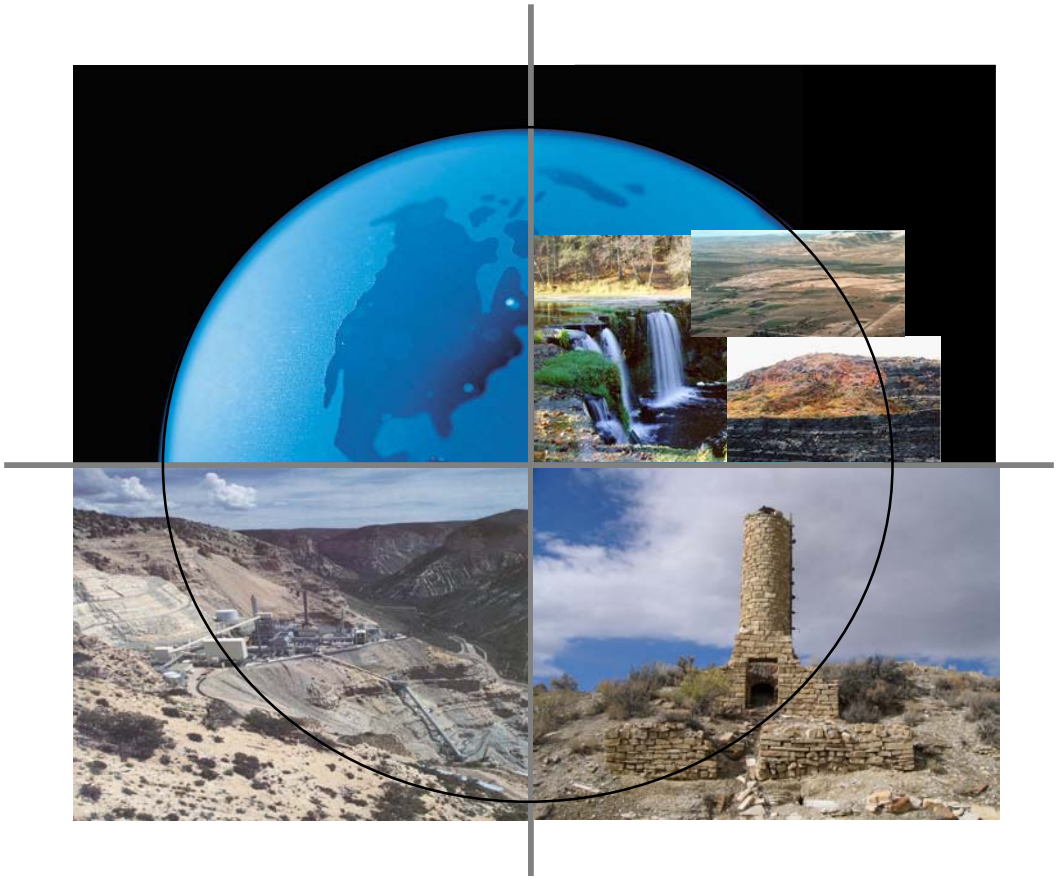
U.S. Department of Energy

America's Oil Shale

A Roadmap for Federal Decision Making



Sustainable Development of the Oil Shale Resources of the United States

Deputy Assistant Secretary
for Petroleum Reserves

Office of Naval Petroleum and Oil Shale Reserves

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Foreword

Worldwide supplies of conventional oil will soon reach a peak production rate and begin an irreversible long-term decline. Options to augment liquid fuel supplies in the United States have once again begun to focus on oil shale as long-term source of reliable, affordable, and secure oil.

The United States government has long recognized the strategic potential of the nation's vast oil shale resources to support national security. President Taft in 1912 established an Office of Naval Petroleum and Oil Shale Reserves and charged that office with ensuring oil for naval military operations. This office continues to oversee the United States strategic interest in oil shale.

America's 2 trillion barrel oil shale resource is recognized as having the same production potential as Canada's tar sands. Tar sand production, initiated in the 1960s, has increased steadily to more than 1 million per barrels/day and is moving toward a near-term goal of 2.5 million barrels per day by 2017. This amount of oil is equivalent to the volume of oil currently imported by the United States from Middle East countries. Tar sands production has enabled Canada to add 174 billion barrels to its recoverable oil reserves, making Canada's proved reserves second only to those of Saudi Arabia.

Successful tar sands development in Canada required a significant public-private partnership sustained over a long period of time. The essential government programs and policies needed to stimulate industry development of oil shale in the United States are not now in place. To initiate a dialogue toward effective government oil shale decisions, the Office of Naval Petroleum and Oil Shale Reserves sponsored a review of the *Strategic Significance of America's Oil Shale Resource*. The two-volume analysis, published in March 2004, attracted widespread interest and favorable comments. Continuing with these planning efforts, the Office identified the elements of a roadmap needed to guide government decisions.

The enclosed Draft Roadmap is a product of these continuing planning efforts. The role of the Petroleum Reserves Office is to expedite, within the limits of prudent public policy, Federal actions to facilitate and stimulate private industry to move forward with development of a domestic oil shale industry. This document is being circulated for review and comment as part of a process to develop an effective public-private partnership aimed at oil shale development. We welcome your comments on the draft document and your suggestions as to how it may be improved.

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Executive Summary

The President and the Department of Energy have determined that increasing liquid fuels supply from domestic sources is an important national objective. America's rich and concentrated oil shale resources, containing as much as 2 trillion barrels of potential oil supply could make a major contribution toward that objective. A domestic oil shale industry would reduce import dependence and associated costs to the U.S. economy while creating thousands of stable, high-paying jobs and stimulating economic activity here at home. Significant public and private collaboration and investment will be required to initiate a domestic oil shale industry and achieve meaningful quantities of shale oil production in the foreseeable future. It is now both prudent and timely for Federal decision-makers to consider the strategic potential of oil shale to meet the nation's energy needs and to stimulate the domestic economy.

Global conventional oil production is projected to peak and decline while global demand is projected to continue to rise, reaching a point where demand will likely exceed supply in the first half of this century. Rising imports of crude oil and refined products, and higher prices driven by rising demand, are already costing the U.S. economy billions of dollars per year. If not addressed quickly, deteriorating global market conditions will result in even higher oil prices and reduced availability of light oil. This could threaten U.S. economic security, limit the fuels available to the military and first responders to defend American interests at home and abroad, and significantly impact the standard of living enjoyed by Americans today.

Oil shale development efforts conducted in this country by government and industry between 1970 and 1993 provide a sound foundation of information and experience on which to build a new oil shale industry. A detailed assessment, entitled "*Strategic Significance of America's Oil Shale Resources"*, was completed by this office in March 2004. As a next step, this Roadmap for Federal Decision-Making offers a path for assessing oil shale's potential benefits and impacts and developing and implementing a program to initiate a domestic oil shale industry.

The Roadmap provides a structure for organizing key Federal agencies (Energy, Interior, Defense, and Treasury) to define oil shale objectives and strategy and develop a multi-agency program plan. Plan elements and initiatives, to be developed with input from key stakeholders, could include oil shale leasing, technology development and demonstration, economic incentives, regulatory streamlining, environmental assessment, and infrastructure development. Immediate next steps include completion of baseline analyses to support program planning efforts, organization of Federal participants and other stakeholders, development of an oil shale strategy, and development of an integrated multi-agency Federal oil shale plan. This roadmap suggests the potential roles of the State and Federal government, industry, affected communities, and other stakeholders in developing a viable domestic oil shale industry.

Recognizing the long lead-times required for industry development and the urgency of increasing domestic fuels supplies, the roadmap provides an aggressive timeline and establishes key milestones for initiating Federal actions. These include seeking Congressional authorization early in 2005, preparing an oil shale strategy by March 2005, responding to Congress's request for an assessment of oil shale feasibility by May 2005, completing initial program plans by June 2005, and initiating program activities by October 1, 2005.

I. Oil Shale Mission and Vision

Mission: America's National Energy Strategy calls for the increased domestic production of "reliable, affordable and environmentally sound energy for America's future". The Department of Energy is responsible for ensuring adequate supplies of fuels at affordable prices to meet present and future needs of U.S. defense, residential, commercial, and industrial consumers.

Due to rising global fuels demand, the anticipated peak in global light crude oil production, and the rising costs of energy imports, the President and the Secretary of Energy have determined that increasing the supply of fuels from domestic sources is a national goal. Among these domestic sources is the nation's endowment of western and eastern oil shales, which hold more than 2 trillion barrels of potential oil supply.

America's rich, massive, and concentrated oil shale resources – if developed in a timely manner – offer the potential to help offset the coming global production decline of conventional oil, reduce oil imports and their economic costs, stimulate domestic employment and economic activity, and provide a reliable domestic source of liquid transportation fuels. Shale oil development can also play a vital strategic role, providing the military with long-term secure access to domestic fuels of superior quality that are not subject to interruption.

Oil Shale Mission

- *Increase domestic fuels production,*
- *Provide a secure source of military fuels,*
- *Reduce oil and refined product imports and dependence and their economic costs,*
- *Reduce fuels supply disruption vulnerability,*
- *Promote national security, and homeland defense,*
- *Create quality jobs, and*
- *Boost economic activity*

Vision

Prudent government actions and cooperative efforts with private industry and other stakeholders will stimulate sustainable private sector development of a domestic oil shale industry producing…

- *2 million barrels per day by 2020…*
- *3 million barrels per day by 2040…*

while respecting and protecting our Nation's environment.

Vision: The oil shale development efforts conducted in this country between 1974 and 1990 provide a solid foundation of information, technology, and experience on which to build a new oil shale industry. When the nascent oil shale industry collapsed in the 1980s, it was due neither to failure of the resource or the potential of the technology. Nor was it due to environmental considerations. It collapsed because crude oil prices fell sharply and projects became uneconomic.

Prudent government actions and cooperative efforts with private industry and stakeholders will stimulate private sector commercialization of the nation's oil shale resources and development of an oil shale industry that will augment domestic fuel supplies by 2 million barrels per day by 2020 and more than twice that amount by mid-century.

Realizing this vision will require Federal and State government policy, technology and economic support, and effective coordination among Federal agencies.

The Deputy Assistant Secretary for Petroleum Reserves and the National Energy Technology Laboratory will lead this coordination effort and work closely with stakeholders to achieve mission success.

Risks: America's growing reliance on foreign sources of oil, increases the risk of supply disruption. The nation's economy and its defense rely on the availability of crude oil and refined products at affordable prices. Rising global demand and peaking crude oil supply will intensify competition for crude oil, resulting in higher oil and refined product prices that will impact the nation's balance of trade, its economic vitality, and its competitiveness.

Risks of Failing to Act

- *National security degradation*
- *Economic dislocation*
- *Oil and refined product supply shortages*

It is unlikely that supplies of alternative fuels now in development will be sufficient, in the foreseeable future, to measurably offset the decline in oil production, respond to supply disruptions, or meet our needs for liquid fuels to drive the economy and defend the nation and its vital interests.

The risks of doing nothing far exceed the costs of a proactive examination of oil shale's potential and prudent public action to enable and encourage private industry to initiate a domestic oil shale industry.

II. Roadmap Goals and Objectives

The Roadmap offers a course of action that will provide Federal decision makers a clear and flexible path forward to determine how the nation should pursue development of a domestic oil shale industry. It seeks to:

- ***Summarize Key Drivers for Including Oil Shale in National Energy Policy***: A priority of the Roadmap is to identify the hurdles facing industry, and articulate the issues and liquid fuels outlook that compel recognizing oil shale as a strategic energy resource and making its development an explicit element of national energy policy.
- ***Define Pathways For Federal Decision Making and Planning***: Decision makers in the Executive Branch and in Congress require specific information about the economic and national security benefits of resuming oil shale industry development, and the impacts it may have on affected communities and stakeholders. The Roadmap defines pathways for assessing costs and benefits.
- ***Review Status of U.S. Oil Shale Industry*:** The Roadmap provides for an assessment of of the oil shale resource and the status of technology development to the point where activities were curtailed when oil prices collapsed in the early 1980s.
- ***Identify Next Steps:*** The Roadmap identifies immediate steps to be taken to support a government decision to pursue oil shale industry development.
- ***Identify Key Participants and Roles:*** The Roadmap describes potential ongoing roles of government, industry, and other stakeholders in advancing and establishing a viable domestic oil shale industry.

III. Summary of Global Situation and Key Drivers for Federal Action

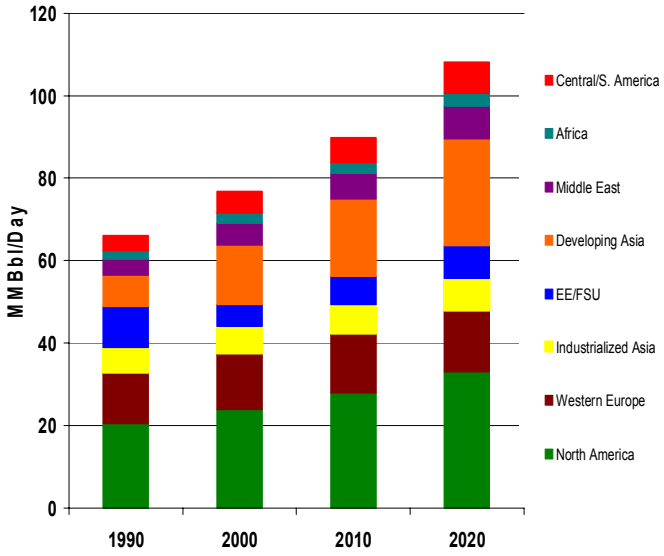
Numerous global oil supply and market factors compel Federal action to encourage and enable industry to develop the nation's oil shale resources.

World Oil Demand is Rising: Global annual consumption of crude oil now far exceeds new discoveries (Figure 1). This trend of producing largely from past oil discoveries is expected to continue. Yet, world demand for conventional oil continues to grow at an unusually high rate, driven largely by developing Asian economies. While U.S. annual demand growth is an estimated 1.5 percent, China's oil demand growth exceeded 28 percent in the past year.

The increase in demand for imported oil into the United States comes at a time when other consuming countries are also increasing their demand for oil. China's demand for imported oil is expected to rise by over 7 percent annually and India's by more than 6 percent (Figure 2).

Most of the global demand increase can only be met from OPEC. Is such a growing dependence advisable? Is it possible for OPEC to meet the increasing world demand for oil? If so, is increasing dependence on OPEC in America's best interests?

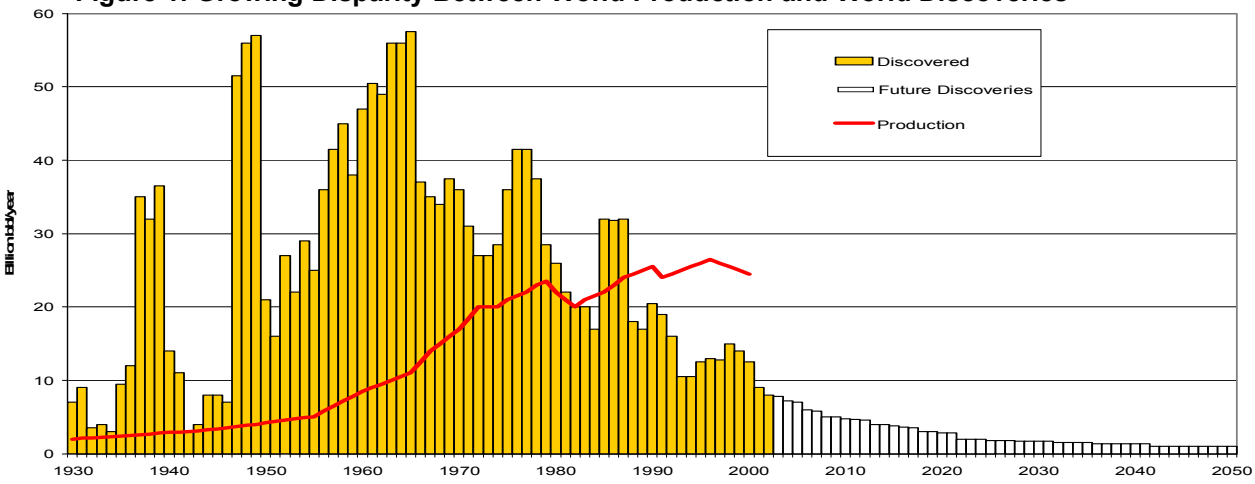
Figure 2. World Conventional Oil Demand is Rising



U.S. EIA, International Energy Outlook, 2003.

The high demand worldwide is rapidly reducing OPEC's spare oil production capacity and taxing its ability to offset supply shortfalls that may occur elsewhere in the world. OPEC's estimated excess or "swing" capacity has decreased from 15 million barrels per day in 1985, to less than 1 million barrels per day in 2004. The ability of Saudi Arabia to increase production to moderate world oil prices is now in question. Once OPEC's spare production

Figure 1: Growing Disparity Between World Production and World Discoveries



Oil and Gas Journal, July 21, 2003.

capacity is exhausted, worldwide competition for oil will cause a switch in the world petroleum economy from the historical buyers' market to a sellers' market. This situation will significantly increase oil prices, at a high cost to the U.S. and world economies. A more expansive discussion of the effect of OPEC's excess capacity reduction on the U.S. economy, excerpted from *Strategic Significance of America's Oil Shale Resources*, is provided in Appendix 1.

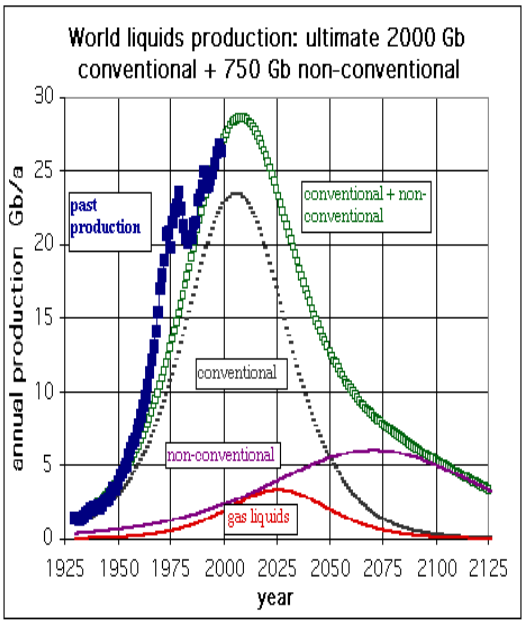
World Conventional Oil Supply May Soon Peak and Decline: Adding urgency to the rising global demand situation is the indication that world oil production may peak sooner than generally believed, accelerating the onset of competition among consumers for ever-scarcer oil resources (Figure 3). Except for the Organization of Petroleum Exporting Countries (OPEC), most of the world's oil producing provinces have *already* reached peak production and are in a steady decline.

New field discoveries and reserve additions and extensions brought on by new investments and advances in technology may slow the rate of decline, but are unlikely to reverse it. In 2003, the world consumed 27 billion barrels of petroleum, but only replaced 3 billion barrels of reserves. Development of petroleum resources in other producing countries is unlikely to keep pace with rising demand and declining production. Perceptions of a coming supply shortfall may stimulate irrational behavior by nations and consumers. Whether the global supply shortfall begins as early as this decade or as late as 2040, the nation needs to prepare *now* for a reduction in global petroleum supplies and the higher prices and economic impacts that will follow.

U.S. Energy and Economic Security is Increasingly at Risk: U.S oil imports have reached a historic peak level of nearly 60 percent of demand, and imports are expected to grow as U.S. demand increases and domestic production continues its inexorable decline (Figure 4).

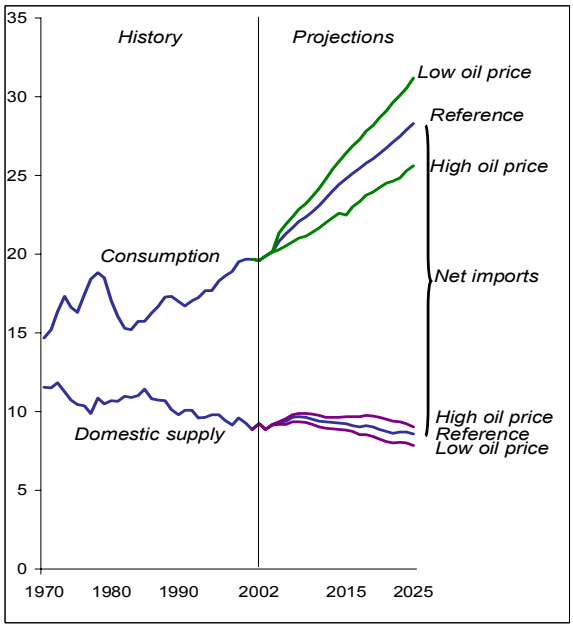
The nation's rising dependence on oil imports from politically unstable sources places national energy and economic

Figure 3. World Oil Production May Soon Peak and Decline



Laherrere, Future Sources of Crude Oil Supply, 1997.

Figure 4. U.S. Dependence on Petroleum Imports Will Continue to Grow (MM B/D)



U.S. EIA, Annual Energy Outlook, 2004.

security at risk to supply interruptions caused by terrorist acts, political fiat, or natural disaster. A labor strike in Venezuela or Nigeria, a pipeline explosion in Iraq, or a terrorist attack on key shipping terminals could cut global oil supply, causing immediate price shocks with far reaching economic impacts.

Increasing geopolitical risk also deters the global petroleum industry from making long-term investments that are now needed to explore, find, and produce new oil supplies. This risk contributes to higher current world oil prices and cost of goods and exacerbates the long-term supply problem. These conditions, along with limited global oil exploration opportunities and activity, underscore the increasing risk that America's growing reliance on imported oil poses to national security and economic vitality.

Military Preparedness and Homeland Defense Require Secure Fuel Sources: The nation requires reliable sources of military fuels to defend itself and to protect its vital interests around the world. Growing competition for increasingly scarce sources of foreign oil, coupled with greater risks of supply disruptions due to geopolitical instability, could hinder America's military preparedness and responsiveness at home and abroad. National Guard and other domestic first-responders also share in that risk. Rising oil prices increase the cost of the nation's defense. A secure, domestic supply of fuels would significantly reduce this risk and help to maintain the readiness of U.S. armed services and first responders.

Current Energy Policy Relies Heavily on Middle East Oil: Current national energy policy is based on optimistic projections of future increases in Middle East oil production. It is also dependent, perhaps to an extreme, on assumptions about the future economic, technical, and environmental feasibility of alternative energy resources and technologies that may result from long-term research and development. If these alternate energy expectations are not achieved in a timely manner, the impacts on economies that rely on petroleum could be catastrophic, causing both significant socio-economic dislocation, and political instability.

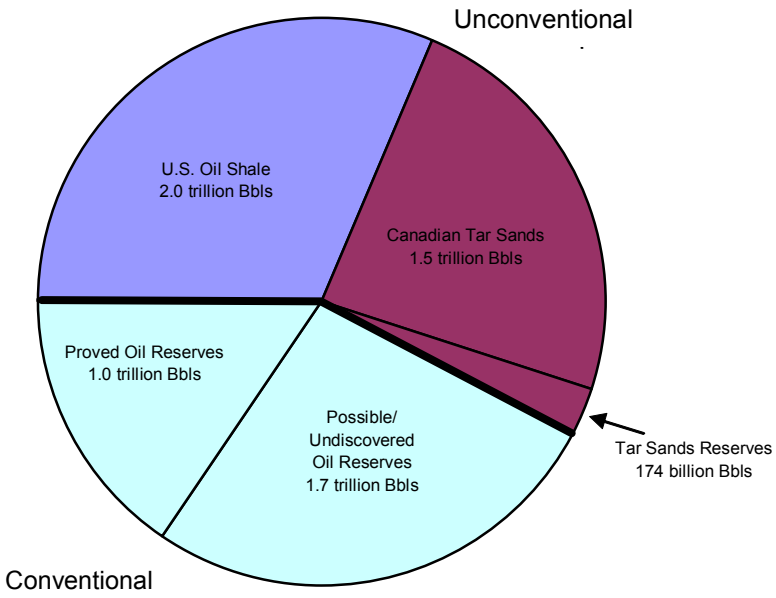
Domestic Energy Options are Limited: America's domestic energy production options to address the coming dislocation in global petroleum supply and demand are limited, especially in the near-term. Nuclear energy, and solar and renewable energy resources, are better suited to producing electricity and heat than to producing liquid transportation fuels.

The only other resources within the United States that can produce liquid transportation fuels to replace imported oil in significant quantities are coal and oil shale, both fossil fuels. Coal can be converted to liquid fuels through direct liquefaction or by gasification and conversion (by Fischer-Tropsch technology) to liquids. Both approaches require sustained higher global oil prices in order for coal liquids to be economically competitive.

Oil shale was a sound idea in the 1970s. Oil shale, though long recognized by industry and the government for its enormous potential, has been largely ignored since the oil price decline of the 1980s terminated initial commercial development of this resource. Given further erosion of America's domestic fuels supply base, expected higher sustained global oil prices, and the potential economic and price impacts of a coming global supply peak, oil shale looks even more promising today.

Unconventional Oil Resources are Plentiful: An enormous resource base of unconventional oil exists worldwide and,

Figure 5. Unconventional Oil Resources Exceed World Conventional Resources



U.S. EIA, International Energy Outlook, 2003.

particularly, in the Western Hemisphere, where significant quantities of hydrocarbons are found in oil shale, tar sand, and very heavy oil (Figure 5). These resources are deemed "unconventional" because they have been economically or technically infeasible to produce relative to conventional oil. However, as expected future oil prices continue to rise, technology improves, and development costs fall, these known, secure resources become competitive and viable.

America's Oil Shale Resources Can Help Bridge the Gap: A domestic oil shale industry could provide the needed "bridge" between conventional petroleum and future alternative energy sources as global petroleum supply peaks and begins its inevitable decline.

It is conceivable that a 2 million barrel per day shale oil industry could be developed in the United States by 2020, a near-term venture in contrast to the timelines envisioned for transition to other fuels.

The potentially recoverable oil contained in U.S. oil shale deposits exceeds one trillion barrels by most estimates. U.S. oil shale is among the richest and most geographically concentrated in the world, yet lies undeveloped mainly in the Western United States, in Utah, Colorado, and Wyoming

Eastern oil shales also offer significant promise but their development will likely follow the more concentrated western resources. Future development of this rich and massive resource will require access to the resource, technology maturation, large capital investments, and stable and reliable government policies and incentives that create a receptive climate for industry investment and commitment.

In light of current and expected world events, and the long lead-times required to turn investment decisions into actual fuels production, it is now prudent to recognize and pursue the potential of U.S. oil shale and to include oil shale in the mix of energy resources, policies, and programs that are essential to sustain U.S. economic growth and vitality and bolster national energy security.

IV. Hurdles Constraining U.S. Oil Shale Development

The Department of Energy has identified a range of public policy, technical, economic, environmental, and socio-economic hurdles that constrain private industry's aggressive, near-term development of a viable domestic oil shale industry within the next two decades - the time frame needed to meet national needs and goals.

Overcoming these investment and development hurdles will require aggressive Federal action and support. Such support may encompass oil shale leasing, technology development and demonstration, economic and tax incentives; environmental assessment, regulatory streamlining, and infrastructure development support.

Prior attempts to establish an oil shale industry in the United States raise reasonable questions about the technical feasibility, economic viability, and environmental acceptability of successfully implementing a domestic oil shale industry in the coming decades. These questions must be addressed to dispel common misperceptions, to inform policy decisions, and to guide program design and implementation.

The numerous hurdles that constrain oil shale industry development (summarized below) suggest key objectives and areas of focus for Federal actions and for public-private collaborative efforts.

Technology Performance and Readiness

The feasibility of various technological approaches to recover and process U.S. western oil shale at commercial scale remains uncertain. Such uncertainty represents a risk to the investments needed to build a domestic oil shale industry.

A domestic oil shale industry can be initiated building on our existing knowledge and technology base. Technologies developed in the 1980s may be able to be commercialized swiftly to help achieve early production goals. Advances being developed in the United States and elsewhere in the world suggest that many technological challenges to commercial-scale oil shale production may soon be overcome. This assertion needs to be borne out by further analysis of past and current efforts and by demonstration of the most promising approaches at or near commercially-representative scale in U.S. Western Shales.

These demonstrations are unlikely to occur without cooperative public support to reduce front-end costs and investment risk. No public programs currently exist to encourage or assist the demonstration of oil shale technologies at this scale in the United States.

While the industry is being *initiated* with current technology, aggressive R&D is also needed to explore and advance new approaches and novel concepts that promise to expand technology options, improve operability and efficiency, and reduce costs of producing shale oil, over time.

Advancement of novel concepts and new approaches requires significant investment in long-range, high-risk research and development (to achieve proof of concept) and applied R&D (to develop and prove technology at bench or field scale) prior to demonstration at a commercially-representative scale.

However, industry investment in such long-term high-risk, basic research, and applied oil shale technology R&D is unlikely to be of sufficient magnitude to achieve the needed results in the timeframe necessary to meet the nation's needs and to achieve domestic energy production goals, without a government commitment and significant public investment.

Economic Viability of Shale Oil

Production of shale oil has been perceived as uneconomic at historical crude oil prices.

As a result of decades of research and capital investment, Canada has recently achieved economic production of oil from its massive Alberta tar sand resource. The producible Alberta tar sand deposits, once deemed unconventional, are now recognized as proven crude oil reserves. An analogous development path leading to improved resource economics and addition of proved reserves is possible for U.S. oil shale. The current and potential future economic viability of U.S. oil shale needs to be analyzed and understood as a precursor to oil shale development.

Oil Shale Resources on Federal Lands

Nearly 80 percent of the United States' Western oil shale resources are owned and managed by Federal and State government agencies. Policies are needed to make these resources available on terms attractive to industry while ensuring efficient resource development.

The 1920 Mineral Leasing Act restricts the number and size of leases available to private entities for oil shale development. A moratorium on oil shale leases has been in place since the 1980s. The Prototype Oil Shale Leasing Program, developed by DOI in 1973, provides a strong foundation for crafting a new leasing policy. However, it will require revision to reflect advances in mining, in-situ conversion, and surface retorting technologies, new environmental practices, and regulatory changes.

Potential Environmental Impacts and Concerns

Air quality, carbon emissions, groundwater, spent shale disposal, land reclamation, and other environmental issues associated with the development of oil shale challenge swift industry commercialization.

Although environmental controls and technology performance were important issues, curtailment of previous oil shale industry development efforts in the United States was due principally to the precipitous decline in world oil prices.

Environmental controls and mitigation technologies have matured during the past 25 years, as have environmental regulations and permitting processes. Modern oil shale projects will include environmental controls and regulatory compliance in their project designs and economic projections.

Environmental characteristics of specific technologies need to be assessed relative to State and Federal environmental regulations. Much data exists from prior oil shale leasing and industry commercialization efforts, but require analysis in the context of regulatory requirements.

Significant stakeholder outreach, education, and communications will be required to overcome negative perceptions of the environmental impacts of oil shale production, to achieve community support, and consensus, and to expedite project permitting.

Water Availability and Usage

Current water supply from the Colorado River Basin System is likely to be adequate to support the initial phases of oil shale industry development. However, the quantity of water required for a large-scale industry, producing 2 – 4 million barrels per day or more, could present a significant hurdle.

Population expansion in areas served by the Colorado River Basin is expected to increase water consumption. However, new technologies and processes may significantly reduce water requirements relative to oil shale projects designed in the 1980s. Nonetheless, the quantity of water

required and measures to reduce that quantity need to be evaluated in detail. Alternate water sources, including inter-basin transfers and new gathering and storage projects, need to be identified. The means for water to be supplied in the most economically and environmentally sound manner need to be fully analyzed and understood. New technologies to treat connate water and process water for recovery and re-use need to be identified.

Other Process Inputs and Infrastructure

Some oil shale processes require external inputs of natural gas or electric power for process heat or for upgrading raw kerogen oil to refinery-grade feedstocks. Yet, some other processes are self-sufficient or even net-gas or power producers

Although natural gas is indigenous to the western oil shale region, and major pipeline infrastructure exists, the quantities to be required, their availability to oil shale projects, and the adequacy of infrastructure to deliver gas to project sites or upgrading facilities may be limited, particularly as natural gas demand continues to rise.

Sustainable Development and Socio-Economic Impacts

Because of the dense concentration of the resources in a relatively small area of the country, oil shale industry development and operation will stimulate rapid and significant population growth in the affected communities, accompanied by expanded investment requirements for community infrastructure and support services.

Analyses of these requirements, their costs and socioeconomic impacts, and approaches for providing this critical supporting infrastructure, are needed to support policy making and development planning. Federal support and legislative action may be needed to ensure that state and local governments do not bear inordinate cost or economic risk during the early phases of an oil shale industry.

Investment Risk

Oil shale production is characterized by high front-end capital and operating costs and long lead times between capital investments and operating revenues. The potential for changes in economic conditions, energy markets, capital markets, government leadership and policies, and public support for oil shale projects, imposes greater risks than many other energy project investments.

Coupled with technical uncertainty and the volatility of crude oil and product prices, oil shale investment risks pose a high hurdle to project financing, especially in first-generation projects. Such hurdles may make oil shale investments less attractive than other investment options. They may limit access to capital and/or increase the cost of capital. Public actions and policies to reduce or share investment risk are needed to improve the investment climate and achieve public goals.

Public and Private Commitment to Oil Shale are Uncertain

The economic risks, technical and regulatory uncertainty, and absence of explicit government support, along with the lingering memory of billions of dollars of public and private investments lost when oil prices collapsed in the early 1980s, deter aggressive pursuit of the U.S. oil shale opportunity.

Oil shale development may represent *both* prudent public policy to meet the nation's strategic needs *and* an important new business opportunity for the energy industry, as global oil production approaches its peak. The Federal government needs an expression of interest from industry and the investment community, as well as from impacted communities, to initiate major

Federal support. Industry and the investment community need a similar commitment from the Federal government before they can proceed. Until this apparent impasse is resolved, little progress can be achieved. The government needs to take the initiative by firmly demonstrating its interest and willingness to commit support for development of an oil shale industry. This must be done quickly if public goals and objectives are to be met in a timely manner.

Federal Assistance is Now Warranted

Overcoming these hurdles will require significant capital investment and risk by industry to conduct research and advance technology; to build and demonstrate production, upgrading and refining facilities; to meet strict environmental standards; and, to support the development of community infrastructure.

Cooperative Federal assistance may be required to mitigate risks and empower industry to take the initial steps toward commercialization of the nation's vast oil shale resources.

Pathways to Address Hurdles to Oil Shale Industry Development

Based on initial review of the current status of the resource, technology, market, and commercialization hurdles faced by industry, several potential pathways and oil shale program options are apparent. These are summarized in Table 1, below. These *options* include an array of tax incentives, regulatory efforts, research and development, demonstrations, and commercialization efforts that may be considered depending on supply impact desired by policymakers, industry needs, and the scope of authority and funding available for the effort.

Table 1. Potential Pathways for Oil Shale Program Development

Hurdle Area	Goals and Objectives	Potential Pathways	Key Participants
Oil Shale Policy and Commitment to Oil Shale Development	Establish oil shale as a priority for domestic and military liquid fuels. Understand potential costs and benefits of various policy and program options. Authorize / fund analysis to underpin policy and plans.	Oil Shale Statement of Policy Program Authorization Budgets and Appropriations Initial analytical basis for policy development and decision-making	White House, DOE, DOI, DoD Congress
Government Coordination and Program Development	Develop structure for oil shale program planning and implementation. Develop analytical basis for making and evaluating program and policy decisions.	Interagency Collaboration MOU Comprehensive Oil Shale Policy Roadmaps and Program Plans (R&D, Commercialization) Industry collaboration Public-Private partnerships	DOE, DoD, DOI, Treasury Interested companies and associations States
Education and Stakeholder Outreach	Understand stakeholder issues and concerns. Facilitate stakeholder understanding of oil shale resource, technology, benefits, and impacts.	Technical Exchange forums Stakeholder outreach plan Communications plan	DOE, Industry, DOI Public/Private Partnership States Local Communities NGOs
Environmental Impacts and Concerns	Understand environmental impacts of development; Identify requirements and methods for mitigation.	Environmental assessment Expedited permitting State /Federal coordination	EPA, DOT, States, Localities DOE, States
Oil Shale Resource Access, and Conservation	Ensure competitive access to and efficient development of oil shale on public lands.	Resource characterization Oil shale leasing policy and plans Competing use issues	DOI / BLM, USGS, DOE Interested companies and organizations; Private landowners
Economic / Investment Climate and Risk Factors	Reduce economic barriers. Create positive climate for private oil shale investment. Reduce front-end costs.	Demonstrate costs of various development scenarios. Economic incentives (i.e., Purchases; Royalty Relief). Tax incentives / structure changes.	DOE, companies, industry associations, others DoD, Treasury, DOI, States
Technology Performance and Readiness	Improve performance / reduce technical risk of mining, in-situ, surface retort upgrading, and refining processes. Demonstrate current technology at commercial scale. Develop novel and next-generation technologies.	Demonstrate current technology Identify technology gaps and future R&D needs and priorities Cost-share research, development and demonstration R&D incentives for industry	DOE, companies DOE, companies, industry associations, research organizations Industry, universities, and research organizations DOE, Treasury, States
Project and Community Infrastructure	Develop secure infrastructure to supply project inputs (i.e., water, natural gas, electric power) and transport products / outputs. Develop essential community infrastructure to support rapid population growth.	Investment incentives Financial aid to States / localities Infrastructure protection support Federal water supply projects Expedited permitting	Congress, Treasury, DOE Congress, Treasury States, DOE, Congress, Treasury, DHS Congress, Corps of Engineers EPA, DOT, States, Localities

V. Initial Pathways for Federal Decision-Making

Fully understanding, addressing, and overcoming the hurdles to oil shale industry development will require extensive collaboration between the public and private sectors over a period of several years. Federal involvement in this process will occur in several phases portrayed simply in Figure 6.

Efforts to examine the potential of oil shale, and determine the merits of further public and private efforts to commercialize the resource began in earnest with DOE's assessment of the *Strategic Potential of America's Oil Shale Resources*, completed in March 2004. This study provided a preliminary view of the potential of America's oil shale and the status of oil shale projects, technology, and advances since the 1980s.

Although additional analysis is required to support prudent policy decisions, the results of this study were sufficiently compelling to initiate organization, strategy development, and planning efforts for a broader Federal effort.

Figure 7, provides a Roadmap for Federal actions leading to implementation of an oil shale program plan. The activities and steps that comprise the Roadmap are discussed in greater detail below

1.0 Organization

One goal of ongoing efforts is to establish the business case for an oil shale industry commercialization program and to demonstrate the potential of oil shale to help offset civilian or military fuels shortages due to global supply and demand shifts or temporary supply disruptions. Another goal is to organize key Federal participants to work effectively with one another and with industry and other stakeholders to effectively stimulate oil shale development. Several specific activities have been initiated or planned to achieve these goals:

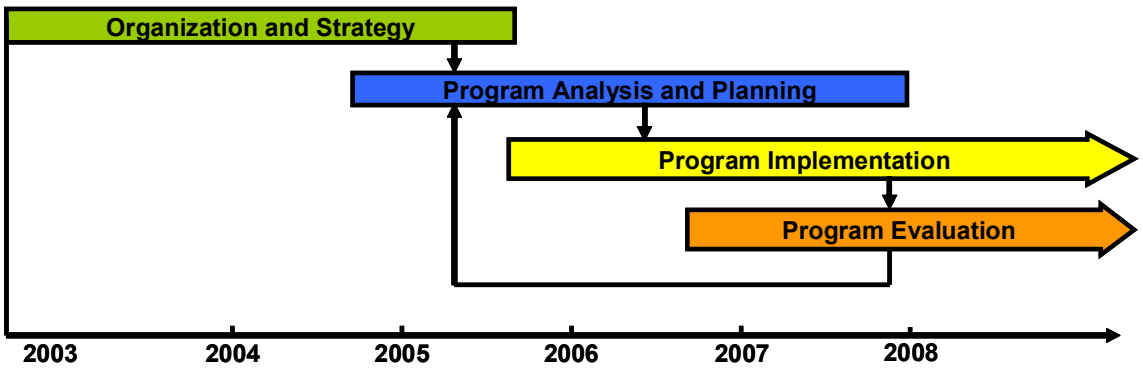
1.1 Authorization and Funding Request

The Deputy Assistant Secretary for Petroleum Reserves will prepare a program authorization request by January 2005 and coordinate its approval through DOE and OMB channels, as appropriate. While this request is in process, strategy development, supporting analysis, and program planning efforts will proceed.

1.2 Federal Oil Shale Task Force

Numerous Federal agencies, including the Department of Energy, the Department of the Interior, the Department of Defense, and the Department of Treasury will be involved in the planning of a Federal Oil Shale Program. Initial steps have already been

Figure 6: Systems Approach to Oil Shale Program Development



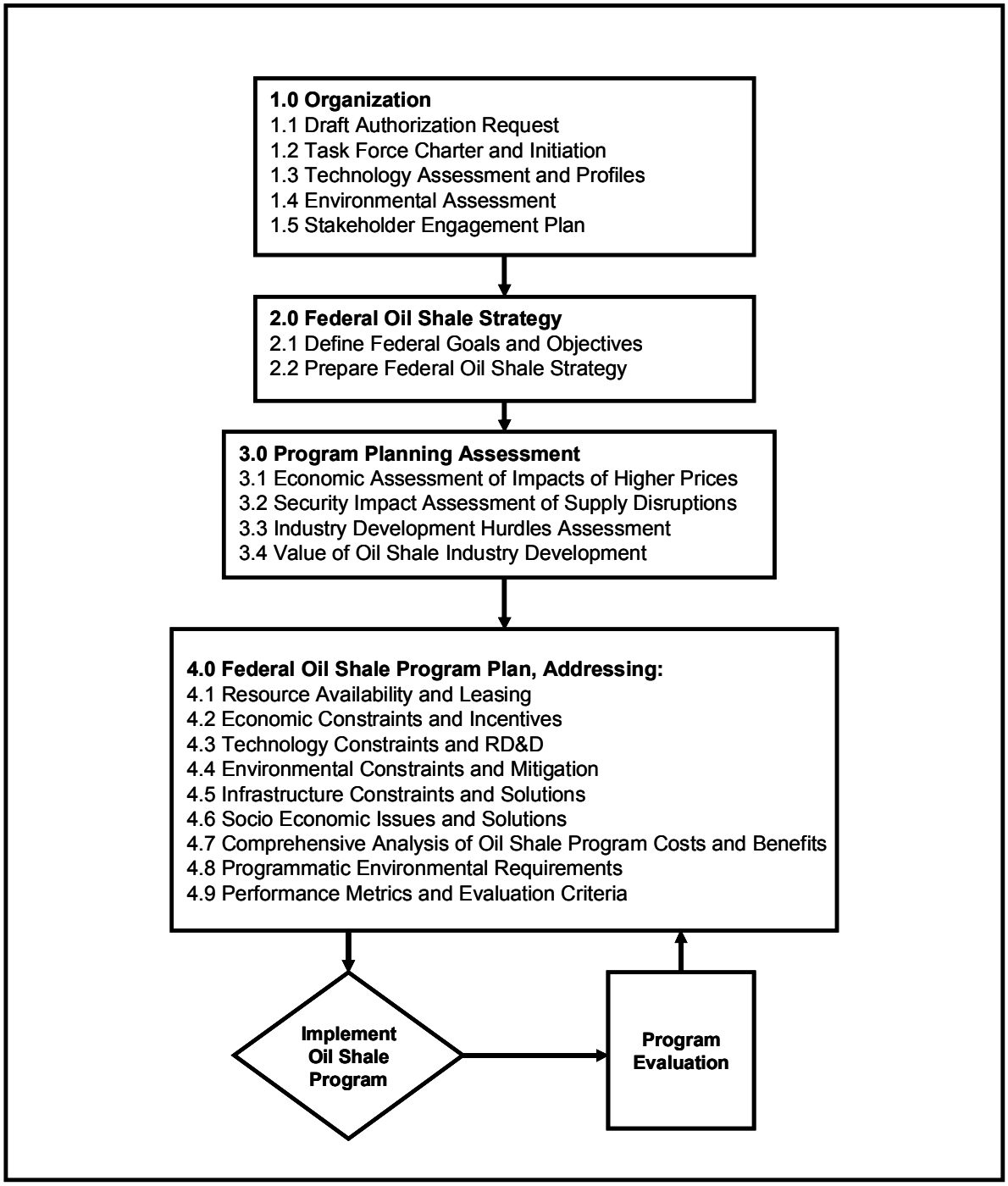
taken to lay the ground work for interagency collaboration through the development of a draft Memorandum of Understanding (MOU) between DOE, DoD, and DOI.

To implement the MOU and support a collaborative multi-agency effort, a charter will be drafted for the formation of a Federal Oil Shale Task Force, under the direction of the Petroleum Reserves Office within the Department of Energy, consistent with that office's historic mission and charter. The Task Force will be initiated in January 2005.

1.3 Technology Assessment and Profiles

DOE has identified a requirement for additional information regarding the status, performance, and availability of specific oil

Figure 7: Oil Shale Program Development Roadmap



shale technologies that were developed and tested at various scales during the 1970s and 1980s. Existing information about these technologies will be collected and assembled as a resource for analysis and planning purposes. This will provide a baseline for identifying technologies and processes that could be demonstrated and commercialized quickly to initiate domestic shale oil production. DOE's National Energy Technology Laboratory is conducting this effort to be completed in January 2005.

1.4 Environmental Assessment of Oil Shale Technologies

A wealth of data exists within the Department of Energy about the environmental performance of oil shale technologies and processes that were developed during the 1970s and 1980s. Extensive analysis was also conducted by DOI for the 1973 Environmental Assessment of the Prototype Oil Shale Leasing Program. These data will be reviewed and summarized to provide input to oil shale strategy development and program planning efforts. DOE's National Energy Technology Laboratory is conducting this effort to be completed in January 2005.

1.5 Stakeholder Engagement Plan

A critical factor in the success or failure of oil shale program development and industry commercialization efforts will be the effective input of key stakeholders in industry, the states, affected communities, and other organizations. As demonstrated by Alberta's development of its tar sands program, early stakeholder involvement and input is essential. DOE will prepare a draft Stakeholder Engagement Plan for review and approval by the Oil Shale Task Force. This will include a broad range of approaches for providing information and outreach to stakeholders as well as soliciting and assessing stakeholder input and evaluating and incorporating that input in strategies and program plans. A draft plan should be complete in February 2005. A Technical Exchange meeting is also planned in February 2005 to explore issues and concerns and approaches for achieving oil shale goals objectives.

2.0 Federal Oil Shale Strategy

A key role of the Oil Shale Task Force will be to draft and recommend a Federal Oil Shale Strategy. The Federal Oil Shale Strategy will provide the basis for preparing a Federal Oil Shale Program Plan.

2.1 Federal Goals and Objectives

The strategy will define Federal goals and key objectives toward achieving those. A preliminary set of possible goals and objectives, aimed at overcoming identified hurdles to industry development, were included in DOE's preliminary assessment of oil shale potential and are summarized in Section IV (Table 1) of this Roadmap.

2.2 Draft Strategy Document

DOE will prepare a draft strategy document for consideration by the Oil Shale Task Force. It will identify Federal goals and objectives, and define federal activity areas, program options, and high-level approaches. The target date for completion of the draft strategy is March 2005.

3.0 Program Planning Assessments

As noted above, additional analyses will be required to support the development of prudent and effective program plans and activities that support the Federal Oil Shale Strategy and achieve public and private goals and objectives. These include: (1) an assessment of the potential economic impacts that can be expected from expected higher oil prices; (2) an evaluation of the

security impacts of potential fuel supply disruptions; (3) more detailed assessment of the hurdles that constrain oil shale industry development in the United States; and (4) a reliable valuation of the national economic and security benefits that could be achieved by developing a domestic oil shale industry. These assessments, described in greater detail below, are being initiated in the near-term with the expectation that they can be completed in March 2005 in order to inform and focus program planning efforts.

3.1 Economic Impacts of Higher Oil Prices and Changes in Supply and Demand

Reaching peak oil production globally in shorter timeframes than some predict will dramatically drive up the price of oil, impacting the U.S. and world economies. This prospect accelerates the need for a range of solutions, including: (1) conservation to reduce demand; (2) alternatives including renewables and intermediates (such as hydrogen); and (3) unconventional oil (including oil shale and tar sands) to increase domestic fuels supply.

To assess the national economic benefits of oil shale production, DOE will model and analyze the economic impacts of rising prices and reduced supply under a variety of price / supply scenarios. DOE will update analyses of future worldwide petroleum supply and demand, using Energy Information Administration (EIA), International Energy Agency (IEA), and private sector forecasts to bracket a range of uncertainty.

DOE will determine the price impacts of various scenarios of reduced world oil supply and increased global demand, as well as a number of supply interruption scenarios. DOE will then correlate the price impacts to specific measures of U.S. economic well-being, including:

- Product prices for fuels
- Domestic fuels demand and energy imports
- Gross domestic product
- U.S. Employment
- Balance of trade and balance of payments.

These analyses will establish the economic rationale for program actions to stimulate oil shale development.

3.2 Security Impacts of Oil Supply Disruptions

Supply disruptions from political crises, economic dislocations, natural disaster, or physical constraints may result in short-term or intermediate-term fuel supply shortfalls. Scenarios such as disruption of Saudi shipping terminals, a tanker sunk in the Straits of Hormuz, an extended labor strike and production shutdown in Venezuela, or a severe hurricane in the Gulf of Mexico are not difficult to imagine. The potential impacts of these shortfalls on liquid fuel supplies for military preparedness and homeland defense, including first responders, need to be understood and considered in formulating policy and determining program elements. DOE and DoD will:

- Assess both the credible probability of a variety of supply disruption scenarios of varying levels and durations and determine respective supply impacts.
- Update analyses of the security implications of supply disruptions from potential political crisis or physical constraints that may result in short-term or intermediate-term shortfalls.
- Evaluate military fuel requirements and preparedness benefits of developing a secure domestic resource of quality military fuels.

- Demonstrate the relationships among domestic supply, the Strategic Petroleum Reserve, and the benefits of developing a large and stable domestic oil shale industry.

3.3 Major Factors Influencing Oil Shale Industry Development

To support economic benefits assessments, policy analyses, and program planning efforts, DOE will analyze and update its understanding of a range of factors that influence or determine the cost, timing, ultimate size, and potential fuel supply contributions of a domestic oil shale industry. The results of these analyses will provide direct inputs to the assessment of the potential economic and security value of oil shale industry. Specific components will include:

3.3.1 Infrastructure Gaps: An assessment of gaps in the infrastructure required to support oil shale industry development (e.g. water supply, natural gas supply, upgrading facilities, roads, pipelines, and community facilities) and a practical, phased schedule for expanding infrastructure to meet future needs as the industry grows, will be developed.

3.3.2 Characterization of U.S. Oil Shale Resources: Updated assessments and characterization of the U.S. oil shale resource that reflect improved resource knowledge and improvements in oil shale technology performance will be performed. This analysis will help identify which oil shale resources and locations are best suited to specific mining, in-situ, or surface retorting technologies and allow revised estimates of potential shale oil production.

DOE, BLM, and USGS will meet to concur on a consistent set of resource estimates for the purpose of program planning and supporting analyses. The results will provide key inputs to economic analyses as well as guidance to leasing programs. A wealth of data already exists within the Department of the Interior (BLM and USGS) that can be used for this purpose.

3.3.3 Review Oil Shale Leasing Issues and Needs: A review of the 1973 Prototype Oil Shale Leasing Policy developed by DOI/BLM will be conducted to identify key issues that must be addressed in developing a new Oil Shale Strategy and a new leasing plan.

BLM's 2004 proposed rulemaking to establish R&D leases for oil shale development will also be reviewed and comments will be prepared and submitted as appropriate.

3.3.4 Lessons From the Alberta Tar Sands and International Oil Shale Projects: Experience in Canada, with its massive tar sands reserves, and to a lesser extent, emerging oil shale technological advances around the globe, point toward opportunities and methodologies that could be needed to build a profitable, robust, and environmentally sound industry in the United States. Lessons learned from these efforts could inform assumptions about industry development timing, costs, and technology performance. DOE will:

- Review the history of U.S. oil shale development and examine the reasons for prior failures, the lessons, and benefits resulting from that experience, and the opportunities to build on past and recent accomplishments.
- Review the Alberta Tar Sands industry development experience.
- Review other active oil shale projects around the world.

3.3.5 Oil Shale Technology Status and Gaps: Technologies for oil shale mining, retorting, in-situ conversion, processing, and upgrading have improved due to continued

research and the experience of oil shale projects elsewhere in the world. DOE will:

- Update understanding of technology performance, costs, and products of oil shale projects underway in the United States and around the world
- Identify known technical gaps and deficiencies
- Identify technologies that are ready for "next-step" commercialization based on operability, sustainability, efficiency, and environmental compliance.
- Identify and prioritize R&D areas where Federal participation will help accelerate commercial development while protecting the environment.

3.3.6 Model Hypothetical Oil Shale Plants: To provide a technology baseline for program planning and for evaluating program impacts and economic costs and benefits, a series of "model" project profiles are needed. DOE will:

- Define as many as six hypothetical surface and below-ground mining and retorting combinations (i.e: Surface mine / surface retort; Room and pillar mine / surface retort; In-situ conversion; Modified in-situ; and combinations.)
- Characterize product development, upgrading and refining requirements and assess prognosis for improvements.
- Estimate (in ranges) development, capital, and operating costs and revenues
- Model approximate economics of each project type, on a consistent and directly comparable basis, using a classic project financing approach to illustrate the business case for each and to determine if projects are self-sustainable in a competitive market.
- Identify pros and cons, including limitations and technology gaps, associated with each project type.

3.3.7 Assess Economic Viability of Oil Shale Relative to Other Alternative Liquid Transportation Fuel Sources: To demonstrate that oil shale development can/will compare favorably with other liquid fuel resources (in terms of costs, contributions to domestic energy supply, and energy efficiency) DOE will:

- Evaluate unconventional oil sources, such as tar sands and coal liquefaction.
- Evaluate conventional investments in petroleum extraction, such as ultra-deep off-shore production and certain enhanced oil recovery technologies.

3.3.8 Understand Potential Research, Development and Demonstration (RD&D) Requirements: A variety of research and demonstration work will be required to enable current technologies to make the final step to commercialization. DOE will work with industry to identify technologies that are ready for "next step" demonstration and commercialization. DOE will also identify R&D requirements to overcome the technology gaps previously identified. Working with industry and other experts, DOE will:

- Identify technologies that already exist that could be demonstrated quickly to initiate domestic shale oil and fuels production.
- Identify and prioritize research and demonstration needs to advance technology performance, reliability, efficiency and cost effectiveness and mitigate risks.
- Define parameters for joint industry/government research and development collaboration and demonstrations.

3.3.9 Socio-Economics Impacts, Risks and Costs of Development: Development of massive oil shale resources in Colorado, Utah, and Wyoming will cause both significant economic costs and benefits to the region. Oil shale industry development will need to be managed as to minimize the adverse socioeconomic impacts on the region while delivering intended benefits. Working with State and local representatives, DOE will:

- Assess the potential costs and timing of improvements in community services and infrastructure that will be needed to support population growth attributable to oil shale industry development and associated economic activity.
- Evaluate Alberta's socio-economic development approach for its oil sands development as an analog or model for U.S. oil shale development
- Conduct economic benefit and risk analysis to determine regional impacts.

3.3.10 Environmental Impacts: Depending on the profile of a given project, (i.e. surface or underground mining; retorting technology; in-situ approach; upgrading approach, etc.) oil shale projects will have varying environmental impacts. It is expected that impacts can be reduced through cost-effective project designs or mitigated in the future, through restoration and reclamation or other approaches. DOE will characterize the ranges of potential impacts from various hypothetical technology scenarios and suggest alternative mitigation strategies.

3.4 Evaluate Potential Economic Value of Oil Shale to United States

DOE will assess the potential economic value that development of an oil shale industry could offer to the United States. To do so, DOE will augment its modeling capability to analyze a range of plausible scenarios of resource availability, technology performance, industry development timing, and shale oil production levels.

Using the results of analyses described in Section 3.3 above, the analyses will estimate the potential levels and timing of:

- Shale oil production and oil imports avoided
- Impacts to dampen global fuels prices
- Gross Domestic Product (GDP) impacts of industry development and operation
- Employment impacts
- State and federal revenues

4.0 Federal Oil Shale Program Plan

Based on the goals, objectives, and limitations established in the Federal Oil Shale Strategy and on the results of various analyses and assessments described above, as well as effective input from key stakeholders, an integrated Federal Oil Shale Program Plan will be drafted by the Oil Shale Task Force.

To effectively respond to the known issues and hurdles that constrain private sector development of a domestic oil shale industry, it is expected that the integrated Federal Oil Shale Program Plan may include the following major program elements:

- Resource Availability and Leasing
- Economic Constraints and Incentives
- Technology Constraints and RD&D Requirements
- Environmental Constraints and Mitigation
- Infrastructure Constraints and Development
- Socio-Economic Constraints and Solutions

- Comprehensive Analysis of Oil Shale Benefits and Costs
- Programmatic Environmental Requirements
- Performance Metrics and Evaluation Criteria

It is anticipated that various agencies will take the lead in developing specific segments of the integrated plan. For example, it is likely that the Department of Interior's Bureau of Land Management will lead efforts for planning oil shale leasing. Similarly, the Department of Treasury may lead or play a key role in evaluating potential economic and tax incentives. These assignments will be determined by the Oil Shale Task Force consistent with its charter.

Additional analysis and modeling efforts will be required to support the development and justification of specific elements of the Federal Oil Shale Program Plan. These may include resource and technology modeling, and environmental analysis, as well as cost-benefit analysis of various program elements and government actions. Additional analytical effort will be required to establish near-term and long-term performance metrics to support program evaluation and ensure program effectiveness.

VI. Key Milestones and Schedule

The Deputy Assistant Secretary for Petroleum Reserves has developed an aggressive schedule for initiating Federal activities to stimulate creation of a domestic oil shale industry. (Table 2).

Building on the preliminary efforts already coordinated by DOE and others, the first version of the Oil Shale Program Roadmap will be completed for final review and comment by mid-December 2004.

Analytical work will commence immediately to support program planning and impacts assessment, including economic impacts assessment, security impacts assessment, assessment of industry development constraints, and initial assessment of the potential value of developing a domestic oil shale industry. These analyses are to be completed in early February, 2005.

Table 2: Major Milestones for Oil Shale Program Assessment and Initiation

Activity / Milestone	Expected Completion
Roadmap	December 04
Draft Authorization Request	January '05
Task Force Charter & Initiation	January '05
Technology Assessment & Profiles	January '05
Environmental Assessment	January '05
Stakeholder Engagement Plan	February '05
Federal Oil Shale Strategy	February 05
Economic Assessment of Oil Price Impacts	March '05
Security Impact Assessment	March '05
Industry Constraints Analyses	March '05
Technical Exchange Meeting	March '05
Value of Oil Shale Industry Development	March '05
Report to Congress	May '05
Federal Oil Shale Program Plan	May '05
Program Implementation Begins	October 05

A draft charter for a Federal Oil Shale Task Force will be prepared by mid-January.

Cooperative efforts have already begun with the circulation of a draft Memorandum of Understanding (MOU) among several of the principal Federal agencies involved, including the Department of Energy, the Department of the Interior (BLM), and the Department of Defense. This MOU will support initiation of the Oil Shale Task Force by late January.

Preliminary efforts are already underway within the Department of Energy to outline and draft the Federal Oil Shale Strategy by February 2005. This effort will accelerate the pace of Federal activity once the Task Force is in place and allow for the rapid development of a Stakeholder Engagement Plan. Effective stakeholder outreach and participation is essential to achieve oil shale development goals in a timely manner.

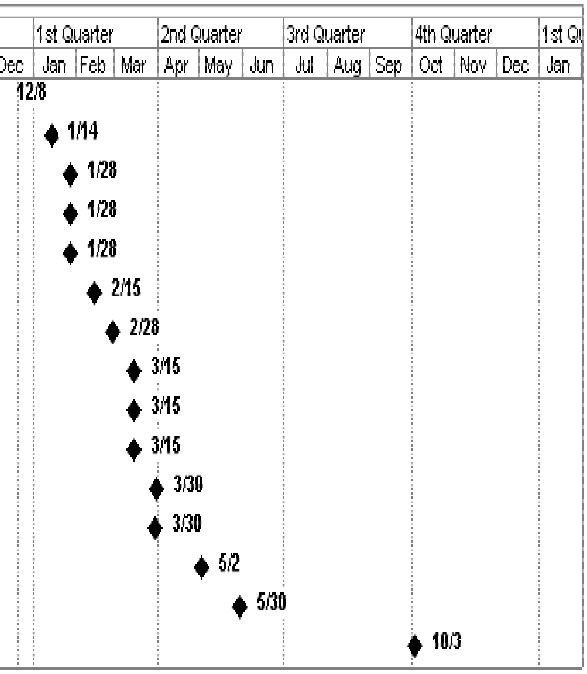
The Task Force will provide effective direction for the development of the detailed elements of an integrated Federal Oil Shale Program Plan. With effective participation and collaboration, a preliminary Federal Oil Shale Program Plan, could be available for review and comment by mid-May 2005.

Additional analysis will be required in all areas of activity envisioned in the plan. Refinements to the Program Plan will be made over the ensuing months in collaboration with policy makers, the States, stakeholders, and industry.

Initial program activities are expected to start early in the new Federal fiscal year, beginning October 1, 2005. These major milestones are reflected in Figure 8.

Figure 8: Major Milestones for Oil Shale Program Assessment and Initiation

ID	Task Name	Duration	Finish
1	Roadmap	0 days	Wed 12/8/04
2	Draft Authorization Request	0 days	Fri 1/14/05
3	Task Force Charter & Initiation	0 days	Fri 1/28/05
4	Technology Assessment & Profiles	0 days	Fri 1/28/05
5	Environmental Assessment	0 days	Fri 1/28/05
6	Stakeholder Engagement Plan	0 days	Tue 2/15/05
7	Federal Oil Shale Strategy	0 days	Mon 2/28/05
8	Economic Assessment of Oil Price	0 days	Tue 3/15/05
9	Security Impacts Assessment	0 days	Tue 3/15/05
10	Industry Constraints Analyses	0 days	Tue 3/15/05
11	Technical Exchange Meeting	0 days	Wed 3/30/05
12	Value of Oil Shale Development	0 days	Wed 3/30/05
13	Report to Congress	0 days	Mon 5/2/05
14	Federal Oil Shale Program Plan	0 days	Mon 5/30/05
15	Program Implementation Begins	0 days	Mon 10/3/05



VII. Potential Ongoing Roles of Key Participants

Assessing the potential of America's oil shale to help meet the nation's future fuels requirements in an economically competitive and environmentally sound manner and developing and implementing a long-term public-private oil shale development program, will require the concerted and ongoing participation of a broad range of participants in:

- The Public Sector (Federal, State, and Local government) and
- The Private Sector (Mining and Petroleum industries, Technology and Engineering companies, Financial community, Community groups, and Non-Government Organizations)

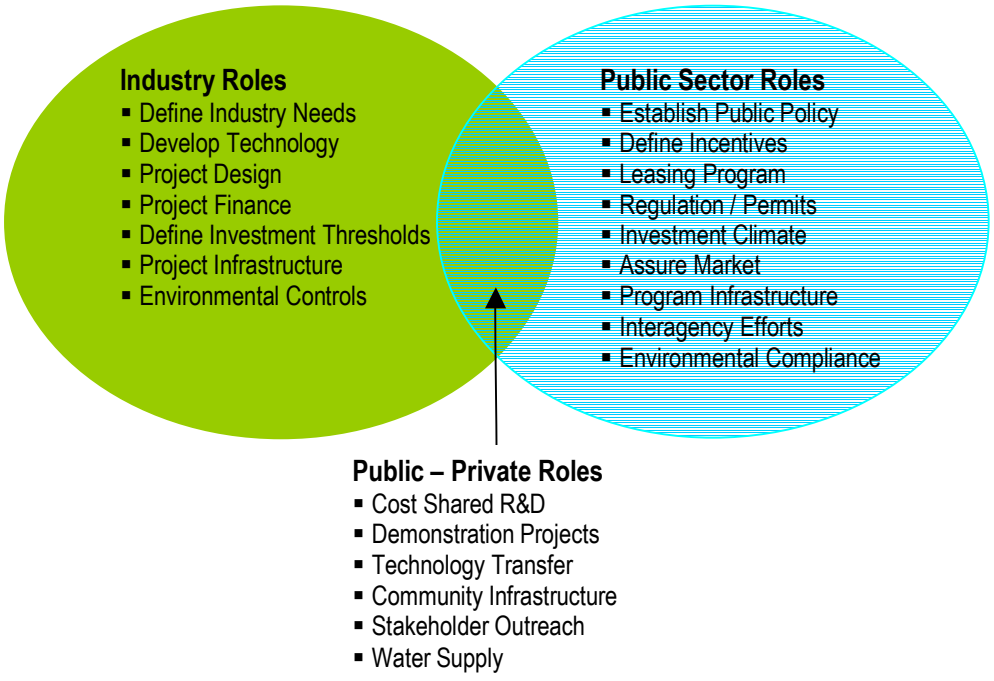
Some roles and responsibilities will be exclusive to a particular sector. However, many elements of the decision making process will require collaborative effort across public and private sectors.

The relative roles of each sector are summarized in Figure 9 and in the text that follows.

Federal Government Responsibilities

- Articulate a comprehensive energy policy and plans that balance the nation's needs with available supply and emphasize production of secure fuels from domestic resources.
- Establish oil shale goals and policies that create a favorable investment climate and reduce investment risk.
- Provide the analytical basis for assessing economic viability of various technology scenarios for oil shale development (including: surface mining, deep mining, in-situ, and surface retorts).
- Provide the analytical basis for assessing costs, benefits, and energy supply impacts of various potential incentives

Figure 9. Major On-Going Roles of Key Oil Shale Development Participants



and policy actions to stimulate oil shale production (including tax, R&D, environmental, socio-economic).

- Conduct energy supply and demand modeling that accounts for investment risk, conservation trends, efficiency trends, and world petroleum economics.
- Identify and effectively coordinate agency-specific responsibilities and directives (DOE, DoD, DOI, and Treasury).
- With industry, identify key research, development, and demonstration needs, develop a technology roadmap, and programs to meet those needs.
- Produce a resource model that evaluates resource characteristics (i.e. depth, thickness, richness, overburden, accessibility, etc.) to classify the resource on public lands, determine optimal development approaches, and ensure effective resource conservation (maximum recovery), and energy efficiency.
- Complete an assessment of government lands and implement appropriate leasing policy and regulations to ensure access to the nearly 80 percent of western oil shale resources that underlay Federal lands.
- Review the status and applicability of environmental regulations and respond to permit applications in a timely manner.
- Coordinate effective outreach and communication efforts to engage affected stakeholders in the decision-making process, identify and effectively respond to critical stakeholder issues, forge consensus on key decisions, and share information about plans and progress with affected communities.

Stakeholder Responsibilities (including citizens, interest groups, and NGOs)

- Offer perspectives and advice on issues of importance to stakeholders.
- Identify perceived impediments and make recommendations for mitigating those impediments.
- Participate in forums designed to achieve public consensus on the need, the methods, and the expected results and national and community benefits of oil shale development.

Industry Responsibilities

- Express the need for a government policy initiative in oil shale.
- Express interest in oil shale as an investment opportunity.
- Identify impediments to oil shale industry development and offer recommendations for their mitigation.
- Offer advice and recommendations on government incentives that may be needed (type, amount and duration) to reduce the investment risk, while maintaining the corporate incentive to minimize costs.
- Identify technical barriers and recommend research, development, and demonstration efforts essential to industry development that industry would be unlikely to do, without Federal assistance, in a time frame consistent with achieving national goals and priorities
- Provide review and advice on issues such as resource classification and land management policy.
- Interact with Federal, state and local entities to identify and mitigate potential socio-economic impacts and community risk attributable to oil shale industry development.

- Work with Federal and State entities to develop and implement an effective communications plan to apprise communities and stakeholders of plans and progress.

Responsibilities of State and Local Government

- Participate in environmental and socio-economic impact mitigation with the Federal Government and Industry.
- Assist in stakeholder outreach and consensus building efforts.
- Establish policy and respond legislatively to needs identified in the consensus building process.
- Coordinate state incentives with Federal incentives to maximize energy supply benefits while minimizing public sector costs and impacts
- Articulate and coordinate regulatory requirements to minimize unnecessary delays in the permitting requirements.
- Coordinate with other legal entities to assist in resolution of unforeseen issues.

Appendix 1
Oil Supply and Demand Analysis

(Reproduced from *"Strategic Significance of America's Oil Shale Resources"* March, 2004.)

4.1 Oil Demand

World demand for crude oil (including natural gas liquids) is projected by the U.S. Energy Information Agency to increase from 77.1 MMBbl/D in 2001 to 89.7 MMBbl/D in 2010, an increase of 12.6 MMBbl/D in just 9 years. (Ref. 9, p. 185) The forecasted oil growth rate is 1.7 percent per year, a significant increase over the actual 1990 to 2001 rate of 1.4 percent (***Figure 5***).

The projections are based on the EIA Office of Integrated Analysis and Forecasting's National Energy Modeling System (NEMS), an integrated market-based approach to energy analysis. The NEMS model correlates numerous historical interrelationships governing supply and demand, with the common interface being the price and quantities consumed by the end-user. In the reference case, the model projects that the real price of crude oil (in 2001 dollars) will remain steady, at about $26.50/bbl, in 2025 ($48/bbl in nominal price). This model assumes that no shortage will develop.

Three other organizations provide forecasts comparable to the EIA's: the International Energy Agency (IEA); Petroleum Economics, Ltd.; and, Petroleum Industry Research Associates. All of the projected growth rates for energy consumption fall within 0.2 percentage points around the EIA reference case (Ref. 9, Pg. 19). All of them also project that the world's consumption of oil will increase in a manner similar to the EIA reference case (Ref. 9, Pg. 21).

The demand for oil may be underestimated in these forecasts. For example, oil demand in China is projected by the EIA to grow, on average, 3 percent per year. By 2010, China will consume 6.5 MMBbl/D, second only to the United States' forecasted demand of 25.2 MMBbl/D (Ref. 9, pg. 185).

However, China's booming economy may already be making the EIA 2003 forecast obsolete. In September 2003, China's monthly crude-oil imports grew almost 60 percent as compared with September 2002. Year-to-year imports are up about 30 percent as the economy of China expands.

Higher living standards are making new cars affordable for more Chinese. Car production for the domestic market nearly doubled in the first seven months of 2003 to more than 1 million vehicles, and it is expected to increase five-fold within a decade. *The Wall Street Journal* cites increased Chinese demand for oil as a fundamental reason for the high price of world oil in the fall of 2003 (Ref. 14).

4.2 Oil Supply

All official forecasts project that plentiful oil supplies will be available, that supply will balance with demand, and the real price of oil will remain steady at or near 2001 price levels.

Other recent and unofficial projections challenge IEA and EIA projections. A growing number of petroleum geologists believe that oil production will soon become limited by geologic constraints, irrespective of demand requirements. The issues are framed quite clearly in a series of special reports by the *Oil & Gas Journal* (OGJ) (Ref. 2 thru 5). The OGJ articles illuminate arguments regarding an eventual peak in world oil supply that, if accurate, would cause oil prices to spike and cause unprecedented and difficult economic adjustments to follow.

The two sides of the debate are being referred to as the depletionists and the non-depletionists. Depletionists argue that world production will peak, perhaps in the near term, and that the advent of the peak portends a long, painful decline with serious world-wide economic consequences. Non-depletionists argue that advances in technology and favorable investment climates will continue to stave off the peak in production long enough to promote a smooth transition to other energy forms with higher use-efficiency.

Campbell and Laherrère, in a 1998 Scientific American paper titled "The End of Cheap Oil," pointed out that:

> *"About 80 percent of the oil produced today flows from fields that were found before 1973, and the great majority of these are declining." (Ref. 15)*

Discoveries *did* peak before the 1970s as shown in ***Figure 6***. This figure also shows that no major new field discoveries have been made in decades. Presently, world oil reserves are being depleted three times as fast as they are being discovered. Oil is being produced from past discoveries, but the reserves are not being fully replaced. Remaining oil reserves of individual oil companies must therefore continue to shrink. For example:

> *"Royal Dutch/Shell Group, one of the world's largest oil companies…failed for a third year to find as much oil as it pumped" (Ref. 16).*

The disparity between increasing production and declining discoveries can only have one outcome: a practical supply limit will be reached and future supply to meet conventional oil demand will not be available. The question is when peak production will occur and what will be its ramifications.

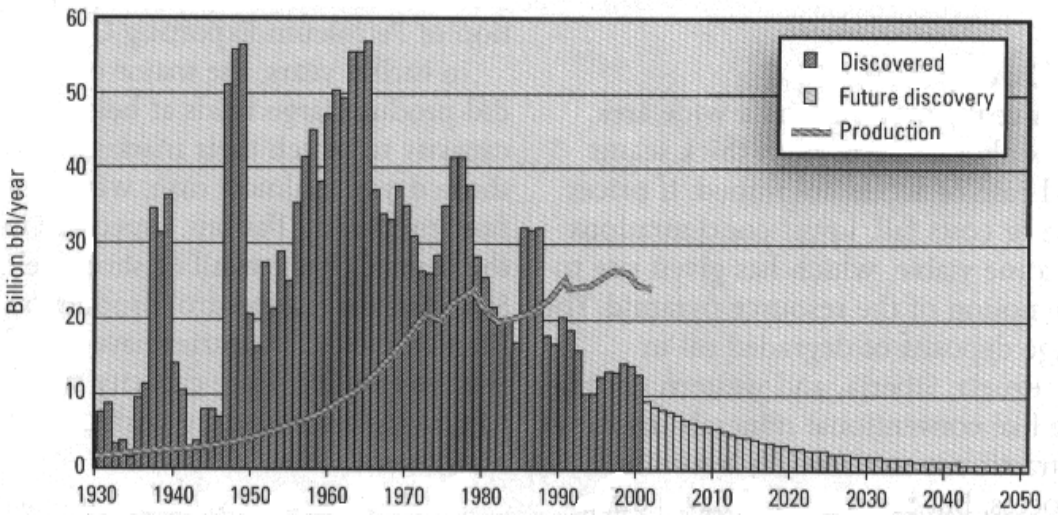
Whether the peak occurs sooner or later is a matter of relative urgency, but does not alter a central conclusion; the United States needs to establish a supply base for its future energy needs using its significant oil shale, coal, and other energy resources.

4.3 Declining World Oil Production

In spite of projections for growth in non-OPEC supply, it appears that non-OPEC and non-Former Soviet Union Countries (non-FSU) have already peaked and are currently declining (***Figure 7***).

The production cycle of the countries shown in Figure 7, and the cumulative quantities produced reasonably follow Hubbert's

Figure 6. Growing Disparity Between World Production and World Discoveries (Ref. 2)



model (see Appendix A for a more in-depth discussion). Although there is no agreement about the date that world oil production will peak, forecasts presented by USGS geologist Thomas Magoon (Ref. 6), the OGJ, and others expect the peak will occur between 2003 and 2020 (the year the prediction was made follows the name). What is notable about these predictions is that none extend beyond the year 2020, suggesting that the world may be facing shortfalls much sooner than expected by the EIA.

2003 – Campbell, 1998

2003 – Deffeyes, 2001

2004 to 2019 – Bartlett, 2000

2007 – Duncan and Youngquist, 1999

2008 – Laherrère, 2000

2010 to 2020 – International Energy Agency (IEA), 1998

2020 – Edwards, 1997

World production has not yet peaked because output from Russia is growing and, at this point in time, OPEC has excess capacity. The United States and other oil consuming nations of the world are dependent on OPEC not only for imported oil, but also for data and information related to OPEC reserves. As a matter of policy, OPEC holds confidential the estimated oil reserves of the OPEC members.

For the past two decades, OPEC, primarily Saudi Arabia, has assumed the role of the world's "swing" oil producer. Swing capacity entails the ability to offset increases or decreases in supply elsewhere in the global market by increasing or decreasing oil production, thus maintaining market equilibrium and dampening the economic impacts of supply changes. By 1982, OPEC had developed a surplus productive capacity of about 63 percent of its annual production.

However, OPEC's excess productive capacity declined significantly over the next 20 years, as shown in ***Figure 8***, and is now less than 5 MMBbl/day, or about 20 percent of current annual OPEC production.

Figure 7. Non-OPEC, non-FSU Oil Production Has Peaked and is Declining (Ref. 17

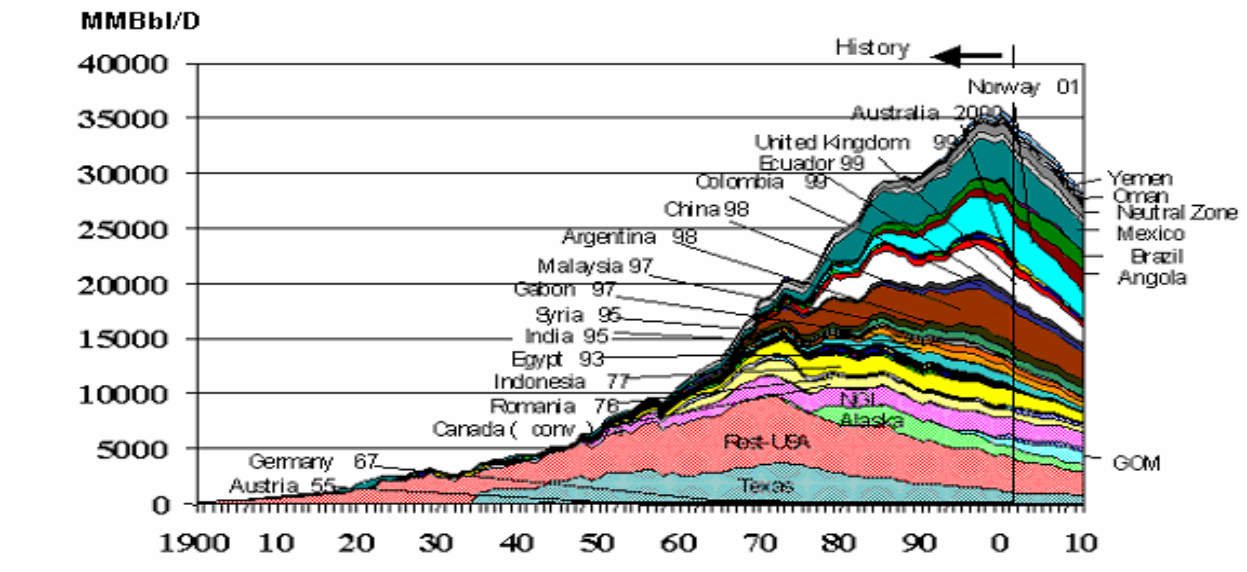
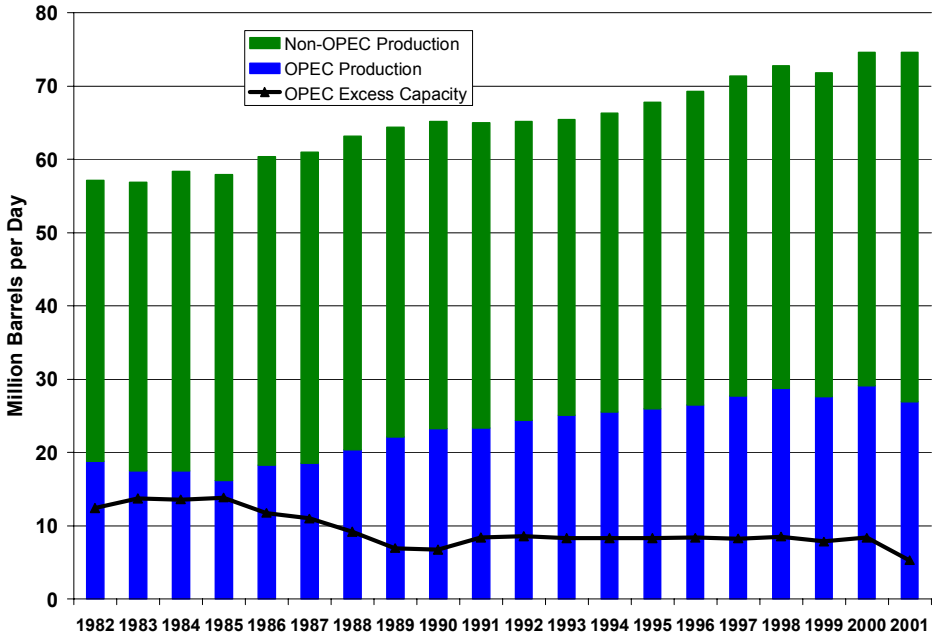


Figure 8. OPEC Excess Productive Capacity Is Declining (Ref. 18)



Once OPEC's excess productive capacity is gone and its oil production peaks, OPEC exports will begin an inexorable decline. At that point in time, the oil markets will shift from what has traditionally been a buyer's market to a seller's market. The production decline and shift of control to the sellers could produce escalating world oil prices

4.4 Effect of Investment on Oil Production

Models that predict continuing growth in supply also assume that investment capital and investment opportunities with acceptable risks will be available. Because the models are based on correlations of historic relationships, the predictions necessarily assume business-as-usual (Ref. 12, p 49). Hubbert models do not directly address investment and instead look at the historical experience of producing fields. The Hubbert analysts assume that sufficient new exploration and production investments will NOT be made, because adequate geologic opportunities will not be present. Thus, projections of increased investment may NOT be realized. For example:

> *"Foreign direct investment in some Middle East countries has practically dried up..." "These [investment] trends suggest that there is a lack of new investment opportunities that can generate returns high enough to satisfy shareholders." (Ref. 19, pg. 20).*

A major part of the world's future oil supply must come from OPEC sources, principally Saudi Arabia. Saudi Arabia has been able to maintain a production capacity of about 10 million barrels per day. The Saudi productive capacity is projected by EIA to nearly double, increasing to 19.5 million barrels per day by 2020 (Ref. 9, page 235). It is not now apparent, however, that adequate investments are being made in the Saudi fields to double oil production by 2020. Economic, political, and legal risks are significant factors when making investment decisions. Without the opportunity to find and produce oil, within acceptable levels of risk, capital investments will not be made. Without massive new investment, new supply cannot keep up with demand. Production will peak and decline and oil prices will rise.

Appendix 2
Potential of Oil Shale to Offset Economic Impacts of Rising Oil Prices

(Reproduced from *"Strategic Significance of America's Oil Shale Resources"* March, 2004.)

5.0 Significance of Oil Shale Development

Projected demand compared to potential supply suggests a continued widening of the gap between oil demand and oil supply. The essential policy question for the United States is how will this gap be filled? The potential impact on the U.S. economy is a critical question that requires immediate attention.

Every effort needs to be made to reduce oil demand. Conservation and improved end-use efficiency are essential. Higher (real) prices will naturally force consumers to conserve and live within supply constraints. However, a severe supply-demand discontinuity could lead to worldwide economic chaos.

One of the most cost-effective initiatives the United States could take to prevent this from occurring is to reduce its own call on world oil by supplying more of its own needs. Bringing new liquid fuel supplies on line in significant quantities in the near future may be essential to achieving this goal.

The adverse impacts of shortfalls could be substantially mitigated by development of fuels derived from oil shale. The oil shale resources of the nation total 2 trillion barrels. As much as 750 billion barrels has a richness of 25 gal/ton or greater and could be produced with near-term adaptations of existing technology.

Without arguing the rate at which shortfalls may occur, and instead looking to what is possible with a coordinated industry-government effort, it is possible that an oil shale industry could be initiated by 2011, with an aggressive goal of 2 MMBbl/D by 2020. Ultimate capacity could reach 10 MMBbl/D, a comparable capacity to the long-term prospects for Alberta's tar sand.

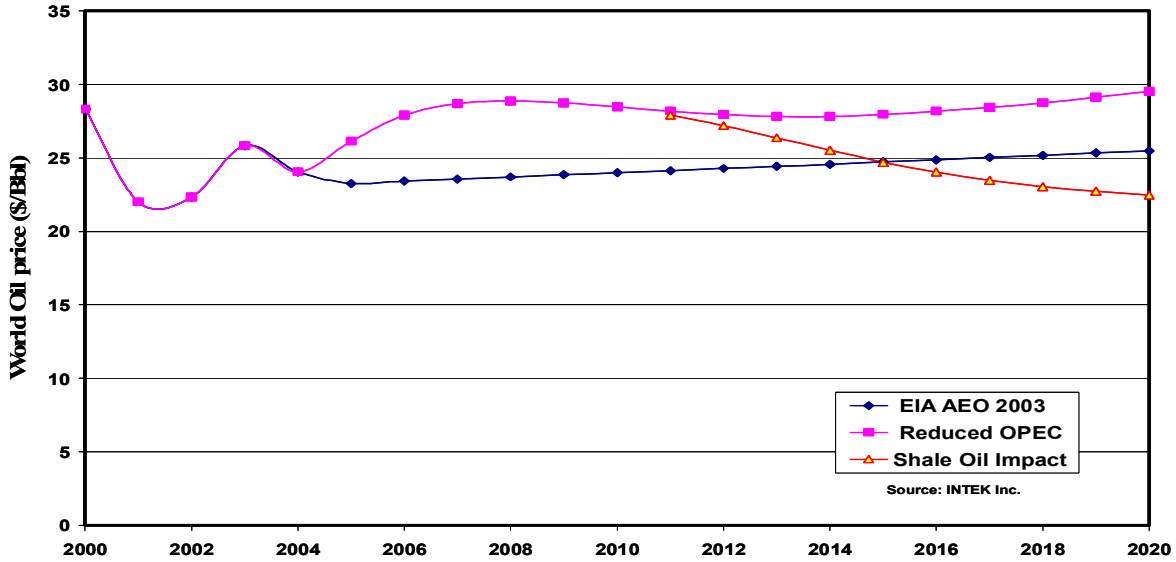
An analysis was conducted to assess the potential benefits and impacts that could be achieved by the development of a domestic shale oil industry. The results of that analysis are provided in the remainder of this section of the report.

Oil shale development can play a vital role in the future economic well-being of the nation. While oil shale's direct economic value to the nation may approach $1 trillion by 2020, other strategic and national security benefits may not be fully measurable in dollars. The benefits of oil shale development will continue well beyond the forecast period, as the resource base is capable of producing for more than 100 years.

5.1 Significance to Oil Price

Higher world oil prices will increase the costs of gasoline, distillate oil, jet fuels and other products made from petroleum, negatively impacting economic activity and reducing the U.S. Gross Domestic Product (GDP). The impacts of higher prices on the U.S. economy were evaluated for the purpose of this study (Ref. 20).

Figure 9. Reduced OPEC Productive Capacity Will Increase Oil Prices (Ref. 20)



The analysis assumes that the established decline in OPEC productive capacity (see Figure 8) will continue through 2020. Continued loss of OPEC excess productive capacity will tighten world wide supplies and increase the world oil price by an estimated $5 per barrel (in constant dollars) as compared with the EIA AEO 2003 forecast (***Figure 9***).

The analysis assumes that shale oil production begins in 2011 with initial production of 0.2 MMBbl/D and reaches an aggressive goal of 2 MMBbl/D by 2020. Shale oil development will decrease U.S. demand on world oil supplies; which will reduce the world oil price by over $5 per barrel compared to the reduced OPEC case.

The positive impact on world oil price shown in *Figure 9* will continue beyond the forecast period, since production will continue and., unlike conventional petroleum, there will be no natural production decline associated with the resource. Shale oil production can continue at a constant, or increasing, rate for many decades.

5.2 Significance to Gross Domestic Product (GDP)

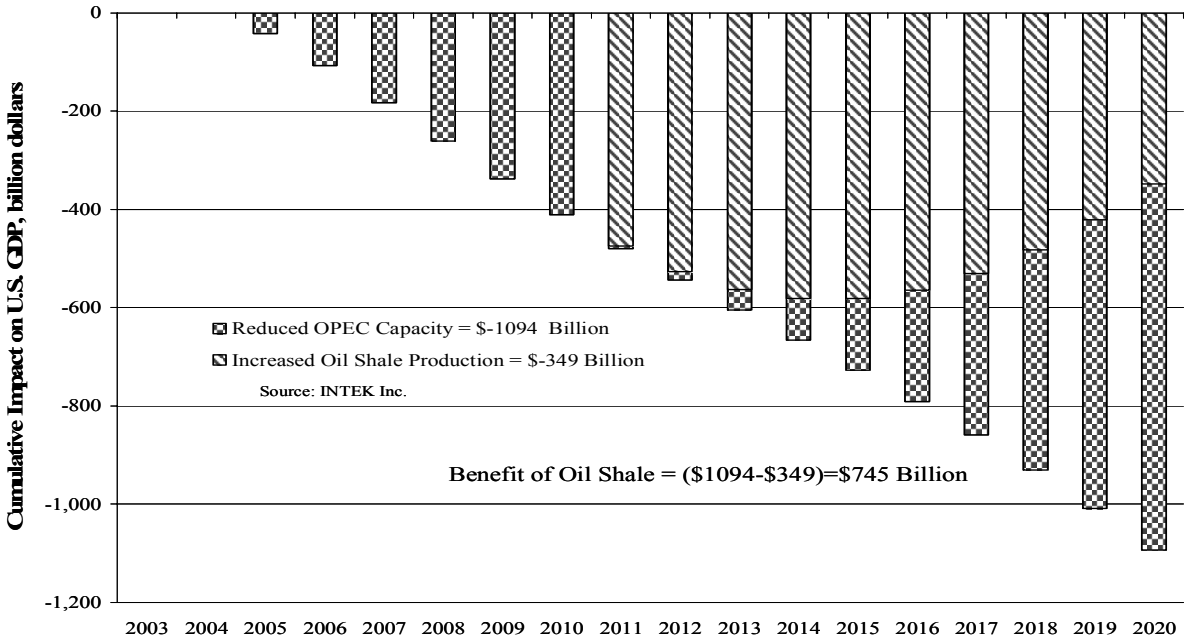
Over the forecast period, reduced world oil supplies will cost the U.S. economy $1.1 trillion as higher world oil prices drive up the costs of gasoline, jet fuel, distillate, and other products (***Figure 10***).

This cumulative negative impact on GDP begins to moderate when shale oil becomes available in 2011 and increased oil supplies cause the world oil price to fall. By 2020, the cumulative negative impact on the GDP has been reduced from $1.1 trillion to $0.3 trillion. Oil shale development therefore has a direct positive value to the U.S. economy of $0.8 trillion over a 10-year period. With continuing shale oil production the value to the economy will accumulate beyond the forecast period. Shale oil production could directly offset much of the loss of OPEC production, and hold down both world oil price and, the price consumers pay for gasoline and other fuels.

5.3 Natural Gas By-Products

Natural gas, a clean-burning fuel, is an essential component of the nation's energy future. North America has been able to meet most of its natural gas needs in the past, but there will be a growing shortfall of

Figure 10. Increased Shale Oil Production Will Benefit the U.S. GDP (Ref. 20)



domestic gas production to supply increasing demand. To fill this gap, the United States is beginning to turn to Liquefied Natural Gas (LNG) imports. It is apparent that the nation will soon become increasingly dependent on LNG imports to satisfy its projected natural gas demand.

Shale oil development could contribute to domestic natural gas supply in two ways:

1) shale oil can be used as a substitute for natural gas feedstocks in chemical processes, and free up natural gas for other uses, and
2) in-situ technologies for shale oil production can produce as much as one-third of the heating value of its total production in the form of natural gas (discussed in Volume II).

5.4 Consequences of Failure to Act

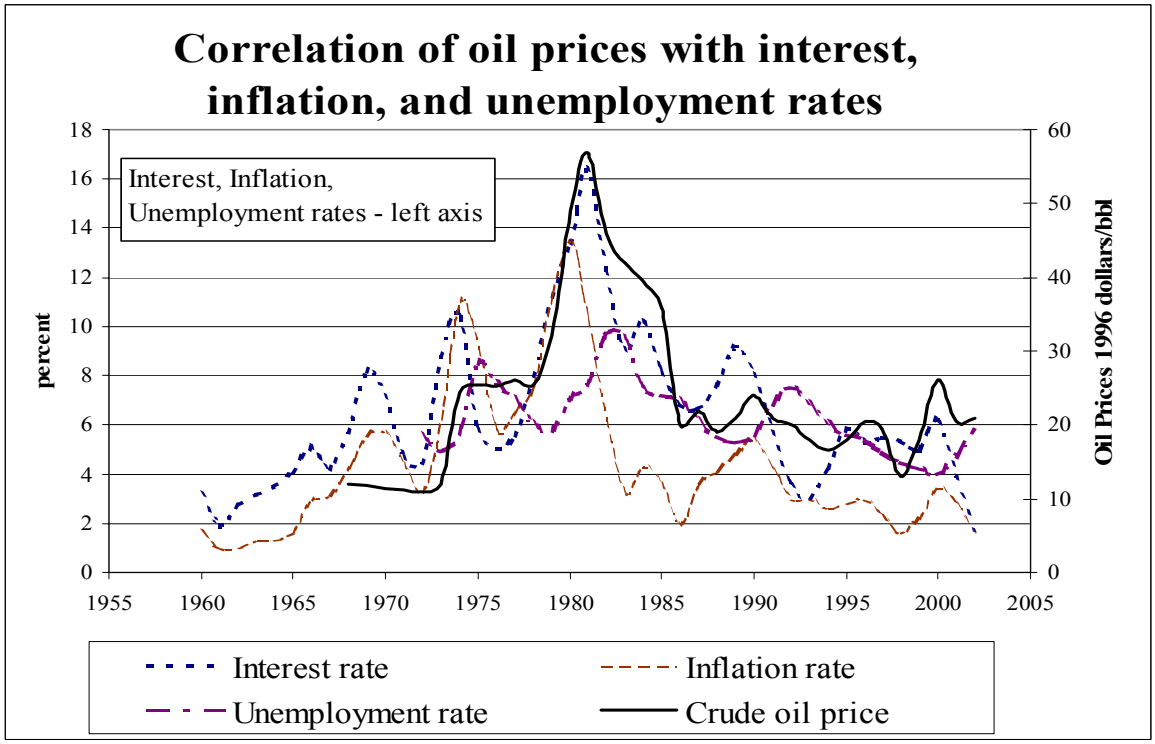
Worldwide competition for oil could result in price escalation and supply disruptions similar to those experienced in the 1970s. Unlike the crisis of the 1970s however, this time relief by simply finding more conventional oil will not be possible.

During the oil price shocks of the 1970s the United States experienced rising interest rates and high inflation, resulting in the condition known as 'stagflation', defined as slowing growth in the economy accompanied by a general rise in prices. The relationship between oil price, inflation, interest rate, and unemployment is presented in ***Figure 11***.

The effects of the oil price spike of the 1970s are succinctly summarized by Blanchard as follows:

> *"...the four-fold increase in oil prices imposed by OPEC in 1973-74 raised price levels throughout the economy while slowing economic growth at the same time. This left policy-makers in a quandary.*
>
> *World central banks, worried about a severe economic slowdown, chose loose monetary policies and inflation took off. The 1973 Arab oil embargo created a massive price rise and economic dislocation, from Tokyo to Paris to*

Figure 11. Correlation of Economic Variables over the Past 40 Years



Chicago. The explosion in oil prices ushered in a decade of "stagflation" in which inflation soared while economies stagnated. By the end of the decade, the United States experienced double-digit unemployment, double-digit inflation and double-digit interest rates." (Ref. 21)

In the 1970s, a 5 percent imbalance between supply and demand created shortfalls of liquids, gasoline, and long lines at the pump. At that time, high price was less of a worry than availability of fuel. Such a loss, even though a small percentage of total needs, was enough to adversely affect the flow of goods and the mobility of people, with severe consequences to the U.S. economy.

The period of the 1970s represents a model, at least for the early stages of a supply shortfall.

If peak production occurs unexpectedly, the United States will likely experience all of the negative effects seen in the 1970s. The comfortable supply situation of the past decade gives an impression that the favorable supply trends can continue indefinitely. The danger is that we are now lulled into a false sense of security.

Realistically, there are no economically acceptable alternative sources for (liquid) fossil fuels, other than fossil resources themselves, in the intermediate time frame. Oil shale and coal represent our largest, most economically attractive fossil energy resources. A serious shortfall can only be avoided through proper planning and effective action to enable development of these resources before the coming crisis occurs.