PEAKING OF WORLD OIL PRODUCTION: IMPACTS, MITIGATION, & RISK MANAGEMENT

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The peaking of world oil production presents the U.S. and the world with an unprecedented risk management problem. As peaking is approached, liquid fuel prices and price volatility will increase dramatically, and, without timely mitigation, the economic, social, and political costs will be unprecedented. Viable mitigation options exist on both the supply and demand sides, but to have substantial impact, they must be initiated more than a decade in advance of peaking.

In 2003, the world consumed nearly 80 million barrels per day (MM bpd) of oil. U.S. consumption was almost 20 MM bpd, two-thirds of which was in the transportation sector. The U.S. has a fleet of about 210 million automobiles and light trucks (vans, pick-ups, and SUVs). The average age of U.S. automobiles is nine years. Under normal conditions, replacement of only half the automobile fleet will require 10-15 years. The average age of light trucks is seven years. Under normal conditions, replacement of one-half of the stock of light trucks will require 9-14 years. While significant improvements in fuel efficiency are possible in automobiles and light trucks, any affordable approach to upgrading will be inherently time-consuming, requiring more than a decade to achieve significant worldwide fuel efficiency improvement.

Besides further oil exploration, there are commercial options for increasing world oil supply and for the production of substitute liquid fuels: 1) Improved Oil Recovery (IOR) can marginally increase production from existing reservoirs; one of the largest of the IOR opportunities is Enhanced Oil Recovery (EOR), which can help moderate oil production declines from reservoirs that are past their peak production: 2) Heavy oil / oil sands represents a large resource of lower grade oils, now primarily produced in Canada and Venezuela; those resources are capable of significant production increases;. 3) Coal liquefaction is a well-established technique for producing clean substitute fuels from the world's abundant coal reserves; and finally, 4) Clean substitute fuels can be produced from remotely located natural gas, but exploitation must compete with the world's growing demand for liquefied natural gas.

Dealing with world oil production peaking will be extremely complex, involve literally trillions of dollars and require many years of intense effort. To explore these complexities, three alternative mitigation scenarios were analyzed:

- Scenario I assumed that action is not initiated until peaking occurs.
- Scenario II assumed that action is initiated 10 years before peaking.
- Scenario III assumed action is initiated 20 years before peaking.

Estimates of the possible contributions of each mitigation option were developed, based on an assumed crash program rate of implementation. Our approach was simplified in order to provide transparency and promote understanding. Our estimates are approximate, but the mitigation envelope

that results is believed to be directionally indicative of the realities of such an enormous undertaking. The inescapable conclusion is that in the most optimistic case, more than a decade will be required for the collective contributions to produce results that significantly impact world supply and demand for liquid fuels. Under real world conditions, mitigation will surely require more time.

Important observations and conclusions from this study are as follows:

1. When world oil peaking will occur is not known with certainty. A fundamental problem in predicting oil peaking is the poor quality of and possible political biases in world oil reserves data. Some experts believe peaking may occur soon. This study indicates that "soon" is within 20 years.

2. The problems associated with world oil production peaking will not be temporary, and past "energy crisis" experience will provide relatively little guidance. The challenge of oil peaking deserves immediate, serious attention, if risks are to be fully understood and mitigation begun on a timely basis.

3. Oil peaking will create a severe liquid fuels problem for the transportation sector, not an "energy crisis" in the usual sense that term has been used.

4. Peaking will result in dramatically higher oil prices, which will cause protracted economic hardship worldwide. However, the problems are not insoluble. Timely, aggressive mitigation initiatives addressing both the supply and the demand sides of the issue will be required.

5. In the developed nations, the problems will be serious. In the developing nations peaking problems have the potential to be much worse.

6. Mitigation will require a minimum of a decade of intense, expensive effort, because the scale of liquid fuels mitigation is inherently extremely large.

7. While greater end-use efficiency is essential, increased efficiency alone will be neither sufficient nor timely enough to solve the problem. Production of large amounts of substitute liquid fuels will be essential. A number of commercial or near-commercial substitute fuel production technologies are currently available for deployment, so the production of vast amounts of substitute liquid fuels is feasible with existing technology.

8. Intervention by governments will be required, because the economic and social implications of oil peaking would otherwise be chaotic. The experiences of the 1970s and 1980s offer important guides as to government actions that are desirable and those that are undesirable, but the process will not be easy.

Mitigating the peaking of world conventional oil production presents a classic risk management problem:

- Mitigation initiated earlier than required may turn out to be premature, if peaking is long delayed.

- If peaking is imminent, failure to initiate timely mitigation could be extremely damaging.

Prudent risk management requires the planning and implementation of mitigation well before peaking. Early mitigation will almost certainly be less expensive than delayed mitigation. A unique aspect of the world oil peaking problem is that its timing is uncertain, because of inadequate and potentially biased reserves data from around the world. In addition, the onset of peaking may be obscured by the volatile nature of oil prices. Since the potential economic impact of peaking is immense and the uncertainties relating to all facets of the problem are large, detailed quantitative studies to address

the uncertainties and to explore mitigation strategies are a critical need.

The purpose of this analysis was to identify the critical issues surrounding the occurrence and mitigation of world oil production peaking. We simplified many of the complexities in an effort to provide a transparent analysis. Nevertheless, our study is neither simple nor brief. We recognize that when oil prices escalate dramatically, there will be demand and economic impacts that will alter our assumptions. Consideration of those feedbacks will be a daunting task but one that should be undertaken.

The key to mitigation of world oil production peaking will be the construction a large number of substitute fuel production facilities, coupled to significant increases in transportation fuel efficiency. The time required to mitigate world oil production peaking is measured on a decade time-scale. Related production facility size is large and capital intensive. How and when governments decide to address these challenges is yet to be determined.

Our analysis was not meant to be limiting. We believe that future research will provide additional mitigation options, some possibly superior to those we considered. Indeed, it would be appropriate to greatly accelerate public and private oil peaking mitigation research. However, the reader must recognize that doing the research required to bring new technologies to commercial readiness takes time under the best of circumstances. Thereafter, more than a decade of intense implementation will be required for world scale impact, because of the inherently large scale of world oil consumption.

In summary, the problem of the peaking of world conventional oil production is unlike any yet faced by modern industrial society. The challenges and uncertainties need to be much better understood. Technologies exist to mitigate the problem. Timely, aggressive risk management will be essential.

REFERENCE

Hirsch, R.L., Bezdek, R., Wendling, R. *Peaking of World Oil Production: Impacts, Mitigation, & Risk Management*. U.S. Department of Energy, National Energy Technology Laboratory. February 2005.