Further To my submission in support of the WWF.

I intend to refer to the below to show the macro case for the importance of the wind farm at the hearing.

I can also confirm I have now read all of the submissions and Contacts submission.

Kind regards
David Glogau

Peak Oil is not about running out of oil; it's about having reached maximum supply and production. There's a big difference.
Basically what Peak Oil does is that it puts a cap on GDP, where the only way GDP can grow any further is through efficiency gains. The practical effect of this is that we will see repeated cycles of rolling recessions (or worse, depressions) and recoveries, but without a longer term trendline of growth. The longer term trendline will be flat. This is exactly what we are seeing. Global oil extraction and production peaked in 2005 and has been on a plateau since then. We are now on a very slightly decreasing plateau and will likely not see larger declines in oil output for a few years, possibly until 2012-15, when the declines will get steeper. There can be, and will be, lots of oil price volatility within this paradigm, with price basically determined by demand. What we now have is a demand-destruction dynamic, where price will moderate demand and vice-versa, but where total supply is limited and capped by the global peak that is now becoming visible behind us in the rear-view mirror back in 2005 - 2008. Peak Oil is only visible in hindsight, and we're now getting that hindsight to clearly see it.

There are mathematical models which explain the extreme price volatility we are seeing and will continue to see in the oil market. In the absence of any widely developed and available, competing substitute for oil and with the supply of oil constrained and limited to the peak we have already seen behind us and unable to expand any further, I see mathematical queueing models as a good proxy and theoretical construct for explaining this price volatility. In a queueing model, you have a demand rate and a supply rate,
just as in the case of the oil market. Mathematical queueing models do not directly incorporate price into them, but this can be done by proxy, as the length of the queue — or equivalently, the waiting time in the queue (which is proportional to the length of the queue) — can be thought of as a proxy for price, since price will likely be directly proportional to the length of the queue (or equivalently, waiting time in the queue). This may be somewhat counter-intuitive to those without mathematical training, at least on first thought, but the length of the queue (and waiting time in it), and hence, by proxy, the price of oil, takes off exponentially and skyrockets as the demand rate approaches the limited, constrained, fixed supply rate. In fact, the length of the queue, and hence price of oil, actually goes to infinity (in the mathematical model) as slack capacity completely disappears and the demand rate reaches 100% of supply, bumping up against the fixed supply constraint. This can be seen

mathematically, for the simplest M/M/1
queue, with the formula:

L(t) = 1/[mu(t)-lambda(t)]

where

L(t) = length of the queue (as a proxy for price) at time t

lambda(t) = demand rate at time t

mu(t) = supply rate at time t

This mathematical model is a good proxy in explaining the demand-destruction dynamic in a supply-constrained environment, as we now have with the oil market having reached maximum global ouput, and the resulting repeated cycles of rolling recessions and recoveries that we are seeing and will continue to see, with a flat longer-term GDP trendline, where demand continues to bump up against this fixed ceiling at the height of each recovery, causing the price of oil to skyrocket, which then results in demand destruction, leading to another recession and then subsequent recovery, and so on and so on.

As demand backs off of the fixed, constrained supply going into each recession, the mathematical model explains and demonstrates how the price of oil will drop precipitously with the more slack capacity that is freed up through demand destruction. Basically what will happen is that with sufficient slack capacity (of supply over demand) in the global oil market, the price of oil will start to drop back down towards its cost of extraction and production, which is exactly what we are now seeing.

The only way we can get out of the vicious cycle of this paradigm (explained reasonably well by mathematical queueing models), which has stalled and flatlined long-term economic growth, is to develop a widely available competitive substitute for oil, which of course would be electrically-powered transportation, i.e. EVs. That would remove the constraint and ceiling on economic growth and allow the global economy to once again expand.

At I mentioned in my previous submission this expansion would require about 30 PJ of electricity each year, and this wind farm will be critical to the process of transforming from fossil fuels.

From a recent article in the *Independent*

“Electric avenues: Battery-powered cars take over the roads

The oil giants could be taken by surprise at how quickly battery-powered cars take over the roads. David Strahan reports on a world-changing market

Sunday, 29 March 2009

'The future has not been cancelled," quipped BP chief executive Tony Hayward in a bullish presentation about the company's prospects recently. But one thing the company has been forced to cancel, or at least postpone, is a reception to celebrate its centenary at the British Museum this week – shelved because BP feared disruption by climate campaigners gathering for the G20 summit.

A century on from the founding of the Anglo-Persian Oil Company, this may be the least of BP's worries. Because along with the recession, the collapse of the oil price and the struggle to maintain output in the face of global oil depletion, BP and its peers face the rapid resurgence of an ancient rival: the electric car.

Invented in the 1830s, the electric car predated the internal combustion engine and the oil industry by decades, and dominated the car market into the early 20th century. It was only in the second decade that electric cars were overtaken by petrol and diesel models with superior range. But today a combination of factors – climate change, oil-price volatility and improving battery technology – are coalescing to make a powerful case for the electric vehicle once again. Mass-market models will be launched from later this year, the charging infrastructure is being rolled out, and electricity companies around the world are manoeuvring to claim a slice of the new automotive energy market.

Since about half the world's oil production is turned into petrol and diesel, any shift to electric vehicles could ultimately cost the oil industry a vast chunk of its earnings. According to Dale Vince, chief executive of the wind generator Ecotricity, Britain's cars could be powered by fewer than 5,000 wind turbines, and we are on the verge of a rapid shift to transport powered by renewable electricity. "The oil companies are dinosaurs," he says, "and the comet is coming."

It is a dra- matic turnaround, according to Chris Paine, the director of the documentary Who Killed the Electric Car?, which told the story of GM's withdrawal of its EV1 model in the 1990s amid allegations of oil-industry lobbying and corporate chicanery. Today most major car manufacturers are developing battery-powered vehicles, GM is preparing to launch its Chevy Volt plug-in hybrid, and Paine is making a sequel: The Revenge of the Electric Car. "It's totally different now we've had the shock of $150 oil, and the automakers are staring out at thousands of unsold gas-guzzlers. I am convinced the electric car will have its revenge."

Until recently the only models available have been niche vehicles such as the tiny G-Wiz commuter car or the Tesla Roadster, but a slew of mass- market models will start to appear this year. The first to arrive in Britain will be Mitsubishi's iMiEV, a four-door with a range of 100 miles on a single charge from a three-pin domestic socket. The cars will be relatively expensive to start with, at about £20,000, but the company says the price will come down as sales grow, and will be offset by min-uscule running costs. Lance Bradley, the new managing director of Mitsubishi UK, points out that the petrol needed to drive 10,000 miles per year costs about £1,000, whereas the electricity to drive the iMiEV the same distance would cost just £40, and electric motors require virtually no maintenance.

The iMiEV will be the first of many. In 2010 Vauxhall will launch the Voltera, the British version of the Chevy Volt, and Think will unveil an all-electric four-seater. In 2011 Renault will launch three electric cars including a large saloon and a van. New models are also due from Smart, Toyota, Nissan and Subaru. Thierry Koskas, director of Renault's electric-vehicle programme, predicts that within five years electric cars could take 10 per cent of global car sales, even on current battery technology. With further improvements in range, he says that number "could easily double or triple". The consultancy AT Kearney predicts battery and hybrid technology will take 50 per cent market share by 2020, assuming oil rises to $200 per barrel.

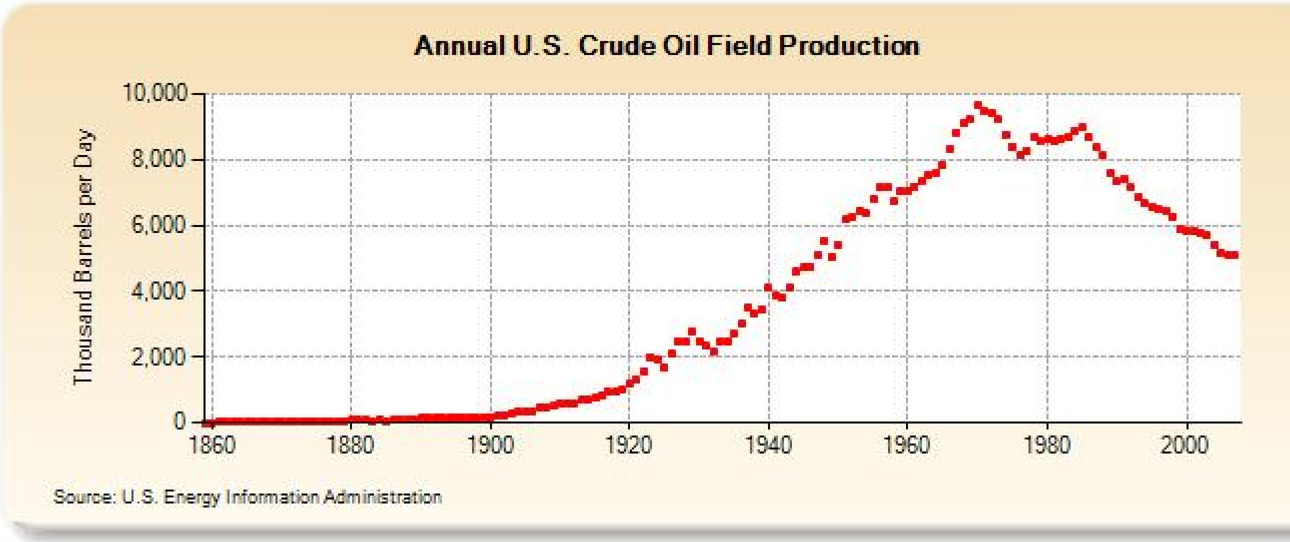
As climate-change forecasts become ever more alarming, the renaissance of the electric car is supported by a growing consensus that it is the only technology remotely capable of delivering zero-carbon private transport. According to Gary Kendall, director of climate change at SustainAbility, a London-based consultancy, and author of a report called Plugged In: The End of the Oil Age, biofuels will continue to rely on fossil fuel and fertiliser and so will not cut emissions enough, while producing hydrogen cleanly is far too energy-intensive. However, electric motors are so efficient, they would roughly halve car emissions, even if run on UK grid electricity that is heavily reliant on coal and natural gas. "Electric vehicles are the best way to cut car emissions quickly," Kendall concludes, "and combined with zero-carbon electricity generation, they are the only realistic way to eliminate car emissions altogether."

Source: http://www.independent.co.uk/news/business/analysis-and-features/electric-avenues-batterypowered-cars-take-over-the-roads-1656473.html

I intend to talk about this at the hearing.

I will also be referencing various charts from the following links:

http://tonto.eia.doe.gov/dnav/pet/hist/mcrfpus2A.htm



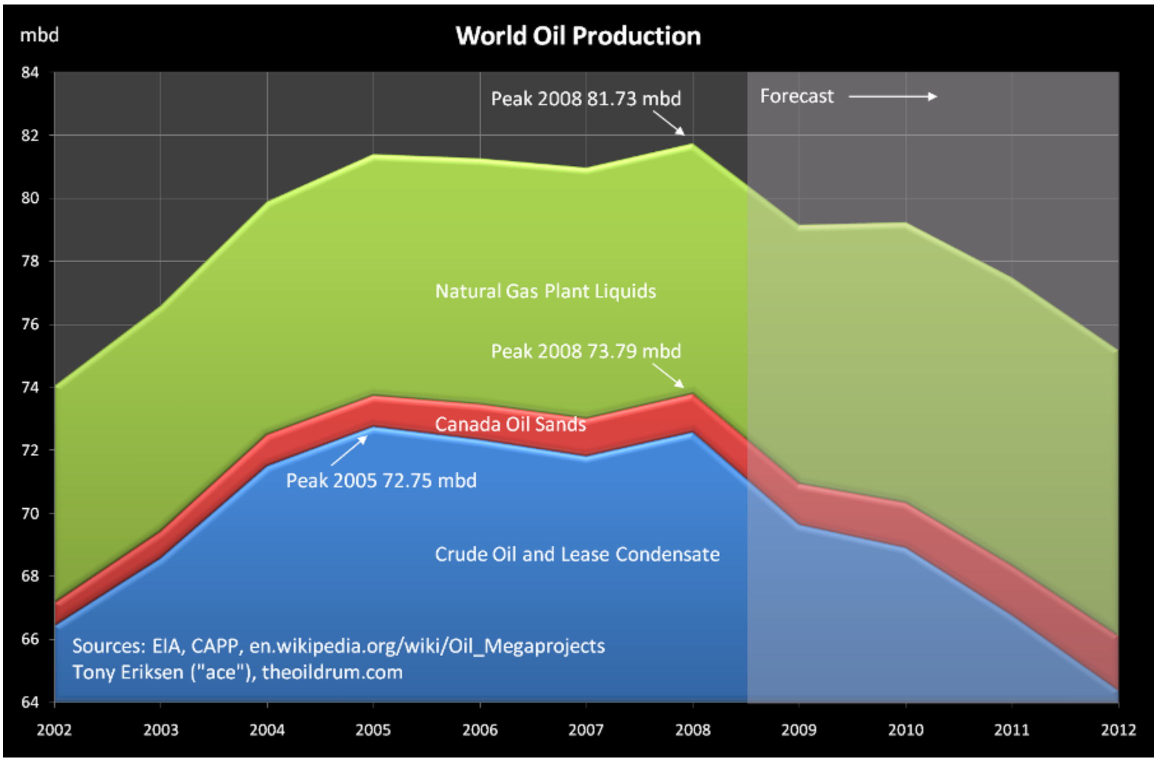
U.S. Crude Oil Field Production (Thousand Barrels per Day)

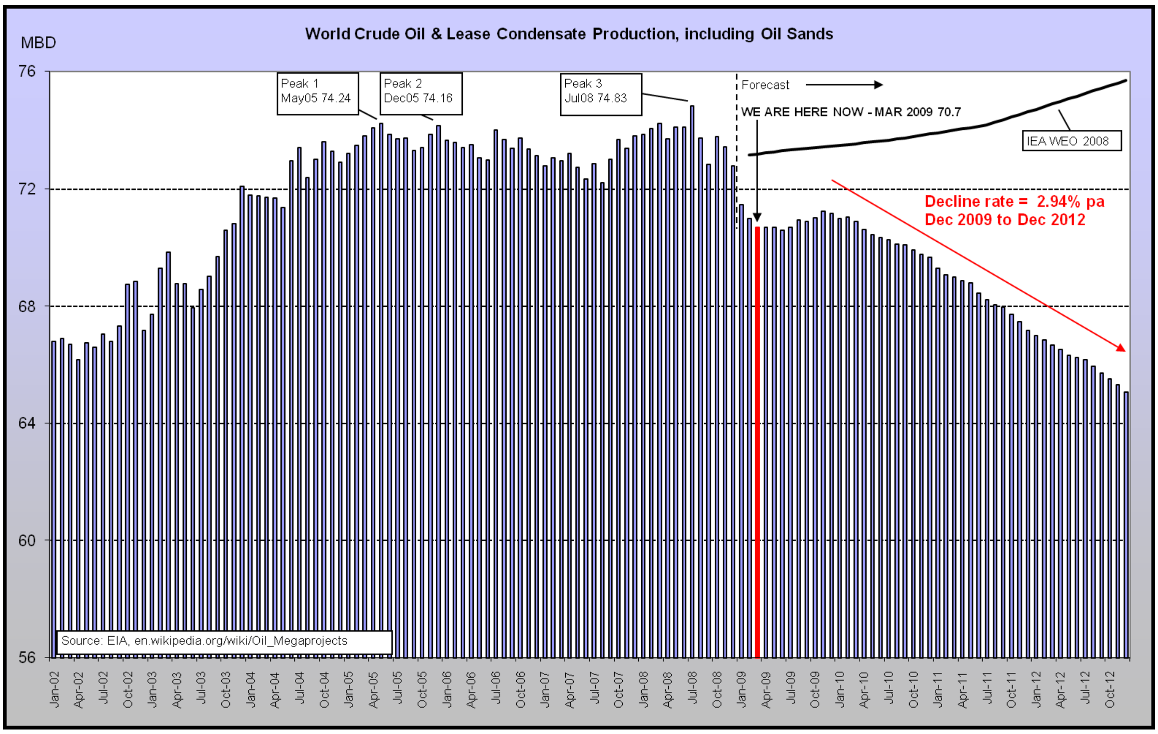
Decade	Year-0	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year
1850's									
1860's	1	6	8	7	6	7	10	9	10
1870's	14	14	17	24	30	33	25	37	42
1880's	72	76	83	64	66	60	77	77	75
1890's	126	149	138	133	135	145	167	166	152
1900's	174	190	243	275	320	369	347	455	488
1910's	574	604	609	681	728	770	822	919	920
1920's	1,210	1,294	1,527	2,007	1,951	1,700	2,112	2,469	2,463
1930's	2,460	2,332	2,145	2,481	2,488	2,723	3,001	3,500	3,324
1940's	4,107	3,847	3,796	4,125	4,584	4,695	4,749	5,088	5,520
1950's	5,407	6,158	6,256	6,458	6,342	6,807	7,151	7,170	6,710
1960's	7,035	7,183	7,332	7,542	7,614	7,804	8,295	8,810	9,096
1970's	9,637	9,463	9,441	9,208	8,774	8,375	8,132	8,245	8,707
1980's	8,597	8,572	8,649	8,688	8,879	8,971	8,680	8,349	8,140
1990's	7,355	7,417	7,171	6,847	6,662	6,560	6,465	6,452	6,252
2000's	5,822	5,801	5,746	5,681	5,419	5,178	5,102	5,064	

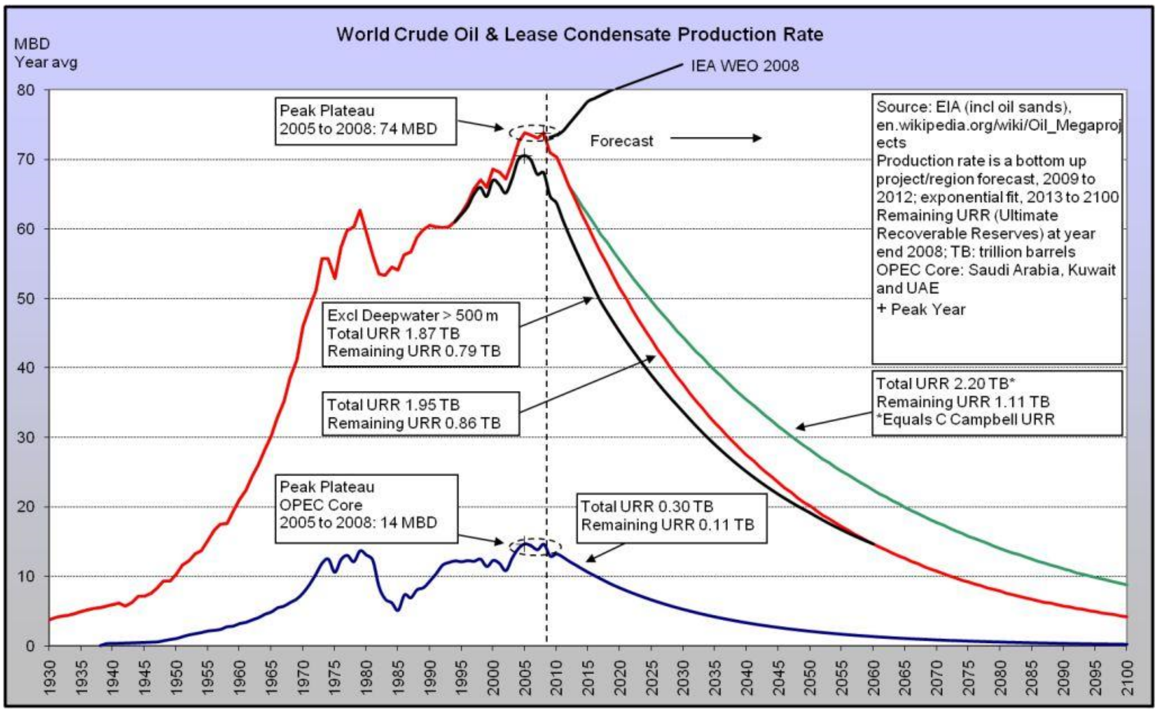
Natural Gas Supply and Demand Balance

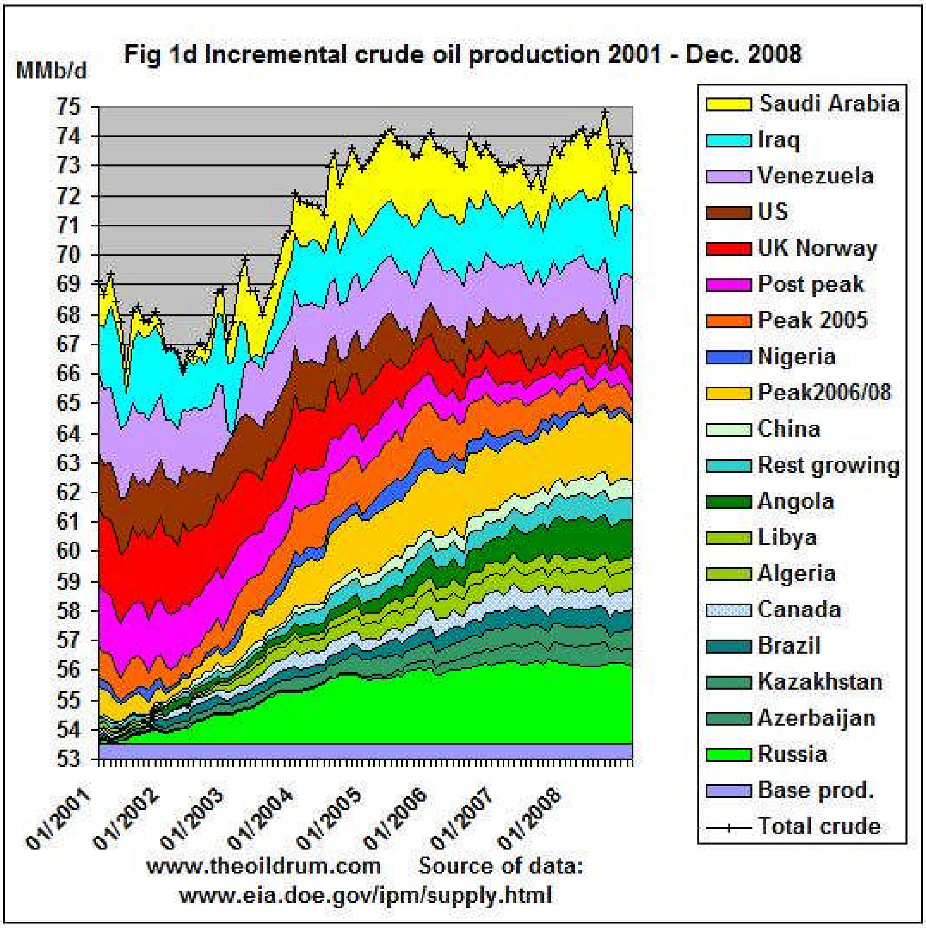
Source: http://www.theoildrum.com/node/5247#more

World Oil Production Peaked in 2008









Source: http://www.theoildrum.com/node/5177#more

Oilwatch Monthly March 2009

Source: http://europe.theoildrum.com/node/5202#more

The Anatomy of a Natural Gas Price Spike - Past and Future

Source: http://www.theoildrum.com/node/5169#more

Analysis of Decline Rates

Source: http://www.theoildrum.com/node/4820#more

The IEA (World Energy Outlook (WEO) for 2008) based its analysis of decline rates on a database of 780 world largest oil fields among which 580 are past their peak production. Fields where categorized according to their size (Super-giants > 5 Gb, Giants > 1.5 Gb and Large) and decline intensity. Three phases are considered for the decline:

- Phase 1: field is in a production plateau above 85% of peak annual production.
- Phase 2: field is past plateau and above 50% of peak production.
- Phase 3: production is below 50% of peak production.

Decline rate averages are computed for each size and decline category which give the following table:

	Decline Phase 1	**Decline Phase 2**	**Decline Phase 3**	**Total**
Super-Giants	0.8%	3.0%	4.9%	**3.4%**
Giants	3.0%	3.7%	7.6%	**6.5%**
Large	5.5%	7.2%	11.8%	**10.4%**
World	**1.4%**	**3.6%**	**6.7%**	**5.1%**

Table I. Decline rate structure according toe the IEA for the Top 580 oil fields in decline.

In addition, the following information is given for the 580 fields dataset:

1. The production-weighted average annual observed for 2007 is decline rate is 5.1% (table above).
2. They have a total initial reserves of 1,241 Giga-barrels, 101 are in a production plateau, 117 in decline phase 2, 362 in decline phase 3.
3. The total production was 40.5 mbpd in 2007 or 58% of 2007 production.

The point 3 above leads to 40.5 / 0.58= 69.8 mbpd for 2007 production (in comparison the EIA gives 73.0 mbpd for crude oil + condensate so I guess they are not considering 3.2 mbpd of condensates and unconventional oil). Even if this oil field subset covers 58% of the oil production, some large fields are missing from this 580 fields sample and are contributing to the resource base decline. They extrapolated the global decline rate bt assuming that the missing fields are large and smaller fields so they must decline at least as fast as the population of large fields above (i.e. 10.4%) which results in a total decline rate of 6.7%. They are using a production-weighted average so the calculation is the following

$$(5.1 * 40.5 + x * 10.4) / (40.5 + x)= 6.7\%$$

where x is the unknown production from small fields not in the 580 fields database with the following value

$$x= (6.7 * 40.5 - 5.1 * 40.5) / (10.4 - 6.7)= 17.5 \text{ mbpd}$$

which means that 40.5 + 17.5= 58 mbpd of 69.8 mbpd are coming from post-peak fields (i.e. 83.0%). Note that if 69.8 mbpd is the total production considered for 2007, then 69.8-58= 11.8 mbpd must come from fields that are not in decline. On their final forecast, they implicitly assumed a decline rate around 4.35% (see post here) which means that taking 81.0 mbpd for C+C+NGL in 2007 (EIA):

$$(6.7 * 58 + (81 - 58) * y) / 81.0 = 4.35\%$$

or:

$$y= (4.35 * 81 - 6.7 * 58) / (81 - 58)= -1.58\%$$

which means that 23 mbpd of crude oil + NGL that is not post peak must grow at least by 1.58% in order to get a global 4.35% decline for total production. That seems reasonable.

A Detailed View of the Decline Structure

On table I, average decline rates are given for each category. Unfortunately, the amounts used for the various production-weighted averages are not given. I propose an estimation of the 3x3 production matrix **P** behind the decline rates using the following constraints:

1. **P** must give the same average decline rates per decline phase or by size category. In all, it gives 8 equations.
2. The total production is equal to 40.5 mbpd.
3. From the list of top 20 oil fields (20 of the 45 known super-giants), we know that at least 1 field is in decline phase 1 (Ghawar), 9 are in decline phase 2 (for a total production of 7.747 mbpd in 2007) and 5 in decline phase 3 (or 3.505 mbpd).

Uisng a standard linear programming algorithm, it converges toward this solution (the residual error on the decline rates was around 0.2%):

	Decline Phase 1	Decline Phase 2	Decline Phase 3	Total
Super-Giants	6.204	8.794	14.400	**29.398**
Giants	0.257	0.822	2.838	**3.917**
Large	0.725	1.255	5.205	**7.185**
World	**7.186**	**10.871**	**22.443**	**40.5**

Table II. Estimate of the production matrix ***P*** *(in mbpd) behind the decline rates given in Table I.*

Figures 1 and 2 below are summarizing the database structure that the IEA may have considered.

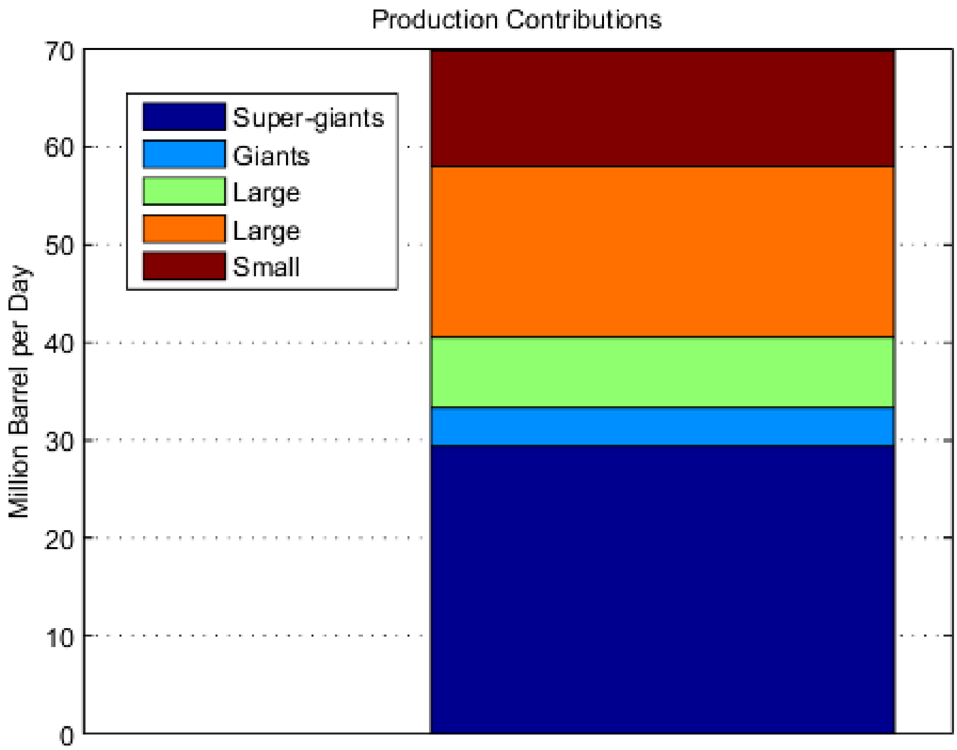


Figure 1. Amounts of post-peak production by field category used for the global decline rate calculation.

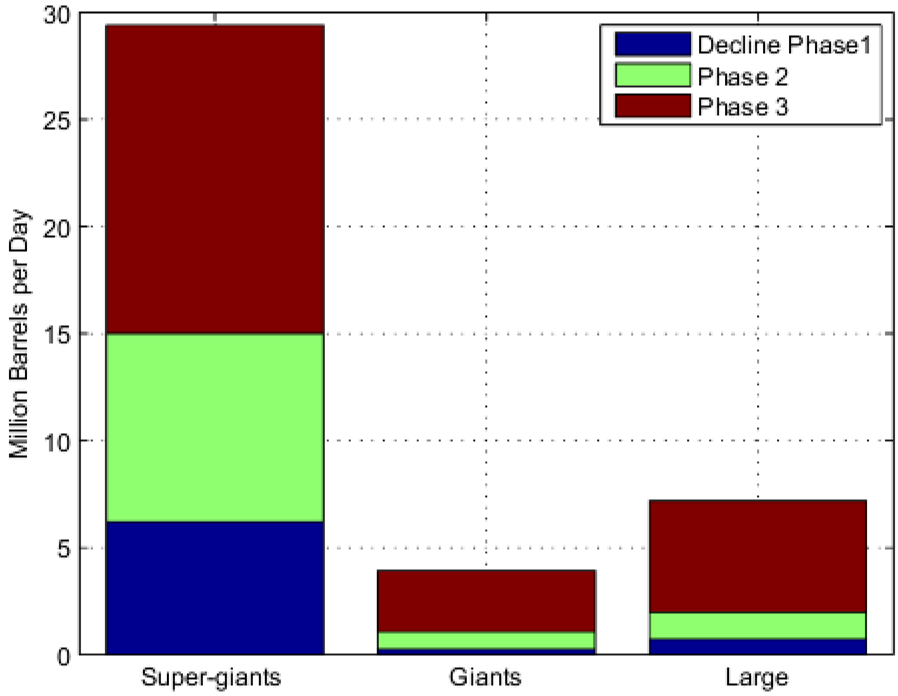


Figure 2. Repartition of decline phase per field size.

The Fate of the Super-Giants

Production from the super-giant and giant fields is the cornerstone of modern oil production. In the top 20, 16 of them are in decline.

Field	Peak Production (mbpd)	2007 Production (mbpd)	Production to Peak Ratio (%)	Decline Phase
Ghawar	5.588	5.100	91.27	1
Cantarell	2.100	1.675	79.76	2
Safaniyah	2.128	1.408	66.17	2
Rumaila N & S	1.493	1.250	83.72	2
Greater Burgan	2.415	1.170	48.45	3
Samotlor	3.435	0.903	26.29	3
Ahwaz	1.082	0.770	71.16	2
Zakum	0.795	0.674	84.78	2
Bu Hasa	0.794	0.550	69.27	2
Marun	1.345	0.510	37.92	3
Gachsaran	0.921	0.500	54.29	2
Shaybah	0.520	0.500	96.15	1
Daqing	0.633	0.470	105.85	2

Samotlor (Main)	3.027	0.464	15.33	3
Fedorovo-Surguts	1.022	0.458	44.81	3
Zuluf	0.677	0.450	66.47	2

Table III. Top 16 oil fields in decline.

Using IEA decline rates (Table I), we get the following production profile for the top 16 in decline:

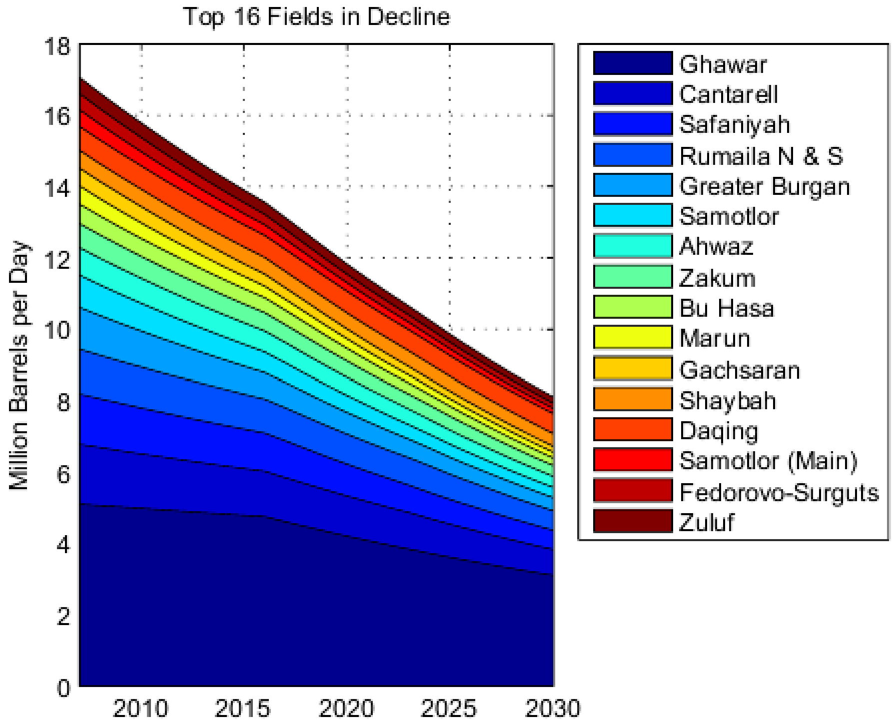


Figure 4. Field-by-field modeling for the top 16 fields using IEA average decline rates for super-giants.

The 2008 IEA WEO - The Oil Drum Initial Review

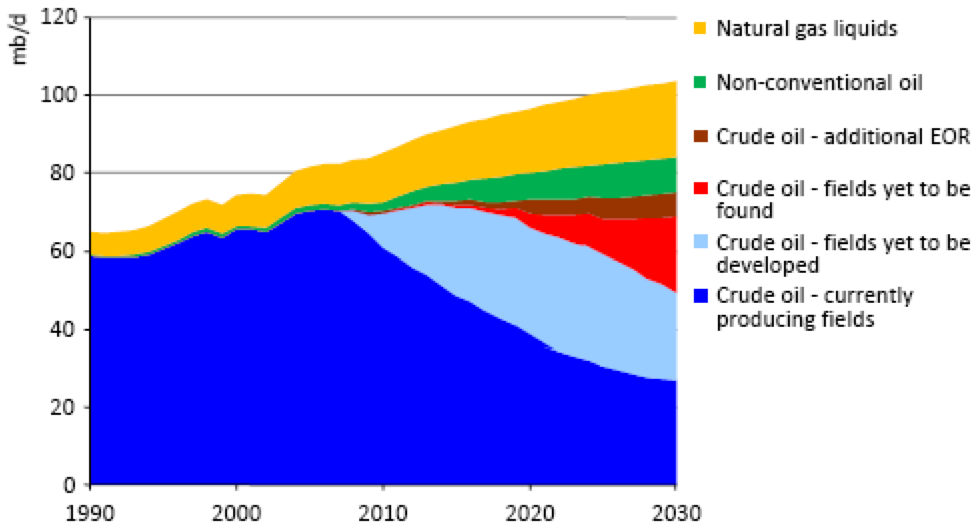
Source: http://www.theoildrum.com/node/4735

Here are the lead paragraphs from the Executive Summary:

The world's energy system is at a crossroads. Current global trends in energy supply and consumption are patently unsustainable — environmentally, economically, socially. But that can — and must — be altered; there's still time to change the road we're on. It is not an exaggeration to claim that the future of human prosperity depends on how successfully we tackle the two central energy challenges facing us *today: securing the supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply. What is needed is nothing short of an energy revolution. This World Energy Outlook demonstrates how that might be achieved through decisive policy action and at what cost. It also describes the consequences of failure.*

Oil is the world's vital source of energy and will remain so for many years to come, even under the most optimistic of assumptions about the pace of development and deployment of alternative technology. But the sources of oil to meet rising demand, the cost of producing it and the prices that consumers will need to pay for it are extremely uncertain, perhaps more than ever. The surge in prices in recent years culminating in the price spike of 2008, coupled with much greater short-term price volatility, have highlighted just how sensitive prices are to short-term market imbalances. They have also alerted people to the ultimately finite nature of oil (and natural gas) resources. In fact, the immediate risk to supply is not one of a lack of global resources, but rather a lack of investment where it is needed. Upstream investment has been rising rapidly in nominal terms, but much of the increase is due to surging costs and the need to combat rising decline rates — especially in higher-cost provinces outside of OPEC. Today, most capital goes to exploring for and developing high-cost reserves, partly because of limitations on international oil company access to the cheapest resources. Expanding production in the lowest-cost countries will be central to meeting the world's needs at reasonable cost in the face of dwindling resources in most parts of the world and accelerating decline rates everywhere.

Capacity Additions



IEA WEO 2008 Slide 8 World Oil Production Under IEA's Reference Scenario[Source](#) *(pdf)*

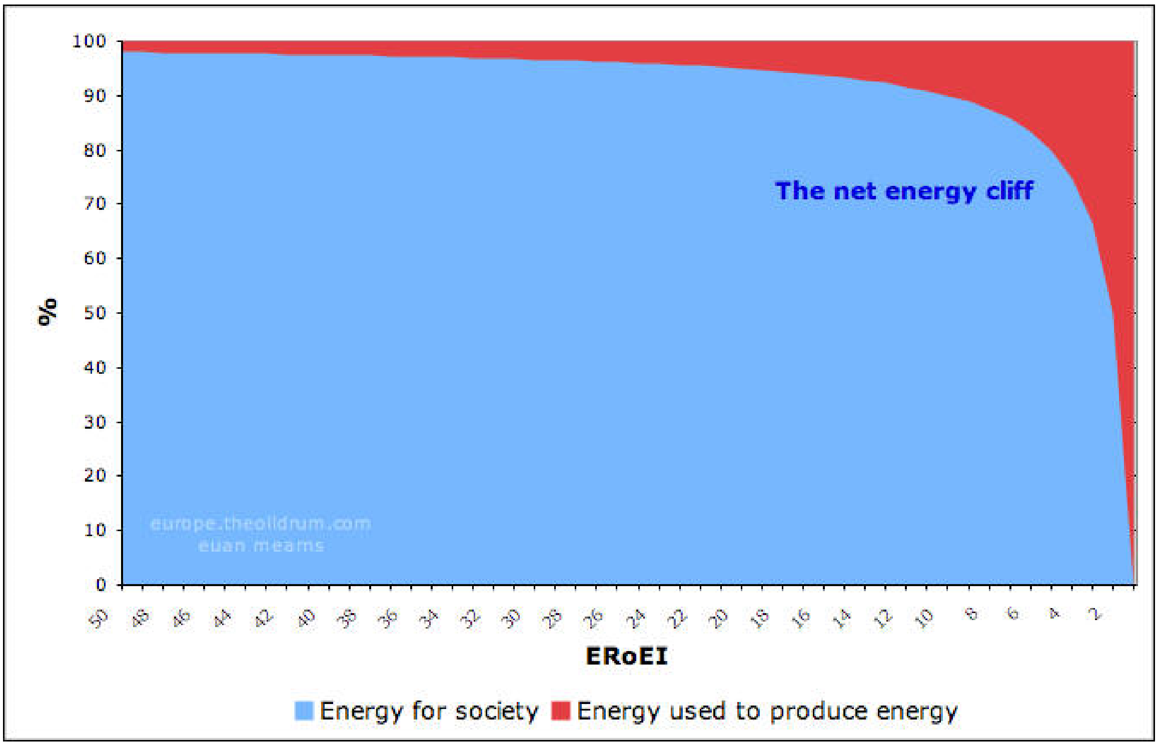
Under the reference scenario, production reaches 104 mb/d in 2030, requiring 64 mb/d of gross capacity additions –(six times the current capacity of Saudi Arabia) –to meet demand growth & counter decline. Historically, the 1960's was the decade with the largest capacity addition, with about 30 Mb/d added during that 10 year period.

So, the IEA Reference Scenario assumes we need to do as well as the best decade ever over the next 22 years.

Technology is clearly better now than in the 1960s - but the resource being worked is in considerably worse shape (fewer large new fields, more old and smaller fields). It's not just the case of doing as well as we did before, it's a case of doing so with a worse resource base - a losing battle. It seems the only way what the IEA is proposing is defendable is if the new resources (like deep water) and/or new technology (EOR) will somehow offset depletion of the old resource base. This has NOT been the case in the United States, where data to measure such a thing at least used to be available, which brings me to my next point.

Net Energy/ Biophysical Economics

The above graph predicts that a full 20% of 'oil production' in 2030 will be comprised of Natural Gas Liquids. On average these liquids have only 70% the BTUs as crude oil, yet this handicap is not reflected in the report as IEA measures by volume, not energy. Of course much deeper than this omission of gross vs net, is the energy cost of harnessing the remaining fossil fuels. No mention of costs in anything other than dollar terms is made in the IEA WEO report. As witnessed by current global currency morass, measuring costs in dollar terms is a moving target. A huge amount of resource may be projected to be recoverable at $100 oil, but once $100 is reached, costs too have increased - this law of receding horizons does not seem to be considered in the IEA analysis. Economic activity is ultimately grounded in energy. It takes energy to procure energy. Therefore, if energy becomes as expensive and difficult to procure as the IEA suggests (requiring $24 trillion investment, etc.), more energy will be used by the energy companies themselves. The only true evidence of this we have (due to lack of data) is the work by energy analysts Hall, Cleveland, Costanza, Kaufman, Herendeen and others on US oil and gas data, showing a 100:1+ energy return in the 1930s, declining to 30:1 in the 1970s and a range of 10-17:1 in 2000. Anecdotally, it is much lower than that at present, though no one keeps data in energy terms anymore. At some point, lower and lower energy gain sends society over a net energy cliff:



Are Reserves of the Largest US Coal Field Overstated by 50%?

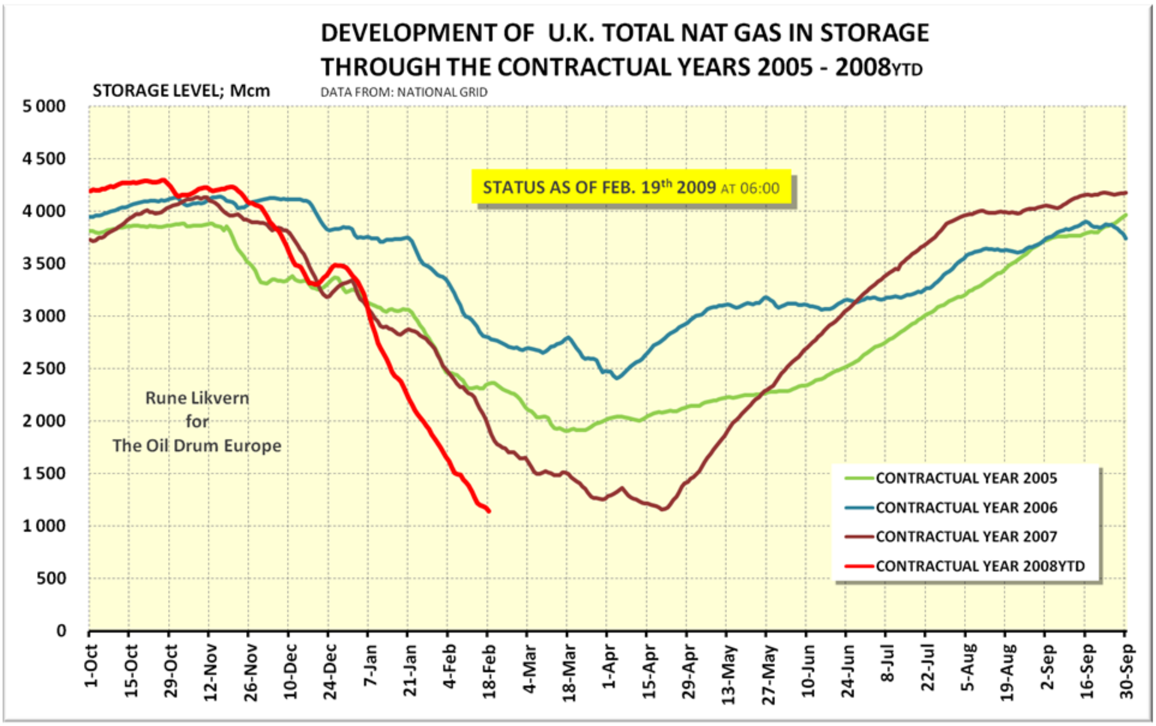
Source: http://www.theoildrum.com/node/5122

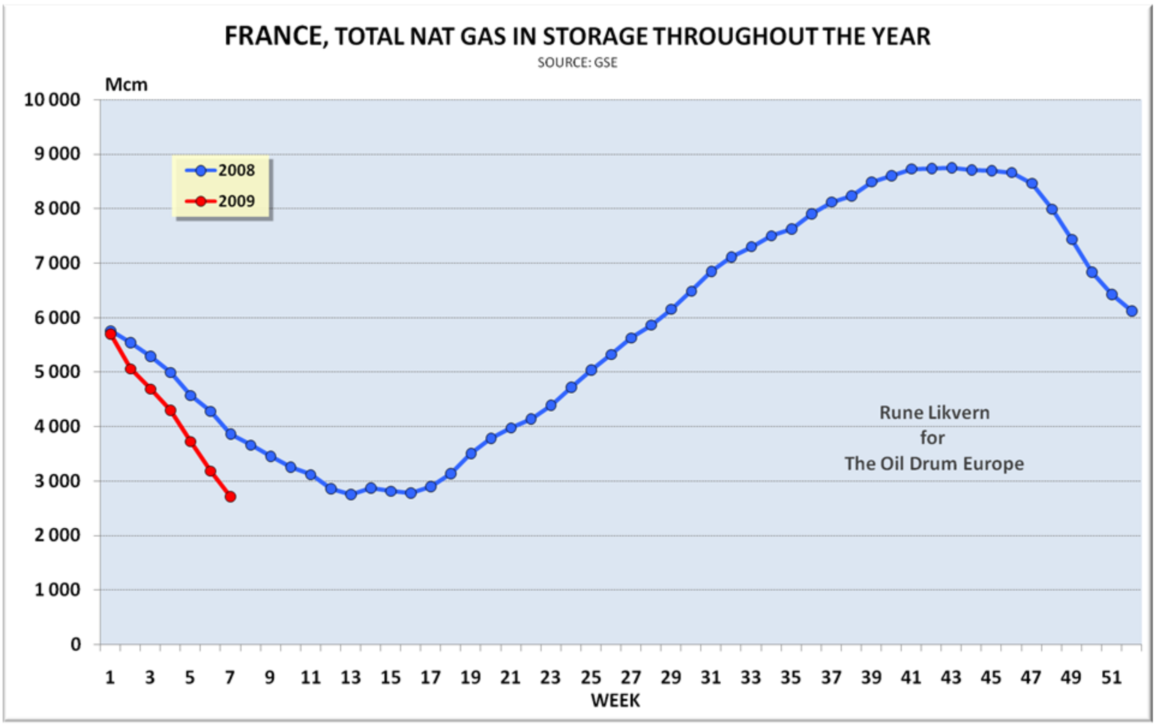
United States coal reserves are taking a beating in a new examination by the USGS of recoverable reserves of Gilette in Wyoming, the largest field in the US with 37% of total coal production in 2006. Its present reserves have been downgraded by half thanks to an improved methodology which incorporates a new dataset with ten times as many datapoints as used in the previous assessment. Of 182 billion metric tonnes of resource in place, 9.16 billion (6% of original resource total) were found to be recoverable under "current technological and economic circumstances". This compares to an earlier assessment from 2002 by the USGS in which 20.87 billion metric tons were estimated to be recoverable.

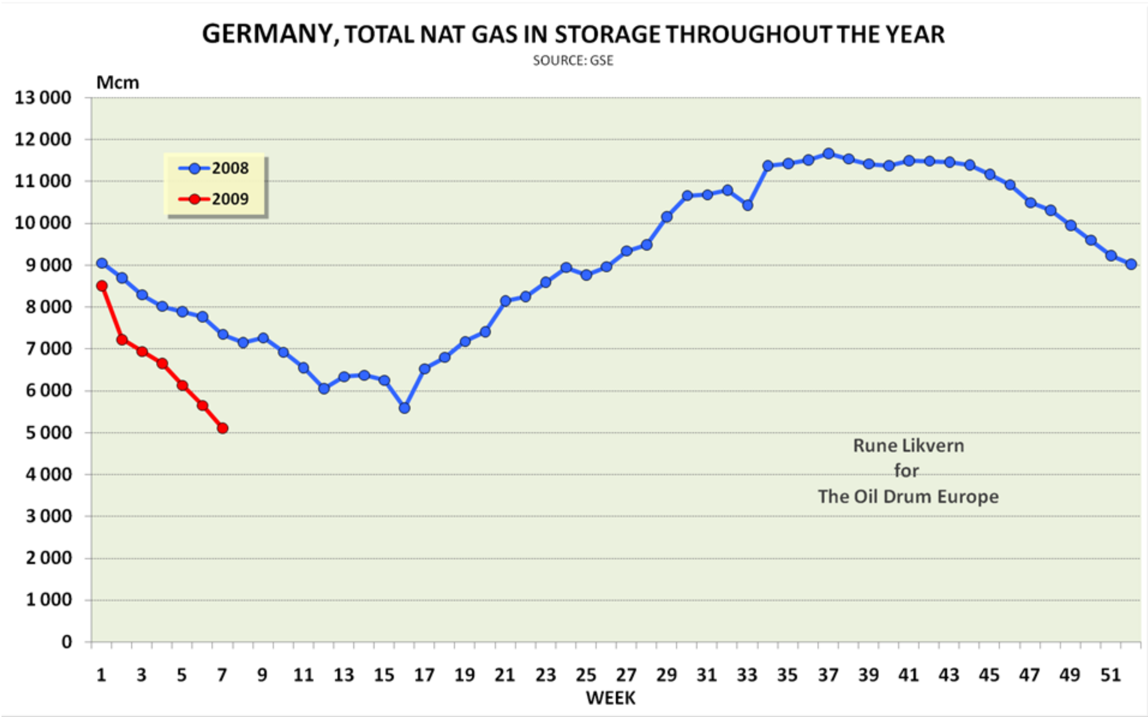
The one catch is that the term "present economic circumstances" depends very much on the price of coal. If the price of coal increases significantly, the newly estimated reserve level of 9.16 billion metric tons can be expected to increase, perhaps several-fold. Although the USGS takes a shot at determining the price-sensitivity of reserves by discussing its effect, there still are a lot of open ends. Nonetheless the economic aspect of coal recoverability should be taken seriously; hence the question mark in the title.

UK NAT GAS WINTER 2009, FEBRUARY UPDATE

Source: http://europe.theoildrum.com/node/5123






GERMANY, TOTAL NAT GAS IN STORAGE THROUGHOUT THE YEAR
SOURCE: GSE
Mcm
13 000
12 000
11 000
10 000
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
2008
2009
Rune Likvern
for
The Oil Drum Europe
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51
WEEK