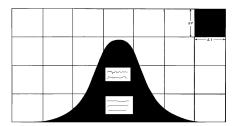
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M. KING HUBBERT CENTER FOR PETROLEUM SUPPLY STUDIES

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THE WORLD'S GIANT OILFIELDS

*How Many Exist?
*How Much Do they Produce?
*How Fast Are They Declining?

by Matthew R. Simmons

Volumes of data are readily available on how much oil most countries produce along with data on each country's proven and/or possible reserves. Rarely, though, does data get published on the important individual oilfields making up each country's oil supply. For the past two decades, virtually no data has been released on any of OPEC's key producing oilfields. There is no published data on which of the universe of major oilfields have passed their peak production and are now in decline. There are certainly no published estimates on what these decline rates will become in the future. I have recently completed a lengthy study on the world's current population of giant oilfields. A copy of the full report is available upon request.

This study of giant oilfields does not focus on proven reserves. Instead, it focuses on what these fields now produce each day. I chose to define a giant oilfield as one which now produces in excess of 100,000 barrels per day. (While a field of this size is significant for any oil company, it only represents 1.3% of the world's daily supply.)

What I found, after extensive digging, is that a small percent of the world's oilfields comprise a surprisingly large percent of current daily supply. Almost all of the biggest giant oilfields are old. Many are very old. The new giants found over the past 50 years have been progressively smaller over time, particularly in terms of peak production rates.

There is an urgent need for better data on these critically important fields. It needs to be published on a timely basis so analysts can start tracking their production profiles. Otherwise, future macro-supply forecasts will all be based on estimates that do not even qualify as being "educated." The principal findings of this study of giant oilfields are summarized below.

THE POPULATION OF THE WORLD'S GIANT OILFIELDS

The world's 120 largest oilfields produce close to 33 million barrels a day, almost 50% of the world's crude oil supply. The 62 smallest of these "giant fields" account for 12% of the world's daily oil supply. In contrast, the fourteen largest account for over 20%. The average age of these 14 largest fields is **43.5** years.

HC#2002/1-1-1 JANUARY, 2002 Thirty-six giant oilfields that were all discovered more than 40-years ago still collectively produce close to 16 million barrels a day. In contrast, twelve giant oilfields found in the past decade together now produce less than one-tenth of this, or 1.5 million barrels a day, 2% of the world's daily supply. The world clearly has a bi-furcated oil supply in terms of both age of our important oilfields and the number of key fields propping up our production base. Another 20 to 25 new giant fields have been discovered but are still being developed. However, no new field whose development program is now underway is projected to have daily production in excess of 250,000 barrels. In sharp contrast, the world's 19 largest "old giant fields" still produce on average more than 500,000 barrels per day, in spite of an average age of almost 70 years!

Most of the world's true giants were found decades ago. In the past two decades, most oil and gas discoveries have been quite small fields. Occasionally a new billion-plus barrel oilfield is announced. But even these "giant" finds tend to be tiny, in terms of daily production, compared with the giant fields found 50+ years ago. The last four oilfields found with a productive capacity that exceeded one million barrels a day were China's Daqing field discovered in 1959, Western Siberia's Samotlor in 1965, Alaska's Prudhoe Bay in 1968, and Mexic o's Cantarell field in 1976. After Cantarell, no new field has come close to this one million barrel a day production level. Only a small group of fields found post-1980 have ever produced 500,000 barrels per day, and many of these new giants are now small producers with natural depletion having taken its toll.

In the decade of the 1990s, more than 400 individually named oilfields were discovered. Only 2.5% of these now produce more than 100,000 barrels per day. In the last two decades, only three giant oilfield discoveries were made, all in the 1980s, whose daily production exceeded 200,000 barrels per day. They are Brazil's Marlim field (530,000 barrels per day), Columbia's Cusiana field (300,000 barrels per day), and Norway's Draugen field (215,000 barrels per day.) I was surprised to learn that so few giant oilfield discoveries with current production levels of 200,000 barrels per day were made in the last 20 years. I would have guessed that the number would be far higher.

Only a handful of deepwater projects are now under development whose peak production will get close to 250,000 barrels per day. Two or three recent onshore Middle East discoveries apparently have multibillion barrels of probable reserves. But none are close to development. So far, none seem to have the capacity to produce more than 300,000 to 400,000 barrels per day and would only reach this level by 2010 at the earliest. The lengthy elapsed time since the discovery of most of our world's really large fields argues that most new fields will be relatively small daily producers.

Traditionally, the definition of a giant or super-giant oilfield has been a field whose reserves exceed one billion barrels. Super giant fields are generally ones whose reserves exceed five or even ten billion barrels. This definition often gets ambiguous as the reserves for some fields too often get depicted as "total possible reserves" or "oil in place" while other field's reserves size adheres to the strict definition of "proven" and "recoverable reserves." Perhaps it is time for the energy world to change this reserve focus and begin defining giant oilfields in terms of their daily production. This yardstick can be accurately measured, unlike total reserves which are always estimates. For the purposes of this study, my definition of a "giant" is one in which production is at least 100,000 barrels per day.

A 100,000-barrel a day producing oilfield is not a tiny field. It represents a significant asset for even the world's largest oil and gas companies. But a field of this size is only "a drop in the ocean" from the standpoint of the world's overall oil supply of more than 75 million barrels of oil each day. A 100,000-barrel a day field represents only 1.3% of total supply. It takes many of these smaller fields simply to offset even a modest decline in the world's existing production base.

While individual oil field production can be measured, there is surprisingly little public data on what most fields actually produce, including many of the world's giant fields, particularly within all the OPEC countries where most of the true giants are located. There is almost no data on the excess productive capacity for any of these giant fields in terms of "shut-in" or choked back daily supply. There is even less data on what the average decline rates for any of those fields might be. Few supply forecasters have ever attempted to model the future decline rates for these giant fields. The task, if performed, would be daunting as the data needed to create such a model is seriously lacking.

For decades too much of the discussion and analysis of the world's future oil supply has focused on the availability of ample oil reserves. Moreover, this analysis has mostly been done from a "top-down" country-by-country basis. Virtually no analysis has been done on what the production rates of all the giant oilfields might be as the future unfolds, let alone the biggest question of all: what are the current decline rates for these giant fields and what are they likely to become over time?

Published estimates of current production rates are available, but not easy to find, for about 45% of the world's population of giant fields, although these particular fields only produce a third of the estimated production volume from all giant fields. I have taken the liberty of "guess-timating" the possible production for the entire group of identifiable giant fields, and I might be off by a considerable margin. Hopefully, this paper might generate some interest in this topic and stimulate the availability of better data on all of these important fields. Key individuals in each region of the world must have detailed knowledge on every one of these fields. I would welcome any feedback for fields I have missed or more important, personal knowledge of what any of these fields actually produce today, or better still what declines each field now experiences.

The world is badly in need of better field-by-field production data. Reliable field-by-field production statistics are only available on a timely basis for the North Sea oilfields. Detailed monthly reports are published for the oilfields in the United Kingdom, Norwegian, and Danish sectors of the North Sea. Outside this region, quality information of any type on the giant oilfields of the world is sparse at best, including even the United States. Field-by-field data does exist for Alaska and the Gulf of Mexico, but it is hard to locate and rarely published. Outside the North Sea and the U.S., locating reliable data on daily field-by-field production for the other non-OPEC producing fields is difficult, and obtaining this data for OPEC oilfields is almost impossible.

OPEC, as the world's most important energy organization, needs to lead an effort to begin creating the same field-by-field data transparency as now exists for the North Sea. If the OPEC producers begin furnishing this data, it will help focus the world's energy planners on the significant expenditure needed in the industry to keep the world's current production base intact. Proper OPEC oil data would likely shatter the current myth that plentiful quantities of cheap oil are abundant throughout the Middle East.

Fortunately, if one is prepared to dig through masses of published data, enough information is available on most of the world's 100,000 barrels per day oilfields to create the probable total universe of these fields. But, the task is extremely time consuming and subject to error. When all existing information is pulled together and properly analyzed, the conclusions reached are enlightening and raise some significant questions on long-term oil supply that have seldom been addressed.

The following table summarizes the probable population of all (or most) oilfields left in the world that now produce more than 100,000 barrels per day. The list is skewed two ways. The bulk of the fields, in total number of fields, is at the lesser end of production volumes. Over half of these fields produce less than 200,000 barrels per day, with an average production of only 130,000 barrels per day. The bulk of the production volumes from these giant fields comes from a small number of mostly old fields.

SUMMARY OF GIANT OILFIELDS

		Total	ERA DISCOVERED					
Giant Fields Production	No. of	Production	Pre-					
Barrels per Day	Fields	000 B/D	1950's	1950s	1960s	1970s	1980s	1990s
1,000,000 +	4	8,000	2	1		1		
500,000 - 999,000	10	5,900	2	3	3	1	1	
300,000 - 499,000	12	4,100	3	1	6	1	1	
200,000 - 299,000	29	6,450	8	4	6	9	1	1
100,000 - 199,000	61	7,900	5	8	13	13	11	11
TOTAL	116	32,350	20	17	28	25	14	12

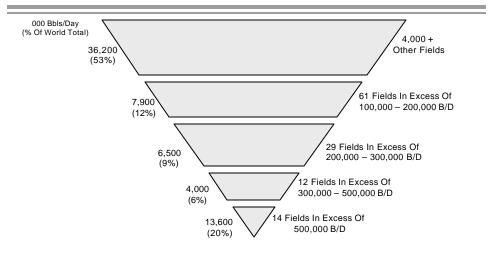
	GIANT FIELDS' PRODUCTION						Total	
	'000 Barrels Per Day						Production	
	Pre-1950s	1950s	1960s	1970s	1980s	1990s	%	000 B/D
1,000,000 +	5,700	1,100	0	1,200	0	0	25%	8,000
500,000 - 999,000	1,500	1,700	1,600	600	500	0	18%	5,900
300,000 - 499000	900	300	2,300	300	300	0	13%	4,100
200,000 - 399,000	1,700	900	1,400	2,000	200	200	20%	6,400
100,000 - 299,000	550	1,100	1,700	1,700	1,500	1,400	25%	7,950
	10,350	5,100	7,000	5,800	2,500	1,600	100%	32,350
Percentage of								
Total	32%	16%	22%	18%	8%	5%		100%

GIANT OILFIELDS AS A PERCENTAGE OF THE WORLD'S OIL SUPPLY

For the past decade, many of the finest energy think-tanks have noted, with some relief, how diverse the world's oil supply now is, with almost 80 countries making up the global 68-million barrels per day crude oil supply. Natural Gas Liquids (NGLs) and refinery processing gains make up the other 7 million barrels per day of total supply.

The diversity myth is shattered once these giant oilfields are analyzed. The reality is that $14 \ \underline{\text{old}}$ individual oilfields make up more than 20% of the world's total supply, so the supply base is anything but diverse. Schematically, the following inverted pyramid reflects how this supply is allocated from Super Giant fields at the bottom to a profusion of tiny oilfields at the top, highlighting how critical giant fields are to the global oil supply.

The Pyramid



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Most of these giant fields are old. Each successive decade's new discoveries have been smaller than their predecessors. The average production from the generation of giant fields discovered prior to 1950 and still producing in 2001 is 5 times greater than that of the fields discovered over the last decade. The steady decline in average production by giant fields found in each decade over the past 50 years is dramatic testament that the adage "most large oilfields get found first" is still alive and well.

World's 2000 Oil Supply (Million barrels per day)

Total

	Production B/D	GIA Number	Percentage of Total		
OPEC	B/D	<u>Number</u>	Daily Production	<u>oi rolai</u>	
Middle East					
Saudi Arabia	8.00	7	7.35	92%	
Iran	3.65	10	7.35 1.85	92% 51%	
Iraq	2.55	5	2.45	96%	
UAE	2.20	7	2.43	95%	
Kuwait	1.75	3	1.55	89%	
Neutral Zone	0.60	1	0.30	50%	
Qatar	0.65	3	0.50	77%	
Qalai	0.03	3	0.50	11/0	
Total	19.40	36	16.10	83%	
Rest of OPEC					
Nigeria	2.00				
Libya	1.30	7	0.85	65%	
Algeria	0.80	2	0.35	44%	
Venezuela	2.90	10	1.70	59%	
Indonesia	1.20	2	0.40	33%	
Total	8.20	21	3.30	40%	
Total OPEC	27.60				
Non-OPEC					
North America	11.40	17	3.70	32%	
Europe	6.40	10	2.00	31%	
FSU	7.90	12	2.15	27%	
Asia	6.30	7	2.75	44%	
Latin America	3.70	4	1.20	32%	
Middle East	1.90	4	0.50	26%	
Africa	2.80	5_	0.65	23%	
Total	40.40	59	12.95	32%	
Total Crude*	68.00	116	32.35	48%	

^{*} NGLs and refinery processing gains adds another 7.5 million barrels per day

Source: 2000 Total Production: IEA Giant Oilfield Data: Matthew Simmons

It is also remarkable how many key producing oil countries of the world still rely on a handful of giant fields for the bulk of their production. Even the U.S., with the most producing fields in the world and the largest population of producing wells, still gets more than 1.5 million of our 5.8 million barrels per day oil supply from only nine fields. Three of these nine fields' ages are close to, or even exceed, 100 years!

Saudi Arabia apparently has only seven giant fields, but they produce more than 7.3 million of its total 8 million barrel a day oil output. Iraq's 5 giant fields account for 96% of its output. Kuwait's 3 giant fields are almost 90% of its output. Nigeria is the only OPEC producer with no fields currently producing in excess of 100,000 barrels per day.

WILL THESE GIANT FIELDS DECLINE?

With production from giant fields providing such a significant share of the world's oil supply, it seems important to understand the decline rates each of these fields now experience and to determine what future decline rates are likely to be. Unfortunately, there is little publicly available data for even the most visible of these giant fields to make an educated guess at this important statistic.

There is ample data showing that giant oilfields do ultimately peak and then begin to decline. All the giant fields of Texas are classic illustrations of this. Prudhoe Bay, Cusiana, or the entire population of the North Sea's true giant fields also demonstrate not only that large fields decline but also that production declines rapidly once it peaks.

Saudi's Ghawar field, still by far the largest producing field the world has ever known, might last another 100 years. But, the field might also have already peaked. That no public data is available to shed any light on this issue places a giant question mark over the supply from this field. Someday even a field as large as Ghawar will begin its decline. If its decline rate comes close to those experienced by the North Sea fields or Prudhoe Bay, it would take a global drilling boom to find enough smaller fields merely to replace lost Ghawar oil supply.

Sooner or later, most of the world's current population of giant fields will all be in decline. If the world's future supply needs to result from <u>new</u> fields that are getting progressively smaller, it could require more than 3,000 new oilfields to be found and developed over the next 10 years, compared to slightly more than over 400 named new oilfields that were discovered in the past decade.

Until there is far better transparency on the world's giant oilfield production data and decline rates, the world can only guess at its future oil supply. There is an urgent need for better data on all these key fields.

The Author: Matthew R. Simmons

Matthew Simmons is President of Simmons & Company International, a specialized energy investment banking firm with offices in Houston, Texas and Aberdeen, Scotland. The firm has guided its broad client base to complete over 450 investment banking projects at a combined dollar value of approximately \$56 billion.

Mr. Simmons was raised in Kaysville, Utah. He graduated cum laude from the University of Utah and received an MBA with Distinction from Harvard Business School. He served on the faculty of Harvard Business School as a Research Associate for two years and was a doctoral candidate.

Mr. Simmons founded Simmons & Company International in 1974. Over the past 27 years, the firm has played a leading role in assisting its energy client companies in executing a wide range of financial transactions from mergers and acquisitions to private and public funding. Today the firm has approximately 100 employees and enjoys a leading role as one of the largest energy investment banking groups in the world.

Mr. Simmons' papers and presentations are regularly published in a variety of journals and publications including World Oil, Oil & Gas Journal, Petroleum Engineer, Offshore, and Oil & Gas Investor.

Matthew R. Simmons - President Simmons & Company International 700 Louisiana Street, Suite #5000 Houston, Texas 77002

Tel: (713) 236-9999 Fax: (713) 227-5827

Email: <u>Jgristwood@simmonsco-intl.com</u>

A. PUT YOUR MONEY WHERE YOUR GAS TANK IS

Environmentalists argue eloquently that if our narrow-minded government and the greedy oil companies could just see our national fuel needs unselfishly, then cheap energy would gush forth from someplace and solve the world's problems. (Where do I get in line?) I only wish that such utopian views were possible. Unfortunately our globe now consumes more than a trillion (million million) gallons of crude oil each year, with the United States burning up one quarter thereof – more than 55 percent of which is imported. Simp ly put, if Americans do not want any oil activity on U.S. lands and seas, then we had all better be willing to reduce our oil use dramatically. Any American who is really concerned about his children's welfare should put his money where his mouth is and pay a more realistic gasoline tax of say \$1.50 per gallon as in the other industrialized countries. (Europeans now pay \$3.00/gallon gas tax.) Increasing our fuel tax would not only promote conservation, but would raise billions in revenues. Other taxes (income, sales, etc.) could be reduced to offset total tax burdens.

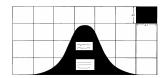
B. GASOLINE TAXES

Our politicians get elected on the "good news" of low gasoline prices – not on the "bad news" of high gas taxes. The economic logic is irrefutable for increasing the U.S. Federal gasoline tax – a 50-cent tax (much less than in Europe) would bring in \$50 billion per year, which would pay for much of our oil trade deficit. But such an unpopular tax should not be expected until a real national emergency occurs. A gasoline tax increase is still a political no-no, due to the vehement objections of two groups of voters – namely: those who buy gasoline, and those who sell it.

C. \$4/BARREL = 10¢/GALLON

There are 42 U.S. gallons in a barrel of oil. A price increase of \$4/barrel represents a $10\phi/gallon$ increase...virtually nil to the average U.S. consumer. Few Americans outside the oil industry are aware of how critical a \$4/barrel (\$0.10/gallon) price difference can be to the many small U.S. oil field operators and to many producing nations – namely the difference between bankruptcy and survival. Taxes are much/most of gasoline's price all over the world.





The M. KING HUBBERT CENTER FOR PETROLEUM SUPPLY STUDIES

located in the Department of Petroleum Engineering
Colorado School of Mines
Golden, Colorado

The Hubbert Center has been established as a non-profit organization for the purpose of assembling and studying data concerning global petroleum supplies and disseminating such information to the public.

The question of WHEN worldwide oil demand will exceed global oil supply is stubbornly ignored. The world's oil problems, timing and ramifications can be debated and realistic plans made only if the question is publicly addressed. A growing number of informed US and European evaluations put this crisis as close as now to 2014. The formation of this center is to encourage a multi-field research approach to this subject.

For further information contact:

Hubbert Center Chairman
Prof. Craig W. Van Kirk
Head of Petroleum Engineering Dept.
Colorado School of Mines
Golden CO 80401-1887
Phone 1-800-446-9488
Fax 1-303-273-3189
Internet Address: http://hubbert.mines.edu

L. F. Ivanhoe 1217 Gregory St. Ojai CA 93023-3038

Hubbert Center Coordinator

Phone 1 -805 -646 -8620 LFIvanhoe@aol.com

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