TASK FORCE ON STRATEGIC UNCONVENTIONAL FUELS

DEVELOPMENT OF AMERICA'S STRATEGIC UNCONVENTIONAL FUELS RESOURCES

INITIAL REPORT TO THE PRESIDENT AND THE CONGRESS OF THE UNITED STATES

PREPARED IN RESPONSE TO SECTION 369(h) (5)(A) OF THE ENERGY POLICY ACT OF 2005 (P.L. 109-58)

September 2006

THE STRATEGIC UNCONVENTIONAL FUELS TASK FORCE

Dear Mr. President and Members of Congress:

We are pleased to provide you with the Initial Report of the Analyses, Findings and Recommendations of the Task Force on Strategic Unconventional Fuels directed by Section 369 (h)(5)(A) of the Energy Policy Act of 2005.

This report is a product of a Task Force of eleven (11) members including the Secretaries of the Departments of Energy, Defense, and the Interior; the Governors of the States of Colorado, Kentucky, Mississippi, Utah, and Wyoming; and representatives of localities in those states that would be impacted by the development of the unconventional resources located therein. This report does not reflect agreement on all recommendations. However, the report lays out legitimate policy options which the Administration, Congress, States and local governments may consider. Nothing in this report reflects an *official* position of any member of the Task Force.

This initial report describes the findings of the Task Force regarding the potential of America's oil shale, tar sands, heavy oil, coal, and oil resources amenable to carbon dioxide injection to produce liquid fuels that could reduce our nation's dependence on imports. These initial findings suggest that aggressive development by private industry, encouraged by government, could supply upwards of 6 million barrels of oil equivalent per day of incremental production by 2030.

The mission of this Task Force is to evaluate the potential contributions of these resources, individually and in aggregate, identify and address constraints to their development, and to offer recommendations and policy options for an integrated program to promote and accelerate their commercial development. The integrated program will achieve these goals in a sustainable manner that enables prudent resource development while respecting the environment and protecting the impacted states and communities from adverse socio-economic impacts.

This report identifies impediments and uncertainties that could constrain development of our resources and offers policy options for Federal and state government that could facilitate development of a domestic unconventional fuels industry.

We appreciate your thoughtful consideration of these findings and policy options.

Respectfully submitted by:

TASK FORCE ON STRATEGIC UNCONVENTIONAL FUELS

Governor Jon M. Huntsman
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I. INTRODUCTION

Declining domestic oil production and rising U.S. demand for oil increase the nation's dependence on imports of foreign oil. This growing import dependence represents challenges to the strategic interests of the United States, particularly as global conventional oil production may soon fall short of global demand.

Significant opportunities exist for producing fuels from the nation's vast unconventional resources, including: oil shale and tar sands, heavy oil, enhanced oil recovery, and coal-derived liquids. Domestic production of fuels from unconventional resources could reduce import dependence and the potential impacts and strategic risks posed by global oil supply and demand trends.

DIRECTIVES FROM CONGRESS

In Section 369 (h) of the Energy Policy Act of 2005, the Congress directed the Secretary of Energy to establish a Task Force to:

- "… develop a program to coordinate and accelerate the commercial development of strategic unconventional fuels, including, but not limited to, oil shale and tar sands resources within the United States, in an integrated manner" [Sec 369(h)(1)], and to
- "make such recommendations regarding promoting the development of the strategic unconventional fuels resources within the United States as it may deem appropriate" [Sec 369 (h)(3)]; and to
- "make recommendations with respect to initiating a partnership with the Province of Alberta Canada for purposes of sharing information relating to the development and production of oil from tar sands, and similar partnerships with other nations that contain significant oil shale resources". [Sec 369 (h)(4)]

Congress further directed that:

- Not later than 180 days after the date of enactment of this act, the Task Force shall submit to the President and the Congress a report that describes the analyses and recommendations of the Task Force, and that
- The Secretary shall provide an annual report describing the progress in developing the strategic unconventional fuels resources within the United States for each of the 5 years following submission of the [initial task force] report. [Sec 369 (h)(5)]

Section 369 of the Energy Policy Act of 2005 also directed the Secretary of the Interior to develop a Programmatic Environmental Impact Statement and commercial leasing regulations for oil shale. This mandate builds on the oil shale research, development, demonstration and leasing program initiated by DOI in 2004. The RD&D leasing effort is carefully phased to ensure that oil shale technologies can operate at economically and environmentally acceptable levels prior to expansion to commercial-scale operations. It also vested DOI with lead agency responsibility for "Inter-Agency Coordination and Expeditious Review of Permitting Process" (Section 369(k)). The policy options and subsequent program elements developed by the Task Force respect the authorities and responsibilities granted to the Department of the Interior and complement ongoing and future DOI efforts related to unconventional fuels development consistent with the Mineral Leasing Act and the Energy Policy Act of 2005.

TASK FORCE ACTIVITIES

As directed by the Act, the Secretary of Energy, in cooperation with the Secretary of the Interior and the Secretary of Defense, has convened a Task Force on Strategic Unconventional Fuels comprised of the Secretaries of the Departments of Energy

(DOE), the Interior (DOI), and Defense (DOD); the Governors of key states in which unconventional resources are located; representatives of localities that could be impacted by the development of nearby unconventional fuels resources; and their official representatives.

The Secretary has provided technical, analytical, and staff support to the Task Force through the DOE Office of Petroleum Reserves (OPR) and has made other relevant resources of the Department available to the Task Force as needed. The Petroleum Reserves Office has prepared and provided extensive background materials and analyses to inform the Task Force and to facilitate its assessments and deliberations that have resulted in the initial findings, recommendations, and policy options provided in this report.

The Task Force has held six meetings to date, including a kick-off meeting on March 22, 2006 in Denver, CO; a conference call on April 7, 2006; a formal meeting held in Salt Lake City, Utah on May 11, 2006; a meeting in Lexington, Kentucky on June 28-29, 2006; a formal meeting in Shepherdstown, WV on August 23-24, 2006; and a formal meeting in Denver, CO on September 25, 2006.

SCOPE OF EFFORT

Task Force Functions: To develop a program to coordinate and accelerate commercial development of strategic unconventional fuels [Sec. 369(h) (1)], with regard to differences among regions and unconventional fuel resources, the Task Force will:

- Define the resources to be considered as strategic unconventional fuels, and
- Define a coordinating mechanism that embraces the federal, state, and local governments and communities, and facilitates appropriate private sector input.

To make recommendations and identify policy options promoting the development of strategic unconventional fuels resources [Sec. 369(h)(3)], the Task Force will:

- Identify and understand major constraints to commercial development,
- Identify and evaluate potential actions and policy options for reducing or resolving impediments,
- Propose the goals, structure, and major elements of an integrated program, and
- Identify specific policy options for consideration by the Administration and Congress to promote and accelerate commercial development.

To make recommendations on the benefits and advisability of international partnerships related to tar sands and oil shale [Sec. 369(h)(4)], the Task Force will:

- Assess potential costs/benefits of partnering to share oil sands information with Alberta,
- Identify foreign countries with significant oil shale resources and/or active oil shale development programs,
- Assess potential costs/benefits of partnering to share information on technology/resource development, and
- Recommend whether and how to partner with others on tar sands and oil shale.

The Task Force has made considerable progress in reviewing and assessing the potential contributions of the nation's key unconventional fuels resources. The following chapter summarizes the analyses and assessments that have been performed to date and the findings and conclusions that lead to the initial policy options provided for consideration in this report.

Resources Addressed by the Task Force: The Act defines the scope of the Task Force's mission to address strategic unconventional fuels, including, but not limited to, U.S. oil shale and tar sands. The Task Force has defined its scope to encompass the resources:

- Oil Shale
- Coal-derived liquids
- Heavy Oil
- Tar Sands, and
- Candidate oil resources for CO_2 enhanced oil recovery.

II. TASK FORCE FINDINGS

ANALYSES AND ASSESSMENTS

In reaching its initial conclusions, The Task Force has relied significantly on supporting analyses and assessments prepared by DOE's Office of Petroleum Reserves (OPR). These analyses include resource profiles, developed from DOE sources and open literature, which describe each of the strategic resources to be addressed by the Task Force in terms of its location, size, and potential contributions to domestic fuels supply.

The resource profiles assess the status of existing technologies for conversion of the resources into fuels, provide estimates of current and potential economics, and identify technical, economic, regulatory, infrastructure, and socio-economic impediments that constrain private sector development of unconventional resources at commercial scale.

The Task Force has also reviewed the independent findings of the Department of Defense, Office of Advanced Systems and Concepts[1], which assess the size and potential of various domestic unconventional fuels resources, including shale oil and coal-derived liquids, to supply defense fuels requirements.

The Task Force has reviewed and considered the findings and recommendations of an *ad hoc* Oil Shale Steering Committee that were provided to the OPR[2], as well as a two volume report on the Strategic Significance of America's Oil Shale Resources" prepared for the DOE's OPR in 2004.[3]

Concurrent with the formation of the Task Force and the preparation of supporting materials and assessments for the Task Force's review, the OPR contracted the expansion of its recently developed National Oil Shale Model to encompass all of the strategic unconventional resources to be addressed.

The initial Oil Shale Model has been reviewed by DOE, industry, and other Federal agencies and provides a basis for the oil shale-specific findings and recommendations in this report. The expanded model has been completed and is undergoing a thorough review by the DOE, to be followed by an independent industry peer review.

The Task Force expects that this integrated model will be available to assess the costs and benefits of various public policy options for stimulating industry development of strategic unconventional fuels as part of the next stage of the Task Force's ongoing efforts.

A variety of options for public action to accelerate and promote unconventional fuels resource development have been defined by the Task Force for further evaluation. These options have been organized under three development scenarios for evaluation of their potential to stimulate unconventional fuels production.

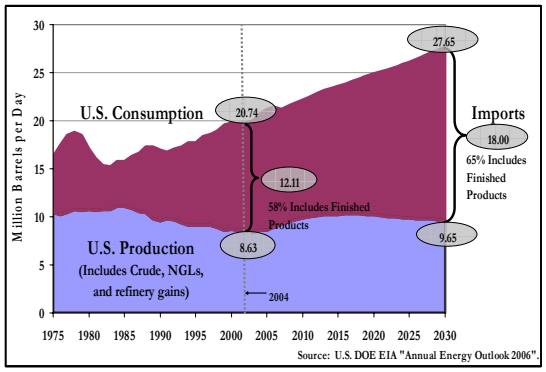
INITIAL FINDINGS AND CONCLUSIONS

General Findings

- Growth in world oil demand is outpacing increases in discoveries of new oil reserves and petroleum production.
- America's increasing dependence on oil imports underscores the need for greater domestic fuels production and more diverse sources of supply.
- Reducing the rate of demand growth and increasing domestic fuels production are both necessary to reduce import dependence and enhance U.S. energy supply security (Figure 1).[4]

  The United States has substantial unconventional fossil fuels resources that could be produced and converted to liquid fuels. These resources differ by region in quantity and composition and in readiness for commercial production.

Figure 1. U.S. Liquid Fuels Demand and Imports Will Continue to Increase



- These resources have heretofore gone largely undeveloped because of high production costs relative to conventional light crude oil and other uncertainties.
- Production of fuels from unconventional resources could reduce imports, reduce our Nation's vulnerability to supply disruptions, and sustain or grow domestic economic activity. As such, America's unconventional fuels resources should be considered vital strategic assets.

Uncertainties constraining industry investment in the development of domestic unconventional fuels resources can include:

- Access to resources on public lands
- Technology performance and efficiency
- Capital investment and operating costs
- Price and market risks
- Federal and state fiscal regimes
- Environmental standards, permitting processes and timelines
- Infrastructure requirements
- Water requirements and availability, and
- Socio-economic impacts of development.

It should be noted that some Federal efforts are already underway to address some of these constraints. The Secretary of the Interior is charged under the Mineral Leasing Act (MLA) with establishing the royalty structure for resources on public lands. Royalty structures exist for coal, tar sands, and heavy oil and the Department of the Interior is presently developing regulations for oil shale.

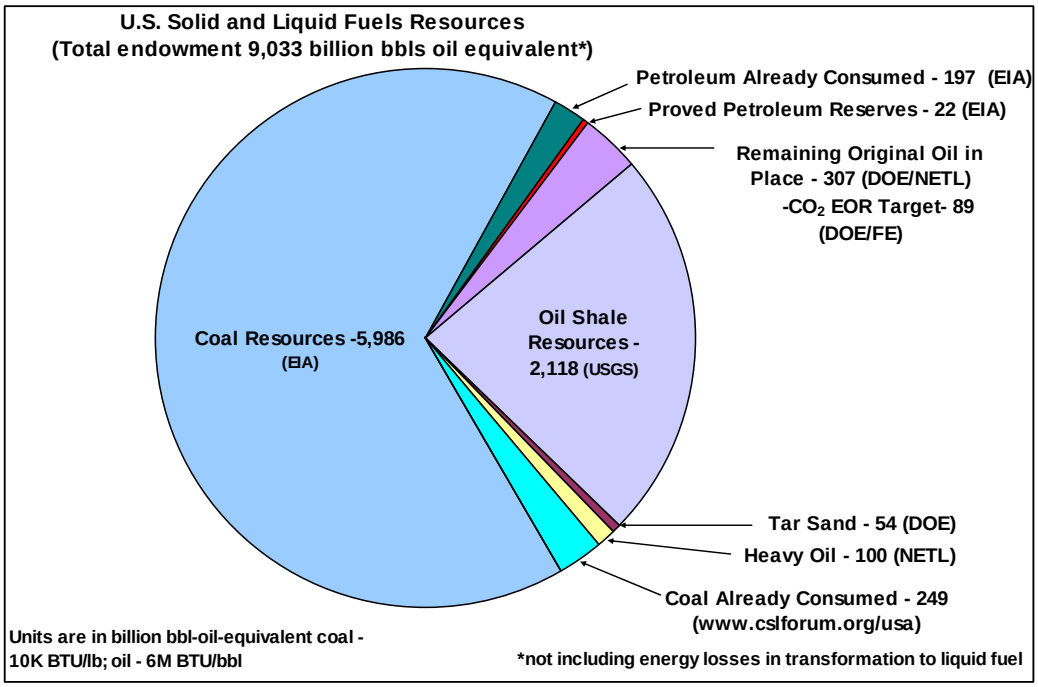
The Department of the Interior is also preparing a Programmatic Environmental Impact Statement (PEIS) for commercial leasing for oil shale, as directed by the Energy Policy Act of 2005. The PEIS, expected to be completed by July 2008, will guide oil shale and tar sands leasing across a 2.4 million acre study area in Utah, Colorado, and Wyoming. Commercial leasing regulations are expected to be promulgated within six months after the completion of the PEIS. The Secretary of the Interior, as directed by the Energy Policy Act, will consult with the governors of the affected states to determine the level of interest in oil shale development prior to the commencement of commercial oil shale leasing.

Prudent development of America's unconventional fuels resources offers an opportunity to secure the Nation's energy future and contribute to global energy supply in a manner that will yield social and economic benefits not only to Americans, but to our neighbors throughout the world.

If we are to realize this potential, before global oil supply and demand imbalances, competition for supply, and higher prices negatively impact our economy and our society, government must use its authority to create an environment that stimulates timely technical advances and industry investment.

- A "base case" approach, assuming the current rate of development, existing laws, processes, and fiscal regimes, demonstrates that it is unlikely that significant investment in, or production of, unconventional fuels will occur in the foreseeable future.
- A "measured" approach to encouraging development of unconventional fuels resources, in which government actively mitigates or responds to major impediments and uncertainties to investment, could result in several million new barrels per day of production by 2035.

Figure 2. America's Endowment of Solid and Liquid Fuels Resources



- An "accelerated" development approach to achieve higher production targets more quickly will require significant government investment and risk-sharing with industry, but could perhaps double the incremental production achievable by the measured case in the same time frame.

Initial findings regarding the potential production of fuels from specific unconventional resources under these scenarios are presented later in this report.

Our Unconventional Fuels Resources

Our Nation's endowment of solid and liquid resources that could be used to produce domestic fuels extends well beyond conventional petroleum. Figure 2 shows the Nation's original endowment of solid and liquid fuels resources, including that which has already been consumed.[5] Principal among these resources are coal-derived liquids, heavy oil, oil shale, and tar sands. The extent and locations of the resource–in-place are both well known and largely quantified. For most, there is little if any exploration risk. Appendix A addresses the energy efficiency of these resources relative to conventional crude oil.

Oil Shale: America's oil shale resource exceeds 2 trillion barrels, including about 1.5 trillion barrels of oil equivalent in high quality shales concentrated in the Green River Formation in Colorado, Utah, and Wyoming. Other lower quality and less concentrated resources, totaling about 619 billion barrels, are deposited in several southern and eastern states. Figure 3 shows the locations of U.S. eastern and western oil shale deposits, with a detailed view of the Green River Formation.[6]

These resources can be processed in-situ, or mined and processed in surface retorts, to generate diesel and jet fuels as well as other high-value chemicals.

- Depending on technology and economics, as much as 800 billion barrels[7] of oil equivalent could be recoverable from oil shale resources yielding >25 gallons per ton. Production of fuels from domestic oil shale, under various growth assumptions, could potentially exceed 2.5 million barrels/day within 30 years[8].
- The sizeable response to the Department of the Interior's 2005 offering for oil shale RD&D leases on Federal lands signals that private industry may once again be ready to aggressively pursue the potential of the Nation's oil shale resources.

Figure 3. Distribution of Eastern and Western Oil Shale Resources

Source: Oil & Gas Journal; Department of the Interior

Coal-Derived Liquids: Current U.S. proven coal reserves exceed 267 billion short tons – approximately 250 years of supply at current production rates, about 1.1 billion tons in 2005.[9] Nearly all U.S. coal production is used for electric power generation.

The four types of coal found in the United States differ in composition and energy yield. They rank from anthracite to bituminous to sub-bituminous to lignite, with carbon content and energy yield decreasing with the rank. Figure 4 shows the geographic distribution of U.S. coal resources by rank.[10]

Recent estimates by the DOE indicate that a 4 million barrel per day coal liquids industry would consume about 700 million tons of coal per year or about 25 percent of current coal reserves over a 100 year period, depending on coal quality.

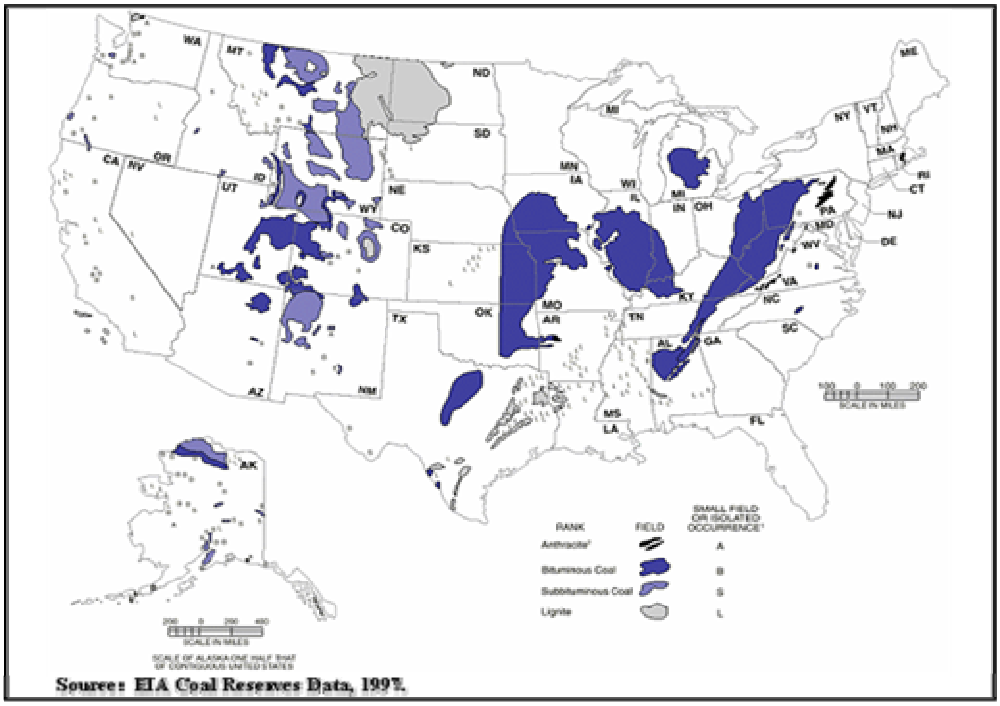
Coal can be converted into liquid fuels by using either *direct* or *indirect* liquefaction technologies. Currently, indirect liquefaction appears to have the greatest potential.

Most U.S. coal is suitable for gasification with oxygen and steam. The synthetic gas can be used to generate clean electric power or various other energy carriers such as hydrogen or liquid fuels such as ultra clean diesel, and jet fuels, using Fischer-Tropsch (F-T) synthesis to convert the gas to liquids. This technology has been demonstrated at commercial scale in South Africa in three facilities operated by Sasol since 1980. The integration of more recent entrained coal gasification technology with F-T synthesis, however, has not been demonstrated with domestic coal, but appears promising.

Indirect coal liquefaction plants can be configured to produce liquid fuels or a combination of liquids, power, hydrogen, and/or chemicals. The "co-production" or "polygeneration" plants may offer superior economic or environmental performance. However, while all of the component technologies – gasification, integrated gasification combined cycle (IGCC) generation, and F-T synthesis to liquids – have been individually demonstrated, no *integrated* plant has yet been demonstrated at commercial scale in the United States.

First of a kind domestic coal to liquids plants are likely to have capital costs ranging from $70,000 to $100,000 per daily barrel of capacity. Capital costs for a 50,000 Bbl/d plant would be between $3.5 and $5 billion.

Figure 4. U.S. Coal Deposits by Rank



With these economics, produced fuels would be competitive at a world price for light sweet crude oil at or above $45 - $60/Bbl, excluding costs for carbon capture and sequestration and tax credits or other subsidies.[11] Plants smaller than 50,000 Bbl/d are likely to have greater per barrel capital costs.

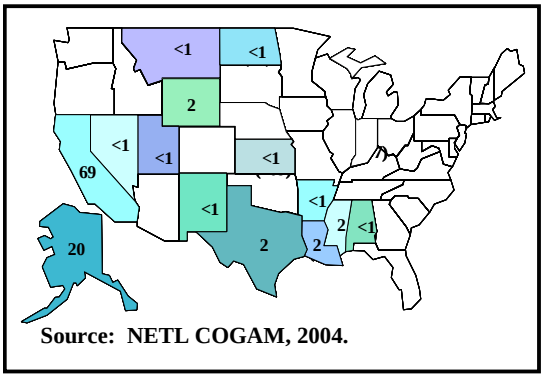
Recently, the National Coal Council estimated that coal liquids production, primarily from *indirect* liquefaction using coal gasification and F-T synthesis techniques, could reach 2.6 million Bbl/d by 2025, consuming 475 million tons per year of coal. At least eight U.S. indirect coal liquefaction projects, ranging in capacity from 2000 to 50,000 barrels per day were being actively considered at the time of this analysis.[12]

Direct liquefaction, refined coal, and coal-slurry liquids offer potential for quality transportation and/or boiler fuels. However, additional analysis is required by the Task Force to assess the production potential for various liquid transportation fuels from coal using indirect and direct liquefaction and other coal-liquids technologies.

Heavy Oil: Heavy oil can be used to produce motor gasoline, diesel, jet fuels, asphalt, and petroleum coke. Estimates of U.S. heavy oil resources in place range from 60 to 100 billion barrels, of which 2 billion barrels are proved reserves and another 20 billion barrels could ultimately be recoverable.

Most U.S. heavy oil resources are located in California (73%) and Alaska (20%) with the remainder in the Gulf Coast, Rockies, Mid-Continent, and Permian Basin regions. In Alaska, the West Sak and Schrader Bluffs fields alone may contain 10-20 billion barrels of resource. Figure 5 displays the approximate size of the heavy oil resource by state.[13]

Figure 5. U.S. Heavy Oil Resources by State (Billion Bbls)



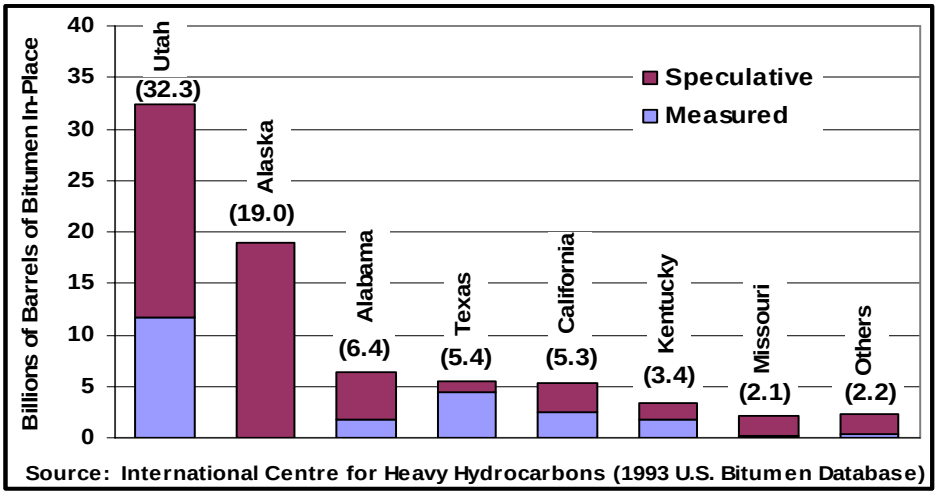
The viscosity (thickness) of heavy oil makes it immobile, requiring heating or solvent gases to make it flow, or direct mining to recover the resource.

- However, technology advances in the United States, Canada, and Venezuela, enable production activities to target heavier and more viscous oils in remote settings. Frequently these heavier oils are located at shallower depths making them accessible. Advances in steam flooding, vapor extraction and CO_2 enhanced recovery offer promise to increase production.
- Application of the most advanced current heavy oil technology is still limited to a small portion of the resource in the "best reservoirs."
- Current domestic heavy oil production by thermal enhanced oil recovery (EOR) processes is about 302,000 Bbl/day and approaches 500,000 Bbl/day when production by other processes is included.[14]
- Additional production of nearly 500,000 Bbl/d could be achieved.[15]

Tar Sands: Domestic tar sands resources in place are estimated to be 54 billion barrels, about 11 billion barrels of which could be recoverable. Some 32 billion barrels of the resource are located in Utah, 18 billion in Alaska, and the remainder is distributed in Alabama, Texas, California, Kentucky and other states (Figure 6).[16]

- U.S. tar sands are typically found in sandstone. Unlike the Alberta oil sands, the grains of sand are often consolidated, or cemented. Much of the domestic resource is also "hydrocarbon-wet" as opposed to "water-wet," making bitumen-extraction by conventional water separation processes infeasible. These characteristics require new technology designs to enable recovery of the bitumen.
- The mature Alberta oil sands industry produces well over one million barrels per day and will achieve 2.7 MMBbl/d by 2015. Ultimate production capacity could well exceed 5 MMBbl/d.
- U.S. tar sands offer a smaller target than either Alberta oil sands or U.S. oil shale and are generally leaner and less uniform. Nevertheless, the successful oil sands industry development and production in the Province of Alberta lends credence to the potential recovery of U.S. tar sands by both surface and in-situ technologies.
- Oil production from U.S. tar sands is limited to minor volumes from a few deposits in California. With higher oil prices and public actions to encourage projects, production could approach 0.2 to 0.3 million Bbl/day by 2025.[17]

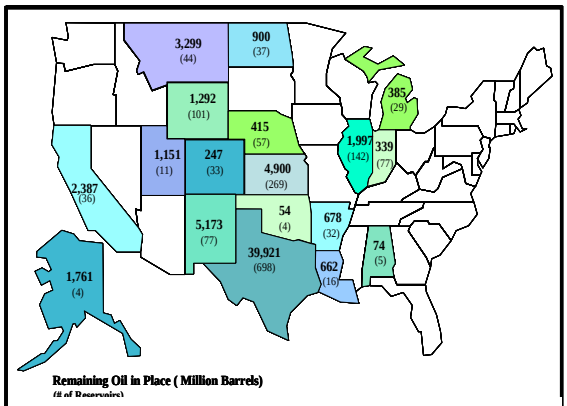
Figure 6. Tar Sands Speculative and Measured U.S. Resource[18]



CO_2 Enhanced Oil Recovery (EOR): Some 300 billion barrels of "immobile" conventional oil remains in known reservoirs, after primary and secondary production. A portion of this oil could be recovered, using demonstrated technologies, by injecting carbon dioxide (CO_2), heat, or chemicals. The distribution of the remaining oil in place eligible for potential CO_2 flooding is displayed in Figure 7.[19]

- Current domestic oil production by CO_2 EOR techniques is about 237,000 Bbl/d from about 82 projects[20]. Production is constrained by economics, the price of carbon dioxide, and the availability of infrastructure to deliver CO_2 to candidate reservoirs.

Figure 7. Remaining Oil in Place for Potential CO_2 EOR



Source: NETL COGAM, 2004.

- An additional 90 to 200 projects could be viable at oil prices between $30 and $50/bbl, constrained by the availability of CO_2 from natural sources.[21] These potential projects could add 2.7 – 2.9 billion barrels of reserves and 350 to 400 thousand barrels per day of oil production over the period 2010 to 2030. They would consume 400 to 600 billion cubic feet of CO_2 per year.

Absent the constraint of CO_2 supply, the number of projects, potential reserve additions, and daily production could be far greater, but would require significant investments in CO_2 pipeline infrastructure that may only be justifiable where target resources are highly concentrated or located in close proximity to natural or industrial CO_2 sources.

The DOE Office Oil and Natural Gas has recently published a series of ten "basin studies" that estimate both technical and economic recovery of crude oil from domestic oil reservoirs using state of the art CO_2-EOR technology. The Task Force will review these studies and consider their findings in the development of the overall program to coordinate and accelerate the commercial development of strategic unconventional fuels discussed at length in Chapter IV.[22]

The potential of increased recovery of conventional crude oil by CO_2-EOR could be enhanced by the availability of increased supplies of CO_2 from industrial sources. These sources could include CO_2 generated by unconventional fuels production, including oil shale, tar sands, and coal-derived liquids.

Significant potential may exist for synergistic benefits to be achieved from the concurrent development of these unconventional resources and increased CO_2-EOR development which could provide opportunities for carbon sequestration in oil reservoirs. The Department of Energy is currently investigating this potential, in collaboration with states, academia and other industry partners as part of its ongoing Carbon Sequestration Program.

Potential Domestic Fuels Production under Various Policy and Fiscal Scenarios

America's unconventional fuels resources, in combination, offer the potential to increase domestic production and global supply several million barrels per day. This potential could be realized in the foreseeable future by accelerating the current "business-as-usual" pace of technology advancement, private investment, and industry development.

Three development cases were analyzed to estimate the potential unconventional fuels supply that could be produced under various levels of government involvement. While some of the actions proposed for the Federal

government may not be current administration policy, they are presented to provide a full range of options to Congress, as directed by Energy Policy Act Section 369(h)(3). The features of these cases are summarized in Table 1. Appendix B provides more detailed descriptions.

1. Base Case: The "business as usual" case reflects the Department of Energy's Annual Energy Outlook for 2006. A business-as-usual case would result in only marginal additions to supply from unconventional resources within the next quarter century. Most of this would come from coal liquids production already stimulated by prior government and industry investment, and ongoing oil shale and tar sands initiatives of the Department of the Interior, further fostered by provisions of the Energy Policy Act of 2005.

Base case projections developed using the AEO 2006 show continuing growth in domestic demand and a nearly flat domestic supply. AEO 2006 for the first time shows contributions by coal liquids in the years 2025 and out. Without a proactive program in unconventional fuels, and efficiency gains beyond the base case scenario, the import gap continues to widen, especially after about 2017. (Figure 8)

2. Measured Development Case: The measured case contemplates that private capital will be attracted to develop unconventional fuels at a measured and logical pace, stimulated by government policy actions and fiscal regimes that require only limited direct incremental Federal expenditures.

For the measured case to materialize, conditions must be established that resolve the primary uncertainties for investors, and that provide confidence that government will be a partner in fostering development,

Table 1. Potential Unconventional Fuels Program Elements Under Three Hypothetical Scenarios

Potential Federal Actions	Business as Usual	Measured (Low Cost) Federal Action	Accelerated (Higher-cost) Federal Action
Policy statements in support of production	X	X	X
R&D and Commercial leasing / land tenure program for resource access	X	X	X
Regulatory stabilization and streamlined permitting	X	X	X
Limited R&D and Technical Assistance Funding		X	X
Fiscal regime changes (i.e., R&D tax credits, expensed investment, accelerated depreciation, production credits, favorable royalty terms, etc.)		X	X
Government organization to expedite Federal actions		X	X
Socio-economic and community planning support		X	X
Establish aggressive production goals			X
Accelerated R&D and Commercial leasing program			X
Significant direct investment in cost-shared RD&D projects			X
Price floors / Purchase agreements			X
Major Infrastructure Development Support (i.e., Water storage projects, highways, bridges, etc.)			X

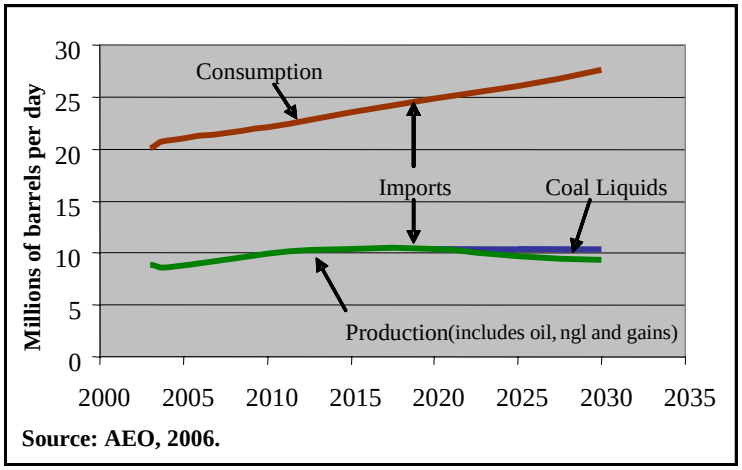
especially for the critical first-generation stage. The pace of development is accelerated by creating competition for opportunities.

Measured case conditions contemplate actions by government, some of which are already being developed, for various resources (Figure 9):

- Competitive access to unconventional oil resources on public lands.
- Regulatory and permit review processes, streamlined per implementation by DOI of EPACT Section 369(k), that provide confidence in permitting timelines.
- A fiscal regime that improves the attractiveness of capital investment through tax and royalty terms in the early years.
- A public organizational structure that expedites Federal actions, decision making, and investments.
- Funding for socioeconomic impact assessment and community infrastructure planning and development.

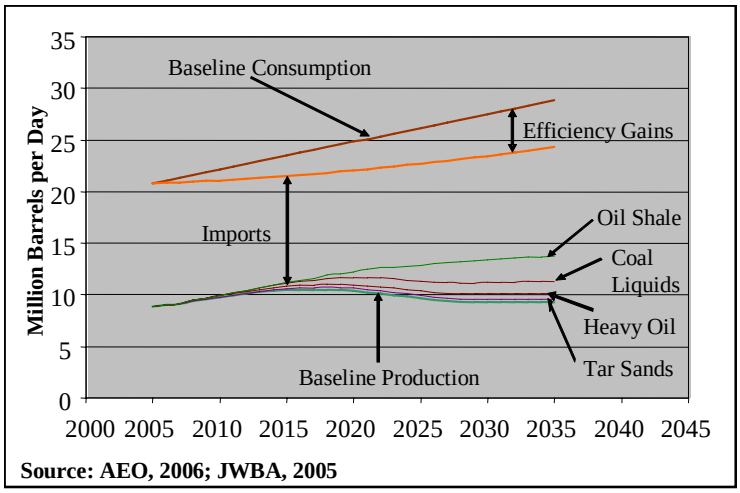
3. Accelerated Development Case: This case contemplates that a significant global oil supply shortfall is sufficiently probable to warrant development at an accelerated pace. The accelerated case (Figure 10) places a large share of the early financial risk on the government, stimulates faster industry investment, and by so doing shortens the time to establish an industrial base. The acceleration occurs by cost-sharing early commercial demonstration of the most plausible existing technologies.

Figure 8. U.S. Oil Production and Consumption – Business as Usual Case



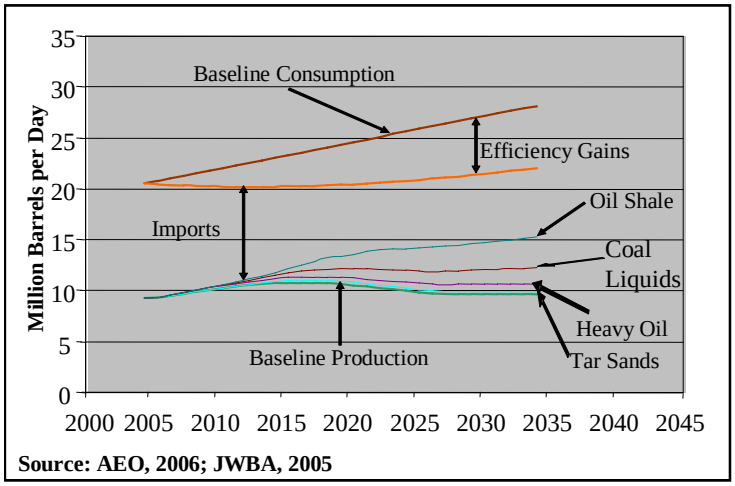
Source: AEO, 2006.

Figure 9. U.S. Oil Production and Consumption – Measured Case



Source: AEO, 2006; JWBA, 2005

Figure 10. U.S. Oil Production and Consumption – Accelerated Case



Source: AEO, 2006; JWBA, 2005

The government would cost-share multiple, simultaneous project developments.

An aggressive, accelerated development case can be made in which the government sets ambitious goals, effectively marshals and commits public resources, and invests and partners with industry to resolve impediments and reduce investment risks. Such a program could include a dedicated and integrated government organization, purchase agreements, and other price assurances, significant public investment in cost-shared demonstrations at pilot and commercially-representative scales, and other features that reduce risk and encourage near-term commitment and investment by industry.

Uncertainties Constraining Development Investment

Expeditious development of U.S. strategic unconventional fuels resources is constrained by a range of impediments discussed below.

- **Resource Access:** Significant portions of the Nation's unconventional fuels resources are located on public lands, some of which are currently restricted from leasing and development.

  Access to domestic unconventional resources will be required to enable and stimulate private investment. Current efforts of the Department of the Interior to develop and implement RD&D and commercial leases for oil shale and tar sands -- as directed by Section 369 of the Energy Policy Act of 2005 -- promise to address some of these critical access issues.

- **Environmental/Permitting Timeline Uncertainties:** Each unconventional fuels resource and technology poses particular environmental issues that must be addressed. Improvements in process efficiencies and performance of environmental technologies can reduce costs and assure environmental protection. Project costs can grow significantly when development schedules are delayed. Major causes of schedule holdup can include permitting delays.

  Regulatory and permit review reform that provides confidence in permitting timelines and regulatory standards and a consistent mechanism for timely conflict resolution are fundamental for private investment to occur. DOI will initiate a permit streamlining effort based on Section 369(k) of EPACT 2005.

- **Fiscal Regime:** Commercial-scale unconventional fuels projects are likely to have upfront investment costs exceeding $1 billion per project for oil shale and coal liquids. Investment risks related to long lead-times for development and lengthy payback times can make these projects less attractive relative to other investment opportunities.

  Significant investment in unconventional fuels technology and resource development at commercial scale requires a fiscal regime that reduces risk and improves the attractiveness of capital investment.

Production Technology: Production technologies exist at various stages of development and reliability. Various elements of coal liquids technologies have been demonstrated, but not at commercial scale in a fully integrated facility in the United States. Demonstrated heavy oil technologies are currently viable for only a small portion of the resource. Both in-situ and surface retorting technologies for oil shale require advanced development, testing, and demonstration at pilot and commercially-representative scales.

Technical assistance, research, and demonstration of near-proven technologies at pilot and commercially representative scale, and technology exchanges could expedite development. The pace by which technologies are developed, tested, and demonstrated at commercially-representative scale will be a major determinant of the rate of development and level of production of domestic unconventional fuels.

- **Socioeconomics and Community Infrastructure:** Unconventional fuels development can have significant benefits as well as impacts for affected communities. Infrastructure and

community services to support industry development and operations typically require significant community planning and investment well before industry-generated revenues are available.

Despite projections of tight world oil supplies and long-term higher prices that would support sustained economic production of unconventional fuels, many communities will be both unable and unwilling to shoulder the financial burden of these requirements without assurances of protection from down-side risk associated with oil price volatility.

Communities prefer upfront funding for impacts assessment and infrastructure planning and access to financial resources to develop services, facilities, and infrastructure that will be required to support industry and population growth.

- **Markets and Infrastructure:** Investors must be assured that product prices will sustain an acceptable return on investment. Infrastructure constraints can limit the pace of project construction and industry development and the ability to transport products to end markets. The availability of adequate road, rail, and air transport infrastructure, and refining capacity, could represent significant constraints on unconventional fuels industry development in some regions.

Assurances that pipelines can be constructed and that road, rail, and other means of conveyance exist or can be established are key needs for unconventional fuels resource development.

- **Air Quality**: Development of unconventional fuels resources, including oil shale, tar sands, heavy oil, coal derived liquids and CO_2 EOR can produce significant emissions such as SO_2, NO_x, CO_2, mercury, and particulates. Existing technologies used in power generation, mining, refining, and chemical industries are likely to be applicable and effective in controlling these emissions. In some areas, however, where industry development could be more concentrated, development may be constrained by limits on the carrying capacity of the environment.

The government should work with industry to implement and advance technologies to reduce emissions, such as those that facilitate carbon capture and sequestration in coal liquefaction and other unconventional fuels processes.

- **Water Availability:** Many unconventional resources require water in significant quantities for communities, recovery processes, and disposal and reclamation purposes. Water requirements can vary by an order of magnitude for differing technologies and resources. Requirements will not be reliably known without the benefit of experience achieved through design, development, and operation of pilot and demonstration projects at a commercially-representative scale.

Water management plans will be important for most major projects and will be important informative components of demonstration projects. Significant public attention will be required, however, to define, plan, and construct critically needed new water storage and distribution systems to meet the needs of the industry and a growing population.

- **Government Organization:** The government is often impeded from acting expeditiously by its own organization structure. Multiple agencies must be involved, each having distinct jurisdiction and responsibilities, priorities, and staff constraints.

To accelerate the development of domestic unconventional fuels resources, the government must effectively organize itself, establish the unconventional fuels development mission as a critical priority, and commit the necessary resources, personnel, facilities, and funding to achieve the integrated mission.

III. INITIAL TASK FORCE RECOMMENDATIONS AND OPTIONS FOR CONSIDERATION

The Task Force has been briefed on the status and potential of the Nation's major strategic unconventional fuels resources and has reviewed a compilation of documents that identify the impediments facing local, state, and Federal Governments and industry in advancing and accelerating private industry development of these resources at commercial scale.

The following initial immediate recommendations of the Task Force are derived from our findings and conclusions and focus on three principal areas:

- Managing the creation of an integrated program for strategic unconventional fuels development.
- Overcoming impediments constraining private industry investment in first-generation projects.
- Exploiting potential synergies that may be achieved by partnering and information sharing.

The Task Force emphasizes that these recommendations do not constitute Bush Administration recommendations or proposals for legislative action, funding, or regulatory action. The following recommendations have not been cleared by the Office of Management and Budget as Administration proposals or for their consistency with the program of the President. Instead, these recommendations are the work product of the Task Force, which by law contains Federal Government representatives as well as State and local government representatives. Hopefully all of the recommendations will provide a useful platform for further discussion on the important issues presented in this report.

OPTIONS FOR ACCELERATING COMMERCIAL DEVELOPMENT OF UNCONVENTIONAL FUELS

Program Development: Congress has directed the Task Force to develop an integrated program for promoting and accelerating the development of strategic unconventional fuels.

The Task Force, supported by DOE's Office of Petroleum Reserves, has prepared an approach for program development that recognizes the distinct roles, interests, and areas of expertise of the participants and organizes them in working groups that address resource-specific as well as cross-cutting issues associated with strategic unconventional fuels development. The Task Force will provide recommendations and oversight to the program development process, which will be supported by the DOE Office of Petroleum Reserves. The initial schedule calls for completion of a draft program plan by the end of 2006.

The Task Force proposes the following options for consideration:

- Support the affected states and localities in: 1) participating in the program development process, and 2) conducting initial socio-economic impact analyses and assessments of investments that will be required to support increased populations resulting from unconventional fuels industry development, during construction and operating phases. Such analyses should be designed to supplement formal agency-sponsored environmental impact statement processes associated with unconventional fuels development.

- Accelerate DOD's Assured Fuels Initiative to define, test and acquire unconventional fuels within the scope of the Task Force.

OPTIONS FOR ADDRESSING MAJOR DEVELOPMENT IMPEDIMENTS

Access to Resources on Public Lands

Provide an effective land tenure system.

- Identify resource access barriers for unconventional resources, specifically: oil shale, coal, and tar sands.
- Prepare regional resource development plans for oil shale and tar sands. BLM will amend, as needed, existing Resource Management Plans to reflect results of the PEIS being prepared as directed by the Energy Policy Act.
- Consider an open nomination process for oil shale commercial leasing, similar to processes for oil, gas, and coal leasing.
- Provide sufficient budget and professional staff to enable DOE and DOI to comply with Section 369.

Regulatory and Permitting

Provide an inclusive regulatory system and review process that encourages expeditious development and a predictable schedule for permitting and approvals, consistent with Section 369(k) and other provisions of the Act.

- Document Federal and state environmental standards that apply to oil shale and other unconventional fuels development as part of DOI's implementation of Section 369(k) of the Energy Policy Act..
- Examine which Federal regulatory responsibilities could be delegated to states.
- Consider creation of a Joint Review Process (Federal, state and local representatives) to coordinate permitting processes and compress the permitting timeline.
- Work with state regulatory bodies to craft a streamlined uniform permitting process (DOE, DOI, EPA, Governors Associations, and Regional councils of government) as part of DOI's implementation of Energy Policy Act Section 369(k).
- Consider establishing joint Federal/state offices in the affected states, similar to BLM's current oil and gas pilot offices, to expedite permits while assuring regulatory compliance
- Enact legislation to better define which parties have standing in legal disputes and to establish time limits on decisions relative to permit application completeness and acceptability.

Economic

Create a fiscal regime that attracts needed private development capital, including but not limited to the following options:

- Allow capital costs for unconventional fuels to be expensed in the year incurred or accelerate depreciation.
- Set royalty rates for unconventional fuels on Federal lands at a level that captures fair market value for the taxpayers and encourages private investment. The Mineral Leasing Act establishes federal royalty for coal, tar sands, and oil and gas. The Secretary of the Interior has the authority under that Act to establish royalty rates for oil shale, for which rule making efforts are presently underway.
- Provide R&D tax credits for technology development and testing relative to unconventional fuels.
- Craft production tax credits designed to establish parity with oil.
- Authorize and implement purchase agreements for shale oil and other unconventional liquids.
- Incentivize first-generation projects that have higher risks but demonstrate commercial feasibility and lead the way for next-generation investors.

- Limit incentives to point of project payback or net positive cashflow where appropriate to protect public treasuries.
- Allow industry a credit against future royalty payments for advance investments to develop socio-economic infrastructure needed to support future unconventional fuels facilities construction and operations in the areas of impact.
- Consider purchase agreements for fuels produced from unconventional resources that feature price floors and collars.
- Provide loan guarantees or other repayment assurances to reduce risk-premiums on debt and encourage lenders to provide financing for first-generation projects.

Technology

Craft a fast-track technology program to attract investment.

- Complete the assessment of unconventional fuels resources and technologies mandated by Section 369(m) and (p) as soon as possible.
- Move best available technologies toward demonstration and commercial development as quickly as possible to urgently initiate fuels production.
- Analyze adequacy of domestic and global design, engineering, manufacturing, and fabrication to support domestic unconventional fuels industry development, and potential impacts on development schedules and costs.
- Focus RD&D and technical assistance efforts on current and next generation technologies, resolve major technical issues, and evaluate and test novel concepts.
- Consider funding facilities and personnel to develop and test oil shale mining and production technologies at pre-demonstration scale.
- Consider establishment of basin-specific environmental R&D efforts to assess environmental impacts and identify and advance environmental management practices and mitigation technologies that facilitate unconventional fuels resource development.
- Provide cost-shared technical assistance from DOE laboratories or other Federal facilities with directly relevant skills, expertise, and resources.
- Cost-share bench-scale and pilot testing for new technologies.
- Cost-share demonstration projects at commercially-representative scale.

Public Infrastructure

Create an integrated local and regional infrastructure plan that will support efficient development, realize synergies among infrastructure requirements for various unconventional fuels, and reduce duplicative investments.

- Identify major infrastructure requirements in affected regions – roads, railroads, airports, pipelines, power, water supply and storage, among others.
- Accelerate investments to coincide with integrated industry development schedule.
- Allow industry to fund or assist infrastructure development in advance of commercial-scale industry development, allowing a credit against future taxes or royalties until infrastructure expenditures are recovered.

Socio-Economic

Establish a program for development planning, funding, and training that mitigates adverse local impacts and maximizes state and local employment opportunities and economic growth. Consider ways to direct mineral revenues to address local impacts.

- Provide immediate planning assistance funds for affected communities.
- Encourage and assist financing of infrastructure development that is needed before industry revenue flows become

available (such as low-rate loans, loan guarantees, and bonds).

- Immediately create and support university and vo-tech training programs within existing educational institutions so that essential skilled labor is available, when needed.

Government Organization

Ensure the appropriate organizational structure at state, local, and Federal levels exists that will promote and accelerate unconventional fuels development in a reasoned and efficient manner.

- Create and implement the integrated Strategic Unconventional Fuels Program Plan.
- Consider creating a joint government organization to expedite unconventional oil development while looking after the public interest and providing a "one-stop shop" permitting and for management of government efforts and resolution of issues and impediments.
- Consider establishing a dedicated task force, government chartered corporation, or outsource mechanism to manage and accelerate government actions supporting domestic unconventional fuels development.
- Craft and task an environmental advisory panel to support the Task Force's cross-cutting environmental work group and provide input to inform program development and implementation.

RECOMMENDATIONS REGARDING INTERNATIONAL COLLABORATION AND PARTNERSHIPS

Partnering with Alberta on Oil Sands Development

The Province of Alberta, Canada is the global leader in oil sands development. The provincial government has worked closely with industry to understand development impediments and constraints, to advance extraction and processing technologies, and to craft fiscal regimes that stimulated private investment in oil sands development. As a result, Alberta now produces in excess of 1 million barrels per day of synthetic crudes from oil sands and has been able to add more than 175 billion barrels of oil sands as proved reserves.

Alberta's massive oil sands resource is substantially larger than U.S. tar sands deposits, and differs in two fundamental aspects in composition. These compositional differences will require different technical approaches for extracting the bitumen from mined sands. Nonetheless, the lessons learned from the evolution of technologies for Alberta oil sands development could contribute to accelerating the advancement of technologies applicable to the smaller resource. Further, the approaches taken by the Province of Alberta to stimulate private investment, streamline permitting processes, and accelerate sustainable development of the resource offer a valuable model that should be understood, considered, and perhaps adapted to stimulate domestic oil sands, oil shale, coal to liquids and other unconventional fuels development.

Given these findings, it is the conclusion and recommendation of the Task Force that a partnership with the Province of Alberta for the purposes of sharing technology information and public policy approaches should be pursued by the DOE in the immediate future.

DOE is already cooperating with the Government of Canada on issues related to the development of Alberta tar sands. This is being done through the Security and Prosperity Partnership (SPP). The Department should build on these initial efforts and continue to pursue opportunities for constructive engagement that could benefit accelerated development of domestic unconventional fuels resources.

Partnering with Other Countries on Oil Shale Development

The United States has the largest and most concentrated oil shale resources in the world.

However, several countries around the world have significant oil shale deposits, which, if developed, could contribute to increasing global oil supplies. These countries include Brazil, Jordan, Morocco, Australia, China, Estonia, and Israel, among others (Table 2).[23]

Much valuable technology information was developed by public and private efforts during initial oil shale development efforts in the United States between 1970 and 1993. Some of this information is in the public domain, some is archived within the DOE, and other information is still held proprietary by the various companies (or their successors) that participated in development efforts.

Despite the termination of earlier U.S. Government-sponsored oil shale RD&D activity, several companies have continued to develop in-situ and surface retort technologies.

Just as the United States may stand to benefit from advances in oil sands technologies developed in Alberta, there is significant potential for U.S. companies to learn from the experiences of other nations in oil shale development, and for other countries to benefit from the experience of the United States. To the extent that information sharing accelerates the advancement of technologies and increases global supplies of liquid fuels, all countries can be expected to benefit.

The United States has actively assisted the development of oil shale technologies in Estonia through information sharing and other collaborative efforts since 2002.

Given these findings, it is the recommendation of the Task Force that the DOE craft partnerships to exchange technology information and engage in other collaborative efforts that can accelerate the advance of oil shale technology and industry development in the United States and other oil shale bearing countries of the world.

America's unconventional fuels resources, if developed expeditiously and in a sustainable manner that respects our environment and protects the needs and interests of affected communities, can contribute substantially to improving the Nation's energy security, stimulate economic activity and growth, and assure adequate and affordable energy supplies for decades to come.

Table 2: Major World Oil Shale Resources and R & D Activity (With Yields Greater than 15 Gallons per Ton)

Country	Known Resource (Billion Bbls)	Known R&D Activity
United States	1,200	Numerous private R&D efforts for surface and in-situ retort technologies – no active Federal R&D program
Brazil	90	Petrosix Gas Combustion Retort – active production
Jordan	69	Active R&D Program
Morocco	58	Active R&D Program
Australia	35	Stuart Shale Project – ATP horizontal retort and other retort technologies
China	25	Various vertical surface retorts
Estonia	18	Galitor and Kiviter surface retorts
Israel	5	Vertical retort R&D
Canada	NA	Water extraction and coking
Mongolia	NA	Active R&D
Turkey	NA	Active R&D
Russia	NA	Vertical surface retort R&D

IV. NEXT STEPS FOR THE TASK FORCE

The next major steps for the Strategic Unconventional Fuels Task Force include:

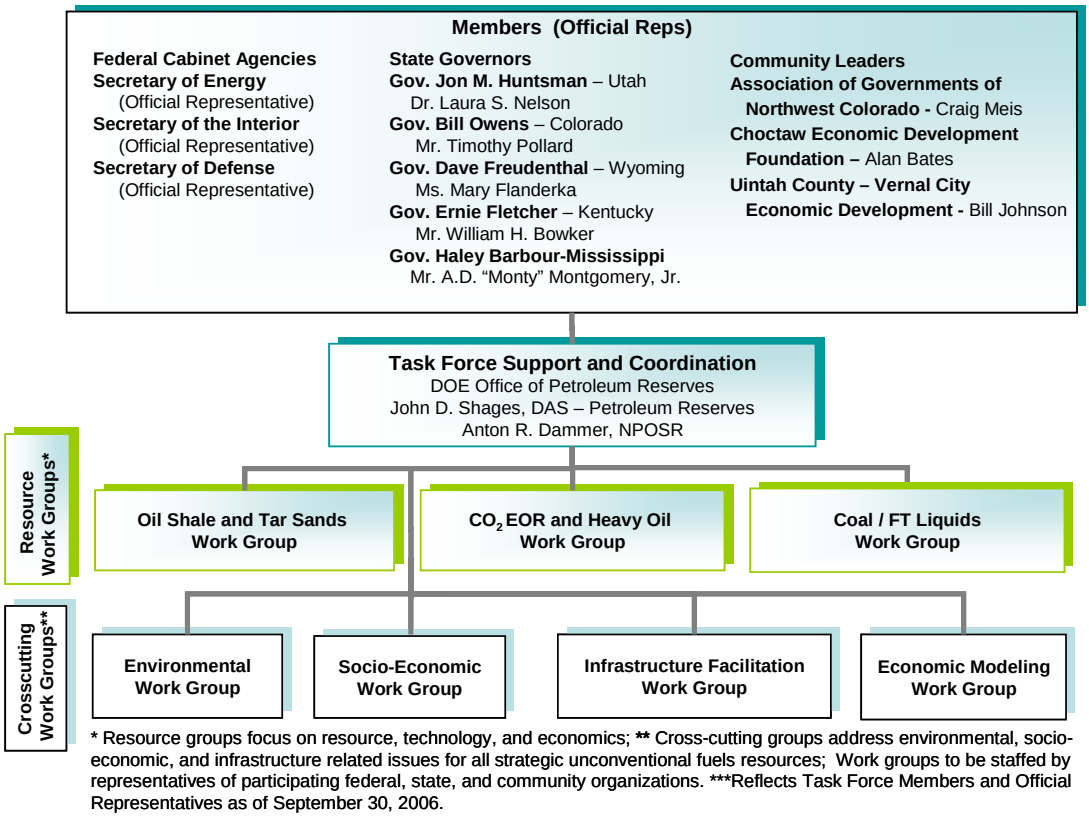
- Establishing the commercialization strategy, vision, goals, objectives, and program elements of the Strategic Fuels Development Program, and
- Preparing an integrated program plan to enable government and industry, in partnership, to achieve critical goals.

Strategic Unconventional Fuels Task Force: With the organizational planning largely complete, and the six meetings of the Task Force accomplished, the Task Force (Figure 11) will continue to work towards completing a Commercialization Strategy and the Strategic Fuels Development Program Plan. Figure 12 identifies the major milestones to be achieved by the Task Force.

Work Groups: The Task Force has established resource specific work groups and cross-cutting work groups. The work groups have had several meetings to discuss such issues as socioeconomic impacts and the effect of economics on unconventional fuels development. The objectives of the working groups are summarized as follows:

- **Resource-Focused Work Groups:** Work groups will be defined and established to assess the status and development requirements for each targeted unconventional energy resource.

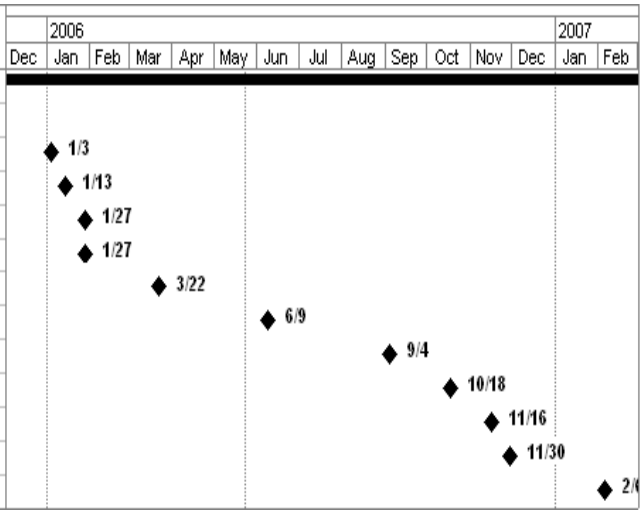
Figure 11. Strategic Unconventional Fuels Task Force***



* Resource groups focus on resource, technology, and economics; ** Cross-cutting groups address environmental, socio-economic, and infrastructure related issues for all strategic unconventional fuels resources; Work groups to be staffed by representatives of participating federal, state, and community organizations. ***Reflects Task Force Members and Official Representatives as of September 30, 2006.

Figure 12. Major Milestones for Strategic Unconventional Fuels Task Force

ID	Task Name	Start
20	**USF Task Force**	**Thu 9/15/05**
21	Charter Documents	Thu 9/15/05
22	Invitations Sent	Tue 1/3/06
23	Review Briefing Materials	Fri 1/13/06
24	Kickoff Meeting	Fri 1/27/06
25	TF Work Plan	Fri 1/27/06
26	TF Initial Recommendations	Wed 3/22/06
27	Initial180 Day Report 02/06	Fri 6/9/06
28	Review Workgroup Reports	Mon 9/4/06
29	Review Draft Program Plan	Wed 10/18/06
30	Approve Final Program Plan	Thu 11/16/06
31	Submit Final Program Plan to Congress	Thu 11/30/06
32	Annual Report 02/07	Tue 2/6/07



They will define the major issues and needs associated with each resource, identify and assess options available to overcome impediments and accelerate industry development, brief the Task Force as required, and draft initial and final program sub-plans for the Task Force to review and deliberate. They will also participate in the preparation and implementation of the final subplans following the Task Force's review.

- **Cross-Cutting Work Groups:** Cross-cutting work groups will be assigned to support the Program Management Office and the resource-specific work groups. They will focus on cross-cutting environmental issues and permitting, industry economics and fiscal regimes, market, infrastructure, and socio-economic concerns and needs. Coordinated by the Program Management Office, these groups will assess issues and needs, define and analyze options, and prepare the major elements of the Strategic Fuels Program Plan.

The schedule for the Working Groups is closely linked with the Task Force schedule, targeting an integrated Strategic Fuels Program Plan by late November, 2006.

Strategic Fuels Program Development

During the next 12 months, the major focus of the Task Force and the working groups will be developing the integrated program plan.

Congress has assigned DOE's Office of Petroleum Reserves (OPR) the responsibility to coordinate plan development and to provide support to the Task Force.

Figure 13, below, details the activities to be conducted and the timeline for development of the Strategic Fuels Development Program Plan. The figure shows the overall work process and the detailed process for one of the resource-focused work groups and one of the cross-cutting groups. The OPR will provide logistical, analytical, and planning support.

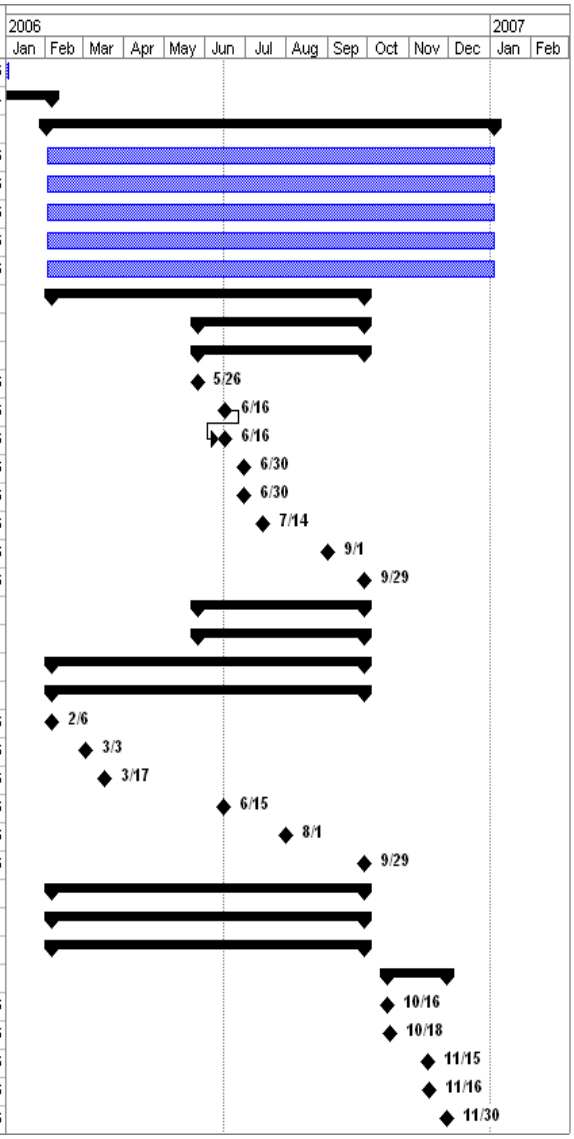
Strategic Assessments

The Task Force is tasked to address the strategic issues associated with increasing dependence on imports from politically or economically unstable sources of supply, and options for reducing that dependence by increased domestic production.

- DOE should work with the Office of the Secretary of Defense to assess the strategic requirements for secure domestic sources of ultra clean fuels to supply military requirements.

Figure 13. Major Milestones for Development of a Strategic Fuels Program

ID	Task Name	Start
1	**Strategic Fuels Program Development**	Mon 1/2/06
2	**Initial Activities**	**Thu 2/5/04**
36	**Program Management**	**Thu 2/2/06**
37	Industry Outreach Coordination	Thu 2/2/06
38	Federal Agency Coordination	Thu 2/2/06
39	Supporting Analysis	Thu 2/2/06
40	Strategic Issues Analysis	Thu 2/2/06
41	Markets Analysis	Thu 2/2/06
42	**Planning & Analysis Workgroups**	**Mon 2/6/06**
43	**Resource Work Groups**	**Fri 5/26/06**
44	**Oil Shale and Tar Sands Group**	**Fri 5/26/06**
45	Nominate Membership	Fri 5/26/06
46	Review Resource Profiles	Fri 6/16/06
47	ID Issues / Needs	Fri 6/16/06
48	Resource Assessment	Fri 6/30/06
49	Technology Assessment	Fri 6/30/06
50	Economic Assessment	Fri 7/14/06
51	Draft Reports and Recommendations	Fri 9/1/06
52	Draft OS Development Plan	Fri 9/29/06
53	**EOR and Heavy Oil Group**	**Fri 5/26/06**
62	**Coal / FT Liquids Group**	**Fri 5/26/06**
71	**Crosscutting Work Groups**	**Mon 2/6/06**
72	**Environmental Group**	**Mon 2/6/06**
73	Review Current Regs / Permit Proc	Mon 2/6/06
74	Assess Resource-Specific Needs	Fri 3/3/06
75	ID and Assess Options	Fri 3/17/06
76	Brief Work Groups	Thu 6/15/06
77	Draft Reports and Recommendations	Tue 8/1/06
78	Draft Environmental Plan	Fri 9/29/06
79	**Socioeconomic Group**	**Mon 2/6/06**
86	**Infrastructure Facilitation Group**	**Mon 2/6/06**
93	**Economic Modeling Group**	**Mon 2/6/06**
100	**Plan Integration**	**Mon 10/16/06**
101	Prepare Integrated Draft Plan	Mon 10/16/06
102	Brief Task Force	Wed 10/18/06
103	Modify Draft Plan	Wed 11/15/06
104	Final Program Plan to Task Force	Thu 11/16/06
105	Submit Final Program Plan to Congress	Thu 11/30/06



- The Task Force also proposes to task OPR to manage an independent expert review of strategic issues and concerns to provide input to the Task Force.
- Other requirements for strategic assessments will be defined by the Task Force in consultation with congressional leaders, as appropriate.

Assessment and Recommendations of Potential Federal Government Actions

Suggested Federal actions that could stimulate various levels of investment to initiate commercial scale production of strategic fuels from domestic sources have already been identified by several sources. For oil shale, these include options discussed in the *Strategic Importance of America's Oil Shale Resources*[24] report, and in the *Findings and Recommendations of the ad hoc Oil Shale Steering Committee*[25].

The Office of Petroleum Reserves has also closely examined the fiscal, regulatory, technology, and socio-economic measures applied by the Province of Alberta to stimulate industry investment in oil sands development and considered how that model might be applied to stimulate oil shale, tar sands, heavy oil, and coal-liquids development in the United States.

During the next 12 months, as part of the program development process, the details of specific actions that could comprise various development scenarios, including their potential costs and benefits, need to be analyzed. The results will provide the analytical basis for the working groups and the Task Force to define the Strategic Fuels Development Program and determine specific actions required for its effective implementation.

Industry/Government Coordination

An effective partnership requires the Strategic Fuels Development Program to focus on the needs and priorities of the industry. As such, industry's direct input is essential to inform effective program development. The Task Force will define and implement a process for information exchange with key industry groups. Existing groups will be used to the greatest extent possible.

Community acceptance will also be a critical program success factor. The program plan must effectively identify and address stakeholder concerns. The Task Force will define a process for seeking, tracking, and addressing stakeholder input, using existing functions and local organizations wherever possible. Several regional councils of government have already been identified and invited to serve as members of the Task Force.

APPENDIX A

Net Energy Balance: The Energy Cost of Producing Energy

Throughout the past two centuries, energy production has been characterized by its low energy cost, which in turn has led to low economic cost. Oil field gushers required only the energy to drill the wells. The easiest and most accessible resources have been recovered first. In some ways, peak oil is a manifestation of the ever-increasing difficulty in producing liquid fuels from conventional resources.

M. King Hubbert's remarkable insight may prove to be the guiding principle for future energy competitiveness. The solid or semi-solid nature of unconventional hydrocarbon resources dictates that more energy will be required to produce a unit of energy than we have enjoyed historically for oil and gas, which are fluid. Hence, for unconventional resources we can anticipate that there will be some cutoff grade below which recovery is not economically possible. Thermodynamics will be a major determinant of this point.

> *"So long as oil is used as a source of energy, when the energy cost of recovering a barrel of oil becomes greater than the energy content of the oil, production will cease no matter what the monetary price may be."* -- M. King Hubbert [Referenced by Ivanhoe, 1982]

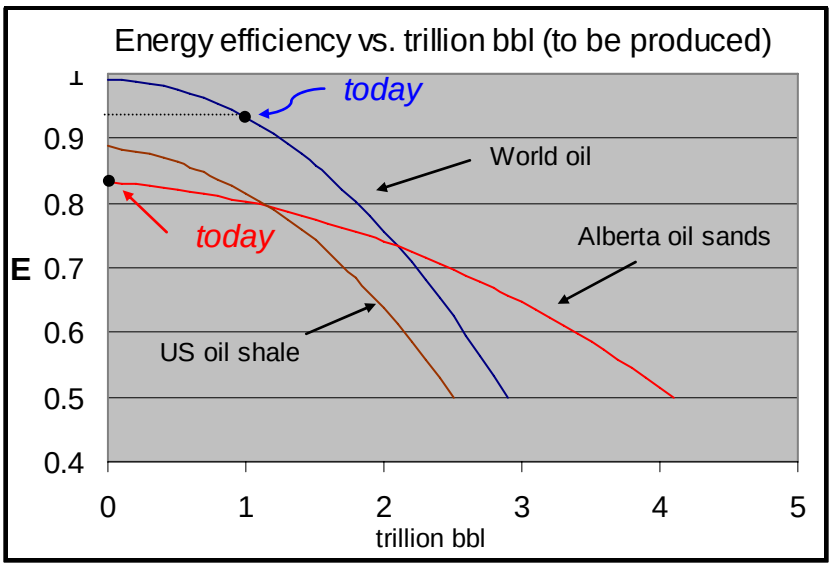
Achieving high technology performance and production efficiency present significant challenges, but the resource base itself is not the problem. There are trillions of barrels of hydrocarbons remaining on earth that are rich and accessible and can be recovered with a net energy gain, including the unconventional resources in the US. As we look to new energy sources of the future, the net energy productivity will be a strong indicator of the economic competitiveness of each alternative. This statement holds true for renewals as well as non-renewable energy.

Figure 1 estimates the "first law" efficiency of resource recovery for oil shale and oil sands over the life of the resources. These efficiencies are compared to petroleum, with the historic efficiencies shown to the left of the data point marked 'today' and future efficiencies indicated to the right.

Each resource enjoys higher efficiencies in the early years as the richest and most accessible resource is recovered. As the higher grade, most accessible resource is produced the energy cost of producing energy increases, and the first-law efficiency decreases.

What we see now is that petroleum production efficiency is declining to a point where oil sands and oil shale are becoming competitive on the basis of net energy yield. In fact, because oil shale is richer than currently produced oil sands, the first law efficiency is initially better for oil shale than for oil sands. One prime reason why oil sands are already competitive with petroleum, in spite of the lower overall energy efficiency, is that there is no decline curve. Petroleum and gas suffer decline curves for individual fields, which decline in first-law efficiencies until individual wells are (economically) depleted.

Figure 1. Energy Efficiency vs. Trillion Bbl (To Be Produced)

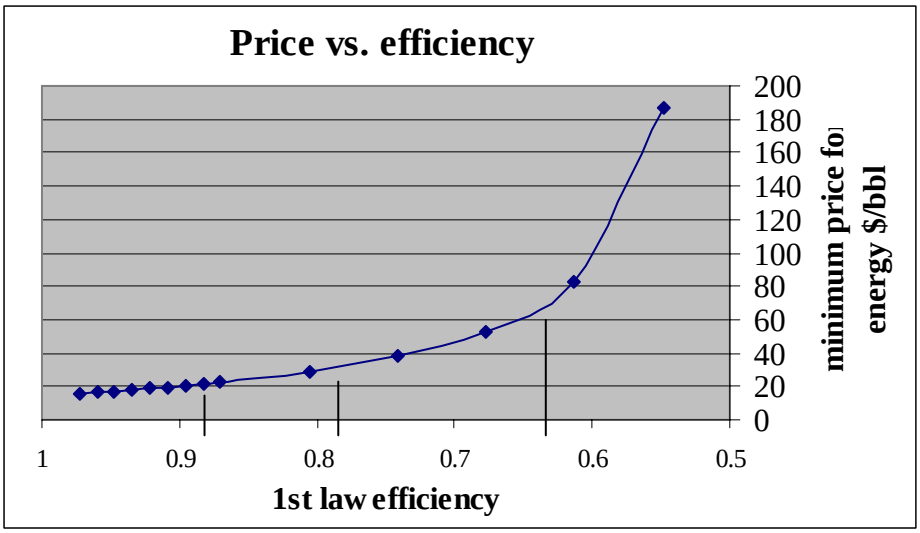


There is an economic point below which the process cannot sustain a positive cash flow (shutting in stripper wells is a good example of this effect). This value can vary a little if the per unit cost of energy input is lower than the value of the energy output. Using this concept we can calculate a minimum price for energy as follows:

> The first law efficiency, E, is defined as the energy in the produced oil divided by the total of energy in the produced oil plus energy added to produce the oil, or E = (oil out)/(oil out + energy imported). Next define a base non-energy production cost, C_p, to produce the oil which represents all costs other than cost of imported energy. (Strictly speaking this C_p value should include one-time energy costs such as the energy required to manufacture equipment.) The process can obtain its on-going energy requirements by consuming some part of the oil or gas produced, purchasing energy from an external source or some combination. Mathematically, it makes no difference to the final results. Call the imported energy cost C. This C is now the cost of oil we seek to calculate from the efficiency, E. From these definitions, C is solved for to be: $C = E\ C_p / (2\ E - 1)$

Accounting for reasonable escalation non-energy costs as the grade of ore declines we can estimate the minimum price for energy as a function of efficiency. The minimum price of energy on a non-subsidized basis is seen in Figure 2. Clearly, from a public policy view, no subsidies should be given to processes that cannot exceed minimum efficiency levels, and even more ideally, subsidies should only be provided to those processes that promise efficiency levels within a reasonable range of the prevailing production efficiency. Today, and for the foreseeable future, this efficiency is above 0.7.

Figure 2. Price vs. Efficiency

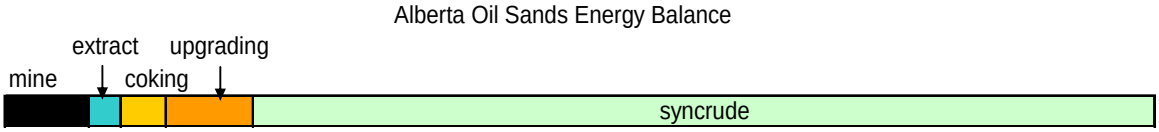


Energy Consumption in the Production of Unconventional Oils

There is a common view that energy consumption in the recovery of unconventional oils is greater than the energy yield. This perception is incorrect; if it were correct, there would be no value in producing these resources and no private investment could be expected.

To illustrate, at each step in the recovery and conversion process usable energy is lost to heat. The engineering and economic objective is to retain as much of the initial energy for end use, as is possible. The energy consumption track is shown for several resources and cases, as shown in Figures 3-6. As can be seen, all processes produce more energy in syncrude than they consume, even if the energy consumed was from external sources.

Figure 3. Alberta Oil Sands Energy Balance



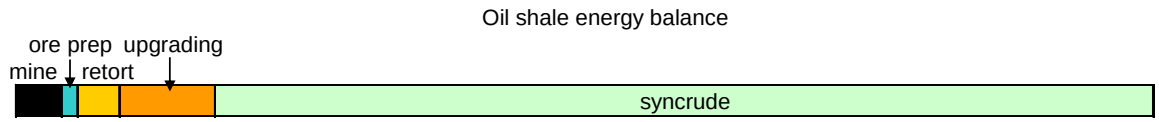


Figure 5. Alberta Oil Sands In-Situ

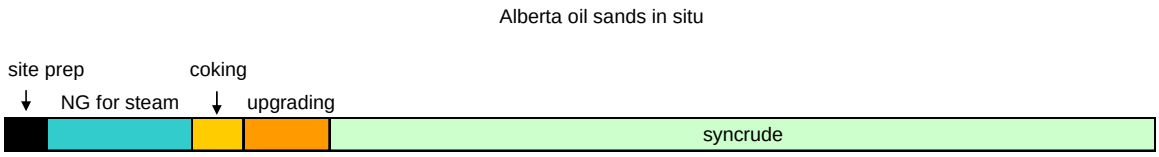
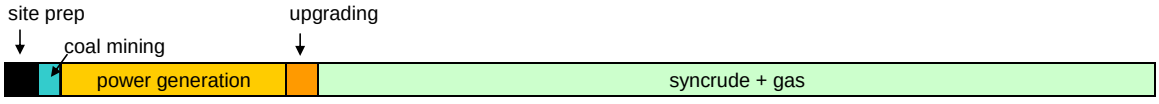


Figure 6. Oil Shale In-Situ



APPENDIX B

Major Assumptions for Estimating Production under Various Policy and Fiscal Scenarios

Oil Shale Resource Characteristics: Resources in Colorado have received the most industrial attention because of the thickness and richness of the beds. Not surprisingly, the initial attention of the major oil companies has been focused on Colorado oil shale. Room and pillar mining and surface processing are possible along the southern reaches of the deposit where erosion has exposed the beds along the Colorado River drainage. Outcrops in the northwestern portions of the Piceance Creek Basin are potentially amenable to surface mining and processing. Historically, tract Ca of the prototype leasing program was contemplated to be a surface mine with surface processing. The deeper and thicker central parts of the basin are more amenable to in-situ recovery such as what Shell is proposing. In-situ recovery can conceivably be used in shallower and thinner deposits as well.

Some of the richest zones, with yield up to 60-70 gallons per ton (gpt) are found in Utah, although these zones are not very thick. The oil shale outcrops on the southern and eastern margins of the deposit. The southern margins are amenable to surface mining. The eastern outcrops are exposed by canyon erosion and are accessible through room and pillar mining. Near the center of the deposit and points west and north, the overburden becomes thick and in-situ processes are thought to be more suitable. The Wyoming deposits, while extensive and accessible to the surface, do not have the level of richness seen in Utah or Colorado.

- **Measured Case:** First production from an in-situ project in Colorado on highly attractive resource by 2016 ramping up to 500K Bbl/d by 2022. A second in-situ project in Colorado, also on highly attractive property first producing in 2020, ramping up to 500K by 2026. A third in-situ project in Utah or Colorado, beginning in 2021 and ramping up to 250K by 2027. Fourth and fifth in-situ projects in Utah or Colorado beginning in 2023 and 2025, respectively and ramping up to 250K each.

- First production from a surface process at a demo scale of 10K/d in Utah or Colorado by 2012, expanding to 100K Bbl/d by 2015.

- Second through fifth surface processes in Utah, Colorado, or Wyoming, each at 100K Bbl/d beginning in 2018 and start times offset by 3 years for each successive plant. After plant reaches full design capacity add 2% growth from debottlenecking, improved efficiency, and minor expansions.

- **Accelerated Case:** Move up the timetable for in-situ schedule by 3 years. Move up the timetable to first-generation surface processing by 2 years. Simultaneous construction of the second and third plants (ideally in two different states) and after 3 years simultaneous construction of two more plants. Add one more in-situ and two more surface plants in the out-years. After plant reaches full design capacity add 3% growth from debottlenecking, improved efficiency, and minor expansions.

Coal-to Liquids Resource Characteristics: Coal characteristics are well-known and include bituminous and anthracitic coal in the east, higher sulfur Illinois basin coal in the Midwest, lignite's in N. Dakota, Wyoming and Montana and low sulfur, bituminous coals in Utah. Of importance is the amount of coal that can be strip mined vs. underground mined. For purposes of this example, these details were not considered, but as the nation pursues coal-to-liquids, these characteristics will be key to the viability of achieving production goals. At present there is quite a bit of interest in Integrated Gasification Combined Cycle power and Fischer-Tropsch liquids production. A commercial demonstration facility is being built in Pennsylvania. Other States such as Illinois, Ohio, W. Virginia, N. Dakota, Wyoming, Montana, and Utah have projects that are in various stages of discussion, plant siting, and engineering.

- **Measured case:** Complete the Pennsylvania project by 2010 (5000 Bbl/d), add 3 other 'first-generation' projects by 2013 for a total capacity of 100K (full scale modules are on the order of 34K Bbl/d, which may be replicated in expansions). Add 3 'second-generation' plants by 2016. Expand all facilities to 100K Bbl/d by adding 34K Bbl/d modules every 4 years. Assume plants in 10 different States; ultimately achieve 1M Bbl/d by 2026. After plants reach full design capacity add 2% annual growth from debottlenecking, improved efficiency, and minor expansions.
- **Accelerated Case:** Cut 1 year from 1st generation facilities and 2 years from 2nd generation facilities. Expansion schedule adds a commercial module every 3 years. Add 3 additional States in the out-years. Achieve 1.3M bbl/day by 2027. After plants reach full design capacity add 3% annual growth from debottlenecking, improved efficiency, and minor expansions.

Tar Sands Resource Characteristics: For this initial productivity estimation only Utah resources were considered. Interestingly, recent State leases have attracted bonus bids far in excess of those attracted for oil shale. Clearly there are a number of entrepreneurs interested in developing these deposits. Of benefit to the development is the requirement by EPACT 2005 that the BLM conduct a programmatic EIS on tar sand lands, and make these lands available for leasing by 2007.

The primary deposits are:

Asphalt Ridge - Characterized by SOHIO as holding about 1 billion barrels recoverable and supporting about a 50K bbl/day facility. In the meantime growth in the community of Vernal has partially encumbered some of the resource. There are two high richness locations that could produce high yields of bitumen but in more modest quantities than contemplated by SOHIO. It is assumed that adaptations of the Alberta technology will be used on the unconsolidated sands from the rich zones.

- **Measured Pace:** Assume a first generation facility of 10K/d will be built by 2010 and expanded to 20K/d by 2013. Product will be asphalt and possibly byproducts.
- **Accelerated Pace:** Go directly to a 20K facility in 2010.

Sunnyside **-** Contains enough recoverable reserve to support a 100K bbl/d operation. Chevron was interested in this deposit two decades ago. Technology may require either thermal or solvent as the ore is consolidated.

- **Measured Pace:** Assume a first generation facility of 50K bbl/day by 2014 producing syncrude, expanding to 100K by 2018.
- **Accelerate Pace:** Assume full development of 100K facility by 2015.

PR Spring - This sizeable resource is close to the surface, but is fragmented by erosion and multiple beds. It is also in an environmentally primitive area, which may slow development. The northern margins of the PR Spring deposit lie under the southern margins of the oil shale deposits. It is possible that these tar sands will be co-produced as part of an oil shale venture.

- **Measured Pace:** Co-production of 25K Bbl/d by 2015 for syncrude using retort technologies. Additional grass roots plant producing 50 MBbl/d using surface processing similar to Sunnyside by 2018.
- **Accelerated pace:** Co-production by 2013. Additional 50K plant by 2016.

Tar Sand Triangle: TST is the largest deposit in Utah, in terms of barrels in-place. The bitumen is characterized by high sulfur, similar to Alberta oil sands and unlike the Uinta Basin deposits described above, which are low in sulfur. TST is also located near Canyon lands national park, and development is likely to meet with challenge. Nevertheless, there appears to be interest in this deposit for in-situ recovery. Assume that product would initially be transported by truck and rail in bitumen, or diluted bitumen state. Ultimately product would need to be upgraded to syncrude.

- **Measured Pace:** 2 MBbl/d by 2015, expanding to full production of 80 MBbl/d by 2021.
- **Accelerated Pace:** Cut 2 years from measured timeline.

Heavy Oil Resource Characteristics: Heavy, and extra heavy oil will require heat to be produced. In this regard, technologies such as SAGD, Vapex, and CSS, commercially practiced in Canada for recovering bitumen may be useful. The following are for new developments using advanced technologies.

- **Measured Case:** Achieve 200 MBbl/year by 2010 and annual growth of 5% year over year thereafter until 2030. This rate yields 530 MBbl/d by 2030.
- **Accelerated Case:** Achieve 200 MBbl/year by 2009 and annual growth of 7% year-over-year until 2030, achieving production of 828 MBbl/year

Efficiency Improvements

While efficiency improvements fall under a different level of responsibility within DOE, the overall supply and demand picture is not complete unless efficiency is included. In this context, "efficiency" is defined as accomplishing the same job with less energy. "Conservation" is defined as changing the way we accomplish tasks as a means of saving energy.

Efficiency Components: Given that the issue is with liquid fuels, the most fruitful place to look for efficiency improvements is light vehicle use. (Heavy vehicles, commercial, and aircraft efficiency improvements are already factored into the AEO 2006 consumption scenarios). Increases in efficiency have been about 30% over the past 20 years; however, efficiency gains have gone into greater curb weight and more horsepower. AEO assumes that these efficiency gains will continue. The difference is that we advocate engaging the public to convert these efficiency gains to greater mileage. With the advent of hybrid vehicles, this should be possible. In order to implement a measured and accelerated pace of reducing imports there are new initiatives that are needed that involve public cooperation. These are:

- Procurement of vehicles yielding higher efficiency.
- Improving driving and maintenance habits (total possible estimated at 7%).

Conservation Components: These improvements deal with greater telecommuting, ridesharing, mass transit using electric power transit, driving fewer miles per capita per year.

Population increase – The projected growth rate in population in the US is 0.0823%/year. All calculations allow for this, and as can be seen by the graphs, after the initial efficiency and conservation is achieved the population increases begin to overwhelm the remaining efficiency savings.

- **Measured Case:** Improve overall mileage by 20% over 17 years. Seventeen years is the mean life of the light vehicle fleet. In practice, this means that each buyer, on the average needs to buy a vehicle that is 1.2% more efficient for each year of trade up. Increase driving and maintenance habits with a public compliance rate of 3% (of those previously not complying) per year. Target improve conservation by 20% over a 20 year period with compliance rate of 3% per year yielding actual conservation savings of 11.6% in 30 years.
- **Accelerated Pace:** Improve overall mileage by 30% over 17 years, requiring purchase decisions to buy vehicles with 1.8% more efficient for each year of trade up. Public compliance for driving and maintenance is 5% per year under this scenario. Boost conservation targets to 30 % over a 20 year period with compliance rate of 5% per year yielding actual conservation savings of 22.3 % in 30 years.

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> **Asphalt Ridge** - Characterized by SOHIO as holding about 1 billion barrels recoverable and supporting about a 50 MBbl/d facility. In the meantime growth in the community of Vernal has partially encumbered some of the resource. There are two rich locations that could produce high yields of bitumen but in more modest quantities than contemplated by SOHIO. It is assumed that adaptations of the Alberta technology will be used on the unconsolidated sands from the rich zones.
>
> **Sunnyside -** Contains enough recoverable reserve to support a 100 MBbl/d operation. Technology may require either thermal or solvent treatment because the ore is consolidated.
>
> **PR Spring** - This sizeable resource is close to the surface, but is fragmented by erosion and multiple beds. It is also in an environmentally primitive area, which may slow development. There are a few rich zones that could each support modest size developments on the order of 25 to 50 MBbl/d.
>
> **Tar Sand Triangle (TST):** TST is the largest deposit in Utah, in terms of barrels in-place. The bitumen is characterized by high sulfur, similar to Alberta oil sands but, unlike the Uinta Basin deposits described above, which are low in sulfur. TST is also located near Canyon lands national park, and development is likely to meet with challenge. Nevertheless, there appears to be interest in this deposit for in-situ recovery. Assume that product would initially be transported by truck and rail in bitumen, or diluted bitumen state. Ultimately product would need to be upgraded to syncrude.
>
> Cumulative production from tar sands under both the measured pace and accelerated pace scenarios is 340-352 Mbbl/d by 2025. No further expansion is contemplated under foreseeable oil prices. Should there be very high prices, then leaner and more fragmented resources might come into production. Also, resources in other States are not included in this initial scenario, and clearly tar sand in other states may also qualify for production.

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