News Focus

New forecasts see a welcome easing of current tight oil supplies, but within a decade production outside OPEC will likely stall, they say, placing the burden on Middle East countries that may be unable or unwilling to respond fast enough.

Bumpy Road Ahead For World’s Oil

The oil business is nothing if not cyclical. Since 1859, when American Edwin Drake began drilling instead of digging for oil, petroleum has been boom or bust. Oil would gush from a newfound province such as east Texas, drillers would rush in, fortunes were made, oil markets became flooded, and prices plunged. But inevitably, the gushing would slow, rising demand would sop up the excess oil, and prices would rise, prompting fears of a permanent shortfall. Then the next big find—west Texas, Saudi Arabia, or the North Sea—would pop up and set off a new gyration as new drilling projects come online in the next few years, juicing supplies and depressing the price of oil yet again. Then, according to forecasts by major oil companies and private consulting firms, the growth of oil production outside the 11 nations of the Organization of the Petroleum Exporting Countries (OPEC) will slow to a stop. Past 2015, OPEC, and especially four or five countries of the Middle East, will be left to slake the world’s growing thirst for oil, currently running at almost 1000 gallons a second.

The prospect of a plateau in non-OPEC oil production only a decade away worries many observers. “The problem is we really don’t know” the true reserves still in the ground in most OPEC countries, says petroleum analyst Michael Rodgers of PFC Energy, a consulting company in Washington, D.C. And even if the oil is there, importing countries have little more than a verbal promise that OPEC will make the Herculean effort to extract enough of that oil fast enough to meet growing demand. “We’ve got a real problem in 2 to 3 decades for oil,” says geologist Thomas Ahlbrandt, who headed the U.S. Geological Survey’s (USGS’s) 2000 world oil assessment out of the Denver office. Coincidentally, 20 or 30 years is about how long it would take a determined United States to rein in its consumption and develop sufficient alternatives to crude oil (see sidebar, p. 1107).

Imminent doom?

High prices at the gas pump have made the fate of the world’s oil supply a hot topic of late, but for aficionados, such concerns are not new. Some oil analysts—primarily geologists retired from major oil companies—have long been arguing that there isn’t enough oil left in the planet to continue pumping out ever more barrels to meet the world’s ever-growing demand (Science, 21 August 1998, p. 1128), which now stands at about 30 billion barrels a year.

These “peakists” have predicted that the world’s total oil production would very soon reach a maximum and begin a sharp decline. Production from individual fields inevitably peaks, they note. Drillers punch into the biggest, easiest-to-produce pools of oil first and pump them out as fast as they can, at least if politics does not constrain the drillers. Production soars until pumping oil from the porous rock becomes a bit like trying to suck a sponge dry through a straw, and oil flow plummets. Whole provinces and even continents have behaved the same way, they note. Production from the lower 48 states of the United States peaked in 1970, as did the United States as a whole, and North Sea production peaked within the past few years, just 30 years after it began.

Peakists see the world oil peak coming within the next decade or so. The late M. King Hubbert of USGS observed that production of natural resources seems to reach a maximum when about half of all the resource that could ever be extracted has been produced. He then nailed the timing of the lower-48 peak 15 years before it occurred. Armed with production records and an estimate of the world’s so-called ultimate recoverable resource, geologist Kenneth Deffeyes, a professor emeritus at
Princeton University, finds that the world peak will come before 2009. Leading peak-ist and retired oil company geologist Colin Campbell of Ballydehob in County Cork, Ireland, puts it before the end of this decade. Others say certainly by 2015 or 2020. The differences arise in part from the way different analysts emulate Hubbert’s methods, but most stem from different numbers for the world’s ultimate recoverable resource.

A brief sigh of relief
Oil production outlooks from a variety of organizations take a quite different view of the immediate future, at least, and oil geology has nothing to do with it. World outlooks from consultants PFC Energy and Cambridge Energy Research Associates (CERA) in Cambridge, Massachusetts, and from major oil companies such as ExxonMobil Corp. and Royal Dutch Shell generally begin by surveying what drilling projects both private and national oil companies have in the works. Ignoring anything as grand as ultimate recoverable resources, they look at individual projects already under construction, firmly planned projects, and known fields being evaluated for their production potential and likely to be developed. From such surveys, analysts estimate how much new world production will likely come on line in the next 5 to 8 years.

But from this added production, analysts must subtract how much less older, “mature” fields will be producing as they reach the descending side of the production peak. On balance, “global oil production capacity is actually set to increase dramatically over the rest of this decade,” reported geologists Peter Jackson of CERA’s London office and Robert Esse of the New York office in their June study. Other recent studies broadly concur. If deepwater projects such as those off Brazil and West Africa move ahead at all the way expected, says Rodgers of PFC Energy, the current tight supply situation could ease, oil supply would once again comfortably exceed demand, and oil prices would drop.

The coming squeeze
Project-by-project analysts may see an improved world supply in the short term, but as they look farther out, they see a possible problem. At 5 to 10 years in the future, additional factors loom large. The rate at which production declines in aging fields becomes particularly important outside OPEC, Rodgers says. Often, 3% per year has been cited as a typical depletion rate. But for particularly mature regions—those outside OPEC and the former Soviet Union (Russia and the Caspian Sea region)—production has not increased since 1998, he notes. Judging by the amount of capacity added since then to avoid any production decline, depletion rates in mature regions must be not 3% but 5% to 8% per year, says Rodgers.

In addition to depletion rates, analysts must estimate how much more oil than expected will be recovered from existing fields. Typically, only about 35% of the oil filling the cracks and pores of a reservoir can simply be pumped out. But advanced extraction techniques such as flooding the reservoir with water to push oil out can sometimes raise recovery rates to 50% and more. Drillers can also find more oil than initially assumed to be in and around a field by using increasingly sophisticated seismic imaging technology. And then analysts

If Not Cheap Oil ...

When the amount of oil being pumped around the world maxes out sometime in the next 30 years or so (see main text), we will need an alternative to tens of millions of barrels of oil per day. At an October workshop sponsored by the U.S. National Academies, though, experts on the leading alternatives made plain that even all the practicable substitutes combined won’t be ready in 25 years to make up for a major shortfall.

Heavy oil—Some crude oil is too viscous to flow easily into a well on its own. Typically, pumping in steam “converts peanut butter into ketchup,” said Robert Heinemann of Berry Petroleum Co. of Bakersfield, California. Currently, about 3 million barrels of heavy oil are produced per day. If the price is right, Heinemann said, heavy oil production might double in the next 10 years.

Oil sands—In Alberta, Canada, humongous steam shovels gouge out 100 tons of oily sand from the land at a time, eventually yielding 50 barrels of oil per shovelful. Steam injected into deep oil sand beds can also free up the oil for pumping. But the arduous and environmentally challenging extraction of oil from sand means that despite Alberta’s abundant sands, only 3 million barrels per day may be produced in 2020, said Eddy Isaacs of the Alberta Energy Research Institute in Calgary.

Coal—Yes, coal could fuel your car. Friedrich Bergius proposed the first process for converting coal’s big, heavy organic molecules into short chains of carbon and hydrogen in 1912. Germany fueled its Luftwaffe from coal during World War II. But David Gray of Mitretek Systems in Falls Church, Virginia, guessed that it would take oil prices consistently above $50 per barrel to get production from coal up to 4 million barrels per day by 2030.

Natural gas—Trucks and buses already run on natural gas, but to ease international transportation of gas and to concentrate its energy, its single-carbon molecules can be chemically joined to form long-chain hydrocarbons, mostly a diesellike product. ExxonMobil is helping build a gas-to-liquids plant in the Persian Gulf nation of Qatar, Emil Jacobs of ExxonMobil in Annandale, New Jersey, said at the workshop. No other site has yet proven commercially viable. When pressed, Jacobs allowed that gas to liquids might yield half a million barrels of oil per day by 2015.

Conservation—John Heywood of the Massachusetts Institute of Technology in Cambridge noted that efficiency increases for U.S. cars have been entirely countered in the marketplace by the American predilection for bigger, heavier cars. And major steps up in efficiency with clean conservation—

Nonstarters—Some energy sources will be of little or no use when the peak comes. Nuclear, wind, and solar do not produce liquid fuels. Liquids such as ethanol from biomass are not yet firmly economic. Oil from organic-rich shale won’t be commercial for a decade or two, if then. Hydrogen for fuel cells would likely take half a century to have a substantial effect.

—R.A.K.
must predict how many wholly new fields will be discovered, a procedure fraught with uncertainty.

Despite a range of methodologies, many production forecasts are now calling for a peak in the 2010s in oil production outside of OPEC. By 2015 or so, they indicate, non-OPEC producers—who supply 60% of the world’s needs and boosted their output 35% during the past 25 years—will no longer be able to increase production. The ExxonMobil outlook, for example, has non-OPEC crude oil production reaching a plateau by 2010, holding steady for about a decade, and then declining. “Non-OPEC does plateau over time,” says ExxonMobil’s Scott Nauman of the Irving, Texas, office. “That’s a reflection of the maturity of areas like the U.K. and the U.S.” PFC Energy agrees. “Even if you make very optimistic assumptions,” says David Greene of Oak Ridge National Laboratory in Tennessee, who has done such an analysis, “you come out with [an] … oil peak outside of OPEC in the not-too-distant future.”

The big one?
If more than half of the world’s oil production is going to peak within a decade, “that has real implications for countries requiring huge imports to keep their economies running,” says Rodgers. “Frankly, I think it’s dangerous for the U.S. to bank on OPEC always being there to fill the gap.” Just how dangerous a looming reliance on OPEC is depends on how soon you think OPEC’s, and thus the world’s, oil production is going to max out.

With the longer outlook comes greater uncertainty. Campbell has the OPEC and world peaks in this decade. While cautioning that the necessary data from OPEC countries are uncomfortably scarce, Rodgers and his PFC Energy team also calculate a relatively early OPEC/world peak. In part, they work from their observation that a country’s production tends to peak and begin to decline when the total amount of oil ever produced from that country reaches 55% or so of all the oil yet reliably found there, called cumulative reserves. (This Hubbertian-sounding approach substitudes the more reliably determined cumulative reserves for ultimate recoverable resource.) Drawing on the available production and reserves data for OPEC countries, they find that—depending on how fast world demand for oil grows—OPEC and thus world production could peak as early as 2018 or as late as 2025.

Other analysts, perhaps most analysts, are more sanguine about OPEC’s oil bounty. They generally argue that OPEC countries have not been exploiting their oil riches the way Americans have theirs, so OPEC production needn’t behave like that of the United States. Ahlbrandt of USGS points out that, unlike North America, the Middle East is seriously underexplored. There are only 7000 wells in the whole region, he notes, a number equaled by the total wells in a few counties in a single U.S. oil basin. The 2000 USGS study he headed finds abundant OPEC oil—oil known to exist in reserves, likely to be found in and around existing fields, and likely to be discovered in new fields. Peakists, however, argue that some reserves are not as large as claimed and that additions to reserves from known fields will not be as large as they have been.

The latest studies by the U.S. Energy Information Administration (EIA) and by the Paris-based International Energy Agency combine the USGS numbers with expected price trends and with demand for oil, demand being a bit of a wildcard in any outlook. Both studies project rising world production out to 2025, which is as far as they looked. And using the field-by-field approach, the CERA study finds no OPEC peak before 2020, the farthest it looks, and the ExxonMobil study none before 2030. “There’s no way we’ll see a [world] peak in oil production for decades,” says ExxonMobil’s Nauman.

Assurances that the world will not soon run short of oil come with a caveat. OPEC countries may well have plenty of oil in the ground, but “we can’t guarantee that the Saudis, the Iranians, and the Iraqis will spend sufficient funds and time to [ensure] demand will be met by growing supply,” says Nauman. Presumably, OPEC countries will make the needed investments, the reasoning goes, or else they would lose oil sales to conservation, more expensive but more reliable sources such as Canadian oil sands, and alternative fuels.

OPEC certainly insists that it will come through for oil-consuming nations. OPEC acting secretary general Adnan Shihab-Eldin told a U.S. National Academies workshop last month in Washington, D.C., that OPEC will expand its production capacity to 38 million barrels per day by 2025, thus keeping supply “well above demand.”

Far-future OPEC production is where politics and economics may prevail over geologic endowment. In its long-term projections, the U.S. EIA simply assumes that because OPEC countries have the oil, they will pump enough of it to fill the gap between future demand and non-OPEC capacity. In the case of Iraq, the latest EIA outlook has the Iraqi oil industry—now struggling to produce 2 million barrels a day—tripling its current production and achieving twice its highest previous production by 2025. At the same time, EIA concedes that OPEC countries would make more money in the long run by producing less than consuming countries demand but selling it at a higher price.

Too late already?
“We know a peak is coming,” Robert Hirsch of SAIC Inc. in Arlington, Virginia, said at the academies workshop, “but we really don’t know when.” A peak a quarter-century away, however, would be uncomfortably soon for Hirsch. Peaks tend to sneak up on analysts, he notes. Even if a consensus on peak timing develops, “there will be no quick fixes,” Hirsch found in a study he did for the U.S. Department of Energy this year.

Hirsch considered technologies for replacing crude oil that are ready or nearly ready for commercial use. He assumed 3 to 5 years to get crash programs up and going and optimistic rates of expansion of each program. Still, unless the crash programs were begun 20 years before the peak, shortages would occur. If they weren’t begun until the peak arrived, “major shortages persisted a very long period of time,” said Hirsch. “The downside of the optimists being wrong is dire.”