EMD Oil Shale Report for the 2008 Annual meeting, Ron Johnson

Active oil shale areas: Estonia, Brazil, Jordan, Morocco, Israel, China, Australia, Mongolia, the Piceance Basin of western Colorado, the Uinta Basin of eastern Utah and western Colorado.

Current production:

In 2006, China produced about 485,000 tons of shale oil all using conventional mining and surface retorts. The largest producer is Fushun province that produced 240,000 tons of shale oil from 140 vertical retorts. They increased production to 300,000 tons of oil in 2007 with the addition of 40 new retorts. Fushun is producing 300,000 tons/year of cement and 240 million bricks per year from spent shale. Five private companies also produce 30,000 tons of shale oil per year. There are plans to process an additional 2 million tons of oil shale a year to produce 200,000 tons of shale oil, with the shale char used to generate power and the shale ash used as a building material. China also uses 300,000 tons of oil shale a year to generate electricity. A fluidized bed technology is used to fuel three boilers with a capacity to generate 12 megawatts of electricity.

About 12 million tons of oil shale is mined in Estonia each year. Estonia produced 2.5 million barrels of shale oil in 2007 but about 85 percent of their oil shale is used in boilers. Due partly to pressure from the EU there is a concerted effort to find uses for the spent shale, and a state-of the-art cement plant is planned. Estonia is selling much of their shale oil at premium prices to manufacture petrochemicals and as a marine fuel for which it excels. In Brazil, small amounts of oil are produced from shale of the Permian Iratí Formation. The deposit is surface mined near the town of Sáo Mateus do Sul in the State of Paraná, and retorted for oil, liquefied petroleum gas, sulfur, and fuel gas.

U.S. oil shale industry:

Active basins for oil shale development in the United States are the Uinta Basin of Utah and Colorado and the Piceance Basin of Colorado. All current projects are in the experimental stage, and thus are not currently producing significant quantities of oil. The three projects in the Piceance Basin employ in-situ extraction of oil shale, whereas the Uinta Basin project plans to use underground mining and surface retorting. Unlike the previous oil shale boom in the 1974 that used mainly underground mining and surface retorting, in-situ methods are favored today. It is hoped that in-situ methods will be more economical and environmentally friendly that conventional mining. For instance, in order to produce 1 million barrels of oil per day with conventional above ground retorts, from 2 to 3 million tons of oil shale will have to be mined and processed every day. Obtaining approval for such an enormous mining operation might be difficult in today's environmentally conscious world. In-situ methods are not without environmental problem as closely spaced drillholes would be required and significant quantities of CO2 gas would be produced. A significant hurdle to the in-situ method is finding enough power or fuel to heat the oil shale in the ground to retorting temperatures. Using electric heaters would require the constructions of major new power plants. An alternative is to use natural gas that is generated by the retorting process itself.

The project in the Uinta Basin is being operated by the Oil Shale Exploration Company. They plan to us an underground mine combined with a surface ATP retort similar to those that are presently being used for the Canadian tar sands deposits. Phase 1 of the project, to retort 300 tons of Utah oil shale in an experimental ATP retort in Canada, was completed in September. Phase 2 consists of reopening an old oil shale mine and installing a 4 ton per hour retort on the site and is expected to take 14 months. Phase 3 is to construct a 250 ton per hour retort at the site and is expected to take 48 months. At full production of about 50,000 barrels of shale oil per day, 75,000 to 80,000 tons of oil shale will have to be mined every day, making it the largest underground mine in the world.

Three experimental projects are on-going in the Piceance Basin. All use an in-situ process where the oil shale is heated to retort temperatures while still in the ground. Shell plans to use a freeze wall to keep hydrocarbons in and groundwater out, and developing freeze wall technology is necessary before Shell can proceed with their in-situ method. They are currently creating a freeze wall around a roughly square area 225 ft to a side, and the freeze wall should be completed by early November. Once completed, they will conduct a series of tests to see if the freeze wall will perform as required. Shell does not plan to heat and retort the oil shale within the existing freeze wall. A commercial freeze wall would have to encompass a much larger area, as a 100-300 ft buffer zone between the freeze wall and the heater holes is required. Shell plans to heat the oil shale using electric heaters installed in vertical heater holes. Shell was contacted in early March about progress in creating their freeze wall but would not give details.

Exxon-Mobil is also developing an in-situ method that will not use a freeze wall because it will be conducted on an interval of oil shale that is considered to be completely isolated from regional ground water. Exxon-Mobil plans to heat the oil shale using horizontal wells beneath the oil shale section. The wells will be fractured and material that conducts electricity will be injected into the fractures. Exxon-Mobil plans to try their experiment on an interval that contains large quantities of nahcolite, a sodium bicarbonate mineral. They plan to produce the oil first and the nahcolite second. Much of the nahcolite occurs in isolated aggregates, and it is hoped that fracturing produced during the conversion of kerogen to oil will assist in producing the nahcolite through solution mining once the oil has been extracted. The process generates large quantities of CO2 that have to be dealt with.

The following update on ExxonMobil's in-situ method was provided by Machael Allen on March 3, 2008.

"ExxonMobil is serious about pursuing oil shale technology and has at least two research concepts that require field testing, Electrofrac and Vaporfrac. Electrofrac is the leading technology candidate at this point... we recently were granted a patent for it. The method heats oil shale in situ by hydraulically fracturing the rock and filling the fracture with an electrically conductive material, forming a circuit through which electric current can flow thus creating a heating element. The hydrocarbons from the heated shale can then be brought up to the surface with vertical wells much like conventional oil and gas. The biggest advantage over other in situ wellbore heaters currently being tested in that Electrofrac should require only 1-2 heater wells per acre, an order of magnitude fewer.

The current field research involves small-scale test(s) of Electrofrac conductive fracture construction on land owned by ExxonMobil in Garfield County at the Colony site. The scope of this work does not include heating the oil shale to the point of hydrocarbon production. Staffing is temporary, housed in hotels; it does not include temporary living quarters. We have obtained the required technical revision to the Colony reclamation permit, and we have obtained permits for our work trailers on the site.

You heard Jesse's talk, and so are aware that we also have a patent pending on a process to develop the oil shale resource while preserving the mineral value of the nahcolite resource and increasing its possible recovery. The process looks like this:

Heating converts nahcolite ($NaHCO_3$) to soda ash (Na_2CO_3).
The increased solubility of soda ash allows it to be solution-mined and converted back to nahcolite using a common industry process of CO_2 addition on the surface. Both minerals have commercial value.
Synergies exist for flushing the heated zone for groundwater protection and solution mining of the sodium minerals after shale oil production.

We are not testing that however at our Colony site, which was originally designed as an ex situ development and its shale is located close to the surface. We will use Colony outcrops for early testing of elements of Electrofrac, but it is not necessarily a good candidate for in situ research and development and we remain interested in securing leases better suited to that.

Going forward, we anticipate a careful, phased approach that allows for prudent technical, social and environmental planning and execution. None of the in situ technologies currently under study has yet demonstrated commercial viability. A long-term commitment to field research will be required to develop one that is, so it is important (we believe) to continue to encourage a broad range of technologies and many different companies to find the best commercial solutions."

E.G.L. , a privately held company is conducting the third experimental in-situ project in the Piceance Basin. They also plan to use horizontal heater wells beneath the oil shale interval, but will conduct their experiment on the illitic oil shales that occur beneath the carbonate-rich oil shales that are the focus of the other two experiments in the Piceance Basin. These oil shales do not contain nahcolite, are highly impermeable and thus it is hoped that the process will be simpler than the previous two experiments. IDT Corporation, a multinational holding company recently bought a 75% stake in E.G.L. and renamed it the American Oil Shale Corporation (AMSO)>