Peak Oil, Risks and Sweden's plan for mitigation.

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ABSTRACT

In December 2005, the Swedish Government appointed a commission to draw up a comprehensive program to reduce Sweden's dependence on oil. The Prime Minister decided to be chairman of the commission. In a speech in Uppsala in December 2005 he told the audience that one of the reasons for appoint the commission was that "someone in Uppsala named Aleklett had pointed out that there were limitations when it comes to production of oil". The first ever "Peak Oil" conference was held in Uppsala in May 2002 and three and a half years later the Swedish Government was the first Government in the world that was ready to deal with the Peak Oil problem.

On 15 October 2005 the Energy Committee at the Royal Swedish Academy of Sciences, the same Academy that every year decides who should get the Nobel Prize in Physics and Chemistry and the Prize in Economy in the honor of Alfred Nobel, released nine "Statements on Oil". Before they delivered these statements they had held hearings with persons with different opinions about Peak Oil and Kjell Aleklett represented ASPO, the Association for the Study of Peak Oil, in these hearings.

In the report "Making Sweden an Oil-Free Society", that the Commission on Oil Independence released 21 June 2006, the Commission states that they "bases its work mainly on the assessment of future world oil carried out by the energy committee of the Royal Swedish Academy of Sciences". The key points in this report are given in Appendix 1.

In this article Peak Oil and its risks will be discussed as well as the Swedish mitigation plans.

KEY WORDS: Peak Oil, import/export of oil, mitigation plans for oil independence.

INTRODUCTION

The French author Victor Hugo wrote on the last night in his life: "More powerful than all the armies in the world is an idea whose time has come". As President of ASPO, the Association for the Study of Peak Oil and Gas, I think that Peak Oil is just such an idea.

"The term Peak Oil refers to the maximum rate of the production of oil in any area under consideration, recognizing that it is a finite natural resource, subject to depletion". Many authoritative forecasts suggest that the global Peak Oil will happen very soon, probably somewhere between 2008 and 2015.

When the oil era started in 1859, Pennsylvania, USA, Drake was very lucky drilling where he did, and happened to strike oil at a depth of just 23 meters. This was a very small oilfield and probably the first oilfield that peaked and declined.

Deep water is now the new frontier when it comes to exploration. The deepest well ever drilled is Jack 2 in the Gulf of Mexico. First we have a water depth of 2100 meters and that happens to be equal to the highest mountain in Sweden. Then they have drilled to a depth equal to the height of Himalayas, the highest mountains on the planet. If it had been possible to find oil on solid ground the oil companies probably should be drilling at these places. The extreme new frontier is indirect evidence for the fact that we are approaching Peak Oil.

Figure 1. An illustration of the global oil reserves.

Let us take a look inside our planet Earth and see how much oil we have left to use. So far we have used roughly one third of the oil and this fraction was light sweet oil, easy to produce and easy to handle. We are now in the process of consuming the next third and this fraction is sour and not so easy to handle. The last third is very heavy, extremely hard to handle and it will take time to produce this part. Environmentally this third should stay in ground. The first oil province was USA and they had around 10% of the global reserves. Now they have used most of that. Russia also initially had around 10% of the global reserves, but has not used all of that. They can still be very busy. China had just 3% of the global reserves and its production is now at maximum capacity. The lucky region when it comes to oil is the Middle East. Even though they have produced large quantities for a long time, they still have about 60% of the remaining crude oil reserves. Canada has huge reserves of heavy oil in what is called oil sand or

tar sand. An increase in the production of oil from tar sand will be limited. Just now everybody is drilling for oil wherever there is a chance of finding it. Figure 1 will be the agenda for the next part of my presentation.

A WORLD ADDICTED TO OIL

Last fall I was invited to Capitol Hill and gave a presentation entitled "A World Addicted to Oil". In the State of the Union address this spring President Bush told the world from Capitol Hill that "America is addicted to oil" and I now have to tell you that "Japan is addicted to oil and that China every day is getting more and more addicted to oil".

I will try to explain why we are addicted to oil. It is because oil contains an enormous amount of energy. A very small teacup of oil, 100 ml, contains energy equal to one kilowatt-hour, 1 kWh, and what can you do with one kilo-watt-hour? If you place a small car, 1.200 kilo, at the base of the Eiffel Tower and tie a rope to the car, and then take the elevator to the top of the tower, 321 meters. By hand you then pull the car to the top of the tower, and when you have done this you have done a work equal to one kilo-watt-hour. If you were paid what you pay for 100 ml of oil, you probably would think that it is a slave labor. The next time you fill a car with 50 liters of gasoline then you have filled it with energy equal to pulling 500 cars to the top of the Eiffel Tower or stored 500 slaves in you tank.

IMPORT AND EXPORT OF OIL

Let us now discuss import and export of oil. (This discussion can be found in detailed in an article that recently was published in the Oil and Gas Journal.)

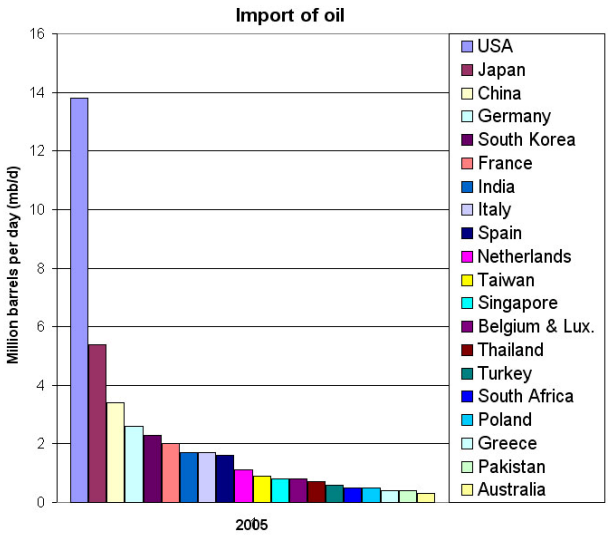

Figure 2. Largest crude oil importers in the world

The largest global crude oil importers in 2005 were USA, Japan, China, Germany and South Korea, as shown in Figure 2. If we add all the global imports we get 49 million barrels per day. The remaining, 42% of the world's production, is used within the producing countries themselves. The concept of import and export is something that everyone understands. If you want to import something there must be someone who can export it. Oil is no exception. In Figure 3 you can see the largest global crude oil exporters in 2005. It is not surprising to see Saudi Arabia with 9 million barrels per day as number one. Then we have Russia, Norway, Nigeria, Venezuela, Iran, UAE, Kuwait and Iraq. If we look into the future, 25 years from now, there will be no other export countries than the ones you can see on this graph.

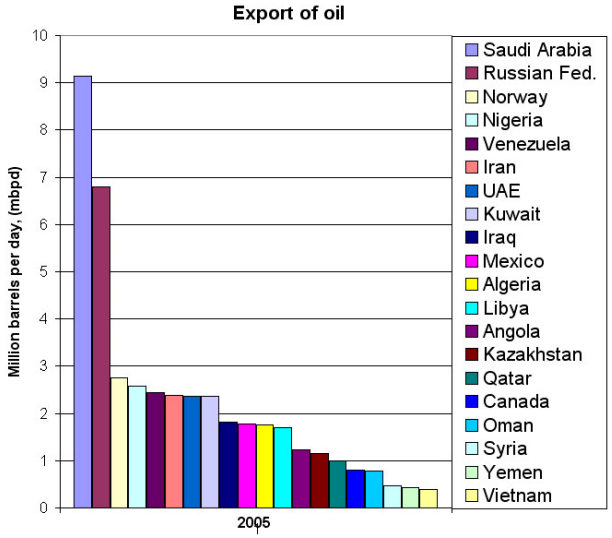

Figure 3. Largest crude oil exporters in the world

In the long-term outlook for the USA energy markets, presented by Guy Caruso from the Energy Information Administration, it is shown that there is an increasing demand of oil consumption in the future. Today USA, with 5% of the global population, is using 25% of the oil produced. The total increase in the demand is 7 million barrels a day by 2030. They want to keep 25% of the global demand. In the same outlook Guy Caruso presented that the production within US will fall by roughly 1 million barrels a day by 2030. Adding this decline to the increase in demand we get that USA in total needs to increase its imports by 8 million barrels a day by 2030.

Let us now look at some numbers for China. China has roughly 21% of the world's population and produces 4,5% of the world's oil. Its consumption is now 8,5% of the global consumption, 7 million barrels per day. If we look at increase in GDP we have a number between 8 and 10 percent and the related increase in oil consumption is around 9 percent per year. If we assume that 21 % of the global population should consume 21% of the produced oil, the consumption in China should be 18 million barrels per day and if demand increases, maybe 25 million barrels in the future.

The first giant oilfield in China was discovered in 1956 and during the next 25 years the rest of their giant fields were discovered. It is unlikely that China will find another giant field. China cannot produce more oil than it has found, and according to studies by the China

University of Petroleum, Beijing, "Peak Oil" in China will be around year 2012. Then the production will start to decline and the need to import oil will increase.

If we add the projected increase in demand in other countries around the globe we find that the importing countries need to increase their imports by 30 million barrels per year by 2030. Can the oil exporting countries deliver?

To address this question I like to turn to discoveries in the past and extrapolations into the future. If we look at average discoveries per 10 year period, we find that most of the world's oil was found between 1956 and 1965. Since then discoveries have declined. At the same time consumption has increased. Since 1980 we have consumed more oil each year then we discovered. We have a gap between discovery and consumption. How large can the gap be?

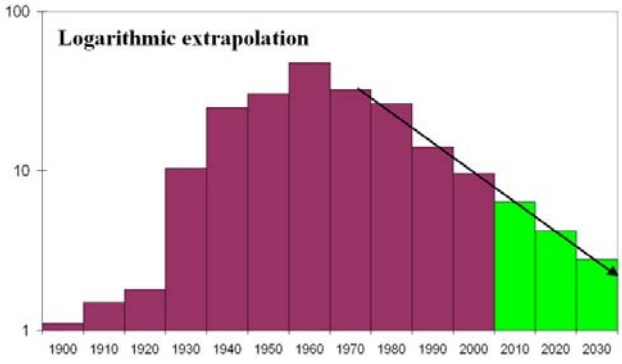

Figure 4. Extrapolation of discovery-rates of oil in the past into discovery-rates of oil in the future.

Following the discovery-rate decline over the last 40 years we can make an extrapolation into the future and estimate future discoveries at around 150 billion barrels over the next 30 years

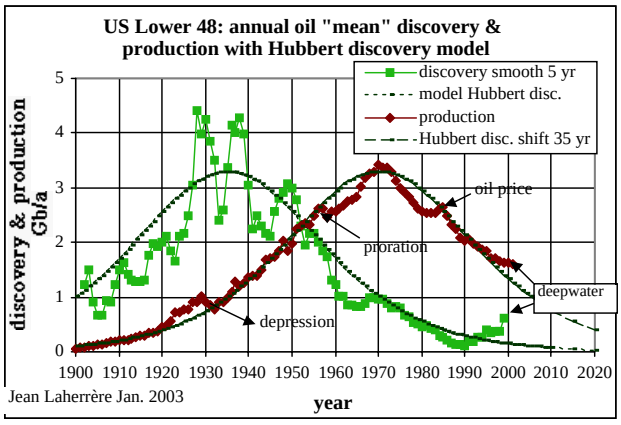

Figure 5. US lower 48 annual "mean" discovery and production.

If we look at the annual oil mean discovery and productions in the US lower 48 states, Figure 5, it is obvious that we cannot produce more than what we have found. The discoveries peaked around 1935 and 35 years later the production peak occurred. The correlation between discovery and production is clear.

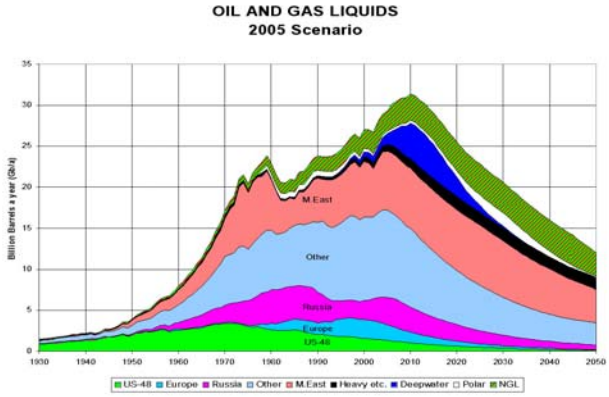

Figure 6. The ASPO 2005 scenario of production of oil and gas liquids

If we now look at al oil discovered in the world, see Figure 4, and how the future production will be we get that it looks to be a peak in the production around year 2010. Included in the forecast is that USA has peaked, Europe has peaked, Russia has peaked and that the rest of the world outside the Middle East is peaking now. With some fluctuations the Middle East will keep today's production for a long time. NGL, natural gas liquid, is condensate from natural gas production and that production is forecast to increase. Deep water and polar oil will be discussed later. In total global "Peak Oil" is likely to occur some time around the year 2010.

The first deepwater field was found in Brazil in 1984 and the peak in the discoveries look to be when the waters outside West Africa were explored. We have to see if the Jack 2 field will change anything. When we look at the plans for production of oil from the deepwater regions and take into account that we can only produce what has been found, we get a deepwater production peak around 2011. The peak production for deepwater together with decline in other regions will define the global peak production of oil. A very successful Jack 2 may perhaps give 1 million barrels a day in year 2014, but this is quite unlikely.

Let us go back to the question: "Where can the world find the needed new 30 million barrels per day in export by year 2030?" The Middle East is the prime region when it comes to export of oil now and the region will continue to be the main exporter of oil 25 years from now. Saudi Arabia plans to increase production by 2,5 million barrels a day. Part of that will be used within the country, but 2 million per day will be exported.

Russia is the number two exporter. The International Energy Agency has estimated that Russia should have the same production in 2030 as they have today, but that exports will decline, as they will use more oil within their country. The Russian government has announced that there will be a maximum in the oil

production in 2009 and exports will decline. If we study the oil discovered and the fact that Russia had a maximum production in the 1980, we think that the decline in Russia in the future might be more than the IEA prediction.

The discovery in Norway peaked around 1978 and the production peaked 27 years later. From now on we will see a decline in the production of oil in Norway. The official numbers from the Norwegian authorities gives that the export of oil will decline dramatically by the year 2030.

In summary, Saudi Arabia will increase production by 2010 and its export can increase by 2 million barrels per day. However, exports from Russia will decline by at least 1 million barrels per day. According to the Norwegian authorities the export from Norway will decline by 2 million barrels per day. We will see a near-term increase in exports from Nigeria and Angola, but in 2030 they will come back to today's exports or less. The other Middle East countries can if they like increasing production by the same amount as Saudi Arabia. The combined exports from Mexico and Venezuela will decline by 1 million barrel per day. Production from Kazakhstan will increase by one million barrels per day, as will exports from Canada. Adding exports from all countries, we should be very happy if global exports remain at the same level as today. The conclusion is that the needed extra 30 million barrels per day by 2030 are missing.

Jeroen van der Veer is CEO of Shell. In an article in the Financial Times in January 2006 he wrote: My view is that "easy" oil has probably passed its peak, but we have deep water and oil sand.

I have discussed deep water and will now discuss oil sand. The BP Statistical Review shows Canadian tar sand as a reserve that is roughly the same size as the oil in Saudi Arabia. The problem is that the production is completely different. We have made a crash program study that shows what the maximum production might be. Most of the production from Canadian tar-sand is just now from mining, then extraction. In the future it also has to be with the in-situ method. To produce one barrel of tar with the in-situ method you have to boil three barrels of water to steam and inject the steam deep into the ground to soften the tar. Then you pump the warm tar and blend it with lighter products to get something that can be sent to the refinery. With the use of nuclear power to generate steam, the maximum production can be 6 million barrels per day.

If we compare the future oil sand production with the expected decline in the production of ordinary crude oil in Canada and the North Sea we see that the crash program production cannot compensate for the decline.

Let me come back to the ASPO 2005 Scenario. Production of NGL, natural gas liquids, will increase as natural gas production increases. We include even polar oil from north Siberia, even if it has yet to be discovered. Deep water and heavy oil from oil sand is included as well as the rest of the crude oil production. But the big problem is the decline in the production of oil from the existing oilfields.

Sadad I. Al-Husseini, former vice president of Saudi Aramco, the largest national oil company in the world, said in a speech in London 2004: If we have an increase in the consumption of 2% per year and also take into account the fact that we have a decline in production from existing oilfields of 5% per year, we need to find by 2025 new production 10 times the production of Saudi Arabia today.

The rate of new discovery of today cannot compensate for this. It is time for the world to plan for a future where oil production will decline.

PHASING OUT DEPENDENCY ON OIL

The Commission on Oil Independence sees five strong reasons for phasing out Sweden's dependency on oil. Improving the efficiency use and in the long term replacing fossil energy sources with renewable energy:

1. We will reduce Sweden's climate impact
2. We will secure Sweden's supply of energy in the long term
3. We can be a leading nation in the development of new technology for sustainable use of energy and more efficient use of energy
4. We will strengthen our international economic competitiveness.
5. We will use and develop the energy resources from forest and fields, "Sweden's green gold"

The commission proposes the following national objectives for more efficient use of energy and reduced dependence on oil by the year 2020:

- Swedish society as a whole should be able to make 20 per cent more efficient use of energy by 2020 and thereby at the same time create intensified, cost-efficient prosperity that is sustainable in the long term.
- By 2020 in principle no oil should be used for heating residential and commercial buildings.
- Rood transport, including transport in agricultural, forestry, fisheries, and building sectors, should reduce use of petrol and diesel by 40-50 per cent by 2020.
- Industry should reduce its use of oil by 25-40 per cent by2020.

Figure 7. Night light from our planet during the night

We very often hear that money is running the world. Figure 7 is showing the light from our planet during the night, gives another picture. Light is energy and the fact is that energy is running the world. Money is just used to buy energy, and the fluctuation of the price of oil is just an indicator of how much we are willing to pay for it.

SUMMARY

1. **Oil Price:** The oil price is set in trades in New York and London.
2. **Reserves:** Around 75 percent of remaining oil reserves can be found in Muslim countries. We must find ways to work together instead of fighting.
3. **Production:** New reserves will in the future be less important then decline in existing oil fields.
4. **Future:** We must save oil and when it is possible use renewable options.

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APPENDIX 1

Key points of the "Statements on Oil" that was released by the Energy Committee at the Royal Swedish Academy of Sciences, on 15 October 2005.

1. Shortage of oil
The global demand for oil is presently growing by nearly 2 % per year and the current consumption is 84 million barrels per day (1 barrel=159 liters) or 30 billion barrels per year. Finding additional supplies to increase the production rate is becoming problematical, since most major oilfields are well matured. Already 54 of the 65 most important oil-producing countries have declining production and the rate of discoveries of new reserves is less than a third of the present rate of consumption.

2. Reserves of conventional oil
In the last 10-15 years, two-thirds of the increases in reserves of conventional oil have been based on increased estimates of recovery from existing fields and only one-third on discovery of new fields. In this way, a balance has been achieved between growth in reserves and production. This can't continue. 50% of the present oil production comes from giant fields and very few such fields have been found in recent years. Oil geologists have a wide range of opinions on how much conventional oil there is yet to be discovered, but new reservoirs are expected to be mainly found in the deeper water, outer margins of the continental shelves, and in the physically hostile and sensitive environments of the Arctic, where the production costs will be much higher and lead times much longer than they are today. A conservative estimate of discovered oil reserves and undiscovered recoverable oil resources is about 1200 billion barrels, according to the US Geological Survey; this includes 300 billion barrels in the world's, as yet unexplored, sedimentary basins.

3. Middle East's key role
Only in the Middle East and possibly the countries of the former Soviet Union is there a potential to insignificantly increase production rates to compensate for decreasing rates in other countries. Saudi Arabia is a key country in this context, providing 9.5 million barrels per day (11% of the current global production rate). Their proven reserves are 130 billion barrels and their reserve base is said to include an additional 130 billion barrels. Iraq also has considerable untapped oil reserves.

4. Unconventional oil resources
In addition to conventional oil, there are very large hydrocarbon resources, so-called unconventional oil, including gas (c. 1000 billion barrels of oil equivalent, much of which could be converted to liquid fuels), heavy oil and tar sands (c. 800 billion barrels) and oil shale (c. 2 700 billion barrels); coal, from which liquid fuels can be produced and methane hydrates provide a vast additional potential. During a transition period, gas often available adjacent to the oil fields, will help to bridge future deficits of conventional oil. With the exception of gas, all unconventional oil is expensive to produce (c. $ 20-40/barrel) and exploitation involves significant environmental problems. At $ 40 oil, which is now commonly accepted as the long term equilibrium price, the cost of developing unconventional oil is less problematic. (see pt. 7 below). At present, 1 million barrels of oil per day comes from Canadian tar sand and 0.6 million barrels from Venezuelan heavy oil. The Canadian government estimates that by 2025 the daily production rate will have increased to 3 million barrels per day. Thus, the problem with these unconventional oils is not so much price, but lead times and non-price related aspects, such as the effects on the environment and availability of water and natural gas for the production process.

5. Immediate action on supplies
Forceful measures to improve the search for and recovery of conventional oil as well as improving the production rate of unconventional oil are required to avoid price spikes, leading to instability of the world economy in the next few decades. Improved recovery of oil in existing fields can be expected.

The estimated reserves of conventional oil are, however, located primarily in unexplored sedimentary basins, in environments difficult to access. A substantial part has yet to be found! Sizeable contributions from unconventional oil need time (some decades) to become really effective. It is necessary to have public funding for long term petroleum-related research, since this must not be an exclusive task for the oil companies.

6. Liquid fuels and a new transport system

Oil supply is a severe liquid fuels problem and less of a general energy supply problem; 57 % of the world's oil is consumed in the transport sector. Unless government's ration oil, there will never be a shortage of oil; just increasing prices. Major programs need, therefore, to be implemented to develop alternatives to oil in the transport sector. Until these measures have been introduced, (which may take one to two decades) demand for oil for the needs of a globally expanding transport sector will continue to rise; other users of oil will suffer, including those concerned with power generation.

7. Economic considerations

At present the high oil prices are due to the limitations of worldwide production, refining and transportation capacities. Furthermore, the price is influenced by the threat of terrorist attacks on the world's oil supply, transport system and infrastructure. In the long run, the price of crude oil will be determined by the price of substitutes. Some estimates indicate that oil may be produced from tar sand at a price of 20-25 USD a barrel, compared to the present cost of about USD 5 for Saudi Arabian oil. Liquid fuels from coal could be produced for many decades; cost estimates vary greatly and generally exceed USD 30. Factors that are hard to estimate are environmental requirements, taxation levels and profit margins. However, we can anticipate continued high oil prices, as long as the pressure from the expanding Asian economics is maintained.

8. Environmental concerns

Unconventional oil will significantly extend the length of the hydrocarbon era, assuming that the negative impacts on the environment can be avoided. Constraints similar to those imposed on other fossil fuels (for example emission controls and CO2 sequestration) will be necessary and provide major challenges for industry. The impact on the environment, in general, and on the atmosphere and climate in particular, produced by combustion of fossil fuels, is not considered here. However, it is worth noting that such considerations provide further support for the conclusions presented below.

9. Increased R&D and international efforts

To avoid acute economic, social and environmental problems worldwide, we need a global approach, with the widest possible international cooperation. Activities in this direction have started and they should be strongly encouraged and intensified; the technically advanced countries have a particular responsibility. Considerably increased resources for R & D on alternative non-fossil energy sources, as well as on efficient and sustainable use of energy, particularly electricity, are necessary. In order to develop a sustainable energy system beyond the fossil fuel era, we need a full system analysis of the energy sector based on realistic time scales. The Energy Committee intends, in the next couple of years, to study other sources of energy and evaluate their relative merits and impact on environment and climate.