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Oil Shale: Toward a Strategic Unconventional Fuels Supply Policy

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I'm pleased to be invited to The Heritage Foundation and to develop with Heritage and in Washington what might be called the "shale story," which currently is almost silent with regard to national policy and world petroleum. Earlier on, I edited a book on the resource war in the Reagan Administration. It was based upon how to understand, how to conceptualize strategic resources: oil, gas, and hard-rock minerals. I'm currently based both on the East Coast and in New Mexico, participating in the New Mexico energy model for the country and maybe the world.

The New Mexico model is based on a diversity of fuels. It is not exclusive; in fact, the language of "alternative," "conventional," "bio," "geo" is almost disappearing. The concern statewide is: What is fuel? Where is the supply of energy going to come from? And the model is diversification, which in New Mexico means solar; the energy technology of national laboratories; the fourth largest producer of natural gas (California depends on New Mexico for 30 percent of its gas and electricity); the potential for hydrogen; the utilization export of CO_2; and, finally, oil.

That's an effective energy production model for the country to follow. In one portfolio, all the energy assets are recognized systemically rather than competitively in terms of production of energy and fuels. Robert Gallagher, who served in Washington in the Clinton Administration Department of Energy (DOE) and is now president of the New Mexico Oil and Gas Association, has made the New Mexico model an operational success.

Talking Points

- Under the Energy Policy Act of 2005, the U.S. government can enter into long-term purchase agreements and buy oil from shale for the Strategic Petroleum Reserve. That would be an internal oil supply, eliminating the national security risk of foreign oil import beneficiaries.
- The way to add to the SPR to improve energy security is to buy into strategic, unconventional fuel produced in the United States. That would mitigate historic market risk a century after discovery.
- Some say that 1.3 trillion barrels, under market and positive circumstances, could eventually become 10 million barrels a day. With 10 million barrels a day, which is doable with existing resources and technology, the U.S. could be 80 percent reliant on North American oil and be 20 percent dependent on foreign oil.

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Shale is a very big part of American history. First of all, shale is not "yesterday" in the sense of the current crisis of energy security. It goes back to 1913, to Winston Churchill, to the British establishing a state company entering Persia to secure the access to petroleum for the Navy, and, in a parallel action, the United States establishing the Office of Naval Petroleum and Oil Shale Reserves (its current designation in the Department of Energy). From 1913 on, government and industry have been watching these oil shale reserves.

Oil shale has an episodic history that relentlessly provokes frustration. Why is it not developed? It even produced histories and congressional hearings in the 1960s and 1970s of almost novel-like proportions. The most interesting point is that the pioneers, with covered wagons, knew about shale. They found it going west in the 19th century and used it for axle grease in their wagon wheels. So the petroleum-like end-use of shale oil took place before the country was unified coast to coast.

While the government established this office, geologists of the time established that in the Rocky Mountain region, in three petroleum basins—the Piceance Basin is one—there was an enormous oil reserve which was locked into shale rock in the form of what is called kerogen. Kerogen is an obscure pre-petroleum organic sediment. It is what nature did not complete by heat and combustion, the process that developed petroleum. There was insufficient heat to transform the molecules in this material into petroleum, so it remains in the pores of enormous shale rock formations in northwest Colorado, Wyoming, and some in Utah, all far from the Persian Gulf.

This oil shale set Congress on its heels. The Mineral Leasing Act of 1920 was changed to promote oil shale development in the United States, because 1920 was a scarce period. We were running out of oil, very similar to some scenarios of the last two years. And then nothing happened; the potential of oil shale went silent. Under President Herbert Hoover, the decision was made to abandon leasing of oil shale. Fifty-four years passed without one lease going into shale.

The Second World War stimulated official interest. The U.S. Bureau of Mines, since abolished, began research on oil shale.

Stewart Udall, who was a founder within the Democratic Party of the environmental movement, was pro-shale. As Secretary of the Interior, he mobilized in the 1960s to move shale forward, to lease it, to make it commercial, but this effort failed again. The debate over oil shale in the 1960s concluded that the very low price of conventional petroleum ruled out shale. Required oil shale investment could not compete against imported, low-cost petroleum as American companies went worldwide in the '60s. At that point, the economics were not favorable.

In the 1970s, with the OPEC embargo and the price escalation, shale once again attracted attention, and the first leases went forward. American oil companies applied for leases and paid $41,000 per acre in Colorado. Seventy-five percent of the shale is federal; 25 percent is patented private.

How large is this resource? In the Piceance Basin, an area of 1,100 square miles, the oil shale is over 1 million barrels per acre, or roughly 750 billion barrels of recoverable oil. If you extend outward to Wyoming and to Utah, it is 1.3 trillion. This is why you hear shale next to trillions, not billions or millions, of barrels. The Air Force in the 1970s looked at shale, tested it, and found that it was a superior liquid for jet fuel. Roughly 65 percent of the oil shale is liquid, which could go into jet fuel. The J-8 engine can take shale oil as premium jet fuel.

These are the dynamics now. From the 1970s, in which the Iranian hostage events and consequent escalation in price led to the 1980s Synfuels Corporation and its abandonment, a good deal of government incentive and private initiative advanced oil shale technology and pilot scale production. Why did it fail in 1982? Look at the price charts. Saudi Arabian exported production expanded, and new supplies, non-OPEC and OPEC, came on the market. The market was saturated with conventional oil from the Middle East, and prices fell rather radically to about $15 a barrel, which was less than breakeven for Texas oil in 1986. So the market again changed the dynamic against shale oil.

Apart from supply and demand, there is the technology variable. The oil shale technology of the 1970s is not the technology of 2007. The technology of the 1970s had imposed a surface disturbance footprint which today would be unacceptable in the United States. The process to recover kerogen and

upgrade it was essentially mining; that is, to take the shale itself, ton by ton, to the surface and to crush it with great volumes of water and retort it, creating spent shale or tailings for disposal. Then there were extraordinary water requirements: over three barrels of water for one barrel of shale.

What has changed since the 1980s are the dynamics of supply, demand, security, and technology. Two years ago, a major superstorm struck the Gulf of Mexico, which supplies 30 percent of our oil and 25 percent of our natural gas. We are increasingly concentrated in the Gulf of Mexico. Congress was unable under the Republican majority to pass Outer Continental Shelf legislation, which would have expanded access to oil and gas offshore. With one minor concession in the Gulf, nothing was done. We are still dependent on a Gulf-centered domestic supply.

Second, what happened with Katrina was that it triggered thinking about natural disaster and its relation to climate change, because the climate change movement saw the storm as the function of superheated oceans, which would cause more superstorms. This caused another development in the market itself. All of the oil and gas, heating oil, and related products' prices are determined in futures markets on a 24-hour basis from Singapore to New York. Both investors and speculators began to see that there was a new vulnerability to oil supply, not only caused by the war in Iraq and the geopolitics of the Middle East, but also from natural disaster linked to global warming. They began unprecedented speculation in oil, driving the price up to the historic high of late last summer.

The interesting part of that was the belief of speculators in the forecasts of climatologists, who study climate change, that there would be seven superstorms last summer of the Katrina class. But none occurred, and gradually the prices of oil fell from the high of $78 per barrel to the low of $50, and now we're in the middle range. This shows some uncertainty and unpredictability about those climate change scenarios.

Shale oil is not responsible for price or technology; the resource is simply in place. Resource recovery is feasible. Around it is a technology change, and around that is always price. Why that Colorado shale hasn't been on the market, and where we would be today if it had been, is a function outside the resource itself and the technology used to make it into oil. It is a function of policy and price.

There is a silence about this that I want to call your attention to. Those of you who are familiar with the Energy Policy Act of 2005 can turn to Section 369, which calls upon the Administration, the DOE, to produce a report to make policy recommendations to commercialize oil shale in the United States and to recognize it as a strategic fuel. That report was mandated by Congress, but it has not yet been released and sent to Congress. It contains incentives that are needed still to develop the shale in Colorado. Those incentives are quite obvious.

There is a market risk in shale, as I pointed out, because of the oil price volatility over the last 87 years and the episodic way shale has been handled by the world market and government. Market risk reduction is among the DOE recommendations, and that translates into production tax credits and possibly one other item which I'm going to mention: streamlining the permitting process. Go to the Energy Policy Act; you'll see in Section 369 what was mandated about shale and perhaps why it is has not been released.

The Energy Policy Act of 2005 created a partnership with Alberta in tar sands development. Alberta is the world's largest producer of tar sands or bitumen, another unconventional fuel source, which could reach 4 million barrels of oil per day by 2012. Alberta's fuel exports to the United States are greater than Saudi Arabia's. It has been a success story. The conversion of tar sands through natural gas and steam injection has produced oil, and those reserves in Alberta are now classified officially as reserves, not resources. That exists in U.S. legislation, in law, to form those partnerships.

So as President Bush leaves Washington this afternoon to go to Brazil to sign a well-publicized agreement on Brazil's sugar conversion to ethanol, why not add to that an agreement under Section 369 of the Energy Policy Act 2005: an agreement with the Brazilians to co-develop, share technology and information on, Brazilian oil shale? The United States has 1.3 trillion barrels of reserves, followed by Brazil with 90 billion barrels. With 90 billion barrels of new oil reserves in Brazil, the geopolitics of Latin America oil will surely change.

Why am I optimistic about shale in 2007? It's been 25 years since the world petroleum price shut down development in Colorado. What is now available in terms of technology that changes the perspective of shale? Why should we not call shale an official strategic fuel in the United States, and why not commercially develop it in a most aggressive way?

The technology issue is moving significantly in terms of progress. For example, one major development is the Shell Oil project in Colorado. Shell has established some leadership; it has been in Colorado for 30 years. It has invested, in terms of research and development, a significant amount of its own revenues and is moving toward commercialization.

Shell has Bureau of Land Management research and development leases and is moving stage by stage to prove up and resolve all the issues around extraction of shale through a proprietary process called the in-situ conversion process. Understanding ICP requires a visualization that eliminates the surface retort heating and disposal of shale rock as a mining-industrial process. Shell is going underground. The refinery of shale will be underground, with almost no surface impact. This is a breakthrough change in technological capability, and it makes shale accessible. Shell is confident that it can recover shale oil with the price of West Texas intermediate oil at around $25 a barrel.

Older studies have always argued—again, using the 1970s know-how and data—that surface processing would create prohibitive costs extending to intractable problems of reclamation; and water use in the older studies, as I said, was projected at three barrels of water to one barrel of oil shale oil. However, Shell is going underground into the shale formation with electrical heaters. The heaters will provide high-temperature radiant heat, which will then do what nature did not do for organic matter when it was transformed into conventional petroleum. The shale rock under very hot conditions and combustion will yield kerogen, which will flow to the surface through production wells.

There is silence about shale in Washington, but not among the bloggers. I read the bloggers, and many of them have discovered shale. Many of the bloggers out in the West have a nightly debate about this.

What you see here is a potential for an environmentally friendly extraction of shale for the first time: no surface problems, nothing on the surface, an underground refinery. That is a change not available in 1981. But it has to be done by way of creating from Shell's conception, under today's social and environmental standards, protection of water. So Shell is developing the technology of an ice wall around the action of heating the shale, and the ice wall that they're going to put up—they're doing it experimentally now—must contain liquids from going into groundwater and protect the thermal process from water intrusion.

Los Alamos joined the shale development technology just three months ago and signed an agreement with Chevron. Chevron is going to use another unique technology; it is going to approach the rock itself, rubbleize it by explosives, and then flush the kerogen out with a critical liquid, which is CO_2. CO_2 is utilized as another method to reduce greenhouse gases or global warming.

The bottom line here is that the approach to shale extraction and converting it into oil in the United States will be a technology that will contain carbon. There will be a carbon footprint that will be established to diminish the carbon emission from the process of production by way of sequestering carbon, storing it underground, putting it into saline aquifers, and so on. Is there any basis for the claim that the conflict between shale oil and the environmental or climate change crisis is irreconcilable? Nothing will move forward without a carbon footprint integrated in the technology of recovery.

The resource, again, is in the trillions of barrels of oil, and if you compare, Saudi Arabia's official reserves are about 289 billion barrels. *The New York Times* said last week that it had discovered what is called essentially unconventional fuel, which is the topic today, and the petroleum industry is looking at how to get more oil out of existing fields. The Saudi response to that was, "We too can do that; we can potentially double our reserves, albeit with extraordinary investment."

If the Saudis upgraded their own recovery technology, which would take billions to do, they would still have one-half of the reserves in oil shale discovered in Colorado. We're talking still about 1.2 trillion, 1.3 trillion barrels of oil; the Rocky Mountain region is the Saudi Arabia of oil shale. The United

States has 75 percent of the world resource, which is about 1.8 trillion barrels. Brazil is next.

As the size of the resource grows, you can see the geopolitical configuration follows. China has announced government incentives for shale development in the last six weeks, while Washington is silent on Section 369. Then there is a series of interesting countries in the Middle East without conventional oil: Morocco, Israel, and Jordan are the next shale reserve holders in the world. This is a configuration of potential shale producers that might have an international organization, an OPEC of shale one day, and transfer of the technology. I should add Estonia, which develops much of its energy from oil shale.

Where are we with regard to the market today and investment? The price of oil will continue as the uncertain variable, and that's why the recommendations are still to look at shale and market risk reduction.

Secondly, there is the permitting process. Shale was once seen in the United States as so valuable that anti-monopoly issues dominated government shale policy. The government decided at one point that it wanted competition in shale and limited the acreage to 5,000 acres per company. We changed that in 2005 to 25,000 in five different locations; but if you look at the acreage per resource, 1 million barrels of oil from oil shale per acre, you'll get the idea of what acreage does. Do your computation: Bureau of Land Management R&D leases are 160 acres each. Underneath an R&D lease, there are roughly around 250 million barrels of oil, or over five months of Saudi Arabian spare capacity needed to stabilize the world market.

How long can oil shale last? There is enough shale to sustain United States consumption of crude oil easily through 2120. One of the arguments in the energy security debate has been foreign oil import dependence. Some elements of the national security community in Washington have joined the alternative fuels community, the biofuels community, under the notion that we are dependent upon potentially hostile supply sources after 9/11, which could be disrupted or politically manipulated.

The national security argument, or the energy security argument, centers on foreign oil import dependency. If shale is commercialized by 2012, we can, under production from Colorado alone, eliminate dependency on Middle East oil by 2020. The President wants to lower it by 20 percent by 2017.

Shale production will eliminate it altogether, and that dependence is roughly 2.3 million barrels a day. The projection is that when it is commercialized, with the ramp-up that will occur, and with everything favorable—that is, world price—we would be at 2 million barrels a day, or the objective of the Department of Energy in the shale process. Currently, we're getting 2.2 million barrels a day from the entire Middle East: 19 percent of our total imports.

Our major sources of imports are Canada and Mexico—that is, North America—and oil shale would expand a North American domestic energy source, which minimizes and reduces foreign oil dependency with GDP benefits to the American people. Some of the projections are that when shale is commercialized in the next three to five years, the market price will decrease at least $5 a barrel. That's conservative, but that depends on supply and demand worldwide and the growth of economies worldwide.

There's been a great deal of excitement about biofuels, and as you know, in Mexico and New Mexico and Arizona, the prime base for a staple tortilla is white corn. Because of the biofuels investment, U.S. farmers are beginning to turn their crops from food to fuel, and white corn has almost disappeared from the market. Even though Mexico has a NAFTA quota of 460,000 tons a year, Mexico is not getting it, so the price of tortilla corn in Mexico has had people demonstrating in the street and has caused low-income families difficulties in buying daily bread. I introduce that in contrast to the notion that we have a resource that has no impact whatsoever on food supply.

I'll conclude with a point about the history of this. When you leave here, the question is, Why is there silence today, in this Administration, on shale? There is a strategic task force that for two years has been meeting with five governors, and they have recommendations. There are two major companies with leases moving through R&D incrementally. A week ago, Shell had community discussions to bring in 600 employees into the shale area in the Rocky Mountain slopes.

That's big news; that's jobs and so forth. The perception is that something is going to happen, and something rather big. But there is a gap between the technology, the availability of the resource, the commercialization that is coming, and Washington policy.

Probably the most effective signal, apart from releasing the DOE report, derives from the President's proposal in the State of the Union to add 750 million barrels of oil to the Strategic Petroleum Reserve by the year 2020. I would propose a long-term contract with shale oil producers, that all of the production from 2013 in shale oil from Colorado and the Rocky Mountains to 2020 be dedicated to the SPR. Under existing law—again, the Energy Policy Act of 2005—the U.S. government can enter into long-term purchase agreements and buy oil from shale for the SPR. That would be an internal oil supply; it eliminates the national security risk of foreign oil import beneficiaries.

This would be a powerful incentive for the oil shale industry. It would itself reduce market risk without subsidies to a phenomenally low level, and it would put the U.S. government in the forefront of assuring energy security. The Department of Defense could also be a buyer of jet fuel, along with the SPR, and this would accelerate rapid commercialization.

So if the intention is to add to the Strategic Petroleum Reserve to improve energy security, then buy into strategic, unconventional fuel produced in the United States. That would mitigate historic market risk a century after discovery.

There are some who say that 1.3 trillion barrels, under market and positive circumstances, could eventually be ramped up to 10 million barrels a day. With a resource like that, at 10 million barrels a day, we are moving back to the 1960s, close to a position where our import dependence on petroleum is becoming marginal. Using that number—and that is a remote number, far off, but absolutely doable under the resource that exists and the technology—that would give us the following composition: We would be 80 percent North American at that point, with Mexico, Canada, Colorado, the oil shale, and conventional Texas, Alaska, all factored in, and maybe 20 percent oil dependent.

Questions & Answers

QUESTION: Ed Borcherd, Borcherd & Company. I'm currently working in Alberta with the Canadians on the water problem. The water problem is one of the biggest problems because it takes anywhere from two gallons to four gallons to produce one gallon of petroleum. It has a terrible effect on the natural environment, and many problems are coming from that. Do you have any comments on that particular problem?

DR. FINE: It's quite true. The retort that I talked about, building your processing and wetting the shale—that was where the water went—was about three to one. This is also cited in the RAND report, which was mildly negative on oil shale. But it is a dimension of the problem that existed in 1979. The two processes that I've mentioned, the injection of the supercritical fluid, which flushes the kerogen out of the rock and so on, is CO_2, and that is recycled. That becomes the problem today: the carbon footprint, how to get that manageable.

Neither the Chevron nor the Shell process is going to be water-excessive; and they have to be sensitive to the Colorado River Basin, because that is the source of the water, and share the water under 21st century standards. So I believe that the water problem is less under technology change than it was. What has changed is the fact that you've got a carbon-based material, and you have to capture the carbon to CO_2, use it, inject it, store it, and that's what's going forward under the Bureau of Land Management leases today. So it's no surprise that the carbon footprint is integrated in shale development; it's not hostile to it.

QUESTION: I'm Kirk Couchman with Sunoco. If you look at a map of where the pipelines that run crude oil in the U.S. are and where the refineries in the U.S. are, middle-American refineries—that is, Ohio, Texas, Oklahoma—the middle part of the country has access to crude pipelines running pretty much from anywhere to anywhere. If you look at the coasts, California and the East Coast—particularly the Philadelphia region—they don't have crude pipelines that run to them.

So when this oil shale is developed to the point where it's very commercially available, getting it to a significant portion of domestic refining capacity is going to be a bit of a problem. Are there any poli-

cies that you would recommend to change the current ability to site crude pipelines to overcome state and local opposition, which currently handle the regulations?

DR. FINE: There are current pipelines in the Piceance Basin, Rio Blanco County, running to Salt Lake; Salt Lake is pipeline connected. The infrastructure was put in place and refining and upgrading again in Salt Lake. It has a regional component.

What I would do is look at a very interesting development. The Canadians face a pipeline problem as well, and a refining problem with their tar sands in Alberta. So a leading Canadian company and ConocoPhillips decided to reinvest, or invest in each other. ConocoPhillips will make its refineries in the lower 48 open to tar sands product, bitumen, coming through. That's the twin of kerogen coming out of the tar sands. So the tar sands from Alberta will go to two or three mid-U.S. refineries. This is the adaptability on the refinery issue to get both tar sands and oil shale to market, to refine and get it into the system as well.

It has not become a problem in terms of development; the obstruction to development is not transportation at this point. Utah has some tar sands and some shale, and they will have to connect Utah into the pipeline infrastructure. It might be a little different. Utah has about 12 billion barrels of oil shale against the Colorado, and Wyoming is another player in that.

If you want a measurement, per ton of rock in Colorado, 35 gallons of oil, roughly, and then it declines in Wyoming to 20, 25 gallons; so Wyoming is less economic than Colorado. So visualize a ton of rock, because this is unorthodox in terms of petroleum, and what the rock will yield in terms of gallons. It is economic at 25 for one ton; that is now economic at $20 to $25 cost.

You all know the geopolitical issues in a world where the national oil companies are changing contracts, expropriating—Caracas, Venezuela—and diminishing the exploration space for the same companies who are in Colorado: Shell, Chevron, and so forth. It becomes almost an irrational resource question: Why is a resource in the United States not developed, and why is there so much silence around it?

QUESTION: What would you say is your answer to that? Why, in your opinion, is there so much silence, and why is the resource so underdeveloped?

DR. FINE: The reason for this is historic, in a way: uncertainty over price. That's why I recommend the SPR as the market-maker or initial buyer. Since the President declared, "We're going to buy the oil," the next step is where are we going to buy it? If it is purchased from oil shale in the Rocky Mountains, this is an indirect way to assist an oil shale industry.

The second reason is the episodic way shale is handled. When The Heritage Foundation said, "What is the best way to present this lecture?" I answered "Back to the Future," because generations of geologists and petroleum engineers, as students in mining schools in the West, were exposed to a pyramid. At the top was conventional oil, petroleum, from Texas. At the base of the pyramid was the hard-to-get stuff. Shale was almost at the bottom, and underneath shale were gas hydrates, which are even more difficult to get.

This was the American perspective from 1913 onward. My point is the expectation that the hydrocarbon cycle could be deferred even in the current crisis of energy security by a third element, apart from economics and technology: namely, public policy distorted by the public and the media reacting to agendas of security and fear—and, of course, by climate change.

The issue on climate change is simple. The Congress debated it for 18 months, and I watched all the debates from one side and the other. A speaker from one faction or the other would say, "We've got to reduce our dependence on foreign oil." The next speaker would say merely "oil." Do we mean dependence on foreign oil or imported oil, or dependence on oil itself?

If you look at it that way, there are two camps. Oil itself is available and abundant: 3.7 trillion barrels in unconventional oil in the world. There is the peak oil thesis, but the peaking out means that your oil-finding level is lower than it has been. You're not replacing as much as you did, in conventional oil only. But "peak oil" simply means that the old pyramid comes into play; you move down the pyramid, and the peak is rolled forward. You're on

plateau, and then you're into unconventional hydrocarbons oil.

Those who say the issue is oil itself make themselves very clear: They want to move away from oil and all forms of carbon. They want a carbon-free world, and that is their position. But let's not confuse import dependency with that issue. Imported oil does not equate with oil itself.

QUESTION: I'm Bob Hershey. I'm a consulting engineer. What do we have to learn from the oil shale experience of Estonia?

DR. FINE: Estonia has derived and continues to develop oil shale for electrical power. It burns the shale. It can make a fuel as well, but shale is around for production into utility—in other words, electric power, burning it. Estonia is a world leader in that respect.

Estonia just entered into an agreement with Jordan to develop Jordanian oil shale and so on. That's why I introduced the question of signing an agreement with Brazil, getting President Bush to enter into two agreements, one for sugar and one for shale, and then staking out, under existing law, technology sharing and agreements and co-development in Brazil. But we have much to learn from Estonia and the tar sands issues and others. There are many co-products.

One co-product, by the way, from Colorado shale is trona—soda ash—which was called nahcolite. The mineral byproduct is very valuable in terms of fertilizer and other products. There is an enormous co-product. It was interesting: The Bureau of Land Management looked at the Exxon application. Exxon wanted a lease, and Exxon did not put down its data, did not surrender data or interest in the co-product, and they didn't get the lease. So there is a valuable co-product in it: soda ash, nahcolite.

QUESTION: My name is Richard Ranger. I'm with the American Petroleum Institute. How do you respond to the contention that the main reason shale has not been developed has been because of economics, because of price, because of the cyclicality of crude oil prices, which at a couple of points, perhaps, reached points where companies were induced to invest in shale technologies as they understood them and then backed away, given downward price cycles. I think part of the response is your proposal to purchase shale oil production, or kerogen production, as you outlined in your talk, but it seems like you're describing history in a more complicated manner; if this had been economic to produce, it would have been produced.

DR. FINE: You introduce the whole history, really, in the question. In the 1960s, Stewart Udall called for shale leases. There was no interest from industry; American industry was not interested at that point, because crude oil was $3 per barrel. So the industry itself, looking at its assets and opportunities on a world scale by the 1960s, had to compare its rate of return from other opportunities against shale.

Why did shale fail in 1982? Why did Exxon close down its operation in Colorado? The slope of supply, the Saudi output up through the 1980s, again took the price down where it was not economic against other opportunities. What's interesting about that is what was economic in shale then and what is economic today. There are some studies still around, dated in the 1970s, which say that shale needs $70 a barrel to be economic and compete against conventional oil. But in testimony in the House Resource Committee in 2005, Shell said it could do business at $25 per barrel.

So we're in a period when the industry has to essentially take some risk. What's the risk of price? How do you evaluate forward prices against risk at this point? The shale story that I see in all cases that I presented today is that it will return industry a minimum of 15 percent return on investment, ROI. That will be indeed possible at prices, we'll say, over $40. And if you see oil going down to $40, as some analysts do, it is economic.

One of the things that the shale oil industry will look at will be a floor price to reduce market risk after years of price volatility. That will be interesting to see, but I think, at this point, the consensus is that the price of oil has reached a plateau. Are we going to go back to the days of $20 oil? If you see that, then you don't invest in shale. But if you see oil at $40 plus, then I think the industry has a real candidate in oil shale.

—Daniel Fine, Ph.D., is co-editor of Resource War in 3-D: Dependence, Diplomacy and Defense *and currently associated with the establishment of a new energy policy center in New Mexico.*