

THE WORLD'S GIANT OILFIELDS

****How Many Exist?***

****How Much Do They Produce?***

****How Fast Are They Declining?***

***by
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Note to cover page: 19 of the world's oilfield giants are circled on the Middle East map. Collectively these fields still produce approximately 15 million barrels a day, over 22% of the world's total oil.

PREFACE

Astute energy industry observers have often noted that the preponderance of the world's oil reserves still lie in the Middle East. Occasionally, someone also reminds the world that as much as 70% of our daily oil supply comes from oilfields that were discovered prior to 1970. Seldom, however, has anyone attempted to analyze the number of giant oilfields still left in the world, their age and how much daily oil they produce. No one addresses whether these giant fields have yet to reach peak production, when they are likely to begin to decline, or how steep the decline rates now are for many of these giant fields. Instead, there is a great deal of rhetoric about how diverse the world's oil supply now is compared to when it was so heavily concentrated in the Middle East.

Not only have most of these questions about giant oilfields been unanswered, there is also little visible data available even to begin analyzing these key petroleum supply issues.

After months of digging through numerous statistics and the help of knowledgeable experts on various regions of the world, the majority of remaining "giant oilfields" can be identified. This energy white paper sets out the best data that now exists on how many giant oilfields there are, where they are located, their ages, and their probable current

production. Some important questions arise from this work, including the need for far better transparency on the actual daily production rates from these fields, the need for some detail on which fields have now peaked, when the balance of all the massive old fields will probably peak and what the decline rates for this remarkably important pool of giant oilfields is likely to be over the next five to ten years.

Some of this report's data on these various oil fields is undoubtedly wrong. The conclusions reached from conducting this study, though, are serious. A large proportion of the world's most important energy source, oil, comes from a small population of giant fields. Too many of these critical fields are now very old. To think that most of these oil fields will still be anchoring the world's oil supply by 2010 could be naïve. But, little data now exists to enable serious energy planners to answer all the questions this report raises. The need to "fill in the key energy dots" is clear.

I hope the readers of this report ultimately share my concerns. A concerted effort to create reliable data on these fields is not an impossible undertaking. To accomplish this task, however, takes a commitment by all the stakeholders of the oil industry. Unless this commitment is made, the world could suddenly awake to a nasty energy surprise.

I would like to thank a number of people and sources for their help in assembling this data. The biggest source of field-by-field production data comes from the Annual International Petroleum Encyclopedia. This remains one of the few sources of

published annual production estimates for many of the non-OPEC oilfields and a few OPEC fields. Some data came from IHS Energy Group and The International Energy Agency (IEA). Particularly helpful input came from Will Davie, Herman Franssen, Jean Laherrere, John Fitzgibbons, Ted Peterson, Colin Campbell, Robert Ebel and Richard Nehring.

EXECUTIVE SUMMARY

There are over 4,000 actively producing oilfields in the world. These fields produce 68 million barrels a day of crude oil from almost one million individual wells. Most of these oilfields are relatively small. The average field produces less than 20,000 barrels per day. Three percent of these oilfields make up almost half of this output. This paper focuses on this small three percent of giant oil fields whose daily production exceeds 100,000 barrels a day.

Approximately 120 giant oilfields in the world produce 100,000 barrels a day or higher. In total, these fields produce in excess of 32 million barrels a day, or 47% of the world's total supply. Even within this tiny tip of the world's oilfields, half of these 120 giant fields barely exceed the minimum 100,000 barrel per day production parameter that I have used to define a giant oilfield. 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.

Thirty-six giant oilfields that were all discovered over 40-years ago still produce close to a combined 16 million barrels a day. In contrast, twelve giant oilfields found in the past decade now produce less than a tenth of this amount, 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.

Around 20 other new giant fields now discovered, but yet to begin producing, are each expected to exceed 100,000-barrel per day output. However, no new field now being developed 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 an average over 500,000 barrels per day, in spite of an **average age of almost 70 years!**

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 get depicted as "total possible reserves" or "oil in place" while other field's reserves sizes adhere 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.

While individual oil field production can be quite accurately measured, there is a surprisingly little data on what most fields actually produce, including many of the world's giant fields. This is particularly the case for almost all OPEC's giant oilfields. 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 for almost half the world’s giant oilfields are available but not easy to find, though these particular fields produce only a third of the estimated production volume from all giant fields. I have taken the liberty of guessing at the possible production for the entire group of identifiable giant fields. Some of my estimates might be off by a considerable margin. Hopefully, this paper might generate more interest on this topic and stimulate the availability of better data on all of these important fields. Key individuals in each region of the world 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 oil fields 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 daily field-by-field production data 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 in 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.

Most of the world's true giant oilfields 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 Mexico's Cantarell field in 1976. After Cantarell, no new field has come close to this one million barrels 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 very depleted.

In the decade of the 1990s, over 400 individually named oilfields were discovered. Only 2.5% of these fields now produce over 100,000 barrels per day. Not a single oilfield found in the past decade produces more than 200,000 barrels a day. Only three oilfields discovered in the decade of the 1980s still produces over 200,000 barrels per

day. They are Brazil's Marlim field (530,000 barrels per day), Columbia's Cusiana/Cupiagua field (300,000 barrels per day), and Norway's Draugen field (215,000 barrels per day.) To find that only three fields discovered in the past twenty years now produce over 200,000 barrels a day was a big surprise to me. I would have guessed intuitively that the number would be far higher.

There are a handful of deepwater projects now under development whose output should have peak production as high as 250,000 barrels per day. There have been two or three recent onshore Middle East discoveries with multi-billion barrels of probable reserves. None of these onshore discoveries are close to beginning production and so far, none seem to have the capacity to produce more than 300,000 to 400,000 barrels per day and only by 2010 at the earliest.

A 100,000-barrel a day 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 overall world oil supply of over 75 million barrels of oil each day, representing only 0.13% of total supply. It takes many of these smaller fields simply to replace the even a modest decline from the world's existing production base.

My biggest surprises of this study were first, how difficult it was to even obtain data on current production rates. Second, how critically important this relatively small population of oilfields still is to the world's total oil supply. Third, how old many of these

fields are particularly the largest of these fields. Fourth, the total lack of good data on the decline rates for almost all of these giant fields. My last surprise was the consistently smaller size of each new generation of giant fields.

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

SUMMARY OF GIANT OILFIELDS								
Giant Fields Production Barrels per Day	No. of Fields	Total Production '000 B/D	ERA DISCOVERED					
			Pre-					
			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 Production '000 B/D
	'000 Barrels Per Day							
	Pre-1950s	1950s	1960s	1970s	1980s	1990s	%	
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 - 499,000	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%

AN OVERVIEW OF THE WORLD'S OIL SUPPLY

In 2000, the world's daily petroleum consumption averaged a new high of 76 million barrels a day. Thirty years ago, the world only used 50 million barrels a day. Two decades earlier, in 1950, daily consumption was only ten million barrels.

Crude oil production makes up 68 million barrels a day of the world's total 76 million barrel a day usage. NGLs and refinery processing gains make up the remaining eight million barrels a day of total supply.

Over 4,000 named oilfields with a population of almost one million individual wells create this 68 million barrel a day oil supply.

31% of the daily crude production comes from the Middle East. 90% of the Middle East's production comes from the six OPEC producers and the Neutral Zone. Five non-Middle East OPEC producers supply another eight million barrels a day or 12% of the world's total supply. 20 other key non-OPEC countries make up most of the remaining 41 million barrels a day of total supply. There are 83 countries, in total, that produce oil. Fifty of these countries produce only a tiny amount of oil.

From the perspective of many energy policy planners, the world now has a broadly diverse supply base, since so many countries now join in producing almost 70 million

barrels a day of oil. Aside from the top ten oil producers: Saudi Arabia, Russia, the U.S., Iran, Iraq, the U.A.E., the U.K., Norway and China, no other producing country supplies as much as 3% of the world's daily supply.

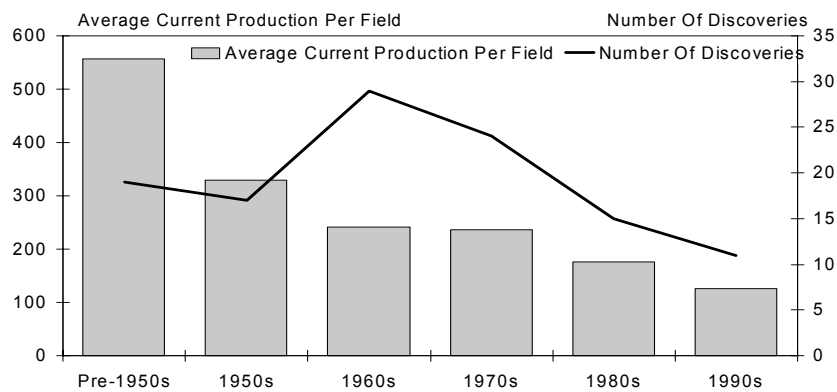
What is often missed in this global overview, though, is the relatively small number of giant oilfields spread around the world that account for almost half of the world's daily oil supply. It turns out that the world's total supply is far from diverse in terms of key oil fields. Instead, the world's core supply is still highly concentrated in a small number of fields. Fourteen individual fields located in six different countries produce over 20% of the world's total supply. The four largest of these 14 fields account for 12% of the world's supply, more than all the oil produced in every continent's total oil supply, excluding these four fields other than the Middle East.

After the top 14 producing oilfields, the next 12 largest fields add another 4.1 million barrels a day, bringing the total giant field production up to 18 million barrels per day or 26% of the world's total. Twenty-nine additional fields producing between 200,000 and 300,000 barrels a day bring the total volumes produced to 24.5 million barrels a day. The world's oil supply turns out to be anything but diverse. A high percentage of the global supply is concentrated in a remarkably small number of fields.

Many key oil-producing countries also have a remarkably small number of large fields that account for the bulk of the country's total output. Every key Middle East producer has this high giant field concentration.

The age distribution of the world's giant oilfields highlights the fact that older fields still produce far higher volumes of oil than the newer giant oilfields. The consistency of the volume decline on newer fields is quite amazing. Table 2 details this distribution.

TABLE 2 DESCENDING SIZE OF GIANT OILFIELDS		
Date of Discovery	Number of Discoveries	Average Current Production (per Field)
Pre- 1950s	19	557
1950s	17	330
1960s	29	242
1970s	24	236
1980s	15	176
1990s	11	126



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As discussed in a subsequent part of this report, there is presumably some chance that this trend of ever-smaller fields will someday reverse and new discoveries will begin growing in size. But the trend towards smaller new fields has been taking place for so long that this scenario is probably unlikely.

The distribution of the world's oil supply, in terms of oil fields vs. individual oil producing countries resembles an upside down giant pyramid.

The Oil Pyramid

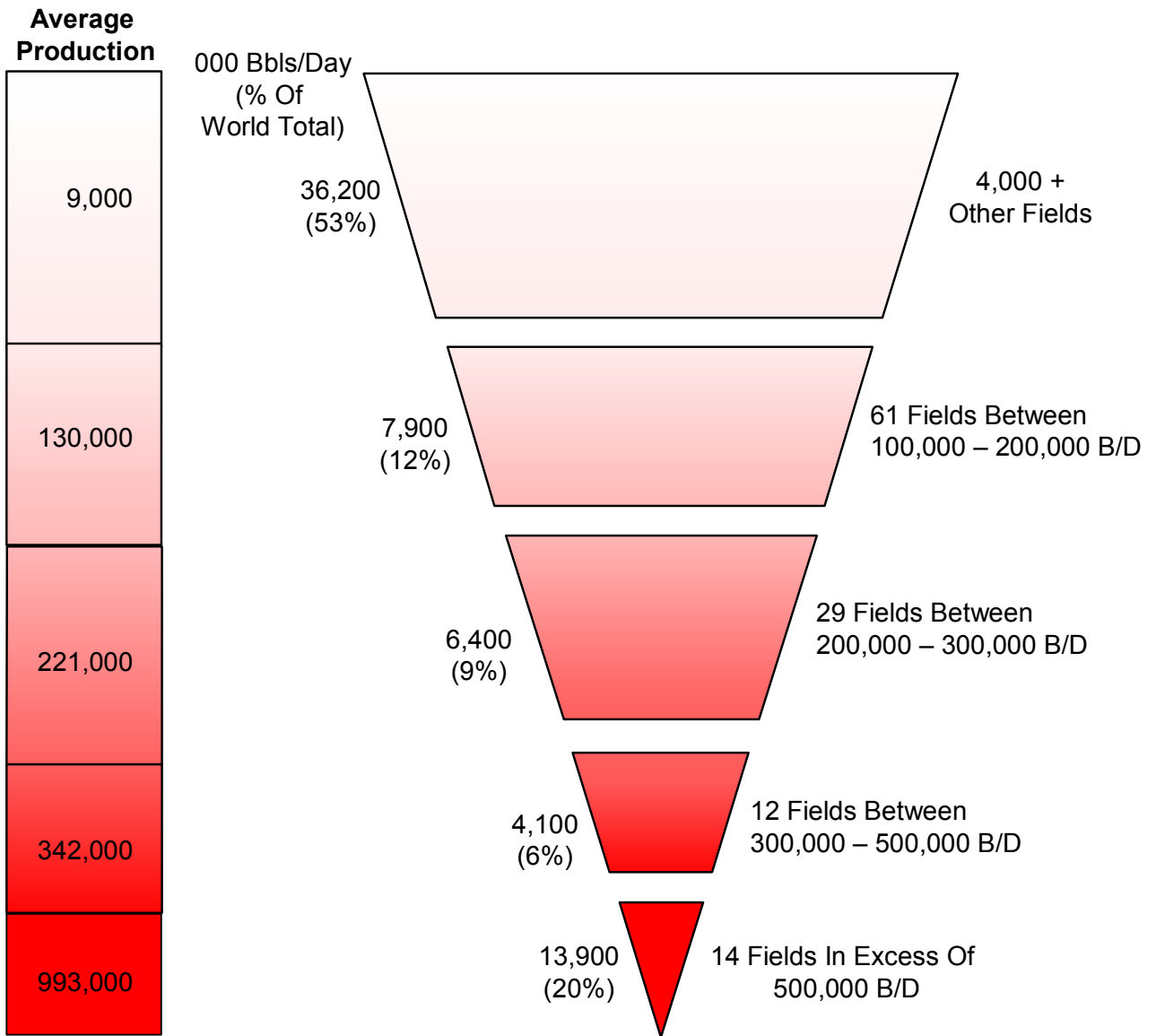


Table 3 summarizes the global oil supply by various regions of the world and the number of giant oilfields in each area. The concentration of giant fields comprising a high percent of many key-producing regions is quite astonishing. Even in North America, which has over 600,000 individual oil wells, 17 giant fields account for 32% of North America's daily supply.

TABLE 3				
WORLD'S 2000 OIL SUPPLY				
<i>(Millions barrels per day)</i>				
	Total Production (Barrels/Day)	Giant Fields		Percentage of Total
		Number	Daily Production	
OPEC				
Middle East				
Saudi Arabia	8.00	7	7.35	92%
Iran	3.65	10	1.85	51%
Iraq	2.55	5	2.45	96%
UAE	2.20	7	2.10	95%
Kuwait	1.75	3	1.55	89%
Neutral Zone	0.60	1	0.30	50%
Qatar	0.65	3	0.50	77%
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	6.4	10	2.00	31%
FSU	7.9	12	2.15	27%
Asia	6.3	7	2.75	44%
Latin America	3.7	4	1.20	32%
Middle East	1.9	4	0.50	26%
Africa	2.8	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: 2001 Total Production: IEA Giant Oilfield Data: Matthew R. Simmons				

The notion that only 36 Middle East oilfields contribute over 80% of daily Middle East supply shatters the myth that the world now enjoys a diversified oil supply. Table 4 details the individual well productivity from a variety of key producing countries.

TABLE 4	
KEY PRODUCING COUNTRIES	
<u>Country</u>	<u>Barrels per Well per Day</u> (1998 Data)
Norway	5,623
Saudi Arabia	5,140
Iran	3,221
Kuwait	2,278
U.K.	1,728
Abu Dhabi	1,595
Indonesia	1,592
Dubai	1,578
Iraq	1,252
Neutral Zone	1,038
Libya	947
Nigeria	940
Mexico	875
Algeria	642
Venezuela	200
China	44
U.S.	11
Source: 2000 International Petroleum Encyclopedia	

The disparity between the handful of countries with highly prolific wells compared to countries like China, Russia and the USA is noteworthy.

WHEN GIANT FIELDS WERE STILL REAL GIANTS

Only three new oilfield discoveries over the past 30 years still produce in excess of 500,000 barrels per day. The largest is Pemex's Cantarell field; the second is the Shayba field, Saudi Arabia's newest oilfield (and the first new giant oilfield christened in over 20 years). The third is Brazil's Marlim Field. Otherwise, almost every other post-1970 new oilfield whose production once exceeded 400,000 barrels per day belonged to the first generation fields found in the North Sea. Most of these North Sea giants are now almost depleted. Many do not even reach my 100,000 barrels per day cut off.

Thirty years ago, the world's top ten oilfields produced over 10 million barrels a day out of the world's 50 million production barrels per day. Their average production was just over 1 million barrels a day each.

TABLE 5		
1971 Top 10 Giant Oilfields		
Field (Country)	Date of Discovery	1971 Production
		<i>(MB/D)</i>
Ghawar (Saudi Arabia)	1948	2,058
Kirkuk (Iraq)	1927	1,096
Lagunilla (Venezuela)	1926	940
Burgan (Kuwait)	1938	900
Abqaiq (Saudi Arabia)	1946	893
Gach Saran (Iran)	1928	882
Marun (Iran)	1964	893
Agha Jari (Iran)	1938	859
Safaniya (Saudi Arabia)	1951	792
Bachaquero (Venezuela)	1930	740
Total		10,053

In 1970, Saudi's giant Ghawar field, which still ranks as the world's largest oilfield ever discovered, was producing just over 2 million barrels a day. This field finally peaked in 1990 when it briefly produced in excess of 6.5 million barrels per day. This production rate resulted in some damage to the reservoir and the field was never again produced at such a rate. Its current recent production is estimated to be about 4.5 million barrels per day.

The only other known field whose daily production ever exceeded 2 million barrels per day was Siberia's giant Samotlor field, which was not even in production in 1971. Samotlor peaked in the late 1980's at just above 3.5 million barrels per day. But this production rate was attained through aggressive water flooding while the field still had natural pressure as its primary drive. As a result, the field's reservoir was badly damaged. Today, it produces just over 300,000 barrels per day.

Aside from Ghawar, the nine other top producing fields in 1971 averaged almost 900,000 barrels per day. These nine fields had a tight production range, with the highest at 1.096 million barrels per day, and the lowest at 740,000. Eight of the ten top fields were in the Middle East. The only non-Middle East producers were Venezuela's two largest producers. In 1971, the average age of these top ten producing fields was 31 years. Every one is still in production as 2001 draws to a close but today these fields have an average life of 61 years!

Only one of the top ten producing fields in 1976 (Cantarell) was discovered in the decade of the sixties. One more, Safaniya, the world's largest offshore field, was discovered just offshore Saudi Arabia in 1951. The other eight fields were discovered between 1927 and 1948. The oilfield adage that most big fields are found first is still "alive and well."

The next 10 largest producing fields in 1971 are detailed in Table 6.

<u>TABLE 6</u>		
<u>1971 Second 10 Giant Oilfields</u>		
<u>Field (Country)</u>	<u>Date of Discovery</u>	<u>1971 Production</u>
		<i>(MB/D)</i>
Murban (Abu Dhabi)	1960	540
Rumalia (Iraq)	1953	480
Bibi Hakimeh (Iran)	1961	452
Sarir (Libya)	1961	441
Minas (Indonesia)	1944	408
Hassi Messaoud (Algeria)	1956	387
Tia Juana (Venezuela)	1928	373
Zelton (now Nasser) (Libya)	1959	360
Sassan (Iran)	1966	356
Gialo (Libya)	1961	359
Total		4,156

This list of the “second ten” fields in 1971 produced an average of about 400,000 barrels per day, less than half the volume of the top ten. Their average age was 12 years, much younger than the top ten fields. This shows that newer fields were already getting smaller as long as 30 to 40 years ago.

A handful of other fields discovered in 1971 but not in the top 20-producing list ended up ultimately becoming giant producers. Table 7 lists the twenty remaining known fields that now produce in excess of 300,000 barrels per day. There is no assurance that this list includes all giant fields. Other fields might need to be added but these cannot be many.

TABLE 7				
2001 Known Top Producing Fields				
<i>('000 Bbl/Day)</i>				
<u>COUNTRY</u>	<u>FIELD</u>	<u>DATE DISCOVERED</u>	<u>ESTIMATED PEAK PRODUCTION</u>	<u>2000 DAILY PRODUCTION</u>
Saudi Arabia	Ghawar	1948	6,300	4,500 ¹
Kuwait	Burgan	1938	1,800	1,500 ¹
Mexico	Cantarell	1976	N/A	1,211
China	Daqing	1959	N/A	1,108
Iraq	Kirkuk	1927	1,500	900
Iraq	Rumailia North	1958	1,200	700 ¹
Saudi Arabia	Abqaiq	1940	800	600 ¹
Saudi Arabia	Shayba	1975	500	600 ¹
U.S.A.	Prudhoe Bay	1968	1,600	550
China	Shengli	1962	N/A	547
Brazil	Marlim	1985	N/A	530 ¹
Saudi Arabia	Safaniyah	1951	1,250	500 ¹
Saudi Arabia	Zuluf	1965	600	500 ¹
Iraq	Rumailia South	1953	N/A	500 ¹
Abu Dhabi	Bu Hasa	1962	N/A	450 ¹
Saudi Arabia	Berri	1964	800	400 ¹
Abu Dhabi	Zakum – Lower	1963	N/A	400 ¹
Abu Dhabi	Zakum – Upper	1963	N/A	400 ¹
Russia	Samotlar	1961	N/A	320
Norway	Ekofisk	1971	N/A	310
TOTAL PRODUCTION				16,526

¹ Estimate

GIANT FIELDS DO ULTIMATELY DECLINE

While some public data is available for what many of the world's population of giant oilfields collectively produce, there is no data on the decline rates for any of these giants. Enough public data is available to infer decline curves for fields like Prudhoe Bay or the North Sea fields, though little attention is paid to this data. Outside these few fields, little data exists on most other large fields to help someone make an educated guess at the decline curve.

Some industry observers have argued that many giant fields might never decline, or that this occurrence is still decades away, as new technologies continuously enlarge reserves and allow greater percents of the oil in place to be recovered. However, there is little public data to support this thesis. The declines that can be observed in some giant oilfields also make this thesis very suspect.

Virtually all the serious petroleum scientists still believe that even the biggest giant fields will finally peak. It is only a matter of time. When these giant fields "roll over," they will all begin a long and steady production decline.

The rate of any oilfield's decline is largely a function of the reservoir management technique employed. Rapid drilling of additional development wells and various enhanced recovery techniques can reduce the natural decline rate, and this is done in most fields. Thus, most field-by-field decline curves do not represent the natural state of decline or "cashless decline rate." Instead, the declines are net of all the money spent to minimize the decline. This is one reason it is so hard to precisely measure decline rates in most regions of the world.

Estimating the onset of an oilfield's peak production is still one of the oil industry's great "black box" mysteries. It took teams of technicians within Exxon to "divine" when Prudhoe Bay would likely peak. Most giant fields' declines have come as great surprises to the field's owners. So far, there has never been an oilfield discovered that did not ultimately peak and then begin to decline, other than those old fields who have yet to have this phenomenon occur.

History has shown that once giant fields peak, the decline can be quite rapid, even when many new development wells are drilled. In fact, one can argue that the only difference in the decline profile of a giant field compared to medium and small fields is the rate of volumes lost.

Prudhoe Bay peaked in 1989, twelve years after it began production. Since then, the number of wells in this world-class reservoir has almost tripled. Prudhoe Bay currently undergoes gas injections, and other secondary recovery techniques to keep production as high as possible. Nevertheless, the decline rate at the wellhead averages about 20% and the net decline of the entire field is about half this, thanks to an exponential increase in the number of producing wells. This year, Prudhoe Bay's production is estimated to be around 550,000 barrels per day, 12 years after it peaked at a production rate of 1.5 million barrels per day.

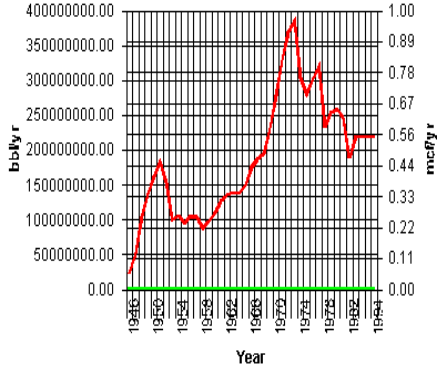
The North Sea's largest giant fields included Ekofisk, Brent, Forties, Statfjord, Gullfaks, Heidrun and Oseberg. Each, at some time, had daily production exceeding 400,000 barrels per day. All have now peaked. The Forties field and Brent both peaked in the early 1980's. Today, both fields struggle to produce a tenth of their peak production. Three of Norway's biggest fields reached peak production only a handful of years ago and now produce only half of what they each did at peak rates.

One of the few databases in the world to gather or estimate many of the world's major oilfield production is that of HIS Energy Group. This was developed by its subsidiary, Petro-Consult, over fifty years ago. Unfortunately, even some of their data on many key oilfields is now close to a decade old, but data too other key fields is available through the end of 2000. This database is still possibly the world's best and most up to date depository of field-by-field data.

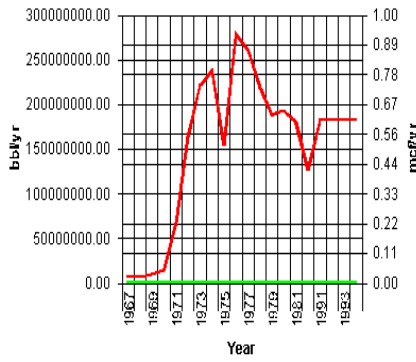
The production profiles for nine key giant oilfields in the Middle East and Russia are detailed in Table 8.

TABLE 8
SAMPLING OF GIANT FIELD PRODUCTION PROFILES

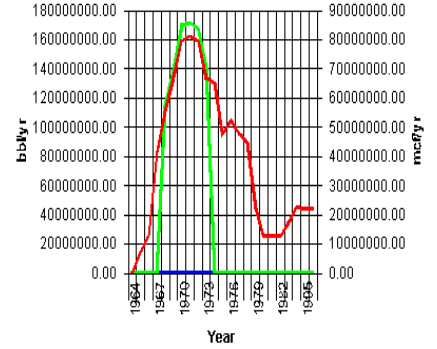
Abqaiq



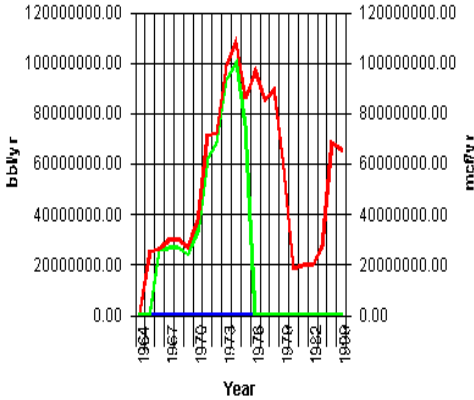
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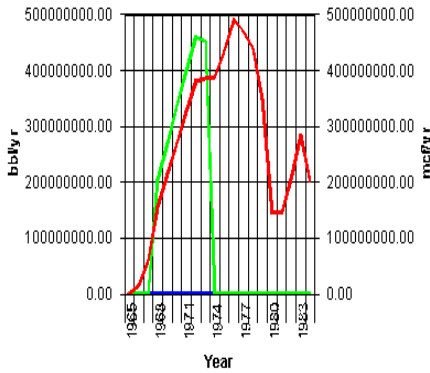
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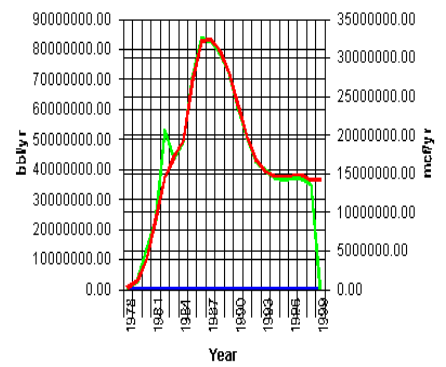
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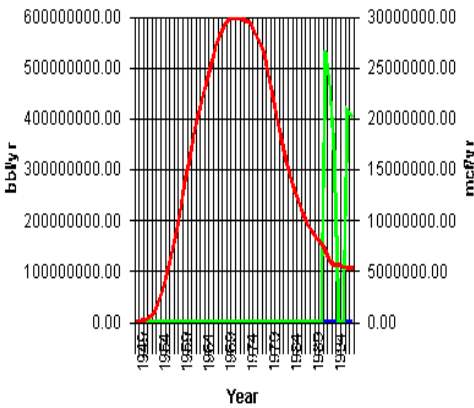
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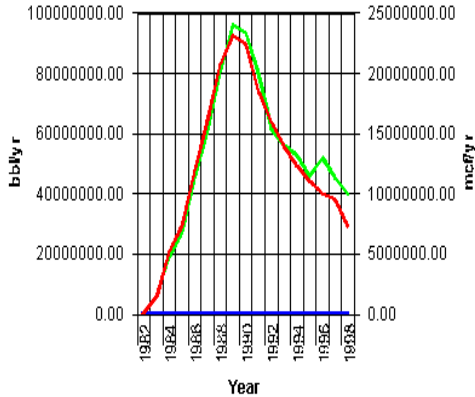
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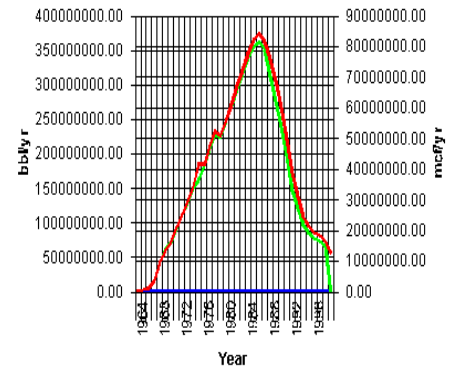
Romashkino



Sutorminsky



Ust-Balyk-Mamortovskoye



The decline patterns in some of these fields are now quite dramatic. In others, the declines only hint at what is still to come. The graphs do prove, once more, that even the largest oilfields ultimately decline.

Some of the world's giant fields have yet to peak. It is difficult to know how many fields in this category are either still at peak production or have yet to reach this level. But at some time they will all peak. Once declines begin, the volume of daily production lost will require an exponential number of new small fields to replace it. Since almost all smaller fields tend to peak fast and then decline at rapid rates, this creates a treadmill of new fields required that few energy analysts ever envisioned.

This does not mean the world has "run out of oil." On the contrary, it highlights how resourceful the world has been in replacing giant fields with rapid and widespread exploration of far smaller fields. It also underscores the need to step up exploration activity throughout the hydrocarbon world. At the same time, we need to get a much better grasp on worldwide decline rates and what the future decline rate will likely be.

OPEC'S LACK OF PETROLEUM DATA TRANSPARENCY

If it proved difficult to grasp the impact of field-by-field decline rates in the North Sea (though this basin has the best field-by-field production data in the world and the data is published on a monthly basis,) it is impossible to analyze decline curves for virtually all OPEC fields. With the exception of fields operated by non-national oil companies in Venezuela, Indonesia and Nigeria, the other OPEC producers stopped releasing field-by-field production data almost two decade ago. The most knowledge-able supply forecasters in the world can only guess at the daily production for each OPEC country. Few analysts even try to allocate this production on a field-by-field basis. There is not even good published supply data for the daily production of the world (and OPEC's) two biggest fields: Saudi Arabia's Ghawar field or Kuwait's Burgan field.

Few, if any, of the published guesses of the excess productive capacity for each individual OPEC country are derived from conducting field-by-field analysis. These estimates are educated guesses at best. More excess capacity assessments are based on sheer assumptions without any support from real production data. The fact that the world "flies so blind" should be disturbing to any serious energy analyst. That it is not primarily results from the general ignorance of the topic.

Occasionally, production data on some of OPEC's giant fields slips into public domain because of major investment projects that involve western firms. For instance, Iran is now embarked on a multi-billion dollar development of its offshore South Pars gas field, reputed to be the largest natural gas field in the world. Several of the phases of this giant project involve producing natural gas to be piped on-shore and then re-injected into some of its aging giant oilfields. Both the Agha Jari field and the Marun field will get access to this gas reinjection. Published data estimates that the daily production from these two fields, both of which once produced nearly one million barrels a day, are now in the 100,000 to 200,000 barrels per day range. This further confirms that Middle East giant fields do finally peak and decline. Until there is more field-by-field data made public by each OPEC producer, the world must simply guess when all the old Middle East giant fields will begin similar declines.

The issue of what these giant OPEC fields now produce, when these fields peak, and how much they decline is of extreme importance for the world's economic well being, and this should not be left in such obscurity. It is in the best interests of each OPEC country to begin sharing this field-by-field data with knowledgeable outside experts. If rapid field-by-field decline rates caught the majority of the North Sea producers by surprise, to think that any of the national oil companies in any OPEC country would be immune from a similar rude surprise is far-fetched. History has shown, time and time again, that hidden data rarely gets analyzed.

OPEC producers probably had solid reasons to create this obscurity around their individual production capacities two decades ago when the notion of any giant OPEC field experiencing a serious decline rate was remote. Today, this risk is no longer theoretical. It is already occurring in many old OPEC fields. It will happen at some point for every giant OPEC field. If field-by-field production data is published on a timely and reliable basis, enough analytical observation can occur to fend off a total surprise. It is OPEC's responsibility to begin furnishing the world with this detailed production data.

Publishing this data on a timely and highly visible basis would also help educate the world's energy planners on the heavy capital costs which most OPEC producers now face to keep their supplies in reliable shape. Defusing the myth that OPEC oil is almost free would help prop up OPEC oil prices to levels necessary to keep their supply in good shape and provide enough excess cash to support the steadily rising social costs each OPEC country faces. In my opinion, OPEC's constituents would all benefit from finally creating genuinely good and timely field-by-field production data. On the other hand, for OPEC to ignore the issue could become "wreckless behavior" to the well being of the global economies.

HOW MANY GIANT FIELDS ARE LEFT TO EXPLOIT?

Production declines must now be beginning to set in for many of the giant Middle East oilfields. There is ample anecdotal data to support this, though the extent of the problem and the field-by-field information is still totally unknown. This looming supply problem raises a key issue of the number of undeveloped massive fields countries like Saudi Arabia, Iraq, Iran, Abu Dhabi and Kuwait still have “on the shelf”, waiting for just the right time to begin production. Beyond these already discovered fields, how many potential new oilfields of massive size have yet to be found? Several of the Middle East countries still have vast areas that are still relatively unexplored. Even so, the few exploratory efforts over the past three or four decades have seldom found new fields close to the size of the early giant fields which still underpin almost all Middle East oil supply. Are there still many giant new fields to be found? Or have most of the true giants already been discovered? Has there ever been any serious debate on this topic?

There are clearly still some big fields being found. Iran recently discovered a new field, Azadegan, with over 25 billion barrels of oil in place. Estimated recovery rates are around 5 to 6 billion barrels. This is the largest oilfield found in Iran since 1964. Yet, this new giant is currently not expected to produce in excess of 300,000 to 400,000 barrels per day.

Early in 2001, Iran also announced the discovery of another very large offshore oilfield, Dasht-e Abadan. According to National Iranian Oil Company (NIOC) officials, this field could contain reserves “comparable” in size to Azadegan. But, no daily production estimates for this field have ever been disclosed.

Iraq has a multitude of fields that have never produced or fields that are in need of a massive rehabilitation. Its 15 billion barrel West Qurna field could potentially produce around 400,000 barrels per day. Its one billion barrel Rataw oilfield, its Majnoon field, which has an expected initial output of 300,000 barrels per day with later development yielding possibly 600,000 barrels per day or more and its Nahr Umar field with potential of producing around 400,000 to 500,000 barrels per day of light gravity crude are all great examples of new giant fields yet to be exploited. But all these projects are merely “on the drawing board,” awaiting the lifting of United Nations sanctions before beginning. In the meantime, Iraq’s Kirkuk field and the two Rumaila fields are old, badly overproduced and could soon decline as rapidly as the Western Siberian oilfields did after years of bad reservoir management.

Saudi Arabia apparently has over 70 fields discovered but yet to produce. (Some of these fields are likely already included in the list of Saudi’s current oilfields.) Aramco has been discussing plans to expand its Qatif field at a cost of \$1.5 billion. This would apparently raise Qatif’s field to a capacity of 500,000 barrels per day. The other major Saudi potential project is the rehabilitation of its Khurais field which could apparently

produce 800,000 barrels per day by 2005 at a cost of \$3 billion. Both projects are still in “drawing board” status.

In the meantime, Aramco’s 2002 budget calls for spending \$1.5 billion on development drilling, a 50% increase over its 2001 budget. This money will be spent on drilling 324 wells. Over half of the oil wells Aramco plans to drill, 125 of a total of 211 wells, will occur in its giant Ghawar field. These expenditures most likely only postpone further decline of Ghawar’s current production base.

Algeria has two new large oilfields under development. The Ourhoud field is expected to have peak capacity of 230,000 barrels per day by 2003 and Anadarko’s Ghadames field hopes to produce 300,000 barrels per day by the end of 2002.

Nigeria has several deepwater fields scheduled to come on stream over the next three to five years. None are expected to exceed 200,000 barrels per day.

There are scores of smaller projects planned in all the OPEC countries but few are likely to exceed 100,000 barrels per day. **IF** many of the genuine giant oilfields all begin to sharply decline at the same time, it will be hard to add enough new fields to grow daily OPEC supply.

Outside of OPEC, there are some other very large oil projects underway or in early planning stages. The Kashagan oilfield in Kazakhstan's portion of the Caspian Sea might become the largest non-OPEC field discovered since the Tengiz field. Some reports now estimate that Kashagan could have oil in place that exceed 20 billion barrels. So far though, only two wells have been drilled. Their reported cost is about \$100 million. The first well only flowed at 3,300 barrels per day, hardly a spectacular production rate by world standards. The field is not expected to begin initial production until after 2005. Until far more data is known, it is too early to pronounce Kashagan as a new genuine super giant field.

There are approximately 25 deepwater fields on the drawing board in the Gulf of Mexico coming on stream between the end of 2001 and 2005. One of these fields, BP's Crazy Horse, will have peak production of 250,000 barrels per day. Seven others will have peak production rates in the range of 100,000 barrels a day each. The remaining 17 deepwater Gulf of Mexico fields all fall under the 100,000 barrels per day "giant field base." Even in deepwater Gulf of Mexico fields, the belief that most big fields get found first seems to hold true still. Moreover, most of these Gulf of Mexico deepwater discoveries experience very rapid decline rates soon after they reach peak production. Declines of 20 to 25% per annum are not unusual.

West Africa has up to ten new giant deepwater fields now discovered. Several deepwater fields in Angola have production targets of 200,000 barrels per day or slightly

higher. None, thus far, are expected to exceed 250,000 barrels per day. Girassol is just beginning production at the end of 2001. Its peak output will be 200,000 barrels per day, and it is expected to remain above this level for at least four years. Then, like most Gulf of Mexico deepwater fields, it starts to decline.

While there are encouraging signs that many new oilfields are still being found, it is also worth noting that virtually all new oilfield projects involve capital expenditures in the billions of dollars. They also tend to take upwards of five to seven years to develop. Many of these new projects tend to peak rapidly. The days of giant fields which maintained huge production rates for decades seems to be at an end.

INDIVIDUAL OPEC COUNTRIES' OVERVIEWS

While there is no reliable field-by-field production statistics for any of the OPEC producers in total, there is enough scattered data on the total number of fields and estimates of total wells to at least guess at each country's production profiles. What this analysis shows is how reliant many OPEC producers now are on a handful of giant fields that make up a large percentage of the country's total production. If my list of OPEC's oilfields producing in excess of 100,000 barrels a day is complete, OPEC has about half or 59 of the world's giant oilfields. Collectively, these fields produce approximately 19 million barrels per day. Each OPEC producer is discussed below.

TABLE 9						
Key OPEC Producers						
(Excluding Indonesia, Nigeria and Venezuela)						
Country	Number of Identified Fields			CURRENT "GIANT" FIELD POPULATION		
	1979	1992	2000	Number of Fields	Est. Bbl/Day	Percent Total Production
Abu Dhabi	9	13	13	6	1,600	10%
Algeria	42	44	59	2	330	2%
Dubai	2	4	5	1	150	1%
Iran	36	39	41	11	2,000	13%
Iraq	14	21	20	5	2,450	15%
Kuwait	8	8	8	3	1,790	11%
Saudi Arabia	15	50	50	7	7,500	47%
TOTAL	126	179	196	35	15,820	100.00%

Source: International Petroleum Encyclopedia

SAUDI ARABIA

Various authorities acknowledge that eight of Saudi Arabia's largest fields contain over 80% of its proven reserves. Seven of these fields apparently now produce over 100,000 barrels per day. Ghawar is still the world's Super-Super Giant Field. It represents about 30% of Saudi's total proven reserves and has historically represented between 50 to as much as 70% of Saudi's daily production. For years, Safaniyah, the world's largest offshore oilfield, has held Saudi's second largest reserves. Safaniyah has also often been Saudi's second largest daily producer. As recently as the early 1990s, this field's daily production exceeded 1 million barrels a day. Current production estimates peg this field at around 500,000 barrels per day or less. Abqaiq, Berri, Zuluf and its new Shaybah field all produce in this same 500,000 barrel per day general range. The other Saudi field whose production seems to exceed 100,000 barrels per day is the Marjan field. Whether this captures all of Saudi's producing giant fields and whether the accuracy of these fields' production estimates are correct highlights how obscure Saudi and all other OPEC producers real supply situation is.

Saudi Arabia lists 49 known oilfields and another 28 gas fields. If Saudi's top seven fields account for over seven million of its total production, this implies that the other 42 Saudi oilfields, if all really produce, have average production rates of only 25,000 barrels per day per field. Many of these listed fields are probably either mothballed or have been discovered but not yet completed.

Saudi reportedly has less than 1,600 wells producing over eight- million barrels per day, making its average production per well over 5,000 barrels per day. Only Norway exceeds this well productivity. There have been no reported new oilfield discoveries in Saudi Arabia in the past decade.

In 2001, Saudi-Aramco will drill 246 wells, an increase of 50% over last year's drilling and double what was drilled in 1999. Their latest 2002 budget calls for drilling 324 wells at a total cost of \$1.5 billion. Many of these wells will be drilled in Ghawar, which suggests that this ultra-giant field is now in its early state of decline.

IRAN

In the late 1970's, Iran produced a peak of six million barrels a day. Its production now averages around 3.5 to 3.7 million barrels per day. Iran's offshore production accounts for over 600,000 barrels per day of its production. The balance of about 3 million barrels a day comes from a group of old, mature fields, most in the Khuzestan region near the Iraq border. Many of its key giant fields are now reported to be in serious states of decline as highlighted by the South Pars gas reinjection programs.

Iran has 41 producing fields. Five or six of fields, including Ahwaz-Bangestan, Agha Jari, Bibi Hakimeh, Marun and Gachsaran once produced close to one million barrels per day each. Today, these five fields collectively account for approximately 1.1 million barrels per day. Iran's has five main offshore fields. Doroud and Salman were apparently producing just over 100,000 barrels per day each several years ago. A new offshore field, Sirri, operated by Elf-Total, now produces just over 100,000 barrels per day. Two other older fields, the Nowruz and Soroush fields are currently being "rehabilitated" by Shell at a cost of \$810 million. These two fields will soon be producing 60,000 barrels per day. Peak production is expected in two years at just under 200,000 barrels per day.

There is no evidence that any of the other 35 fields have ever been true giant fields. Iran still has the second highest reported well productivity, averaging 3,200 barrels per active well in 1998.

IRAQ

Iraq has 20 producing fields. Its peak production occurred in 1989 when it briefly exceeded 3.5 million barrels per day. There are two giant fields in Iraq. The Kirkuk field, discovered in 1927, which was the second largest producing field in the world in 1971. It still produces approximately 900,000 barrels per day. Iraq's North and South Rumaila fields produce around 1.2 million barrels per day. This giant field (or fields) was discovered in 1953. Three other Iraqi fields are estimated to produce over 100,000 barrels per day include its Al-Zubair field (240,000 barrels per day), Bai Hassan field (200,000 barrels per day) and West Qurna (140,000 barrels per day).

If the production estimates are correct, Iraq's other 11 producing fields' average under 40,000 barrels per day per field. Iraq's average well productivity averages 1,250 barrels a day per well.

As previously noted, Iraq has a lengthy list of new fields to exploit or old fields to rehabilitate. But, none are currently active projects and daily production supply estimates could be either overly optimistic or too pessimistic.

KUWAIT

Kuwait has eight producing oilfields. Its giant Burgan field, discovered in 1938 still accounts for the majority of Kuwait's total production which averaged almost two million barrels per day in 2000. The Greater Burgan area has three distinct structures including Burgan, Magwa and Ahmadi. This was where most of the Kuwaiti wellheads were blown off when the Iraqis departed Kuwait in 1991. According to reports at the time, the individual wells were producing just over 4,000 barrels per well until the high-pressure wellheads were blown off. Without wellheads, these wells were letting over 20,000 barrels per day escape into the atmosphere until the fires could be put out and the wells re-capped. How many years of flush, choked back production this cost Kuwait will never be known but it is one reason why many now think Burgan has peaked and is in decline.

The other two fields that are believed to produce in excess of 100,000 barrels per day are the Sabriya and Raudhatin fields. Both have been in production for over 40 years.

NEUTRAL ZONE

There are five fields in this commonly owned territory between Saudi and Kuwait. The largest field is the Khafji field which produces an estimated 300,000 barrels per day. All five Neutral Zone fields produce around 550,000 barrels per day. The average per well production totals 1,040 barrels a day. Khafji was discovered in 1961.

UNITED ARAB EMIRATES (UAE)

Almost all of the UAE's daily oil production comes from Dubai and Abu Dhabi.

Collectively, this tiny nation has a productive capacity of about 2.5 million barrels a day and exports almost all this production. Abu Dhabi has 13 producing fields, while Dubai has five fields. The average well productivity is about 1,500 barrels a day per well.

Abu Dhabi's giant Bu Has a field produces about 450,000 barrels per day. Its Upper and Lower Zakum fields collectively produce about 800,000 barrels per day or 15% of the UAE's total production. Bab, Umm-Shaif and Asab are Abu Dhabi's other giant fields. Dubai's Fateh and Rashid fields account for almost all of its 315,000 barrels per day production. Both Dubai fields are now deemed to be in decline. The Zakum fields are planned to have a sizeable investment program to increase their productive capacity.

Abu Dhabi and Dubai's 19 oilfields produce about 2.4 million barrels per day from approximately 1,400 wells, making their average production about 1,600 barrels per well.

ALGERIA

Algeria has 59 oilfields which produce about 830,000 barrels per day. The average production per well totals 642 barrels per well. Algeria's Hassi Messaoud North and South fields, both of which were discovered in 1956, are believed to account for over 40% of the country's total production. If true, its other 57 fields have an average production of about 9,000 barrels per day per field.

Algeria's 59 fields have almost 1,300 wells, making the country's average production per well about 650 barrels per day.

VENEZUELA

Venezuela has almost 250 individual oilfields though several extremely old fields, all discovered over 70 years ago, still anchor 30% of its daily production of about 2.8 million barrels a day. These giants include two of the top ten fields in 1971 and one of the next ten largest fields. Laqunillas, its largest field, was discovered in 1925.

Bachaquero was discovered in 1930. Tia Juana was found in 1926. Cabimas was discovered in 1917. Collectively, these four fields produced over two million barrels a day in 1971 and still produce over 850,000 barrels a day. These fields are among the oldest producing oilfields of any significant size left in the world.

Venezuela has almost 15,000 individual oil wells, making it one of the smallest OPEC producers in terms of wellhead production of only 200 barrels per well each day.

Various senior PDVSA executives have regularly discussed the country's constant battle of fighting aggressive decline curves. At an OTC presentation in May 1999, an executive stated that the country has to bring on over 800,000 barrels a day of fresh supply to merely keep its 2.75 to 2.8 million barrels a day of production flat. Given the age of many Venezuelan fields, the rate of decline should be no surprise. Whether this is harbinger for other key OPEC producers is a serious question.

When the 10 Venezuela oilfields which produce over 100,000 barrels a day are deducted from the other 240 oilfields, this brings the remaining fields to an average production of only 7,000 barrels a day per field.

NIGERIA

Nigeria has a collection of the smallest individual oilfields of all the OPEC producers. Until a handful of deepwater fields are brought into production, there is no evidence that Nigeria has ever had a single field that produced over 100,000 barrels per day. In total, Nigeria has almost 150 individual fields which combine to enable Nigeria to produce approximately 2.1 million barrels a day.

About half Nigeria's fields still publish reports on their daily production. Collectively, these fields produce in excess of 1 million barrels a day. In 1998, the largest of these fields were Oso, Ubit, Assan and Meren. Together, these four fields average over 360,000 barrels per day with the largest producing 95,000 and the smallest producing 85,000 barrels per day. Most Nigerian oilfields produce 20,000 to 35,000 barrels per day. Nigeria's average well produces 940 barrels a day.

INDONESIA

Indonesia has the oldest and largest number of fields of any OPEC producer with over 300 individual oilfields. A handful of these have been in production for close to 100 years. Its two largest producing fields are Minas field and its Duri field. Each of which produce around 200,000 barrels per day. Both were discovered during World War II. Indonesia struggles to keep its production above 1.3 million barrels a day. Even though it consumes very little domestic oil on a per capita basis, its total domestic consumption now averages close to 70% of total production, making the country the smallest OPEC exporter.

In recent years, a proliferation of small new oilfields has enabled Indonesia to keep its production relatively flat, despite major declines in many of its old larger fields. The average production per well in Indonesia is about 150 barrels a day per well.

LIBYA

Libya has over 80 oilfields that collectively produce about 1.4 million barrels a day. Eight of these fields apparently produce almost one million barrels a day of this total. If true, this makes the daily production of the other 72 fields less than 6,000 barrels a day per field.

Most of Libya's larger fields were discovered in the 1950's and 1960's. Average well production about 950 barrels a day.

QATAR

Qatar is the smallest OPEC oil producer. Its Dukhan field, now over 60 years old, still produces almost 300,000 barrels per day, 40% of the country's total production. Two other fields produce just over 100,000 barrels per day each. Qatar has seven listed fields. Its average production per well is 1,666 barrels a day.

NON-OPEC GIANT FIELDS

18 Non-OPEC countries have the world's remaining population of about 60 other 100,000 barrel a day or greater oilfields. The key countries comprising this list are discussed below.

CHINA

China has the largest volume of oil produced by fields in excess of 100,000 barrels per day. The country's four giant fields still produce over 2.1 million barrels per day which represent two-thirds of China's total production. Its three largest fields account for over 90% of this total. All three fields were discovered in late 1959 to the early 1960's. All three fields have heavy water cuts estimated to average almost 90% of each well's daily output. China's average barrels per well production is one of the lowest in the world, averaging only 45 barrels per well each day.

MEXICO

Mexico has six giant fields that collectively produce over 2 million barrels per day. All are relatively new in terms of oilfield giants. It's largest field, Cantarell, is one of only five fields in the world that produce over one million barrels per day and is the youngest of the five.

All five of Mexico's giant fields lie in a tiny portion of its Gulf of Mexico boundary. All were found between 1976 and 1985. Over 90% of Mexico's portion of the Gulf of Mexico remains unexplored.

NORWAY

Norway has the largest number of fields producing over 100,000 barrels per day of oil outside OPEC. Its nine fields average just over 1.9 million barrels per day and represent 60% of Norway's total production. Most of these have now peaked. Three of the nine had production in excess of 500,000 barrels per day as recently as 1994 but now produce just over 200,000 barrels per day each. Norway might end up being the last country to discover a series of oilfields which produce over 500,000 barrels a day.

RUSSIA

The country outside of OPEC with the least public data on its field-by-field production is Russia, the second largest oil exporter in the world.

There is some published production data from all the oil production associations but none of them list production by each field they operate.

I am listing 10 individual Russian oilfields that likely produce over 100,000 barrels a day. A few of these might have fallen below the threshold. A few other fields might produce enough oil to be added to the list. But the additions would be small.

Only four of the Russian oil companies have total production in excess of 500,000 barrels per day, making it unlikely that the other 13 to 15 producers would have a single field whose production exceeds 20% of its total output.

Russia has over 700 individual oil and gas fields so the ten giant fields listed probably account for production totaling 1.8 million barrels a day, or 26% of Russia's current seven million barrels per day production. There is also relatively good data available on the number of producing wells each production association has. Lukoil has the highest daily production of 1,240,000 barrels per day and also the best output per well (60 barrels per day.) None of the world's giant fields produce only 60 barrels per day per well. Therefore, it is unlikely that Russia has scores of unidentified giant oilfields.

As recently as 1987, Russian oilfield production estimates were still being published. At the time, eleven individual oilfields produced half of Russia's total production. Samotlor accounted for almost 25% of Russia's total oil output. Since then, all these giant fields have suffered major production declines. There are good field-by-field Russian production statistics still available for as recently as 1994. At the time, nine individual fields had production over the 100,000 barrel a day hurdle.

My list of Russian "giant" fields is simply an educated guess, based on various published stories of large fields. Russia's ten largest oilfields account for over 1.8 million barrels a day of Russian production. Its largest producer is still Samotlor, the one Russian field that once produced in excess of 3.5 million barrels of oil each day. Samotlor's output occasionally gets mentioned in various oil journals. The last guess in print had Stamoltor producing 320,000 barrels per day. Almost all the Russian giant oilfields are located in Western Siberia. One giant oilfield outside Siberia is the Romashkino field in the Volga Region. Prior to Western Siberia's oil discoveries, this was Russia's single biggest oil field. It still apparently produces close to 300,000 barrels a day. All of these giant fields are far past peak production. All have high water cuts. Russia is not a low cost oil producer, even in its largest oilfield.

UNITED STATES OF AMERICA

Nine USA oilfields produce over 100,000 barrels per day. Collectively, they produced about 1.6 million barrels a day or 28% of total U.S. oil production. Three of these fields are located on the North Slope of Alaska. Another three are in the deepwater region of the Gulf of Mexico. Prudhoe Bay is still the largest producing field in America, though its daily production is now only one-third of what it averaged in 1989 when it peaked. The other three are the world's oldest remaining giant oilfields. All are located in California, an unlikely energy pioneer. These three fields have an average age of almost 100 years. Collectively, they still account for almost 30% of California's daily oil production.

THE OTHER NON-OPEC GIANT FIELDS

The remaining non-OPEC countries with one or more oilfields producing in excess of 100,000 barrels per day have a collective total of 20 fields of this size. Countries like Angola might soon top this list when all the discovered, but yet to be produced, deepwater fields come on-stream. The current distribution of fields found and in production that exceed this 100,000 barrels per day cut-off is small, highlighting once again how rare it has been to find an oilfield exceeding this size.

THE LIST OF THE KNOWN “GIANT FIELDS”

There has been little data published on field-by-field production on any constant basis over the past few years. Table 5 details the most recent data available for all the world’s oil fields that still produce in excess of 300,000 barrels per day.

The total population of every giant field is detailed in Appendix A. Collectively, these 120 fields account for over 32 million barrels a day of the world’s total oil production.

Appendix B shows the average age of these fields in descending order by volume of oil produced. As can be noted, the number of fields discovered from 1980 onward is remarkably small. The mere fact that the total production from these post-1980 giant oil fields is 4.5% of the world’s daily production and less than 10% of the production from all the giant fields found is remarkable, given the dazzling array of technical tools now available to find new oil reserves.

CONCLUSIONS

Oil remains the world's most important energy supply. It is the only energy source that creates almost all of the world's ability to transport people. There are few real energy substitutes even on the drawing board today if oil supply, for any reason, could no longer continue meeting the world's daily energy demands.

Over the past 30 years, a technological revolution occurred on how oil is found and produced. Far greater recovery rates of oil found are taking place. Oil, in parts of the world unheard of in 1970, now produce billions of oil barrels per year.

Despite these technical miracles, the world's oil supply is still highly dependent on a relatively small number of giant oilfields for our mainstay oil supply. Many of these giant fields are old. Some are very old. There is surprisingly little publicly available data on what many of these giant oilfields even produce. There is no data on which fields have now peaked, let alone data on the average production declines experienced by these giant fields each year.

Over the past few years there has been a growing debate on the reliability and probable cost of the world's future oil supply. One side of this important debate has argued that we are nearing peak production and the end of "cheap oil" is at hand. The other side has put forth the thesis that modern technology is creating an abundance or even glut of oil at an ever-lower cost.

The analysis of the world's giant oilfields circumvents both arguments. Instead, the analysis focuses on daily oil supply and the surprisingly small number of extremely large oilfields which still anchor a big percentage of this daily oil supply. For the past five decades, new giant oilfields discovered constantly produce ever-smaller daily volumes than older fields once did. The fact that giant oilfields also experience declines is not a thesis. Sadly, it is a fact.

This trend of ever-smaller fields might get a reprieve as scores of giant deepwater oilfields begin producing over the next five to seven years. Yet, most deepwater fields are still estimated to produce less than 200,000 barrels per day and many fall below the 100,000 barrel per day hurdle rate that defined "Giant Oilfields" in this report.

In the past decade alone, over 400 named oilfields were discovered. Only 12 of these fields now have production exceeding 100,000 barrels per day. The average production of all these new fields is unclear, as more than half of the new discoveries have no published data on their current output. The 200 plus fields with published data indicate production estimates average only 21,000 barrels per day.

A report in the most recent World Energy Outlook published by the International Energy Agency (IEA) in October 2001 forecast that as much as 61 million barrels a day of new oil supply needs to be discovered and be on production by 2010 if global oil demand grows by only 1.9% per annum. Two-thirds of production by this needed supply is

required to replace production declines assuming that the current oil production base declines by only 5% per annum.

Their 5% average decline is merely an estimate, given the age of so many of the giant oilfield described in this report. The average real decline rate the world will face between now and 2010 might be much higher.

If most new discoveries are still small fields, this implies a need for an exponential growth in the individual new fields discovered and developed as the future unfolds. If the average new field production size is still about 20,000 barrels per day, this implies the need to discover over 3,000 new fields by 2010. This volume of new fields is over seven times the amount of new fields found over the past ten years.

There is no question that a serious amount of our daily oil supply comes from a small number of fields. There is no question that most of these fields are all old. There should be no debate as to the need for far better and timely published reports for what all large fields really produce. It would be comforting to think that the availability of such data would then lead to some solid analyses of the potential decline rates these giant oilfields will likely experience.

Until such data is forthcoming, the accuracy of all future oil supply forecasts has to be somewhat suspect.

If many of today's giant oilfields are now in decline, or are soon to reach this stage, a surge in new field development needs to begin quickly. If most new fields also tend to be ever smaller than those found over the last two decades, the pace of exploration and rapid field development grows ever higher.

The single biggest future need to insure a reliable continuation of the world's oil supply is not any new forms of technology. Rather it is good data on the production and decline profiles of the world's small population of giant oilfields.

APPENDIX A

LIST OF THE WORLD'S GIANT OILFIELDS

Country	Field Name	Date Of Discovery	2000 Production (¹ 000/Day)
Saudi Arabia	Ghawar	1948	4,500 ¹
Mexico	Cantarell	1976	1,211
Kuwait	Burgan	1938	1,200 ¹
China	Daquig	1959	1,108
Iraq	Kirkuk	1927	900
Iraq	Rumailia North	1958	700 ¹
Saudi Arabia	Abqaiq	1940	600 ¹
Saudi Arabia	Shayba	1975 ¹	600 ¹
U.S.A.	Prudhoe Bay	1968	550
China	Shengli	1962	547
Brazil	Marlim	1985	530 ¹
Iraq	Rumailia South	1953	500 ¹
Saudi Arabia	Safaniyah	1951	500 ¹
Saudi Arabia	Zuluf	1965	500 ¹
Abu Dhabi	Bu Hasa	1962	450 ¹
Abu Dhabi	Zakum – Lower	1963	400 ¹
Abu Dhabi	Zakum – Upper	1963	400 ¹
Saudi Arabia	Berri	1964	400 ¹
Russia	Samotlor	1961	320 ¹
Norway	Ekofisk	1971	310
Columbia	Cusiana	1988	300 ¹
Iran	Gachsaran	1937	300 ¹
Iran	Ahwaz Bangestan	1958	300 ¹
Neutral Zone	Khafji	1961	300 ¹
Russia	Romashkino	1948	300 ¹
Venezuela	Cabimas	1917	300 ¹
China	Liaohe	1964	291
Qatar	Dukhan	1940	282
Abu Dhabi	Bab	1958	260 ¹
Norway	Troll (I & II)	1979	260
Venezuela	Bachaquero	1930	260 ¹
Mexico	Ku	1979	255
Malaysia	Tapis	1975	250 ¹
Saudi Arabia	Marjan	1967	250 ¹
Norway	Snorre	1979	240
Abu Dhabi	Asab	1965	230
U.S.A.	Kuparuk River	1969	220
Norway	Draugen	1984	215
Khazakastan	Tengiz	1979	214
India	Bombay High	1974	210
Abu Dhabi	Umm-Shaif	1958	210 ¹
Norway	Oseberg	1979	205
Brazil	Roncador	1996	200 ¹
Indonesia	Duri	1941	200 ¹
Indonesia	Minas	1944	200 ¹
Iran	Agha Jari	1936	200 ¹
Iran	Marun	1963	200 ¹
Iraq	Bai Hassan	1953	200 ¹
Kuwait	Raudhatain	1955	200 ¹
Libya	Sarir	1961	200 ¹
Russia	Tevlin-Russkin	1971 ¹	200 ¹
Russia	Vatyegan	1970 ¹	200 ¹
Venezuela	Lagunillas	1925	200 ¹
Venezuela	Santa Barbara	1941	200 ¹
Venezuela	Mulata	1942	200 ¹
Mexico	Caan	1985	185
Norway	Gullfaks	1978	185
Algeria	Hassi Messaud - South	1956	182
China	Xinjiang	1993 ¹	181

¹ Estimate.

APPENDIX A (Continued)

LIST OF THE WORLD'S GIANT OILFIELDS

Country	Field Name	Date Of Discovery	2000 Production (¹ 000/Day)
Egypt	Belayim	1953	181
Iran	Karanj	1961	180 ¹
Norway	Statfjord	1974	175
Norway	Heidrun	1985	170
Brazil	Albacora	1986	160 ¹
Russia	Lyantor	1966 ¹	160 ¹
Yemen	Camaal	1991	160 ¹
Dubai	Fatih	1966	150
Iran	Salman	1964	150 ¹
Iraq	Al-Zubair	1938	150 ¹
Kuwait	Sabriya	1957	150 ¹
Malaysia	Guntong	1978	150 ¹
Norway	Norne	1992	150
Russia	Fedorov	1971 ¹	150 ¹
U.S.A.	Ursa	1991	150
Yemen	Alif	1984	149
Algeria	Hassi Messaud - North	1956	148
Mexico	Chuc	1985	146
Iraq	West Qurna	1974	140 ¹
U.S.A.	Mars	1989	140
Equatorial Guinea	Zafiro	1995	135
Libya	El Shahraral	1988	135
Angola	Takula	1971	131
Canada	Hibernia	1978	130
Iran	Doroud	1961	130 ¹
Iran	Faroozan	1966	130 ¹
Mexico	Abkatun	1978	126 ¹
Russia	Mamontov	1965 ¹	125 ¹
Iran	Bibi Hakimeh	1961	120 ¹
Venezuela	Petrozuata	1991	120
Oman	Nimr	1980	111
Azerbaijan	Chirag	1990 ¹	110 ¹
Oman	Yibal	1963	110
Libya	Bu Attifel	1968	108
Qatar	Al-Shaheen	1994	107
Venezuela	Cerro Negro	1980	105
Mexico	Pol	1979	104
Qatar	Idd Ed Shardi	1960	104
Angola	Chinkuito	1998	100
Denmark	Dan	1983	100
Egypt	October	1978	100 ¹
Iran	Mansuri	1963	100 ¹
Libya	Defa-waha	1959	100 ¹
Libya	Nasser	1959	100 ¹
Libya	Gialo	1961	100 ¹
Libya	Messia	1971	100 ¹
Russia	Urdaneta Oest	1955	100 ¹
Russia	Sutormin	1975 ¹	100 ¹
Russia	Povkhov	1975	100 ¹
U.S.A.	Kern River	1899	100 ¹
U.S.A.	Belridge South	1911	100 ¹
U.S.A.	Midway-Sunset	1884	100 ¹
U.S.A.	Auger	1996	100
U.S.A.	Alpine	1999	100
Venezuela	Tia Juana	1926	100 ¹
Venezuela	Lamar	1958	100 ¹
Venezuela	El Furrial	1986	100 ¹
Total Production			32,361

¹ Estimate.

APPENDIX B

AGE OF THE WORLD'S GIANT OILFIELDS

Country	Field Name	Date Of Discovery	2000 Production (¹ 000/Day)
U.S.A.	Midway-Sunset	1884	100 ¹
U.S.A.	Kern River	1899	100 ¹
U.S.A.	Belridge South	1911	100 ¹
Venezuela	Cabimas	1917	300 ¹
Venezuela	Lagunillas	1925	200 ¹
Venezuela	Tia Juana	1926	100 ¹
Iraq	Kirkuk	1927	900
Venezuela	Bachaquero	1930	260 ¹
Iran	Agha Jari	1936	200 ¹
Iran	Gachsaran	1937	300 ¹
Iraq	Al-Zubair	1938	150 ¹
Kuwait	Burgan	1938	1,200 ¹
Qatar	Dukhan	1940	282
Saudi Arabia	Abqaiq	1940	600 ¹
Indonesia	Duri	1941	200 ¹
Venezuela	Santa Barbara	1941	200 ¹
Venezuela	Mulata	1942	200 ¹
Indonesia	Minas	1944	200 ¹
Russia	Romashkino	1948	300 ¹
Saudi Arabia	Ghawar	1948	4,500 ¹
Saudi Arabia	Safaniyah	1951	500 ¹
Egypt	Belayim	1953	181
Iraq	Bai Hassan	1953	200 ¹
Iraq	Rumailia South	1953	500 ¹
Kuwait	Raudhatain	1955	200 ¹
Russia	Urdaneta Oest	1955	100 ¹
Algeria	Hassi Messaud - North	1956	148
Algeria	Hassi Messaud - South	1956	182
Kuwait	Sabriya	1957	150 ¹
Abu Dhabi	Bab	1958	260 ¹
Abu Dhabi	Umm-Shaif	1958	210 ¹
Iran	Ahwaz Bangestan	1958	300 ¹
Iraq	Rumailia North	1958	700 ¹
Venezuela	Lamar	1958	100 ¹
China	Daquig	1959	1,108
Libya	Defa-waha	1959	100 ¹
Libya	Nasser	1959	100 ¹
Qatar	Idd Ed Shardi	1960	104
Iran	Bibi Hakimeh	1961	120 ¹
Iran	Karanj	1961	180 ¹
Iran	Doroud	1961	130 ¹
Libya	Gialo	1961	100 ¹
Libya	Sarir	1961	200 ¹
Neutral Zone	Khafji	1961	300 ¹
Russia	Samotlor	1961	320 ¹
Abu Dhabi	Bu Hasa	1962	450 ¹
China	Shengli	1962	547
Abu Dhabi	Zakum – Lower	1963	400 ¹
Abu Dhabi	Zakum – Upper	1963	400 ¹
Iran	Mansuri	1963	100 ¹
Iran	Marun	1963	200 ¹
Oman	Yibal	1963	110
China	Liaohu	1964	291
Iran	Salman	1964	150 ¹
Saudi Arabia	Berri	1964	400 ¹
Abu Dhabi	Asab	1965	230
Russia	Mamontov	1965 ¹	125 ¹
Saudi Arabia	Zuluf	1965	500 ¹

¹ Estimate.

APPENDIX B (Continued)
AGE OF THE WORLD'S GIANT OILFIELDS

Country	Field Name	Date Of Discovery	2000 Production (¹ 000/Day)
Dubai	Fatih	1966	150
Iran	Faroozan	1966	130 ¹
Russia	Lyantor	1966 ¹	160 ¹
Saudi Arabia	Marjan	1967	250 ¹
Libya	Bu Attifel	1968	108
U.S.A.	Prudhoe Bay	1968	550
U.S.A.	Kuparuk River	1969	220
Russia	Vatyegan	1970 ¹	200 ¹
Angola	Takula	1971	131
Libya	Messia	1971	100 ¹
Norway	Ekofisk	1971	310
Russia	Tevlin-Russkin	1971 ¹	200 ¹
Russia	Fedorov	1971 ¹	150 ¹
India	Bombay High	1974	210
Iraq	West Qurna	1974	140 ¹
Norway	Statfjord	1974	175
Malaysia	Tapis	1975	250 ¹
Russia	Sutormin	1975 ¹	100 ¹
Russia	Povkhov	1975	100 ¹
Saudi Arabia	Shayba	1975 ¹	600 ¹
Mexico	Cantarell	1976	1,211
Canada	Hibernia	1978	130
Egypt	October	1978	100 ¹
Malaysia	Guntong	1978	150 ¹
Mexico	Abkatun	1978	126
Norway	Gullfaks	1978	185
Khazakastan	Tengiz	1979	214
Mexico	Ku	1979	255
Mexico	Pol	1979	104
Norway	Oseberg	1979	205
Norway	Snorre	1979	240
Norway	Troll (I & II)	1979	260
Oman	Nimr	1980	111
Venezuela	Cerro Negro	1980	105
Denmark	Dan	1983	100
Norway	Draugen	1984	215
Yemen	Alif	1984	149
Brazil	Marlim	1985	530 ¹
Mexico	Caan	1985	185
Mexico	Chuc	1985	146
Norway	Heidrun	1985	170
Brazil	Albacora	1986	160 ¹
Venezuela	El Furrial	1986	100 ¹
Columbia	Cusiana	1988	300 ¹
Libya	El Shaharal	1988	135
U.S.A.	Mars	1989	140
Azerbaijan	Chirag	1990 ¹	110 ¹
U.S.A.	Ursa	1991	150
Venezuela	Petrozuata	1991	120
Yemen	Camaal	1991	160 ¹
Norway	Norne	1992	150
China	Xinjiang	1993 ¹	181
Qatar	Al-Shaheen	1994	107
Equatorial Guinea	Zafiro	1995	135
Brazil	Roncador	1996	200 ¹
U.S.A.	Auger	1996	100
Angola	Chinkuito	1998	100
U.S.A.	Alpine	1999	100
Total Production			32,361

¹ Estimate.