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"Oil Shale Development Imminent"

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[editor's note, by Prof. Goose] Hey folks, see these buttons to the left? Note that they include reddit and digg. If you recommend TOD articles at these sites (account required, but they take seconds to set up, and once setup and logged in, all you have to do is click!), we can get more traffic driven over here! Do it for every article you think is worthy.

Update [2006-6-18 10:34:44 by Super G]: A large portion of this article was cut off when it was originally posted. I have just added in the rest.

I have recently noticed an increase in oil shale coverage in the media, so this seems like a good time to take a look at the potential for oil shale to meet a portion of our energy wants (as opposed to "needs").

First, what is oil shale? Wikipedia has a nice overview on oil shale here. Briefly, oil shale started off just like the plant material that was ultimately converted into oil, but the material was not subjected to high enough temperatures and pressures to convert it completely to oil. But it is feasible to complete the process that nature started and convert oil shale into oil and natural gas by heating it. Given that the U.S. has an estimated oil shale reserve of a trillion barrels or so, it is not surprising that billions of dollars have gone into figuring out how to economically extract the oil from oil shale.

What I would like to do here is to highlight a pair of articles that recently appeared in the press and to evaluate the claims made in those articles. The first is from USA Today, and the article is "Oil shale enthusiasm resurfaces in the West". (1) It is also the source of the title I picked for this article. The first part of the article reads:

> The headline on the newspaper that state Rep. Bernie Buescher keeps in a box at home captures the allure of the vast petroleum riches under the rolling hills and arid mesas north of this western Colorado city. "Oil Shale Development Imminent," the paper reads. That edition of the defunct Grand Junction News, Buescher notes, was published at the dawn of the 20th century.

So, attempts to develop oil shale are certainly nothing new. The development of oil shale has been "imminent" for over 100 years. This should be the first indication that there are some fundamental challenges that have proven difficult to resolve. The article goes on to describe the potential energy riches at stake:

> There is no dispute that a thousand feet below the isolated ranch country here on

> Colorado's western slope lie almost unimaginable oil riches. It's locked in sedimentary rock — essentially immature oil that given a few million years under heat and pressure would produce pools of oil easy to extract.
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> The Energy Department and private industry estimate that a trillion barrels are here in Colorado — about the same amount as the entire world's known reserves of conventional oil. The entire Green River Formation might hold as much as 2 trillion barrels.
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> Pushed by the Bush administration and legislation from Congress last year, and spurred by oil prices above $70 a barrel, the energy industry is mobilizing to unlock the secret of oil shale. As it has before, oil shale holds out the hope of a USA no longer dependent on foreign oil.

The potential payoff is huge. But I see this as somewhat akin to the vast amount of gold in the ocean. There are trillions of dollars of gold in the oceans, (2) for anyone wishing to extract it. The problem, as has historically been the case with oil shale, is that it costs more to extract gold from ocean water than the gold is worth. But Shell is developing a new process for oil shale extraction, which the article briefly discusses:

> Shell's new process involves sinking heaters deep underground, cooking the rock at 700 degrees and recovering the oil and natural gas with conventional drilling. Early results are promising, says Terry O'Connor, a vice president in the oil giant's unconventional resource division. But, he admits, "no one has been able to develop oil shale on a commercially sustainable basis." Shell has four more years of research here before it will know if it has the answer.
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> U.S. Sen. Pete Domenici, R-N.M., who heads the Senate Energy and Natural Resources Committee, was less cautious at a tour of Shell's test site Wednesday: "This is not pie in the sky. It's real this time."

Here we have Shell saying it will be four years before they know the answer, but Sen. Domenici is already saying “it’s real this time”. However, there are some things we can investigate, and the other article gets into a bit more depth on the problematic areas. The Colorado Springs Business Journal recently published "Oil Shale Exploration Near Rangely: Bonanza or Bust?" (3) The article quickly frames the debate:

> Shell Oil is attempting to wring oil from the rocks in the Green River Formation near Rangely. If successful, supporters say the oil shale could supply the nation's energy for decades; detractors claim it's expensive, inefficient and environmentally hazardous.

The article went on to describe the Shell process in greater detail:

> Despite a century of trying, and $10 billion in investment, oil shale currently provides an infinitesimal .0001 of world energy, said Randy Udall, director of the Community Office for Resource Efficiency in Aspen. The (Shell) technology is incredible - incredible in an insane way, incredible in a fantastic way, maybe both.

> Shell decided that previous efforts to exploit oil shale used too much energy, too much water and displaced too much land. Instead of taking rock out of the ground, heating it inside enormous retorts and releasing unstable hydrocarbons that must immediately be refined into oil, Shell plans to do something different, said Jill Davis, public relations director for the Shell Mahogany project.
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> Imagine a football field, Udall said. Now, imagine that they freeze the perimeter of the field to about 2,000 feet deep. Then, they take the water out of the middle of the field. Once the water is removed, they will drill wells 30 to 40 feet apart, and insert long electric heaters. Shell then plans to heat the rock to about 700 degrees Fahrenheit, and keep it that hot for three years - completing the work that nature would have done if the oil shale had been buried deeper, Udall said.

I have to admit that this sounds insane. Heating up rock to 700 degrees Fahrenheit and maintaining that temperature for 3 years sounds incredibly inefficient. However, I try to keep an open mind about these things, despite my skepticism. Previous efforts to extract oil from oil shale involved digging the oil shale up, retorting it, and then replacing the processed shale. This is similar to the processing of tar sands, with the environmental concerns that go along with that process.

But Shell says that despite estimates that the process is very energy intensive, it has a positive EROEI:

> To do it on a large scale you'd need a power plant larger than any power plant in the history of Colorado. And you'd need a new power plant for each 100,000 barrel increment. Davis says estimates about power plants and energy costs are premature because Shell has not decided to take its experiments to a commercial level. We are not releasing what our power needs would be, she said. So anything coming from opposition would be estimates. But, when you compare how much energy is spent - apples to apples, BTUs to BTUs - you get 3.5 more energy units out of the oil shale than you put in through the process. Davis said those figures come from coal-fired electricity, off the grid. But Shell hasn't decided how to create the electricity that would be used on a commercial project.

An EROEI of 3.5 is not great, but it is comparable to tar sands. But how is that EROEI defined? Is it based on the actual electricity used to heat the field? Or is it based on the coal used to make the electricity? That distinction is very important. If it is based on the electricity used, then we must take into consideration the energy efficiency of turning coal into electricity. That is only around 30%, so that would reduce the “net” EROEI down to about 1. Proponents might argue that this doesn’t matter, since you are taking something that can’t be directly used as transportation fuel – coal – and turning into a usable liquid fuel. I have seen this argument applied to producing ethanol from corn using coal as the heating source.

I strongly suspect that the net EROEI is around 1 or less. Why? Because if the overall EROEI was 3.5, the U.S. would probably already be exploiting oil shale instead of depending on Canada to develop their tar sands. The EROEI of tar sands is in the 2-3 range, and due to the similarities of the process, the capital costs should be comparable. So, I am left to conclude that the EROEI of oil shale is poor compared to tar sands.

Shell claims that their process is economic when oil prices are above $30/bbl. (4) However, it is

always important to note that this is a moving target – especially with a low EROEI process. A process with a low EROEI by definition is very susceptible to increases in the cost of the energy inputs, and $30/bbl presumes that the price of the energy inputs is not increasing along with the cost of oil.

It is important to note that the EROEI calculations also don't take into consideration the steps that will be required to protect the environment. Shell is just now getting ready to do those experiments:

> The success (of the pilot studies) means Shell is moving to the next area: testing a freeze wall to keep oil from contaminating ground water. We're moving ahead, but we want to protect the environment, she said. We'll be testing on a larger scale on our private property, and we'll know the results within 18 to 24 months. That will give us more confidence to go forward.

Mitigating ground water contamination will certainly lower the EROEI beyond that of just extracting the oil. The article goes on to explain how long this test will last, and gives an estimate of what would be required to produce just a fraction of current U.S. oil usage:

> Shell's next tests will be determining ways to protect the groundwater: Udall's frozen football field. Construction of the freeze wall is expected to be completed by 2007, and the experiment will run for 13 years, according to Shell's web site, www.shell.com/us/mahogany .
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> But with today's technology, the potential energy comes with a steep price, says Udall and others who are opposed to producing oil from shale. The energy required is a 'gigabunch,' Udall said. To produce 100,000 barrels a day, would require raising the temperature of 700 billion tons of shale by 700 degrees Fahrenheit. How much coal, how many power plants? One million barrels a day would require 10 new power plants, five new coal mines. Given the expenditure of energy just to get the kerogen out of the rock, oil shale is a poor contender to solve the nation's energy problems, Udall said.

Call me a skeptic. Current U.S. oil usage is over 20 million barrels a day, and it would require 10 new power plants and five new coal mines to replace less than 5% of our consumption. Add to that a multi-billion dollar capital expenditure, increased greenhouse gas emissions, and a process with a marginal EROEI. Consider that we could "create" the same amount of oil by simply cutting consumption by 5%. It seems to me that enacting conservation policies would be far more cost effective than developing oil shale.

References

1. Oil shale enthusiasm resurfaces in the West, USAToday.com, June 1, 2006.

2. Seas hoard treasure; bugs have green, skinny hearts, USAToday.com, March 25, 2005.

3. Gillentine, Amy, Oil Shale Exploration Near Rangely: Bonanza or Bust?, The Colorado Springs Business Journal, June 9, 2006.

4. Shell's Ingenious Approach to Oil Shale is Pretty Slick, Rocky Mountain News, September 3, 2005.