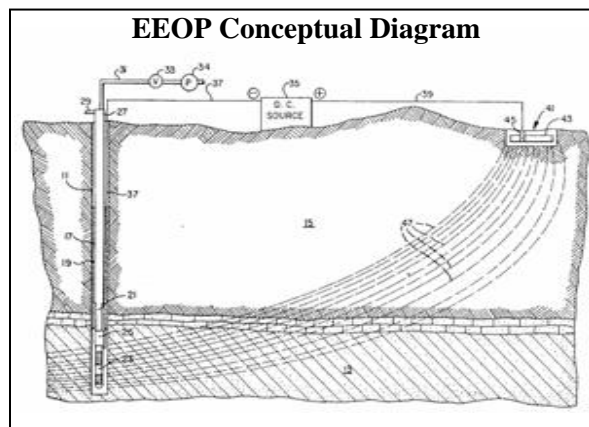
INDUSTRY ROLE

EPI has been focusing its research and technology development on the application of DC to heavy oil recovery. Recently a new patented DC electrochemical process, cold cracking, is being applied to heavy oil. The process also has applicability to oil shale in which water is incorporated into the rock matrix.

DESCRIPTION OF EEOP TECHNOLOGY

Electrically enhanced oil production (EEOP) is an emerging technology that could significantly improve heavy oil recovery at costs below other secondary and tertiary oil recovery technologies.

- EEOP involves passing direct current electricity between cathodes (negative electrodes) in producing wells and anodes (positive electrodes) either at the surface or at depth in other wells.
- The passage of the current through the reservoir heats the formation via Joule heating, reducing oil viscosity.
- Short-term EEOP field tests the Santa Maria Basin (CA) and Eastern Alberta show results of up to ten times baseline oil production. The trial resulted in increased oil gravity of produced crude, reduced water cut, increased gas production and energy content, and reduced H₂S.
- Electro-osmosis can enhance the pressure gradient toward the well bore, creating an additional drive mechanism, resulting in increased production.



Comparison of Baseline vs. EEOP Production		
Item	Baseline	EEOP
Production Rate (bbl/day)	5	50
Crude Oil API Gravity	8.1°	9.4°
Water Cut	45%	12%
Gas Production (scf/day)	1,750 to 2,000	3,800
Produced Gas Energy Content (Btu/scf)	1,197	1,730
H ₂ S Content (ppm)	2,290	4 to 40

Oil Shale and Tar Sands Industry Profiles

- Electro-chemistry has been shown to degrade large molecular-weight hydrocarbons into lighter hydrocarbons, upgrading crude by reducing viscosity.
- Energy efficiency is also significantly improved over the use of conventional Cyclic Steam “huff n puff” approaches.
- The technology is cost competitive with steam flooding.
- The technology has no “thief zone” issues, no apparent depth limitations and requires no water supply. It does not use a working fluid.
- The technology produces no greenhouse gases.

Energy Efficiency EEOP vs. Steam Flooding	
Recovery Method	Btu/Incremental Barrel
EEOP	7,014
"Huff & Puff" Steam Flood	1,300,000
Steam Flood	4,300,000 - 7,600,000

LOCATION OF RESOURCE HOLDINGS

- Electro-Petroleum conducts research at facilities in Coleraine, MN in conjunction with the Natural Resource Research Institute of the University of Minnesota.
- Additional research was conducted in Canada with the assistance of a major Canadian oil company.
- A field demonstration of the technology is proposed to be conducted in California in a field partially owned by the firm’s founder and lead technologist, Mr. Christy Bell.

PROJECT STATUS / STATE OF DEVELOPMENT

The technology has been demonstrated to achieve improved production and reduced costs in applications at lab scale and in small field trial demonstrations. The developers are currently evaluating new venues and new field protocols for application of the technology.

RELEVANT EXPERIENCE

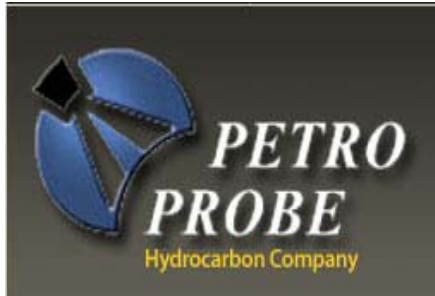
The company has been conducting research and field applying direct current for heavy oil recovery and oil shale pyrolysis since 1973. Electro-Petroleum’s newest patented technology builds on basic research conducted by General Electric prior to the acquisition of the research and technology by Electro-Petroleum.

OUTLOOK / FUTURE PLANS

Electro-Petroleum is seeking funding for a field demonstration of the technology to be conducted in a California heavy oil reservoir. As part of this RD&D effort, the technology would be extended to examine the potential for in-situ de-sulfurization and production of hydrogen as a process by-product. Electro-Petroleum intends to partner with resource developers, service companies and others entities to expand application of the technology to commercial scale in appropriate venues and settings.

REFERENCE

Wittle, J.K. and Hill, D.G. World Heavy Oil Conference, Beijing China 2006, Paper 2006-409.



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COMPANY DESCRIPTION

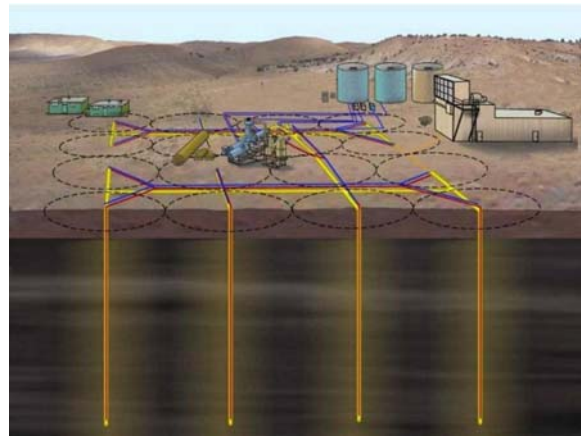
Petro Probe, Inc. – a subsidiary of Earth Search Sciences, Inc. – is an emerging technology company that focuses on the use of cost-effective and environmentally-responsible technology to search for and produce hydrocarbon products.

OIL SHALE INDUSTRY ROLE

Earth Search Sciences and Petro Probe are engaged in technology and project development to produce oil and gas liquids from domestic oil shale resources.

DESCRIPTION OF TECHNOLOGY

Petro Probe has licensed a new processing system with great potential for recovering oil from oil shale deposits. Air is superheated in a burner on the surface, its oxygen content carefully controlled. As superheated air travels down a borehole, it interacts with the oil shale and brings hydrocarbons to the surface in the form of hot gases. The gases are then condensed to yield light hydrocarbon liquids and gases. The process achieves a controlled and relatively quick production of product.



- No mining is involved in the technology. The process begins by drilling into the body of oil shale and locating a processing inlet conduit within the hole. An effluent conduit is anchored around the opening of the hole at the ground surface. Pressurized air is introduced to an above-ground combustor, superheated and directed underground into the oil shale through the inlet conduit to heat the rock and convert the kerogen to a gaseous state.
- Radiant heat in the inlet conduit produces a non-burning thermal energy front of predictable radius in the oil shale surrounding the hole. High temperatures and correct pressures cause the porous marlstone to gasify and allow its gaseous hydrocarbon products to be withdrawn as an effluent gas.
- Four products result: Hydrogen; 45 gravity condensate; 1000 BTU methane gas, and water.
- This is a self-sustaining system: effluent gas is transferred to a condenser where it is allowed to expand and cool; the gaseous fraction is separated from the liquid fraction and scrubbed to provide an upgraded synthesis gas; a portion of this gas is recycled and combined with other recycled feed stocks to create continuous fueling within the combustor – resulting in a significant product cost savings.
- The process is environmentally sensitive: Produced CO₂ produced is compressed, then pumped back into the oil shale body where it remains. Earth Search Sciences' patented remote sensing technology is used to establish a baseline before the project starts. Thereafter, continual monitoring during testing and production provides early-warning of problems, allowing them to be fixed quickly.

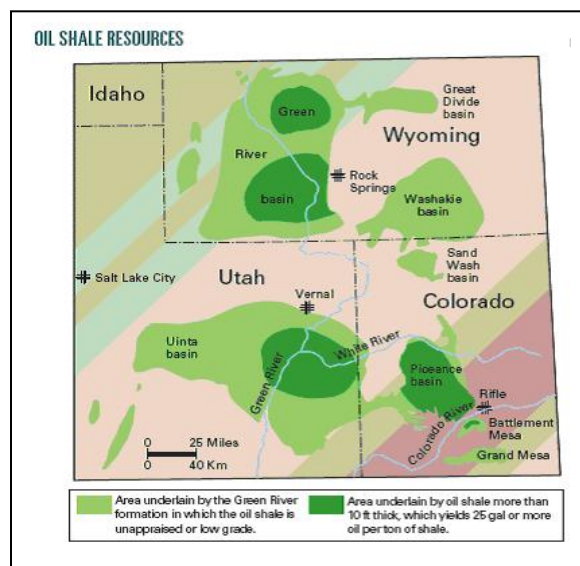
Oil Shale and Tar Sands Industry Profiles

- The in-situ process can gasify and recover products from oil shale deposits as deep as 3,000-plus feet. The formation retains 94 to 99% of its original structural integrity once the kerogen has been gasified.

The surface plant's portable design allows it to be dismantled and moved to the next site. All surface structures are modularly designed and self leveling, easily moved from one location to another – without leaving permanent scars on the landscape. Each complete plant will cover approximately one acre of land and produce products for 10 to 20 years before depletion occurs.

LOCATION OF RESOURCE HOLDINGS

- Earth Search used remote sensing technology to identify an ideal test site and promising production site with infrastructure already in place on the Ute Reservation. A gas pipeline runs in front of the site to Salt Lake City. The site Earth Search has engineered is on the Naval Oil Shale Reserve.
- Petro Probe is focused on obtaining oil shale mineral rights in Wyoming, Utah, and Colorado. Opportunities have been identified in Vernal, UT Rock Springs, WY and; Rifle, CO.



PROJECT STATUS

Earth Search Sciences is currently negotiating to acquire General Synfuels International, Inc. – a private company that holds the patent – assigned to GSI in 2006 – to recover the oil and gas carried within oil shale. Petro Probe has been examining the process through a license and has completed due diligence to indicate the value of the process may exceed all expectations.

RELEVANT EXPERIENCE

Earth Search Sciences is an emerging growth company with more than ten years of research and development invested in bringing breakthrough remote sensing technology to the commercial marketplace. The company started out developing new technologies for resource exploration and development. Since 1994, Earth Search has teamed with major aerospace and technology firms, along with EPA, Bureau of Reclamation, Bureau of Land Management, and U.S. Forest Service. The company's cutting-edge airborne hyperspectral remote sensing technology accurately reads the detailed chemical properties of the Earth's surface from great altitudes, producing easily-interpreted maps.

While remote sensing does not replace the need for geological knowledge, geochemistry, geophysics, and seismic drilling, it does identify more exploration targets faster and improve the probability of finding anomalies that may indicate valuable resources. Conventional exploration methods take decades longer and cost more to cover the same ground. Earth Search Sciences' clients and partners are strengthened by the competitive advantage of the technology.

OUTLOOK / FUTURE PLANS

Three areas of proven oil shale deposits have been chosen as the sites for proof-of-concept plants to be built in three stages: the first stage will prove the patented procedure using custom-designed equipment; the second stage will prove the economics of recovering multiple products from in situ oil shale; the third stage will test the capacity and operation of a complete plant. Approximately \$30 million is budgeted for the three stages. CH2M Hill will be the professional engineering firm of record during the testing and commercial stages.

ExxonMobil

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COMPANY DESCRIPTION

Exxon Mobil Corporation (ExxonMobil) is a major integrated energy company active in all aspects of oil and gas development. Based in Texas, it has operations all over the world.

OIL SHALE INDUSTRY ROLE

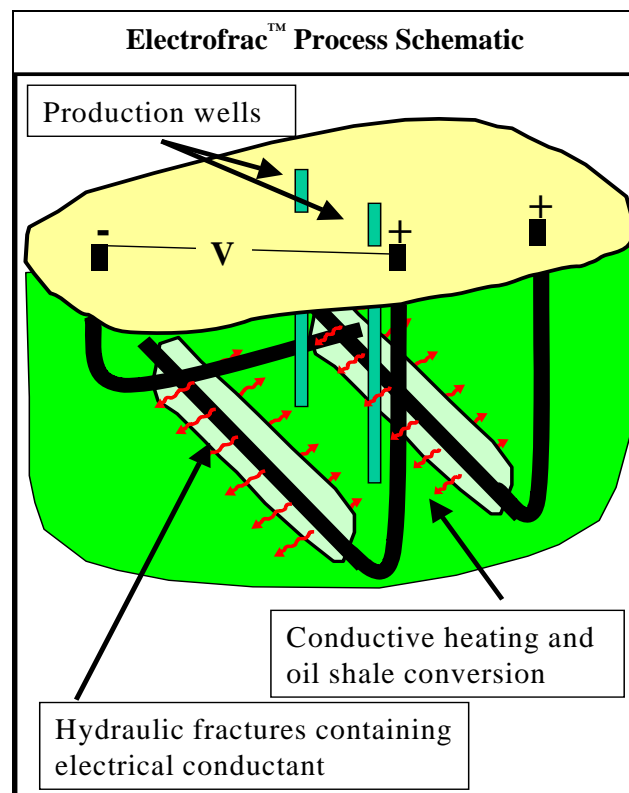
ExxonMobil has been engaged since the 1960s in the oil shale industry as a resource owner, technology developer, and project developer. ExxonMobil is currently focused on the field testing and development of in situ technologies to produce oil from oil shale. The company continues to evaluate advanced ex situ mining and retorting processes, seeking a paradigm shift to reduce costs that could make commercial production feasible.

DESCRIPTION OF TECHNOLOGY

While ExxonMobil is pursuing multiple ideas for commercializing oil shale, its leading candidate technology is the Electrofrac™ process for in situ oil shale conversion to producible oil and gas. As shown in the schematic, the method heats oil shale in situ by hydraulically fracturing the oil shale and filling the fracture with an electrically conductive material, forming a heating element.

Electrofrac is depicted here in what we expect to be a preferred geometry, using longitudinal vertical fractures created from horizontal wells and conducting electricity from the heel to the toe of each heating well. Other geometries are feasible, and the process may be applied with either vertical or horizontal fractures.

The use of fracturing was motivated by early ExxonMobil screening of over thirty candidate technologies, which concluded that linear heat conduction from planar heat sources is likely to be the most effective method for “reaching into” organic-rich rock to convert it to oil and gas. Planar heaters such as these should require fewer wells than wellbore heaters and offer a reduced surface footprint.



TYPE / LOCATION OF RESOURCE HOLDINGS

ExxonMobil owns fee lands in the Piceance Basin in Rio Blanco and Garfield counties in Colorado, covering an area > 50,000 acres. These were acquired primarily for development by mining and retorting.

PROJECT STATUS / STATE OF DEVELOPMENT

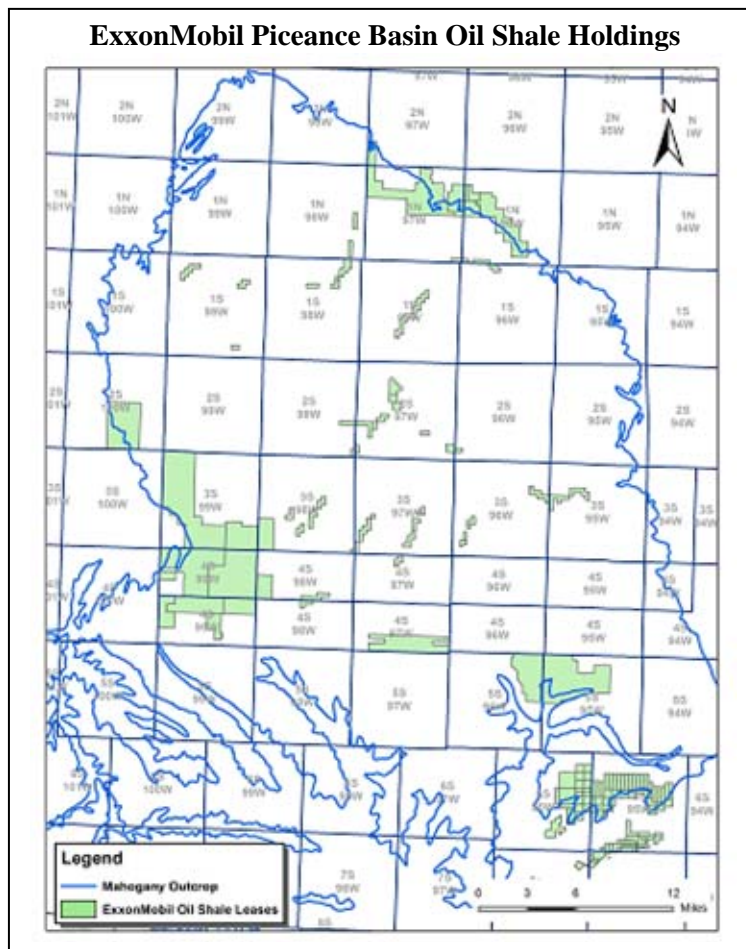
ExxonMobil has conducted extensive laboratory research on Electrofrac including small-scale experiments, numerical modeling, and resource description work addressing critical technical issues. Results to date have been encouraging. Plans are being developed for field experiments designed to test Electrofrac process elements on a larger scale. Multiple field sites are under consideration, including ExxonMobil's Colony oil shale property in Parachute, Colorado.

RELEVANT EXPERIENCE

ExxonMobil has extensive experience in oil shale technology and project development. It was an active participant in oil shale development efforts in western Colorado in the late 1970s and early 1980s. Since the 1990s, ExxonMobil Upstream Research Company has investigated over 30 different technologies to extract oil from oil shale. In addition to oil shale experience, ExxonMobil has extensive experience in developing other frontier resources, including heavy oil and tight gas. In the Piceance Basin, ExxonMobil has demonstrated best-in-basin tight gas completion technologies to optimize tight gas recoveries.

OUTLOOK / FUTURE PLANS

ExxonMobil plans to continue research, development, and demonstration efforts on the Electrofrac™ process, to determine its technical and economic feasibility for commercial scale application. We are interested in research and commercial leases that would provide access to high grade oil shale resources best suited to in situ development.



Dr. Brent C. Fryer

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COMPANY DESCRIPTION

Dr. Brent C. Fryer is a self-financed entrepreneur and developer of the Black Box Pyrolysis Processes - I & II. He is in the process of developing a joint venture in which to apply these two processes.

OIL SHALE INDUSTRY ROLE

Dr. Brent C. Fryer is engaged in the oil shale industry as a technology and project developer. He currently owns no private oil shale mineral rights, nor state or Federal leases. His application for a BLM RD&D Program lease was rejected. A BLM commercial lease will be sought when available.

DESCRIPTION OF TECHNOLOGY

Dr. Fryer has two proprietary oil shale oil/gas extraction processes under development.

Black Box Pyrolysis Process-I is a surface process requiring the mining of raw oil shale and the disposal or development of beneficial utilization of the de-charred spent shale. The process meets critical acceptance criteria.

- It recovers 100% Fischer Assay quantities of raw shale oil and TOSCO Assay raw shale gas. The raw shale oil will be fractionated within the process.
- Other than startup, the process is energy self sufficient requiring no external energy source input. All pyrolysis process heat is provided from oxidation of residual char and regenerative heat recovery of stored energy contained within the spent shale. In addition the process will produce surplus thermal energy for steam production to meet hydrotreating and raw gas separations/clean up processing needs in terms of either process heat, mechanical power for pumps/compressors, or surplus electricity. After startup, there is no other energy input to the Black Box Pyrolysis-I process other than the kerogen in the oil shale. Energy efficiency (output/input) and quality of energy out are very high.
- Process-I is inherently simple, with low capital costs, and no moving parts. With the exception of feeding raw shale and removing spent shale and product oil/gas it requires no operators or operating costs. No water is consumed in the process; however, raw shale connate water will be recovered together with the raw shale oil and raw shale gas. This water will require treatment, and may be used in down stream processing or spent shale disposal, reclamation, and remediation.
- A complete engineering and cost mathematical computer model has been developed for the process including all transport phenomena and kinetics.
- Potential Price/Cost uncertainties: (1) market price of energy, particularly crude oil/natural gas; (2) the true costs of mining, spent shale disposal, and reclamation; and (3) the true costs of downstream processing of raw shale oil and raw shale gas including hydrotreating of the raw oil to remove nitrogen, sulfur, and oxygen, heavy metal removal, and processing and separating the gases including removal of hydrogen sulfide to produce refinery acceptable syncrude and pipeline quality gas.

Black Box Pyrolysis-II is less developed. It is an in-situ process with some limited surface disturbance, but requiring no mining. In this process, de-charred spent shale will be left underground, its ability to contaminate any underground water will be far less than spent shale with large amounts of residual char, but even then the potential for ground water contamination must be thoroughly evaluated.

Oil Shale and Tar Sands Industry Profiles

- This process employs the same mathematical modeling, with modifications for underground characterization, as Process-I. It is capable of the same high energy efficiency and energy self sufficiency (except for startup) and recovers 100% Fischer Assay of raw shale oil and TOSCO Assay raw gas.
- Minimum surface disturbance, as compared to other in-situ schemes, will be obtainable. Spent shale will be totally de-charred minimizing ground water contamination. No testing of this concept has been conducted.
- It is not clear at this time if the required underground rubblization can be attained and the required sealing within the processing zone can be achieved with current technology. In addition the potential for underground water contamination by the resultant de-charred shale must be thoroughly evaluated.

TYPE / LOCATION OF RESOURCE HOLDINGS

Dr. Fryer currently owns no private oil shale mineral rights, nor does he own leases to oil shale mineral rights on State or Federal (BLM) land. Several hundred tons of oil shale has recently been provided by the BLM from material previously moved from the Prototype U-A White River Mine stockpile. This is currently being combined/partitioned with shale from other developers in a cooperative effort for test purposes. Dr. Fryer may also avail himself of mined shale to be made available by OSEC under the terms of its BLM lease to operate the White River Mine.

PROJECT STATUS / STATE OF DEVELOPMENT

- All aspects of the Black Box Pyrolysis –I technological concept can be demonstrated. Dr. Fryer has field tested a first of a kind two ton/day unit and produced 2 barrels of raw shale oil.
- No testing has been conducted on the Black Box Pyrolysis II technology. It is not yet clear if the required underground rubblization can be attained and the required sealing within the processing zone can be achieved with current technology.

RELEVANT EXPERIENCE

Dr. Fryer is a Mechanical Engineer with almost 50 years of experience in energy/process industries. He has worked on most energy conversion processes including mathematical modeling, testing, design, fabrication, construction and management, economic optimization, and environmental compliance. He was lead mechanical engineer for Exxon USA's \$6 billion Colony Project on the TOSCO pyrolysis unit.

OUTLOOK / FUTURE PLANS

Further tests with the more refined and optimized Process-I design and operating conditions are planned. The unit is currently undergoing fabrication and instrumentation. The objective of this round of tests is to obtain engineering performance data for comparison to the mathematical model. Process-II is much further behind in development. Mathematical modeling to determine the required rubblization and the geometry of the underground processing zone and its dynamics will be the first step. Discussions will be held with organizations with underground rubblization expertise to explore business possibilities.



Global Resource Corporation

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COMPANY DESCRIPTION

Global Resource Corporation is a worldwide petroleum research, engineering and development company that is responsible for bringing innovative and new technologies to the petrochemical industry. The company offers proprietary solutions for secondary and tertiary crude oil recovery processes as well as oil shale, resid oil, tar sands, drill cuttings and mud. Based in New Jersey, it operates globally.

INDUSTRY ROLE

GRC's role in unconventional fuel development is that of a technology developer as well as a manufacturer of the equipment necessary to extract such fuels. The firm's technologies could be licensed by end-users to pyrolyze oil shale in order to create fuel feed stocks, or to crack bitumen in tar sands or resid oil to enable separation, production and upgrading to synthetic crude oil. GRC has removed all but .01% of the hydrocarbons from drill cuttings.

DESCRIPTION OF TECHNOLOGY

Global Resource Corporation has a patent pending process that allows for removal of oil and alternative petroleum products from various resources including shale deposits, tar sands and waste oil streams with significantly greater yields and lower costs than are currently available utilizing existing technologies. The process uses specific frequencies of microwave radiation to extract oils and alternative petroleum products from secondary raw materials, and is expected to dramatically reduce the cost for oil and gas recovery from a variety of unconventional hydrocarbon resources.

GBR's technology will not only be developed to extract oil from shale, but from depleted oil fields in the U.S. and elsewhere. Many of these fields still contain more than half of their original hydrocarbons because the residual oil is too viscous to extract with conventional technology.

The GRC gasification process uses highly efficient and economical RF energy with a specific microwave frequency along with a vacuum environment to extract hydrocarbons from their original and natural source and crack it into fuels without environmental issues.

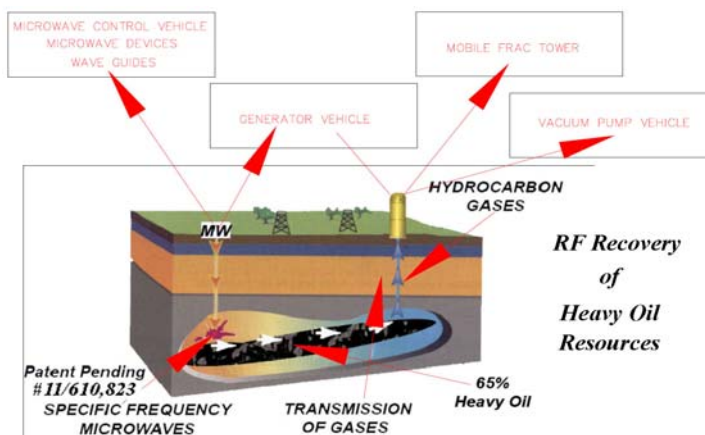
- The vacuum creates uniform gasification.
- The process is dry - It requires neither water, nor any type of liquid injections.
- GRC has patents pending for a wide range of frequencies. According to GRC, all current patented microwave solutions use a single common frequency (2.45 GHz). The GRC process offers Software Controlled Frequencies that are adaptable to the energy source target.



Oil Shale and Tar Sands Industry Profiles

GCR's technologies for oil shale, resid oil, tar sands and bypassed oil have been tested at laboratory scale. Since November 2006, Global Resource Corporation has been running microwave tests on oil shale. After exposing the rock to the patent-pending microwave process, Global Resource collects the byproduct gases and heat exchanges them into oil and gases that do not convert back to liquids. The liquids range from C-14 to C-28 and up to 70% of the initial weight of the oil shale (depending on where the sample was mined) is gasified. The energy balance for this gasification is running at approximately \$30 per barrel and produces Fractionalized Petroleum Products as opposed to the bitumen that is normal to shale and tar sands after they are liberated from their raw material. Specifically with regard to oil shale, GRC's Gas Chromatograph shows they are producing finished products of diesel fuel and heating oil potentially eliminating additional refining.

For heavy oil and unswept mobile oil in conventional oil reservoirs, the GRC RF technology could be applied to gasify oil resources in-situ. The produced gases would be brought to the surface in conventional wells, condensed, and fractionalized on-site into diesel fuel, oil, and combustible gases. Oil wells may be drilled by several methods and multiple well configurations allow multiple points for directional microwave applications.



Coal liquids: Initial testing results have produced large quantities of Hydrogen and Methane gases without CO or CO₂ contaminants making GRC's process one of the first environmentally friendly coal gasification technologies available. The gases are produced within seconds when exposed to the patent pending process.

RESOURCE HOLDINGS

GRC does not currently own or lease hydrocarbon resources. It intends to develop and license its technologies for use by other industry participants.

STATE OF DEVELOPMENT

GRC's next phase is to manufacture a 10-ton per/hour system capable of producing combustible gases and petrochemical fluids.

RELEVANT EXPERIENCE

GBC's technologies were invented by Mr. Frank Pringle who began to identify specific microwave frequencies in 1996. Over the past ten years, Mr. Pringle has specified over 8700 RF microwave frequencies intrinsic to hydrocarbon elements/materials. These frequencies are protected by patent pending filings.

OUTLOOK / FUTURE PLANS

GRC is negotiating with several major companies to form joint ventures for commercializing this technology.



Imperial Petroleum Recovery Corporation

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COMPANY DESCRIPTION

Imperial Petroleum Recovery Corporation (IPRC) is a Dayton Texas based public company that has developed a unique patented Microwave Separation Technology (MST) for use in petroleum, renewable energy, maritime and environmental energy applications. Since their inception, the crude oil production and refining industries have been forced to deal with emulsions that inhibit throughput and cause a wide range of maintenance concerns as they pass through the plant. Eventually, these emulsions form waste sludge that tie-up valuable tank capacity and create costly tank cleaning and other environmental liabilities. MST is designed to address these problems by providing an effective and economic way to handle emulsions on a continuous basis before these liabilities are incurred.

OIL SHALE INDUSTRY ROLE

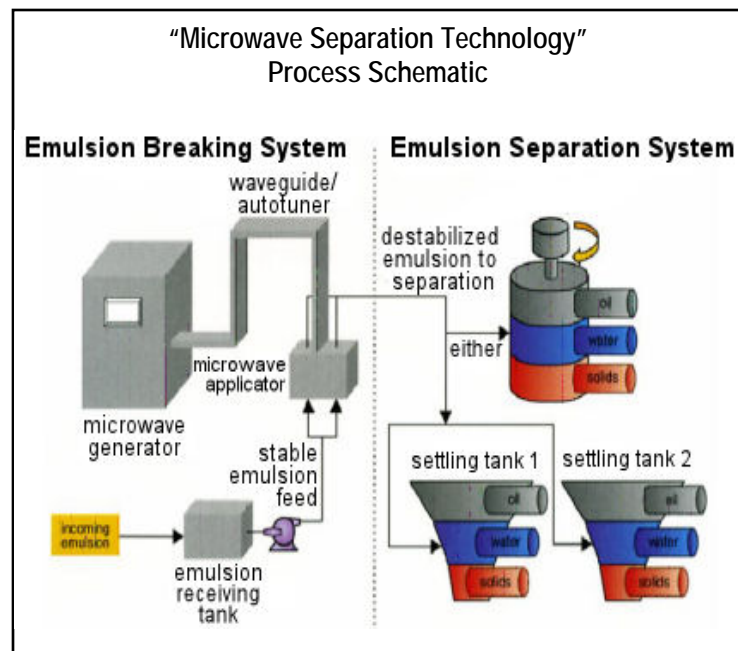
IPRC's goal is to become a leader in developing and marketing innovative commercial radio frequency energy applications for use within the petroleum and associated industries to treat emulsions containing oil, water, and solids. MST may be added to existing technology to enhance production processes.

The emerging oil shale industries have challenges similar to those in the crude production industry, compounded by additional water-intensive separations processes. IPRC would serve the oil shale industry as a service provider whereby MST would be utilized to optimize oil shale processing, wastewater treatment and tank farm separations. MST helps to eliminate bottlenecks, increase production, reduce energy requirements, and reduce waste generation, storage and treatment costs. As a technology developer, Imperial may devise other products that can enhance the oil shale industry in terms of effectiveness, efficiency, and environmentally sound practices.

DESCRIPTION OF TECHNOLOGY

The Company utilizes a proprietary, patented process using high-energy microwaves called Microwave Separation Technology ("MST") for efficiently breaking refinery, chemical plant and oil/gas production sludge.

- Industrial emulsions are stable, undesirable byproduct mixtures of oil, water and solids that occur in many industries and cause a broad range of operating inefficiencies that limit production capacities, increase operating costs and result



Oil Shale and Tar Sands Industry Profiles

in the production of environmental wastes.

- MST is a simple add-on system that will facilitate the continuous, automated separation of these emulsions into usable products that will result in reduced environmental wastes and increased production from existing plants. MST is particularly applicable to the crude oil, tar sand, oil shale, petrochemical, environmental, marine and biodiesel industries.
- MST increases the throughput capacity of equipment, reduces maintenance and environmental costs, and increases useful byproducts available for sale or other uses.
- MST is a simple and automated add-on system that exploits microwave energy to selectively destabilize the polar and charged molecules that cause most waste emulsions to form.

TYPE / LOCATION OF RESOURCE HOLDINGS

- Imperial is a technology developer working to market its product, the company does not have resource holdings.

PROJECT STATUS / STATE OF DEVELOPMENT

Imperial has a commercial scale 150 Bbl/D mobile unit that contains power generation, centrifuge separators, water cooling capability and a laboratory for emulsion analysis and available for self-contained field trials. A commercial MST installation for ExxonMobil at their production site in Chad is scheduled to be commissioned in the third quarter of 2007.

RELEVANT EXPERIENCE

Imperial treated heavy California crude oil for three years at ExxonMobil refinery in Torrance, CA without the use of chemicals and avoided chemical related liabilities. The technology eliminates the need to adjust chemical dosages as the emulsion composition varies by providing robust emulsion breaking on a wide range of emulsions. The MST System is a continuous, automated and unattended real-time operation which makes proactive low-cost emulsion breaking and instantaneous phase separation possible into water, solids and usable oil.

Imperial found the benefits of the MST project at Torrance to be impressive: The overall capacity of the crude complex increased from 135K bpd to 155 bpd with MST contributing to this increase in throughput; desalter stability increased and heavier crude streams were able to be processed. BS&W in the recovered oil was reduced to <2% resulting in increased preflash temperatures and decreased pressure in the crude unit. Significantly less water traffic was experienced in the atmospheric tower and its overhead system resulting in decreased pressure at the top of the tower leading to increased production and a reduction in operating costs. Users of MST can anticipate a reduction in corrosion, erosion and fouling in the crude complex and increased flexibility in the daily running of the units.

OUTLOOK / FUTURE PLANS

Imperial has proposed to DOE a four year, \$30 million grant program to deploy a total of 18 mobile units: 10 in refineries, 3 in oilfields, 3 in oil shale and 2 to oil/tar sands as an approach to achieve the benefits of MST within half of the nation's refineries to generate a significant increase in refinery throughput and help reduce the amount of imported refinery products from overseas. A refinery trial using a mobile MST unit on the Gulf Coast is scheduled to begin during the 3rd quarter of 2007. Interest has been generated for utilizing MST within the Marine industry to reduce the volumes of marine-generated bilge and tank/tanker heel wastes requiring offsite remediation. MST has been shown to be effective at increasing biodiesel plant capacities by converting from semi-batch to continuous operations and adding flexibility to handle low-cost feed stocks to improve the economics of providing domestic, renewable and environmentally friendly alternative fuels.



Independent Energy Partners UNCONVENTIONAL OIL RESOURCES AND TECHNOLOGY

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COMPANY DESCRIPTION

Based in Denver Colorado, Independent Energy Partners, Inc. (IEP) is pursuing the development of vast unconventional hydrocarbon resources, including oil shale resources already under its control, by applying patented breakthrough in-situ production technology. IEP owns the exclusive rights to a broad, patented Geothermic Fuel Cell™(GFC™) technology¹, that can dramatically lower the cost of oil and gas recovery from oil shale, coal, tar sands and heavy oil deposits, while producing electricity as a by product.

INDUSTRY ROLE

IEP is engaged in the oil shale industry as a resource owner, technology developer, and project developer. IEP is actively pursuing mineral interests in oil shale and coal deposits in Colorado, Utah and Wyoming, on which to employ its proprietary GFC technology to produce oil, other hydrocarbons, and electricity.

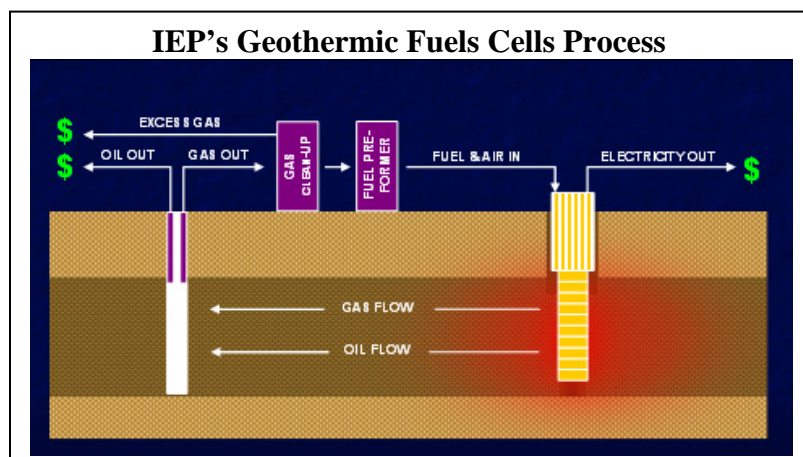
DESCRIPTION OF TECHNOLOGY: IN-SITU GEOTHERMIC HYDROCARBON RECOVERY

Geothermics—the application of heat to the ground - has a long history. Originated in Sweden during World War II to produce oil from oil shale, the use of Geothermics has since expanded to applications to remove toxic wastes and to produce fuels from heavy oil, tar sands, and other resources.

Heating: In the IEP concept, rather than a burner or electric heater, a high-temperature fuel cell stack is placed in the formation to heat the ground. As the ground is heated, hydrocarbon liquids and gases are released from the resource into collection wells. A portion of the gases are processed and returned to the fuel cell stack, with the rest available for sale. After an initial warm up period (during which the cells are fueled with an external source of natural gas), the process becomes self-fueling from gases liberated by its own waste heat. The system, in steady-state operation, produces oil, electricity and natural gases. The GFC is designed to produce a net energy ratio of approximately 18 units of energy produced per unit used, when primary recovery is combined with residual char gasification and resulting syntheses gas.

Uniform Heating: Geothermic fuel cells heat formations by solid-to-solid conduction more efficiently than non-conductive applications. GFCs produce heat at a uniform rate along its length and therefore heat the formation uniformly from top to bottom, leading to far greater yields and simplified production cycles

Fracturing: Raising the formation temperature increases fluid pressure in the heated zone by 100 to 200 psi over native pressure,



Oil Shale and Tar Sands Industry Profiles

which can be enough to fracture oil shale. Alternatively, the formation can be pre-fractured to enhance the hydrocarbon flow and communication between heating and producing wells.

Energy Efficiency: Unlike other conductive approaches, geothermic fuel cells do not consume vast amounts of energy — rather, they become self-fueling. Instead of consuming hundreds of kilowatt hours (Kwh) of electricity, geothermic fuel cells would yield approximately 174 Kwh per barrel recovered.

Economics: Thus, the operating costs of a GFC system are expected to be much lower than other heating approaches. Capital and operating costs are estimated at \$30 per barrel, decreasing to approximately \$14 per barrel when offset by revenues from the sale of produced gases and electricity.

Environmental Benefits: The environmental benefits of the in-situ, GFC closed-loop system are that:

- GFCs produce minimal air emissions. With no combustion – fuel cells produce electricity through an electrochemical reaction – there is negligible production of NO_x, SO₂, particulate or toxic emissions.
- GFCs are essentially self-sufficient in process water. They produce steam as an exhaust which is re-circulated through fuel pre-reformers, thus obviating most if not all needs for outside process water.
- GFCs produce minimal surface impact compared to mining and retorting operations that dispose of high quantities of waste “tailings” and dust. Since GFCs utilize a true “in-situ” approach, in which the ore body is left in place relatively undisturbed, waste disposal problems are eliminated

IEP’s GFC technology is expected to be well received by those who seek to balance the growing demand for energy with environmentally friendly processes.

TYPE / LOCATION OF RESOURCE HOLDINGS

On August 31, 2005, IEP entered into an agreement with private land owners to secure the exclusive right to produce energy from oil shale on property located in Rio Blanco County near the richest part of the Piceance Creek Basin. The property holds an estimated 1.374 to 1.63 billion barrels of oil.

PROJECT STATUS / STATE OF DEVELOPMENT

IEP’s technology is patented in the United States and patents have been applied for in Canada. IEP has concluded negotiations with Battelle; operator of the DOE’s Pacific Northwest National Laboratory for prototype development of IEP’s patented Geothermic Fuel Cell™. The work will include modeling to optimize GFC™ efficiencies and establish design parameters, culminating in the development and demonstration of a working GFC™ prototype ready for “in situ” oil shale and other applications.

RELEVANT EXPERIENCE

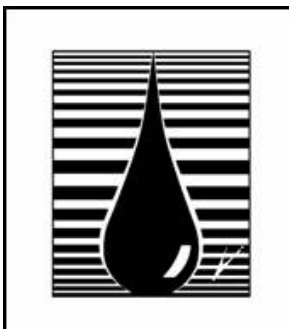
IEP’s management team has broad entrepreneurial, technology, and project development experience in the energy industry. Chairman and CEO, Alan K. Forbes, has launched and grown energy ventures that include advanced power generation systems and control systems. He has held management positions with leading engineering firms, and has led major energy projects. Marshall T. Savage, Vice President is the inventor of Geothermic Fuel Cell. He has technology development responsibility, including ongoing patent applications, design refinement, and prototype development. IEP is also working with industry partners who are leaders in their respective fields.

OUTLOOK / FUTURE PLANS

IEP’s development plan estimates prototype development and testing of the GFCs for commercialization to be achieved within 24-30 months.

REFERENCES

1 (US Patent Nos. 6,684,948 B1-Apparatus and Method For Heating Subterranean Formations Using Fuel Cells and 7,182,132 B2-Linearly Scalable Geothermic Fuel Cells)



J. W. Bunger and Associates, Inc.

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COMPANY DESCRIPTION

J.W. Bunger and Associates, Inc. (JWBA) provides technology, engineering, products and services to the petroleum, chemical and environmental industries. The Company specializes in unconventional resources; oil shale, tar sands and coal. The Company's software for analysis and digital description of molecular composition of hydrocarbon mixtures has afforded it a niche market in process optimization and product development. Dr. Bunger and his staff (and students, while at the University of Utah) have designed, constructed and operated more than a dozen process development units for recovery, extraction and upgrading of products from unconventional resources.

OIL SHALE INDUSTRY ROLE

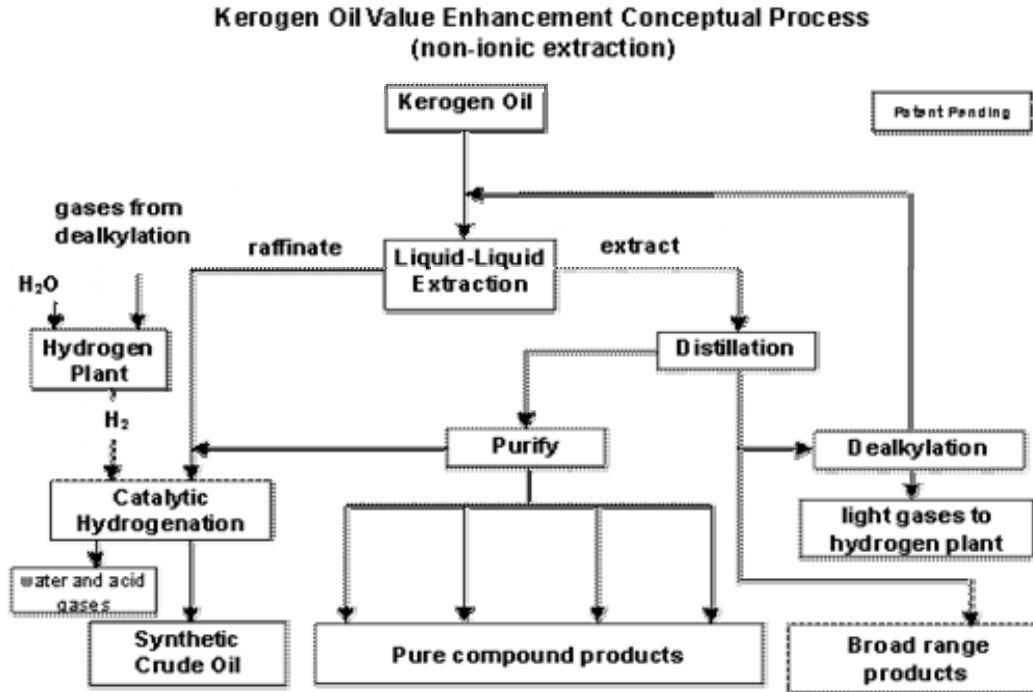
JWBA has developed technology concepts for upgrading of shale oil to fuels, commodity products and specialty chemicals. The concepts have been proven at the semicontinuous and batch process levels. The Company principals have been active in oil shale and tar sand development for more than 35 years and serve as consultants in this field to both Government and industry. The Company holds patents and other intellectual property that it is actively marketing for project development. The Company is a holder of State of Utah oil shale leases.

DESCRIPTION OF TECHNOLOGY

Value Enhancement Processing: The essential feature of the company's Value-Enhancement Processing technology is the highly selective extraction of raw shale oil into a heteroatom-rich extract and a heteroatom-lean raffinate. This step upgrades both sides of the separation for subsequent processing.

- The extract is refined for commodity products and specialty chemicals; non-marketable products from this refining operation are sent to the raffinate upgrading unit.
- Raffinate, plus miscellaneous streams from the extract refining, are catalytically hydrotreated to obtain a premium refinery feedstock. By first extracting the majority of heteroatoms, the hydrotreating step is relatively easy and inexpensive.
- The key to project viability is produce a few, marketable products. As the technology matures, additional products may be developed from the heteroatom rich shale oil.

Z-BaSIC™: Supporting its process and product development activities, the Company has developed a proprietary Z-BaSIC™ methodology for digitizing molecular composition and estimating properties.



TYPE / LOCATION OF RESOURCE HOLDINGS

The Company believes that mining and surface processing will provide the highest yield and afford the lowest economic and environmental risk for recovery of oil from oil shale. The Company has pursued leases that are amendable to surface mining.

PROJECT STATUS / STATE OF DEVELOPMENT

- The Company is currently collaborating with Great Western Energy, LLC and Red Leaf Resources, Inc. in their oil shale development efforts.
- The Value-Enhancement Process technology is at the stage where pilot plant verification of product yields and specifications is required.
- The Z-BaSIC™ methodology is functional and available to support these developments.

Examples of Hydrotreated Raffinate and Light Extract from Value Enhancement Process



OUTLOOK / FUTURE PLANS

JWBA expects to continue research, development, and demonstration efforts on its VEP technology and to utilize its molecular-level analytical technology to optimize a project based on mining and surface recovery.

The Company expects to look to other developers for the production of the raw shale oil, and to develop and deploy processes for upgrading raw shale oil to high-value products.

James Q. Maguire, Inc.

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COMPANY DESCRIPTION

James Q. Maguire, Inc. is a small independent oil and gas development company located in Norman, Oklahoma. It is primarily engaged in oil and gas production and in drilling operations.

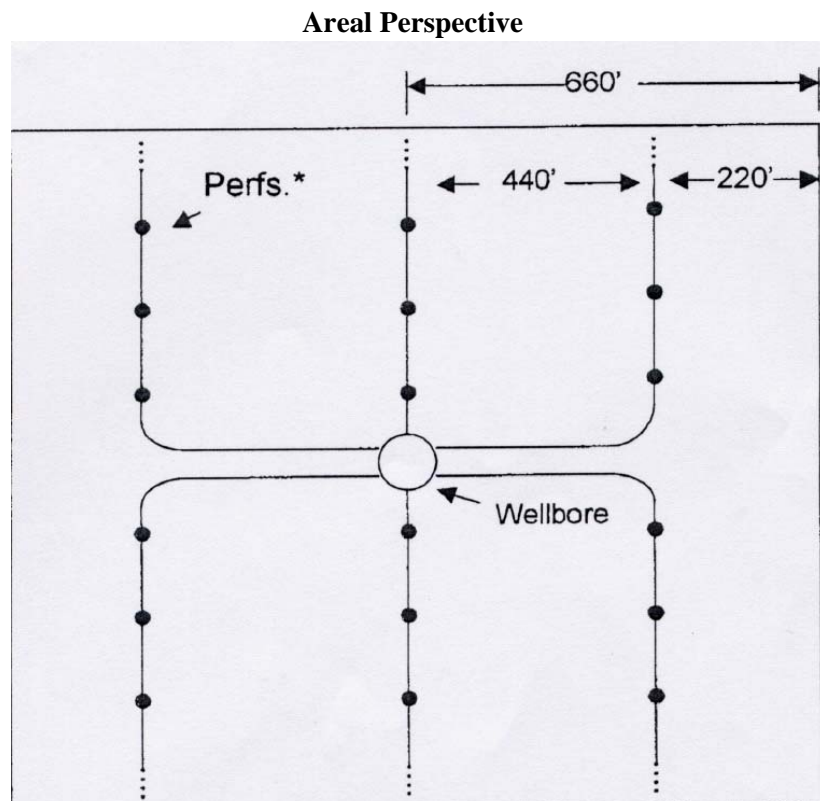
OIL SHALE INDUSTRY ROLE

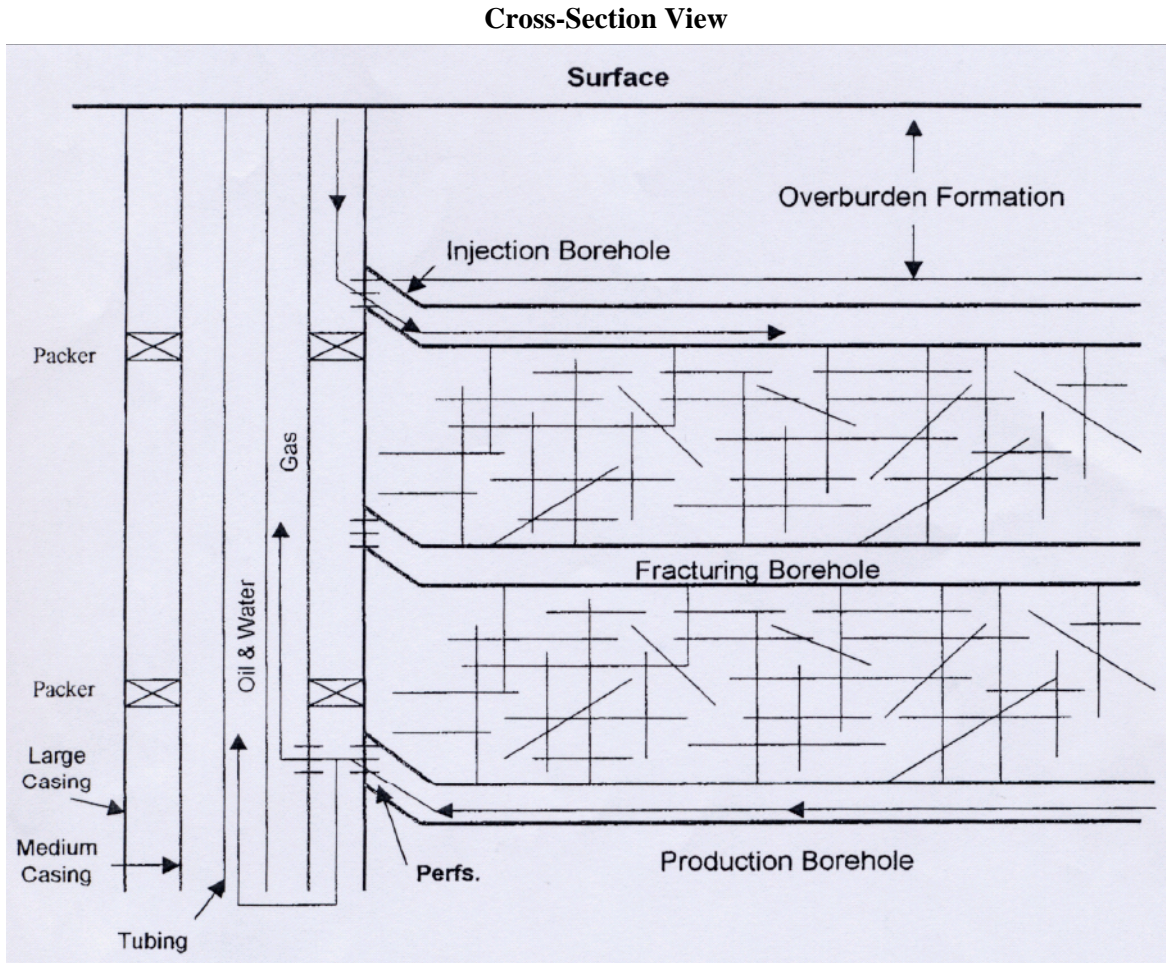
James Q. Maguire Inc. is involved in the oil shale industry as a technology developer with a patent pending. He has a patent pending operation which he believes is superior to any described in-situ method to date and which he believes will be a “showstopper” solution to a successful and economical oil shale in-situ production operation. He owns no shale oil acreage, but is looking for financial participants to develop his patent pending method.

DESCRIPTION OF TECHNOLOGY

Maguire’s patent pending in-situ process for the production of shale oil:

- Involves drilling a “motherbore” vertical well bore and from it six horizontal fracturing boreholes and six injection boreholes above the fracturing boreholes and six production boreholes below.
- The crux of the “Maguire Process” is a fracturing method which will end up creating a “spider web” fracture system so that a very large area is created to apply heat to the oil shale reservoir.
- This fracturing process consists of injecting very large amount of liquid nitrogen at very high rates into the horizontal fracturing boreholes.
- If its volume is confirmed, liquid nitrogen will build up to pressures in excess of 12,000 psi. In fracturing, the volumes will expand but if the volume of injected liquid nitrogen and the very fast injection rate exceeds the volume of propagating fractures, then pressures two to three times the propagation fracture pressure will result in perpendicular fractures which in turn will have perpendicular fractures so that a “spider web” fracture system is created.







Millennium Synfuels, LLC

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COMPANY DESCRIPTION

Millennium Synfuels, LLC, was established in the fourth quarter of 2006 resulting from a joint venture of Ambre Energy Pty Ltd (an Australian mining and alternate fuel enterprise) and Oil-Tech (a Utah oil shale technology corporation). Ambre Energy is the majority owner of the enterprise. Millennium is a Delaware company with offices in Salt Lake City, UT and Brisbane, Australia. Millennium intends to incorporate Oil-Tech's patented retorting technology, along with proprietary technology and funding from Ambre Energy, to establish an alternate fuel production operation over the next 3 years. Oil-Tech has contributed its patented retort technology, pilot plant and 34,000 acres of oil shale leases in Utah to Millennium Synfuels. Millennium Synfuels is charged with commercializing the Oil-Tech retort technology from this point forward.

OIL SHALE INDUSTRY ROLE

Millennium Synfuels is currently a technology developer and lease owner. The company intends to expand its scope to include production of alternative fuels from coal and oil shale over the next three years.

DESCRIPTION OF TECHNOLOGY

Millennium has incorporated the patented Oil-Tech vertical surface retort technology into its methodologies for converting oil shale, coal, and lignite into liquid fuels and other commercial byproducts. The enterprise has a demonstration facility near Vernal, Utah. When used for oil shale:

- After shale rock has been mined, the rock is then crushed to the appropriate size distribution. This crushed rock is then lifted via a conveyor to a bin at the top of an 80 foot structure which feeds the heating column, or "retort". As the shale rock passes down the retort, it is anaerobically heated until the hydrocarbon vapors contained within the rock are released. These vapors are then vacuumed into a condensing unit, producing raw shale oil.
- One ton of shale rock will typically produce between 30 and 60 gallons of shale oil, depending on resource quality.



Oil Shale and Tar Sands Industry Profiles

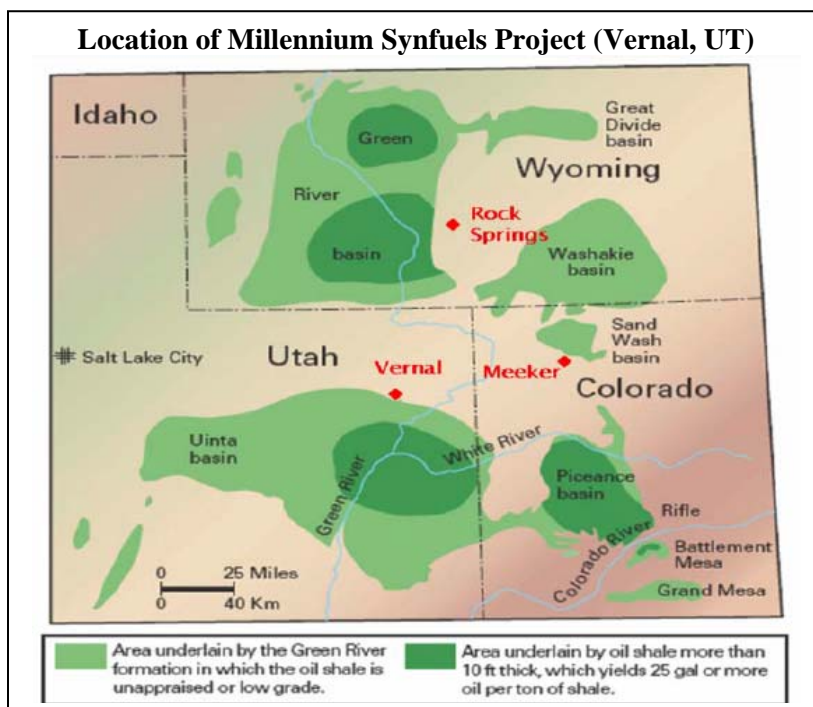
- The shale oil is typically subjected to further processing providing a refinery feedstock as well as useful byproducts such as pyridines. Pyridines are basic, nitrogen containing heterocyclic aromatic compounds, with many uses and markets, including use as asphalt strengthening additives. The produced pyridines represent about two percent of the volume of shale oil produced.
- The refinery feedstock has been shown to be low in sulfur content and is thus viewed as “sweet” or “light”.
- The resulting spent shale has sufficient heating value to be used as an energy source for pre-heating new shale rock entering the retort. Alternatively, the residual carbon content of the spent shale may be combusted to produce energy for other purposes.
- Finally, after condensation of the shale oil from the vapor stream, the non-condensable hydrocarbon values are scrubbed ready to be feed back into the retorting process, or to be exported as a high calorific value gas.
- The spent shale has potential market value in various areas as building materials, industrial spill absorbents and for land fill. Such potential has not yet been fully investigated.
- When applied to low quality coals and lignite, Ambre’s Hybrid Energy Process, which incorporates the oil tech retort technology, produces a clean burning char that results in lower emissions than combusting coal directly, and provides a liquid hydrocarbon stream with applications as a chemical and refinery feedstock. The process also produces surplus co-generated electricity that can be sold into the power grid.

LOCATION OF RESOURCE HOLDINGS

- Millennium controls approximately 34,000 acres of oil shale leases in Utah.
- The company also owns or has access to lignite and other coal resources in the U.S. and Australia.

PROJECT STATUS / STATE OF DEVELOPMENT

The Vernal retort is currently undergoing modifications for pilot-plant scale testing of lignites sourced from the United States and Australia. The pilot-plant testing is expected to be completed by late September, 2007. Site selection for a 3 million tons per year demonstration plant will precede a feasibility study due to be completed by March 2008. The enterprise plans to commission the demonstration plant by the summer of 2009.



RELEVANT EXPERIENCE

Millennium Synfuels LLC builds on the wealth of technical expertise and field experience resulting from the prior efforts of its founders.



Mountain West Energy

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COMPANY DESCRIPTION

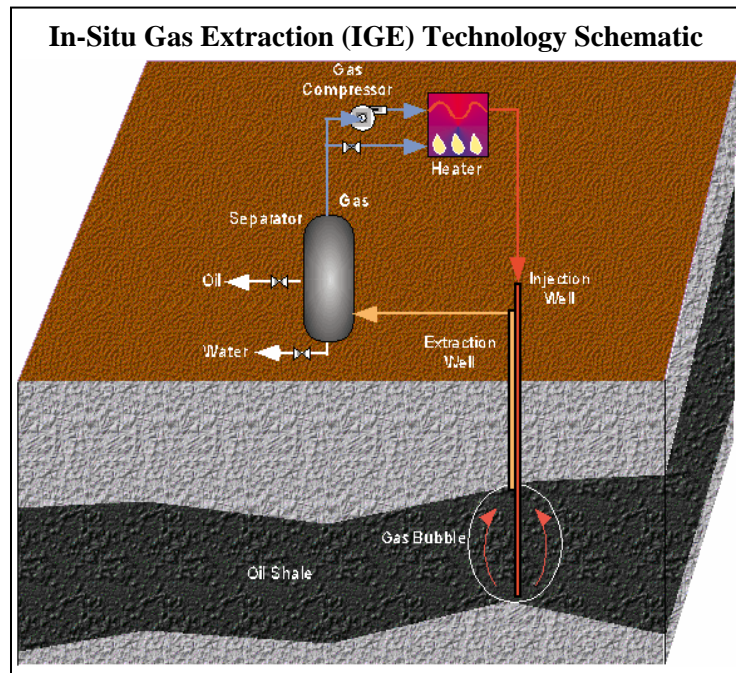
Mountain West Energy (MWE) is developing in-situ gas extraction technology (IGE), a low-cost, scalable, fast, low-impact oil extraction process to produce oil from shale. In addition, IGE produces oil equivalent to synthetic crude oil (SCO) produced from oil sands, without post extraction upgrading. MWE has demonstrated IGE in the laboratory and is ready to deploy the technology in the field.

OIL SHALE INDUSTRY ROLE

MWE is focused on developing the vast oil shale resources of the Green River formation in Utah, Colorado, and Wyoming through technology development, exploration, and operation. MWE in collaboration with industry partners through technology licensing agreements is working to achieve over 1 million barrel per day production from oil shale by 2020.

DESCRIPTION OF TECHNOLOGY

- MWE's IGE process uses high temperature gas injected into the target oil shale layer to heat the oil shale to the decomposition temperature by convection.
- The gas sweeps the oil vapors to the surface where the oil is condensed and separated. The gas is then re-circulated.
- IGE takes advantage of single-phase gas flow, reducing the problems associated with the flow of viscous, liquid oil through the formation.
- The high pressure gas bubble formed within the oil shale layer reduces groundwater flow into the extraction zone.
- IGE uses a single, vertically oriented well, which reduces costs, improves profitability, and minimizes environmental impact.
- In addition, MWE's IGE process can be used for enhanced oil recovery (EOR) from conventional reservoirs, potentially doubling the amount of extractable oil. MWE is working with the Department

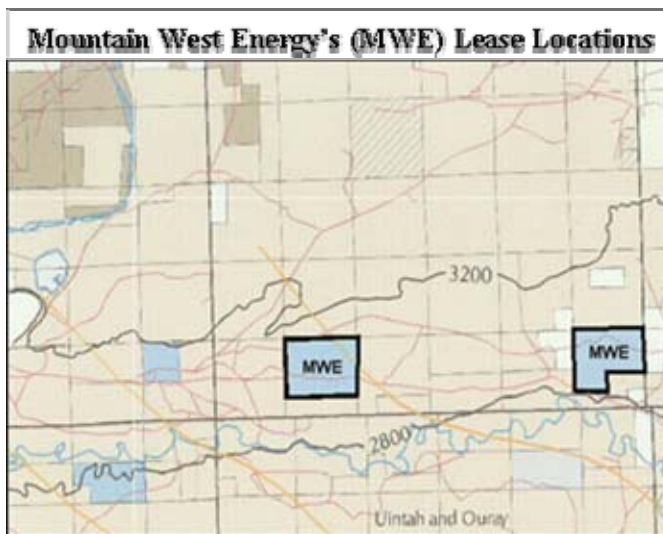


Oil Shale and Tar Sands Industry Profiles

of Energy's Office of Fossil Energy, Rocky Mountain Oilfield Testing Center, to demonstrate IGE for EOR in the field.

TYPE / LOCATION OF RESOURCE HOLDINGS

- MWE has obtained oil shale leases on 880 acres of Utah Trust lands in the Uintah Basin, Uintah County, Utah.
- The target Mahogany zone oil shale layer on its leases is approximately 2800 feet below the surface and approximately 110 feet thick, averaging 22 gallons per ton.
- Each IGE well covers approximately 0.75 acres and should produce over 60,000 barrels of oil over one year.
- IGE is capable of cost effectively extracting oil from oil shale at any depth greater than 500 feet and thicker than 25 feet, which makes oil extraction technically and economically feasible over most of the Green River formation.



PROJECT STATUS / STATE OF DEVELOPMENT

To date, MWE's IGE technology has been tested on a bench-scale system in the company's laboratory, with positive results. MWE is working with the Petroleum Research Center at the University of Utah to simulate IGE on a computer model of an oil shale reservoir. It is also in the process of implementing IGE for EOR in the field on the Shannon formation of the Teapot Dome oil field, which is part of the Naval Petroleum Reserve #3 (NPR-3). MWE is working to obtain an exploratory permit to drill a pilot well on its oil shale leases in Utah.

RELEVANT EXPERIENCE

MWE's team has extensive experience in project development. MWE has assembled professionals from heavy oil, financing, government relations, operations, and R&D to build a successful oil shale company. MWE is also collaborating with industry experts at the Petroleum Research Center at the University of Utah and the Rocky Mountain Oilfield Testing Center. In addition, MWE is willing to work cooperatively with larger oil companies in order to develop the vast, domestic oil shale resources of the U.S. MWE and its partners have the expertise and experience to be successful.

OUTLOOK / FUTURE PLANS

MWE will continue its efforts to research, develop, and demonstrate the IGE process. The company plans to demonstrate profitable oil extraction from oil shale within the next two years. MWE plans to produce commercial quantities of oil from oil shale (16,000+ barrels per day) by 2011.



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COMPANY DESCRIPTION

Natural Soda is currently engaged in solution mining sodium salts in the Piceance Creek Basin. The company's 9,543 acres of leased land contains not only sodium salts, but also significant Green River Formation oil shale deposits which are underlain by natural gas resources. The company also holds very senior water rights in the basin. Natural Soda has recently partnered with an international private equity group, Sentient, to develop the full scope of the company's resources and holdings.

OIL SHALE INDUSTRY ROLE

Natural Soda is engaged in the oil shale industry primarily as a resource owner and potential project developer. The company is seeking an appropriate technology and development partner to pursue effective development of the wide range of resources in its portfolio.

DESCRIPTION OF TECHNOLOGY

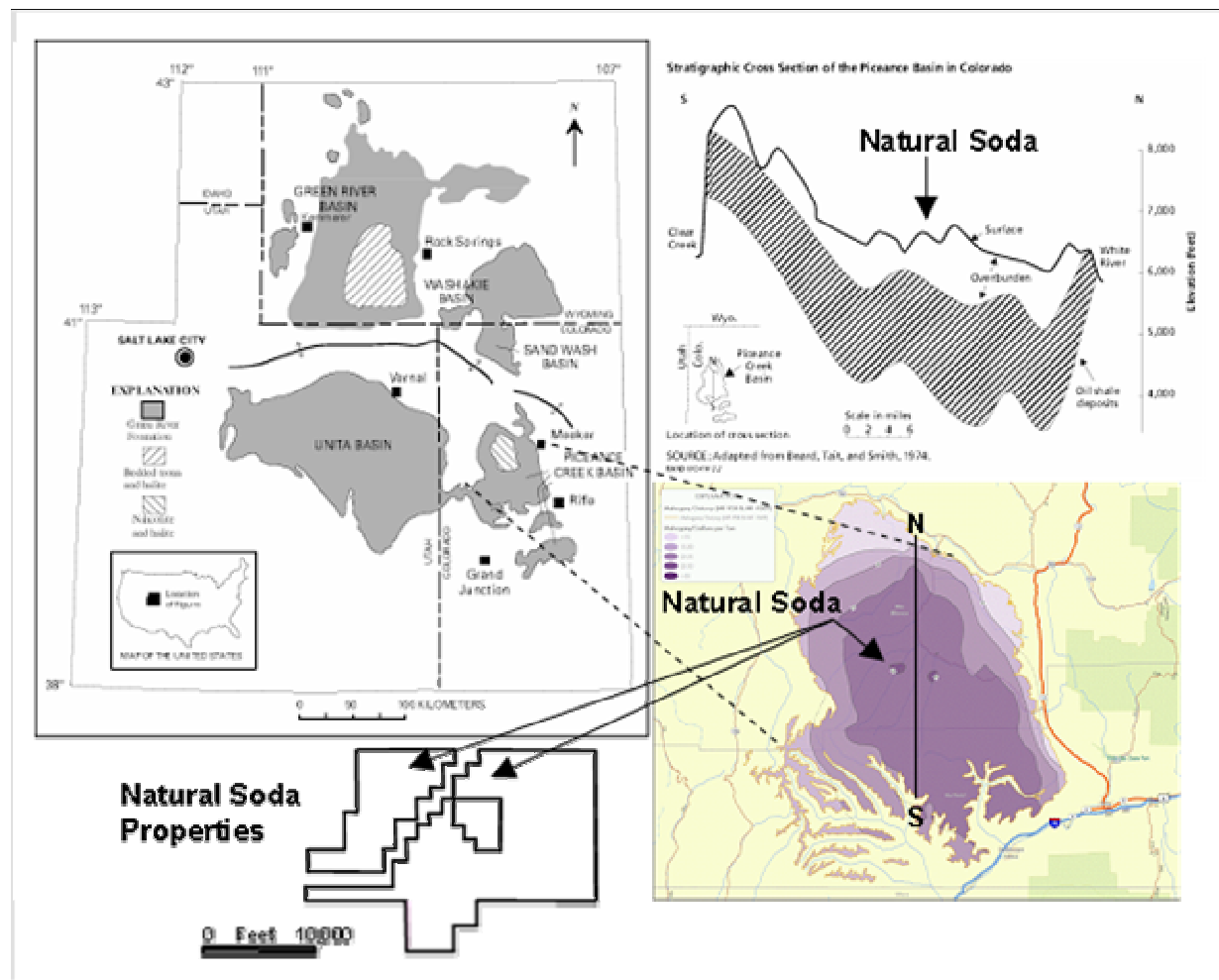
- Natural Soda and Sentient are developing a new technology for in-situ oil shale development, building on lessons from past oil shale efforts and experience with other technologies.
- The company is evaluating various technology options for developing its oil shale resources efficiently while protecting the environment and the sodium resources. These options include in-situ technologies as well as other liquefaction approaches.
- Natural Soda has extensive experience with directional and horizontal drilling and development resulting from its soda operations. Natural Soda's horizontal well experience in combination with another demonstrated technology may result in a low cost horizontal heating process that could include in-situ stabilization of the product stream.

Natural Soda's Current Sodium Plant



TYPE / LOCATION OF RESOURCE HOLDINGS

Natural Soda holds long-term leases on private lands that contain not only nahcolite, but also significant Green River Formation oil shale deposits. These resources are underlain by producible commercial natural gas resources. The leases are adjacent to Shell and near to Chevron's oil shale leases and property holdings.



PROJECT STATUS / STATE OF DEVELOPMENT

To date, Natural Soda and Sentient have compiled a comprehensive study of the resources and have planned a drilling program of the resource that will deliver fresh material for bench-scale concept testing in an experienced synthetic fuel research laboratory. Design engineering and economic evaluation are currently underway, leading potentially to construction of a small (< 10 tons / day) operation on the site beginning in mid-2008.

RELEVANT EXPERIENCE

Members of the Natural Soda / Sentient team, in particular Dr. Peter Cassidy, have significant experience in synthetic fuel research, including coal liquefaction technology that may be applicable and extendable to oil shale development. Cassidy is a PhD Chemist who completed his PhD research in the liquefaction of Victorian brown coal in Australia. He managed BP's coal liquefaction laboratory at Monash University where was part of a team developing new catalyst systems and interacted with Exxon, Chevron, Mobil and Gulf scientists in the 1980s.

OUTLOOK / FUTURE PLANS

Natural Soda and Sentient are considering other partners to participate in development of the oil shale and gas resources on their leases. They will continue to pursue development, testing, and demonstration of an in-situ technology for maximizing recovery of the oil shale and nahcolite resources while protecting the environment.



Nevtah Capital Management Corp.

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COMPANY DESCRIPTION

Nevtah Capital and Black Sands Energy have partnered to pursue the development of the Utah Oil Sands. This joint venture entails the extraction technology development by Black Sands and the financing for the technology and projects within Utah by Nevtah Capital. Recently, the partners signed an agreement with Korea Technology Industry (KTI) which will provide \$29 million for production development in Utah.

OIL SANDS INDUSTRY ROLE

Nevtah and Black Sands are technology developers within the oil sands recovery industry. The partners have several major leases within Utah's 32 billion barrel resource and have been successful in developing an economic, environmentally friendly technique for the extraction of oil from oil sands without water.

DESCRIPTION OF TECHNOLOGY

The joint venture partners have a patented, closed-loop extraction process that utilizes benign, non-toxic solvents to extract oil from oil sands. Recovery of these solvents is 99.9% and is totally recycled within the closed-loop system. The system is a comparatively simple one with few moving parts and operates on a gravity principle. This highly-scalable process recovers as much as 99% of the bitumen from oil sands without the extensive use of water. Direct mining and extraction costs are estimated from \$12.50 to \$13.50 per barrel. Overall costs are estimated to be approximately \$20.00.

This process includes the dissolution of oil sands materials through contact with a benign solvent in an enclosed container at temperatures up to 300 degrees F. and at safe, near-atmospheric pressures. As the material dissolves, it is passed to a wash chamber where any remaining oil is removed. The oil-free sand is then desolventized with heat, which converts the liquid solvent to a gas. The phase change ensures high solvent recovery from the spent sand. The solvent-oil mixture is pumped into a critical unit which allows the removal of asphalt and oil selectively from the solvent through heating and cooling. Since the process does not use water to recover the oil, energy requirements are minimal.

Typically, heavy crude oil contains salts, minerals and water that make processing more difficult and costly. The joint venture's resulting crude oil is virtually free of such impurities. Their separation process produces high API gravity (14 API) crude that is extremely low in sulfur and metals. It also has a lower viscosity than raw crude, which results in easier transportation. This lighter crude is especially attractive to refiners that cannot process heavy crude.



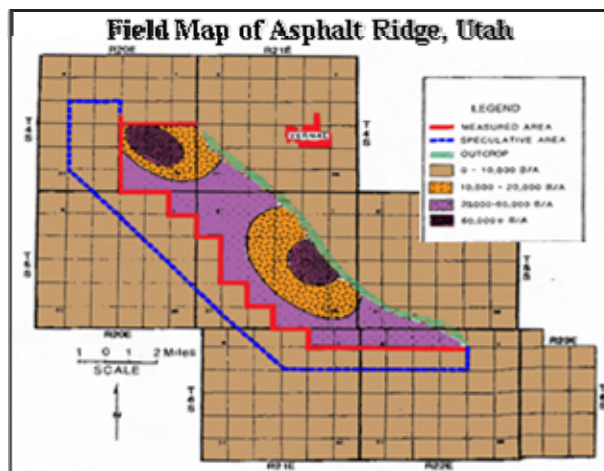
Oil Shale and Tar Sands Industry Profiles

LOCATION OF RESOURCE HOLDINGS

Nevtah/Black Sands hold several key leases in the Uinta Basin in Utah, including Asphalt Ridge, Sunnyside, PR Spring and Whiterocks.

The total estimated resource of these leases is approximately 6.2 billion barrels of oil (U.S. DOE Estimates). The partners are currently focusing on the Asphalt Ridge Deposits mainly due to its high level of richness (48% oil saturation) and very low sulfur content (0.4% by weight).

The joint venture partners are currently prioritizing their leases for permitting and will most likely commence production in the Asphalt Ridge areas.



PROJECT STATUS / STATE OF DEVELOPMENT

The partners' patented oil extraction process was originally proven by another company in Wyoming in 1998, with a full scale production plant operating for one year, producing 2 kbbl/day. As a result, the U.S. DOE issued a report titled, "Closed-Loop Extraction of Hydrocarbons and Bitumen from Oil-Bearing Sands" (<http://www.nevtahoilsands.com/pdf/OIL-DOE.pdf>) which concluded that "the program's objectives were met and that the project successfully demonstrated that the process is economically and environmentally safe." Subsequent to one year of production, the operations at this commercial plant were halted due to low oil prices (\$10 bbl) which made the process economically unviable at that time.

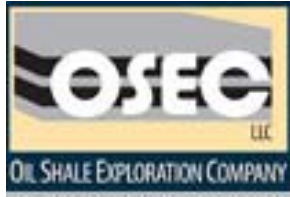
The partners mobilized a pilot plant operation at Asphalt Ridge in 2005 to further improve process efficiencies. Since that time, a 200 bbl/day mobile plant has been fabricated with a vast array of improvements and operating efficiencies. The unit has been converted to a more efficient, continuous flow feed system. A 22 foot drying flue has been added for better sand drying efficiencies with the addition of scrapers and several vibrating heater plates within the drying chamber. A new screening system has been installed to improve sand recapture. Most operations of the plant may be handled remotely. Two heat exchangers have been added to increase the temperature for added efficiencies in solvent removal from the soil. Operating temperatures have now been stabilized to a constant 300 degrees, while operating pressure has been reduced from 52 pounds per inch down to atmospheric pressures. The unit has passed a rigorous series of pressure and vacuum tests, while samples have been sent to an independent laboratory for oil content levels and residual solvent presence in processed sand.

RELEVANT EXPERIENCE

The partners have spent over 4 years enhancing the process and are ready for commercial production.

OUTLOOK / FUTURE PLANS

The partners' 200 bbl/day mobile plant has undergone many efficiency and system enhancements over a 4 year period and it has been demonstrated successfully to several oil and gas company officials who have traveled to Oklahoma. This unit will soon be on its way to previously core-drilled lease locations at Asphalt Ridge in Utah. With KTI's new involvement, the partners are now fabricating a 2000 bbl/day commercial production unit, which will be deployed at one of the partners' lease locations in Utah. The partners' project 2 kbbl/day production by the end of summer, 2007 and 12 kbbl/day by the end of 2007. Ramped up production by the end of 2009 would total 50 kbbl/day. Prior to the development of this patented, closed-loop system, the oil industry has not been able to develop an economic, cost-effective method of extracting oil from oil sands without the extensive use of water. Nevtah and Black Sands intend on being the first commercial producers of oil from Utah's rich oil sands area.



Oil Shale Exploration Company, LLC

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COMPANY DESCRIPTION

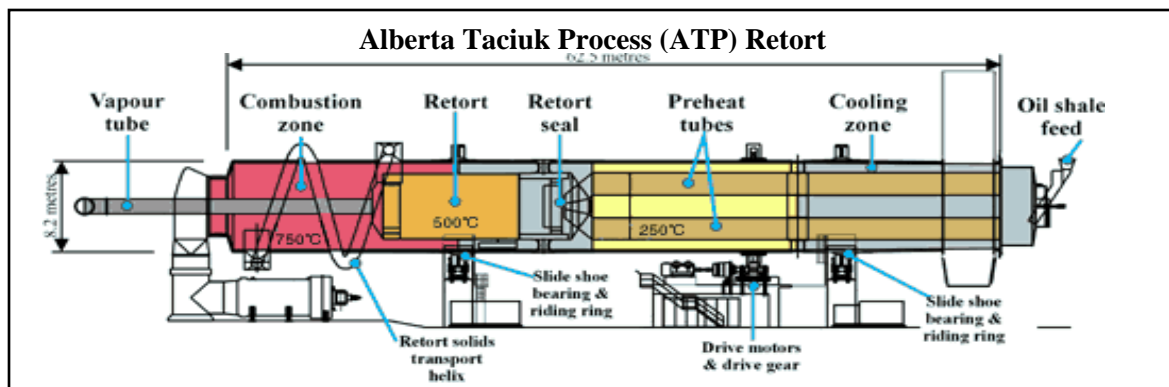
Oil Shale Exploration Company (OSEC) is a limited liability company formed by three companies: L&R Energy, Inc., Twin Pines Coal Company, and Shale Investments, LLC to pursue research and development leading to commercial oil shale production.

OIL SHALE INDUSTRY ROLE

OSEC has secured a research and development lease from the U.S. Department of the Interior, Bureau of Land Management to open and operate the White River oil shale mine in Utah. OSEC intends to operate the mine as a source of oil shale for testing, development, and operation of a surface-based oil shale retort process, ultimately producing 50,000 Bbl/day. OSEC and the White River Mine will also provide oil shale for other RD&D projects.

DESCRIPTION OF TECHNOLOGY

- OSEC believes that the Alberta Taciuk Process (“ATP”), a horizontal rotating kiln process, is the most tried and proven process for development of Utah oil shale.
- OSEC has arranged for an exclusive right from AECOM, a worldwide engineering firm, to license the ATP Process for purposes of oil shale research, development and demonstration on the BLM lease at the White River Mine south of Vernal, Utah.
- The ATP Process is a unique thermal processing technology, applicable to numerous industrial uses, for vaporizing and recovering organic constituents that exist in a large range of feedstock materials.
- The ATP Process was originally developed in 1976 for treating Alberta oil sands and was later refined for use in oil shale and contaminated waste treatment options.
- The ATP Process has successfully produced over 1.5 million barrels of shale oil at the Stuart Shale Oil Project in Queensland, Australia. OSEC believes that the ATP Process is a proven,



Oil Shale and Tar Sands Industry Profiles

environmentally-sound, economic and efficient process for extracting oil from oil shale and oil sands.

- OSEC is committed to developing an environmentally-sound and efficient oil shale production technology to commercially produce this important energy resource.

TYPE / LOCATION OF RESOURCE HOLDINGS

OSEC has secured a 160-acre RD&D lease from BLM in Uintah County, Utah, just south of the City of Vernal. The lease area includes the site of the White River Oil Shale Mine, the only significant existing oil shale mine in Utah.

The White River Mine presently contains an estimated 50,000 tons of previously-mined shale remaining on the ground ready for use in oil shale RD&D purposes.

The 160-acre RD&D Lease combined with the 4,960 Acre preferential lease, totaling 5,120 Acres, contain over 300 million barrels of proven and extractable reserves.

As the recipient of the BLM lease for the White River Mine, OSEC has committed to make oil shale from the mine available to all other R&D projects in Utah.

PROJECT STATUS / STATE OF DEVELOPMENT

OSEC has secured the White River Mine lease from the BLM, and over the course of the next few years, OSEC plans to have a pilot plant in operation. It has also entered in to a license agreement with AECOM for use of the ATP retort technology. Oil shale from White River will initially be shipped to Alberta for testing in the ATP pilot retort at AECOM's facilities.

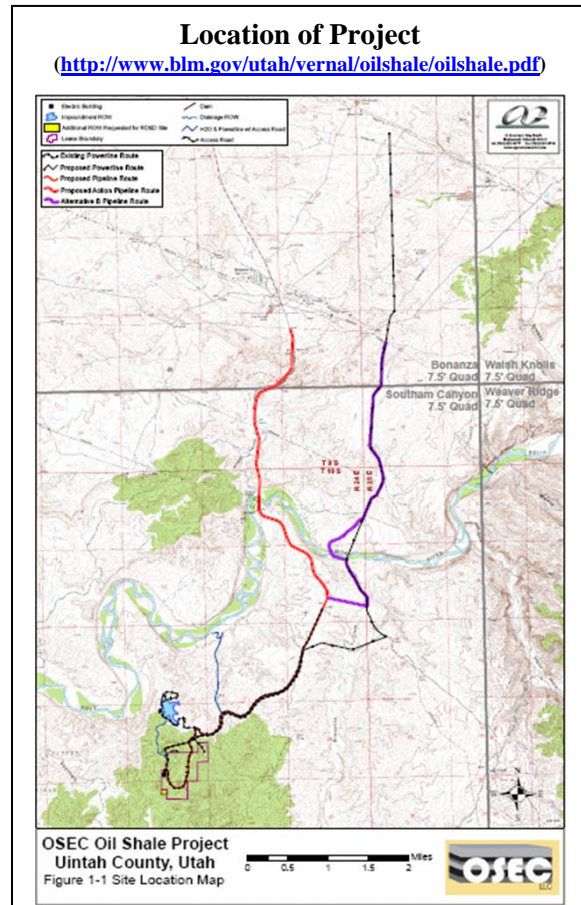
If successful, the retort will be disassembled and shipped to Utah for R&D use on the OSEC site.

RELEVANT EXPERIENCE

OSEC believes that the mining of oil shale is as important as the technology used to produce oil from oil shale and has brought together expertise in both these critical areas. OSEC has spent considerable time and expense in understanding the past problems with oil shale development efforts and has brought together a team of experts with extensive backgrounds in mining, engineering, materials handling, pyro-processing, oil upgrading, environmental, legal and finance.

OUTLOOK / FUTURE PLANS

OSEC's future plans are to ultimately develop a commercial operation that will process 50,000 barrels of shale oil per day.



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COMPANY DESCRIPTION

Phoenix Wyoming, Inc. is a Delaware corporation with offices in metro Denver, Colorado. The company is focused on the development of hydrocarbon resources in the Rocky Mountain region of the US. Its main interest, at present, is oil shale development. Phoenix Wyoming Inc. was one of 8 companies (including Shell, Chevron and Exxon Mobil) who applied to the BLM for an R D & D lease in Colorado by the deadline of August 31, 2005. Only Shell, Chevron and one other company were successful in obtaining BLM oil shale R D & D leases in Colorado.

Although Phoenix Wyoming's technology was approved, it did not have an existing BLM bond and all its investment capital was not 100% pre-arranged. Phoenix Wyoming, Inc. is one of three small, entrepreneurial companies that have banded together to form Oil Shale Alliance, Inc. and intend to commercially develop oil shale quickly and efficiently. The other two companies in the alliance are Independent Energy Partners Inc. and Petro Probe Inc. (See profiles).

OIL SHALE INDUSTRY ROLE

Phoenix wishes to help develop this oil shale, using its own advanced in-situ technology. Phoenix Wyoming Inc. and its technology partners in Oil Shale Alliance Inc. are now seeking leases on 100,000 acres of oil shale that is estimated to contain at least 100 billion barrels of recoverable oil.

DESCRIPTION OF TECHNOLOGY

It now appears that it may be possible to economically produce these oil shale resources in a very environmentally-friendly way. In-situ production avoids the surface disturbance of the ground.

Phoenix Wyoming Inc. has borehole microwave technology that may result in the economic and environmentally-friendly production of some of the vast oil shale reserves in the US, which may greatly lessen the dangerous U.S. dependency on imported oil.

The three companies that comprise the Oil Shale Alliance, Inc. will be using three different in situ technologies: solid oxide fuel cells, borehole microwave, and hot gas injection. All three technologies have significant advantages in oil shale development.

- **Petro Probe Inc.**, a subsidiary of Earth Search Sciences, Inc.) plans to field test its hot gas injection process in six months. Since its patented technology injects and produces from the same well, they will be producing hydrocarbons within days, or even minutes, of their first field tests.
- **Phoenix Wyoming** plans to field test its borehole microwave technology in 12 months. In prior, smaller scale, field tests, the borehole microwave approach (radiation) heated the ground 50 times more quickly than electric heating rods (conduction).
- **Independent Energy Partners Inc.** plans to field test its patented solid oxide fuel cell process in 18 months. Since electricity is produced from the fuel cells, and all the (normally waste) heat is used to usefully heat the ground, the approach results in an outstanding Net-Energy-Ratio of 7.0, which is twice as good as the 3.5 NER of other proposed processes.

Oil Shale and Tar Sands Industry Profiles

TYPE / LOCATION OF RESOURCE HOLDINGS

Phoenix Wyoming Inc. and its technology partners in Oil Shale Alliance Inc. are now seeking leases on 100,000 acres of oil shale that is estimated to contain at least 100 billion barrels of recoverable oil.

PROJECT STATUS / STATE OF DEVELOPMENT

Phoenix Wyoming Inc. was one of 8 companies (including Shell, Chevron and Exxon Mobil) who applied to the BLM for an R D & D lease in Colorado by the deadline of August 31, 2005. Only Shell, Chevron and one other company were successful in obtaining BLM oil shale RD&D leases in Colorado. Although Phoenix Wyoming's technology was approved, it did not have an existing BLM bond and all its investment capital was not 100% pre-arranged.



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COMPANY DESCRIPTION

Raytheon is a technology leader specializing in defense, homeland security, and other government markets throughout the world. With a history of innovation spanning more than 80 years, Raytheon provides state-of-the-art electronics, mission systems integration, and other capabilities in the areas of sensing; effects; command, control, communications and intelligence systems, as well as a broad range of mission support services. Enhancing energy market stability by facilitating increased oil production is part of the company's mission to contribute to national defense and global security.

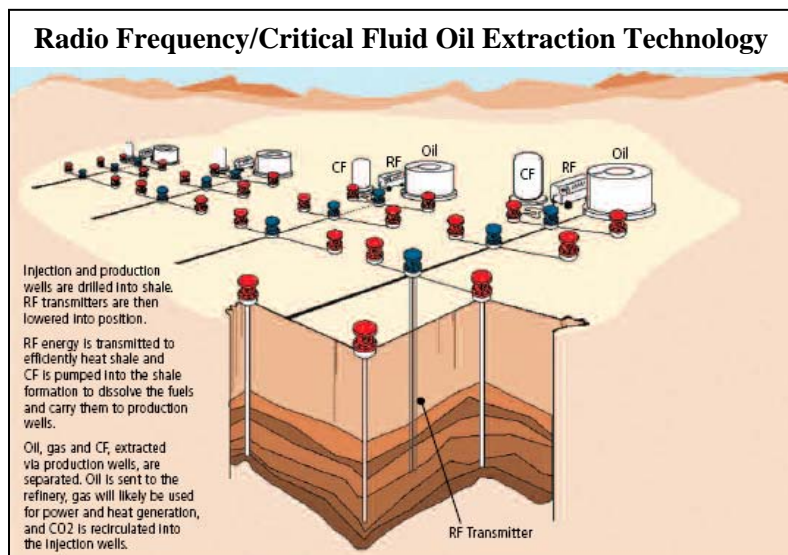
Raytheon is an expert in radio frequency technology. It's Integrated Defense Systems business unit applied applications of radio frequency technology to facilitate production of oil shale and tar sands and heavy oil deposits nearly 30 years ago. The project was revived and dramatically upgraded a few years ago when Raytheon began to look at energy supply as a stability and security issue. The company is partnering with CF Technology of Hyde Park, Massachusetts to offer its shale oil extraction technology for license. CF Technology is an expert in critical fluid technology and is the designer and manufacturer of the combined processing equipment.

ENERGY INDUSTRY ROLE

The company has integrated its proven radio-frequency (RF) technology and antenna design with CF's technology for critical fluids. It intends to license the integrated technology to service companies and heavy oil, tar sands, and oil shale producers on a resource- and region-specific basis.

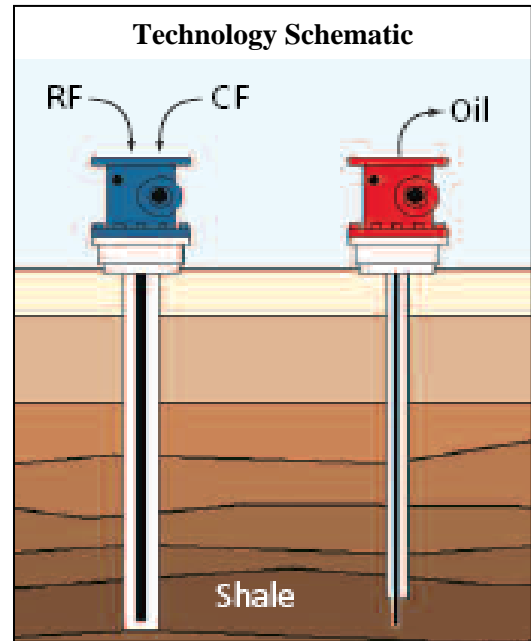
DESCRIPTION OF TECHNOLOGY

- Raytheon and CF Technology have developed a patent-pending extraction methodology involving radio frequency (RF) and critical fluids.
- Under this extraction scenario, oil wells are drilled into the shale strata using standard oil industry equipment. RF antennae, or transmitters, are lowered into the shale. The antennae then transmit RF energy to heat the buried shale.
- Super critical carbon dioxide is pumped into the shale formations to extract the oil from the rock and carry the oil to an extraction well. At the surface, the carbon dioxide is separated and pumped back into injection wells, while the oil and gas are refined into gasoline, heating oil and other products. Ultimately, a self-sequestration approach is expected to yield a neutral carbon foot print for process operations.



Oil Shale and Tar Sands Industry Profiles

- For oil shale, this technology may recover four to five barrels of oil for every barrel consumed; this compares to one and a half to three barrels of oil for every barrel consumed estimated for other in-situ processes. For tar sands and heavy oil, this process could yield 10 to 15 barrels of oil equivalent per barrel consumed, due to the lower heating temperatures required.
- This extraction technology would start producing in only a few months compared to years of heating required by other in-situ processes.
- When applied in tar sands, the combined RF/CF technology performs a mild upgrading in-situ, yielding an attractive light sweet crude oil. The process is “tunable” facilitating production of various product slates.



RESOURCE HOLDINGS

Raytheon does not currently own or control physical oil shale, heavy oil or tar sands resources; rather the company (partnered with CF Technologies) is focused on licensing their technology to qualified energy resource development companies or oil field service companies.

PROJECT STATUS / STATE OF DEVELOPMENT

Raytheon’s RF technology was commercially proven for oil shale applications in the 1970s. Since then, the company has continued to perfect the technology, focusing on antenna design and system integration. While the combined technology has not been tested at commercially representative scale, Raytheon and CF Technologies consider the integrated technology to be demonstrated in the laboratory. The companies recently solicited and received bids from a variety of energy and service companies interested in licensing the technology for adaptation and application to various oil shale, tar sands, and heavy oil resources.

RELEVANT EXPERIENCE

Raytheon is recognized as a global leader in radio frequency technology (one of the main components). Advances in radio frequency knowledge and technology, including increases in efficiency, have been achieved in Raytheon’s state-of-the-art technology development process, which is typically applied to defense and aviation sectors. Raytheon’s partner, CF Technology is an expert in critical fluid processes and is known globally for supercritical extraction processes and equipment design. CF Technology operates in a research park near Boston where the integrated technologies are being tested and refined.

OUTLOOK / FUTURE PLANS

Raytheon is currently working to partner with oil shale companies, other energy companies, and oil field service companies in hopes to license its technology for commercial application. The company expects the efforts to advance and perfect the technology will continue over the next few years while various laboratory and field trials are completed.

Oil Shale and Tar Sands Industry Profiles



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COMPANY DESCRIPTION

Red Leaf Resources, Inc is a Delaware corporation with offices in Salt Lake City, Utah. It is backed by energy hedge fund investors and is managed by Todd Dana (Founder and Chairman), Dr. James Patten (President & CEO), and Dr. James Bungler (a major shareholder and principal consultant), among others.

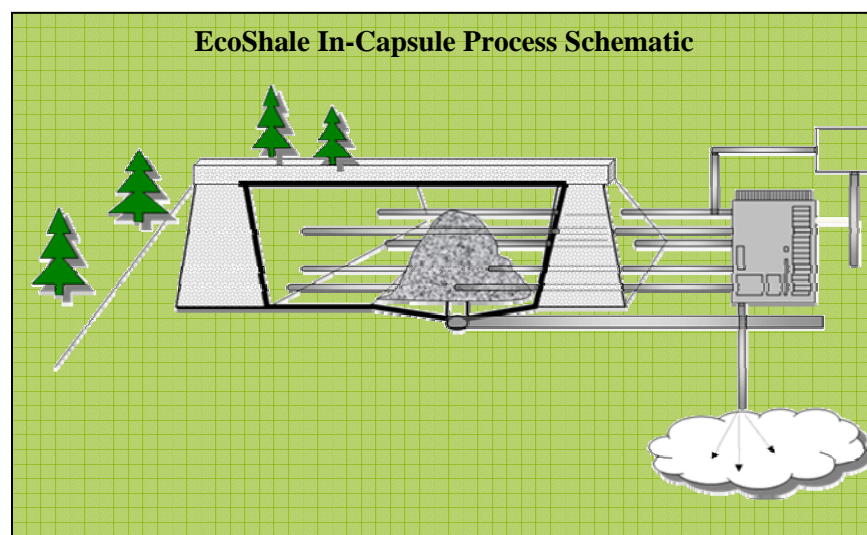
OIL SHALE INDUSTRY ROLE

Red Leaf is engaged in the oil shale industry as a resource owner and technology developer. The company has developed a surface extraction process called the EcoShale In-Capsule Process. Red Leaf has leases on state land in Utah.

DESCRIPTION OF TECHNOLOGY

Red Leaf is focusing its plans on a proprietary and patent-pending surface extraction method known as the EcoShale In-Capsule Process.

- The EcoShale In-Capsule Process employs a low cost earthen impoundment structure to contain a high temperature treatment zone.
- When filled with hydrocarbon resources, the capsule is heated using pipes circulating hot gases derived from burning natural gas, coal bed methane or its own recycled gases.
- By placing the shale in impoundments that are engineered with an impermeable barrier, RedLeaf expects tailings to be inherently sequestered and ground water to be protected.
- Rapid reclamation occurs as the process advances.
- In terms of energy efficiency, the process heat used in one capsule can be recovered by circulating lower temperature gases which transfer remaining heat into adjacent capsules.



Oil Shale and Tar Sands Industry Profiles

- A simple way to envision the EcoShale In-Capsule process is that the energy, the mining, the extraction and the environmental reclamation advance together with the mine face of the hydrocarbon resource.
- The benefits of this process include: extraction without using water, rapid reclamation mining, impounds spent shale to EPA standard, protects surface and ground water, no aquifer interaction, and produces high quality oil/refinery feedstock.
- The process utilizes standard mining equipment, avoiding large steel vessels. EcoShale In-Capsule process also reduces CO₂ emissions, is amenable for carbon sequestration, and approximately restores the topography.

TYPE / LOCATION OF RESOURCE HOLDINGS

- Red Leaf controls oil shale leases of about 16,500 acres on Utah state lands. The properties represent about 1.1 billion barrels of oil-in-place, much of which is available by surface mining.

PROJECT STATUS / STATE OF DEVELOPMENT

- Red Leaf is conducting additional analysis to support the design and development of a field pilot test to be conducted in the near future.

RELEVANT EXPERIENCE

- Although the company was recently formed, its principals have extensive experience in oil shale specifically and energy project analysis and management in general. One of the principals is a recognized scientist and expert in oil shale resources and technologies. Another has directed energy and environmental analysis for the management and operating contractor of several national laboratories.



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COMPANY DESCRIPTION

Shell Oil Company, including its consolidated companies and its share in equity companies, is one of America's leading energy companies with major businesses in oil and natural gas production, natural gas marketing, gasoline marketing, petrochemical manufacturing, wind, solar, and biofuels. Shell, a leading oil and gas producer in the deepwater Gulf of Mexico, is a recognized pioneer in oil and gas exploration and production technology. Shell Oil Company is an affiliate of the Shell Group, a global group of energy and petrochemical companies, employing approximately 109,000 people and operating in more than 140 countries and territories.

OIL SHALE INDUSTRY ROLE

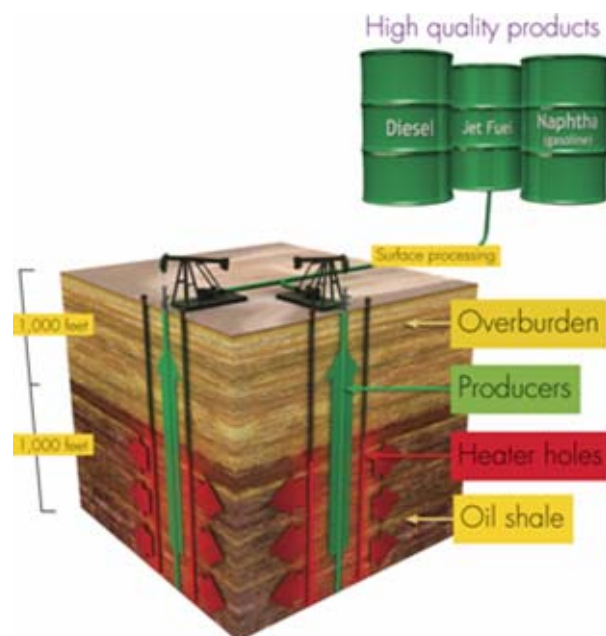
For more than a quarter of a century, Shell's Mahogany Research Project has conducted research on Shell's innovative In situ (in-ground) Conversion Process to responsibly recover oil and gas from oil shale in Colorado. In an effort to help meet the energy challenge, Shell is exploring ways to recover oil and gas from oil shale in a way that is economically viable, environmentally responsible and socially sustainable. The Bureau of Land Management granted approval of Shell's three, 160-acre oil shale research, development and demonstration leases.

DESCRIPTION OF TECHNOLOGY

Shell's innovative In situ Conversion Process generates more oil and gas from a smaller surface pad area than previous oil shale processes. Shell's technique does not involve surface mining and instead inserts heaters underground to convert kerogen in oil shale into high quality transportation fuels.

How the process works:

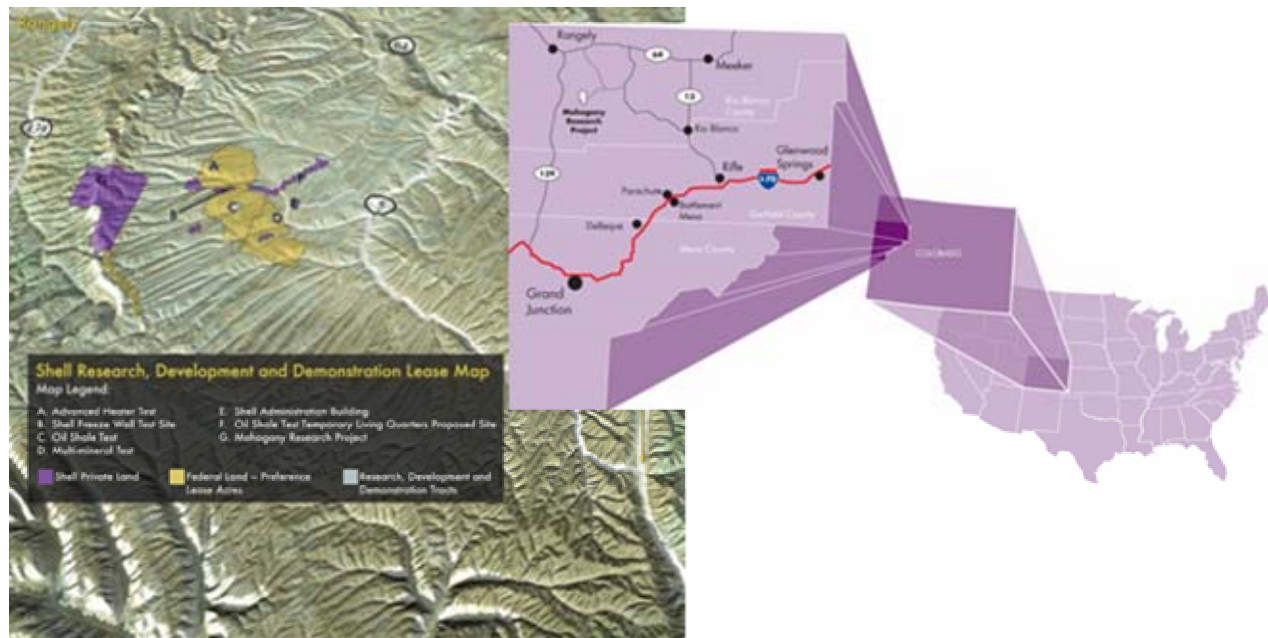
- Electric heaters gradually heat shale beneath surface
- Target depth zone typically from 1,000 to 2,000 feet
- Rock formation heated slowly over time to 650 to 750° F
- Heat changes kerogen in oil shale into oil and gas
- Products are pumped to surface using traditional methods
- Produces approximately 1/3 gas and 2/3 light oil
- Fewer processing steps required to produce high quality transportation fuels



Oil Shale and Tar Sands Industry Profiles

TYPE / LOCATION OF RESOURCE HOLDINGS

The Bureau of Land Management granted Shell three, 160-acre oil shale research, development and demonstration leases. Research activities will likely include an advanced heater test, a multi-mineral test and a demonstration project to mature a potential commercial design.



PROJECT STATUS/ STATE OF DEVELOPMENT

Shell must acquire many federal, state and local permits, including a mining operations permit from the Colorado Division of Reclamation, Mining and Safety, before construction on its next project can begin.

On its private property in Rio Blanco County, Shell is currently conducting the Freeze Wall Test, an environmental study to mature the technology designed to keep groundwater out of subsurface production areas using a frozen, underground barrier.

RELEVANT EXPERIENCE

Shell has been conducting research for more than a quarter of a century to ensure oil shale can be done the right way. Field results from past research have matched predictions, thus giving Shell engineers confidence in the In situ Conversion Process.

On only a 30x40 foot testing area, Shell successfully recovered 1,700 barrels of high quality light oil plus associated gas from a short interval of shallower, less-concentrated oil shale layers, thus determining their technological design works.

OUTLOOK / FUTURE PLANS

Shell will continue to set a high industry standard for public participation, environmental protection and community enhancement in an effort to ensure oil shale is done the right way. Any future Shell commercial development in Colorado will depend on the economic viability and environmental sustainability of the In situ Conversion Process. Shell hopes to make a decision on a commercial project in the next decade.



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COMPANY DESCRIPTION

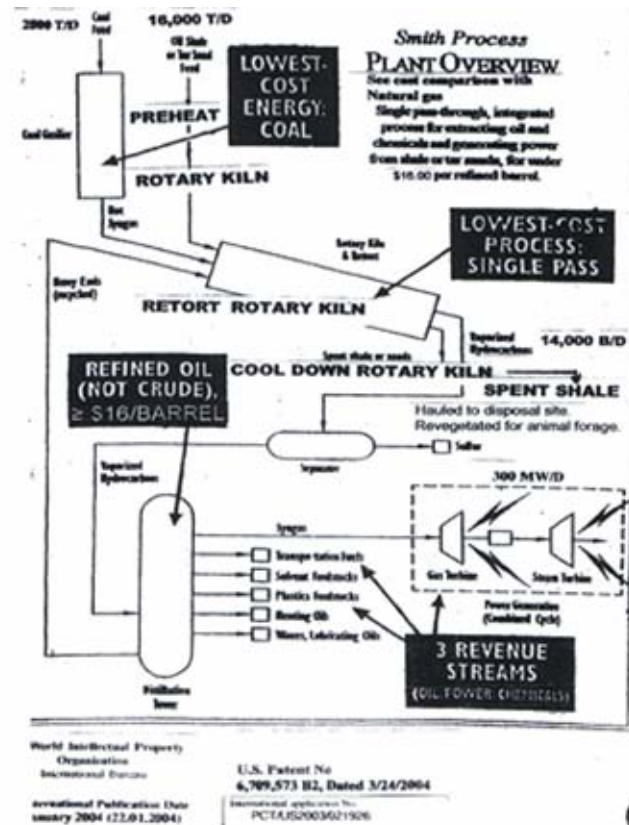
Syntec Energy is an experienced company dedicated to the development of a technologically superior, cost efficient and environmentally friendly process used for the reclamation of shale oil from oil impregnated shale rock.

OIL SHALE INDUSTRY ROLE

Syntec Energy has been at the forefront of developing technologies to optimize the reclamation of kerogen using a patented process which utilize a combination of commercially available technologies. .

DESCRIPTION OF TECHNOLOGY

- Syntec Energy has developed a new process for economic and environmentally clean surface retorting of mined oil shale.
- This new hybrid technology involves combining coal gasification technology with a rotary kiln for extraction of oil from shale. The process uses the heat from the gasification process to release the oil in the shale.
- The Smith process involves the use of proven surface or underground mining coupled with a patented retort technology.
- The new Smith approach allows for immediate fractionation of the reclaimed product to increase efficiency and reduce costs to produce commercially usable distillates.
- In addition to achieving very high yields, the Smith process has additional benefits of saleable by-products which include hydrogen, anhydrous liquid ammonia and/or electricity.
- The developers estimate that the technologically advanced process uses approximately 75% less water per barrel than other conventional shale oil recovery processes.



Oil Shale and Tar Sands Industry Profiles

EXPECTED BENEFITS OF THE SMITH PROCESS

- The process uses an inexpensive heat source (coal)
- The process uses equipment that is available on-the-shelf.
- The rotary kiln has a 16-minute retention time, versus 16 hour retention times for some vertical kilns
- Vaporized oil can be sent directly to a distillation tower, eliminating cooling and reheating requirements
- Cuts of gasoline, jet fuel, and diesel are separated and hydrotreated to take the form of finished products. -- U.S. refinery capacity is increased without addition of new equipment
- Syngas is cleaned and CO₂ and sulfur are removed – CO₂ can be used for enhanced oil recovery – the process is environmentally clean
- Estimated production costs per barrel are ~\$25/ Bbl.
- The technology is ready for commercialization.

TYPE / LOCATION OF RESOURCE HOLDINGS

Syntec Energy does not own or control oil shale resources or lands. The process can be applied by licensees to the extensive mineable oil shale resources located in Colorado, Utah, and Wyoming.

PROJECT STATUS / STATE OF DEVELOPMENT

To date, the Smith process has been tested and proven at bench-scale at the University of Utah's Department of Chemical Engineering. Design engineering and economic evaluations have been completed for pilot plant to full scale operations.

RELEVANT EXPERIENCE

The late founder, Leon Smith, has been involved in the study of high temperature gasification technology for over twenty years and has been the frontrunner in bringing the interest in alternative fuel research involving oil shale and tar sand resources to government and public awareness.

OUTLOOK/ FUTURE PLANS

Syntec continues to do further research and development of its process, while seeking full implementation of the technology on a commercial level. Modifications to the process to further increase yield and efficiency optimization can be completed concurrently with the construction process.



Temple Mountain Energy, Inc.

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COMPANY DESCRIPTION

Temple Mountain Energy, Inc. (TME) is active in all aspects of oil/tar sands development and production (mining, ore processing, and logistics (storage, transportation and sales)). Based in Minnesota, it has operations Utah, Kansas, Trinidad and Tobago and Canada. It is presently putting its heaviest efforts in its oil/tar sands ore processing pilot plant in Utah. The pilot plant is 99% complete and will be commissioned in July 2007. The generalized process is illustrated below; which is already built.

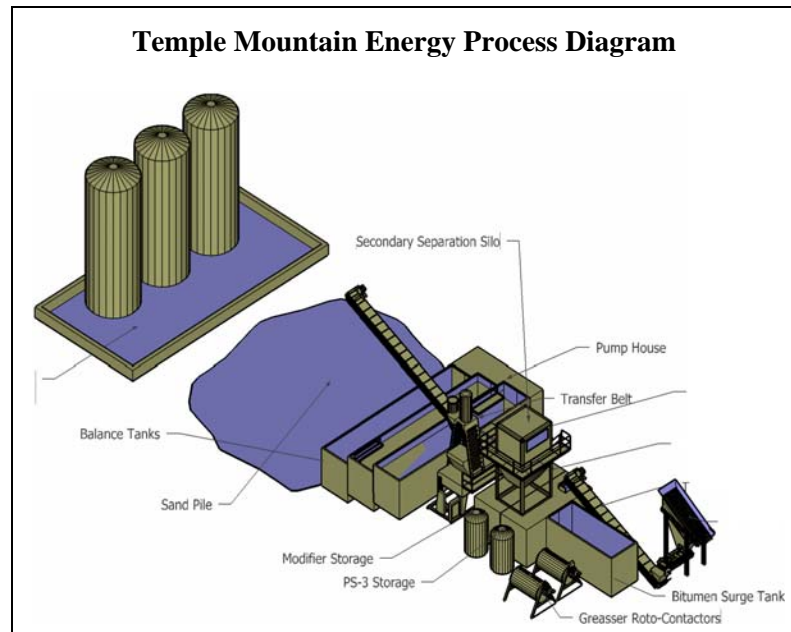
OIL/TAR SANDS INDUSTRY ROLE

TME is engaged in the oil/tar sands industry as a resource owner, technology/process developer, and project developer/operator. The company is developing an advanced mining and ore process on privately held lands, expanding to potential commercial scale production within a year depending on the economic feasibility, volume scaling of the pilot process and other investment criteria.

DESCRIPTION OF TECHNOLOGY

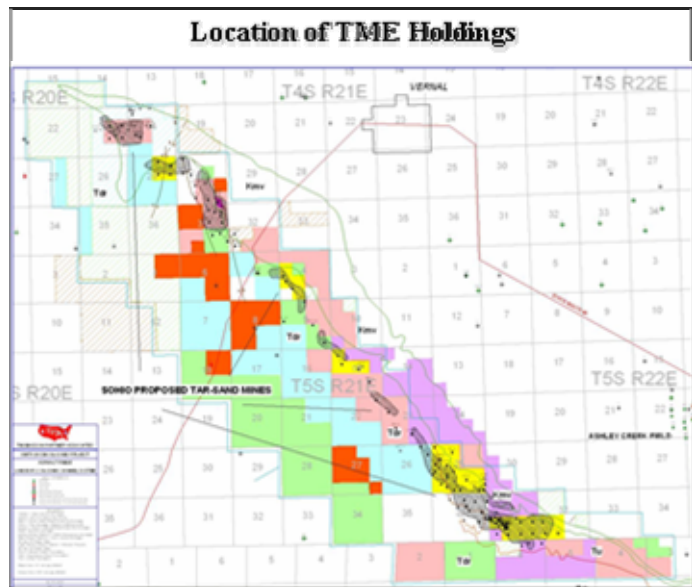
TME has developed a new process for economically processing mined oil/tar sands. The TME process involves the use of proven surface-mining coupled with TME's advanced sand cleaning/remediation process using no heat and powered by electricity rather than carbon fuel. The process uses water as a motive force.

- The approach allows faster throughput of oil sands separation at low temperatures, achieving more efficient energy usage and greater product yields, while not creating carbon dioxide and other emissions.
- The process applies advances from the soil remediation industry in Europe who are at least 10 years ahead of the U.S.A. in process design.
- The processes' improved water management and re-use technologies. It also reduces process requirements and reclaims and recycles the water at about 93% recovery.



TYPE / LOCATION OF RESOURCE HOLDINGS

- TME owns fee lands in Uintah County in Vernal, Utah, on the Asphalt Ridge, covering an area of 1280 acres with another 1280 acres of state land under control (Section 35 and 36). (See yellow on map below plus Section 35 and 36)
- The properties have over 80 million barrels of surface mineable oil with another 70 million barrels of in-situ oil. This is per a 100 plus core drillings database obtained from SOHIO.
- The large mine permit has been applied for with the State of Utah. Two 5 acres sites (permitted) are being mined presently that have surface outcroppings and little overburden.
- Mining has been initiated on the fee lands with 8,000 tons stockpiled for the pilot plant. Another 20,000 tons has been mined and sold for road asphalt use.



PROJECT STATUS / STATE OF DEVELOPMENT

To date, TME's process has been tested at bench-scale, and small scale internal demonstration, with positive results enough to move to the pilot plant stage. The pilot plant is completed and ready for commissioning in July 2007. Design, engineering and economic evaluation are currently underway, leading to construction of the first production module (250 tons/hour) on the site beginning in mid-2008. After commissioning the first module, the plan is to build one every six months into two 4 module pods, capable of processing 1000 tons per hour per pod (2000 tons per hour total) at 20 hour days with 4 hours of maintenance time.

RELEVANT EXPERIENCE

The expertise of the firm lies in the experience of its people, including: Dr. Robert Trent - A world known mining expert; David Bower – A world known soil remediation and reclamation process expert; Ed Lubbers - A world known petroleum logistics expert; Larry Clynch – President of TME and past President of TransMontaigne and past President of Conoco Pipeline USA.

COMPANY OUTLOOK / FUTURE PLANS

The company has the process to produce bitumen oil from the oil/tar sands in the pilot stage and is designing for going to the commercial stage within the next year. The mining, processing and logistics areas to make this an economical and viable business are in place. The properties are in place to extract the ore from, and the overburden ratios look great. TME will run the pilot plant at a rate of 125 TPH which will make it economical to continue its production will getting the production systems up and running.

TME's Oil/Tar Sands Pilot Plant



Western Energy Partners, LLC

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COMPANY DESCRIPTION

Western Energy Partners, LLC is an energy development company with direct and affiliate interests in oil and gas development, alternative and renewable energy fuels and processes. Based in Salt Lake City, Utah, and through its affiliates (Resource Assistance Development, LLC (RAD) & Strategic Capital Investments, LLC (SCI) and other strategic and project partners, it is involved in diverse energy technologies and projects throughout North America and the world.

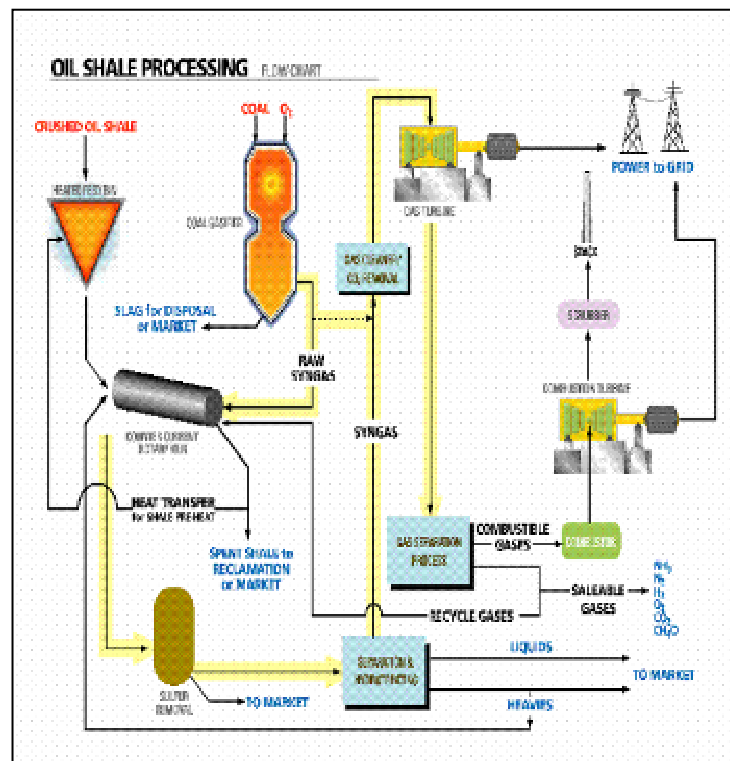
OIL SHALE INDUSTRY ROLE

Western Energy Partners, LLC is a proponent of further development and implementation of certain retorting technologies that it believes can be employed for commercial production. It is interested in furthering the demonstrated technologies and developing projects in the oil shale industry as a resource owner / developer / facilitator.

DESCRIPTION OF TECHNOLOGY

This process for extraction of hydrocarbons from oil shale involves the bringing together of a number of established industry technologies resulting in a number of positive, commercially viable outcomes.

- The core technology utilizes inexpensive, abundant, coal which is gasified to produce a hot, hydrogen-rich “syngas” as process “sweep gas” which is introduced into a rotating kiln containing crushed oil shale.
- Under tightly controlled conditions, the hydrocarbons are vaporized from the shale in a continuous process.
- The enriched hydrocarbon vapors are removed from the kiln, separated from the syngas and upgraded (also using established technologies) into high quality petroleum/ petrochemical feedstocks.
- The remaining hot, hydrogen-rich syngas is utilized to create added process revenues including the cogeneration of electricity and/or production of valuable chemical byproducts - an effectual “polygeneration” of clean energy efficiency.



Oil Shale and Tar Sands Industry Profiles

TYPE / LOCATION OF RESOURCE HOLDINGS

No present land / lease holdings

PROJECT STATUS / STATE OF DEVELOPMENT

In 2004, a study was completed under the auspices of the Department of Chemistry and Fuels Engineering of the University of Utah. That study applied the above referenced oil shale extraction technology to shales originating in the same formation as those of interest to this project. The publicly released Executive Summary of that study listed among its conclusions:

- the recovery of hydrocarbon values from mined and crushed shale can be accomplished in a rotary kiln in a synthesis gas environment, with liquid yields in excess of 25 gallons per ton could be achieved under optimized operating conditions
- the produced oil shale derived liquid would be an acceptable hydrogen refinery feedstock; however, the produced liquids could be transformed into high quality synthetic crude if the upgrading technology employed at the Canadian Oil Sands Bi-Provincial Upgrader were applied to the derived liquid.

The study also noted:

- that the overall product distribution yields were encouraging in that rotary kiln pyrolysis of oil shale in a synthesis gas environment is feasible
- that (the technology) may be a preferred process for the recovery of hydrocarbon values from mined oil shale and
- that there remain opportunities for experimental design for the optimization of the rotary kiln oil shale pyrolysis process.

RELEVANT EXPERIENCE

A finalist in the Department of the Interior / Bureau of Land Management's Oil Shale Research, Development and Demonstration (R, D & D) Program, Western Energy Partners, LLC, its affiliates and advisors have extensive experience in oil shale development, enhanced oil recovery, combined heat & power / cogen / polygen technologies and projects. Details and references are available upon request.

OUTLOOK / FUTURE PLANS

Working synergistically with its affiliates, strategic partners and others, Western Energy Partners, LLC will continue its efforts in advancing oil shale extraction technologies / development with the goal of the realization of large-scale commercial production; this within the larger vision of the nation achieving a greater degree of energy independence.

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COMPANY DESCRIPTION

Great Western Energy (GWE) is a privately held company devoted primarily to the acquisition and control of shale resources. Corporate headquarters are in Northern Virginia and operations primarily in Utah.

OIL SHALE INDUSTRY ROLE

GWE's role in the shale industry is to control, lease, own and assemble land packages of realistic size and with sufficient and accessible resource appropriate for development. Operations and acquisitions have been primarily in the Uinta basin of Utah.

TYPE / LOCATION OF RESOURCE HOLDINGS

GWE owns or controls oil shale leases on 16,500 acres of State of Utah lands in Uintah County, Utah.

RELEVANT EXPERIENCE

GWE, through its members, has extensive experience in oil shale technology and project development. Its principals were active participants in the oil shale development efforts in Utah and Colorado during the late 70's and early 80's and have been continuously active in the scientific, geologic, mining and processing aspects of oil shale utilization and development.



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