



Peak Oil Production May Already Be Here

Outside of OPEC's vast resources, oil production has leveled off, and it's looking like it may never rise again

FIVE YEARS AGO, MANY OIL EXPERTS SAW trouble looming. In 10 years or so, they said, oil producers outside the Organization of the Petroleum Exporting Countries (OPEC) would likely be unable to pump oil any faster (*Science*, 18 November 2005, p. 1106). Non-OPEC oil production would peak, no matter the effort applied. All the high-technology exploration and drilling, all the frontier-pushing bravado of the oil industry would no longer stave off the inevitable as OPEC gains an even stronger hand among the world's oil producers.

Five years on, it appears those experts may have been unduly optimistic—non-OPEC oil production may have been peaking as they spoke. Despite a near tripling of world oil prices, non-OPEC production, which accounts for 60% of world output, hasn't increased significantly since 2004. And many of those same experts, as well as some major oil companies, don't see it increasing again—ever. In their view, it's stuck on a flat-topped peak or plateau at present levels of production for another decade or so before starting to decline. “Stable [non-OPEC] production is

the best we can hope for,” says energy economist Robert Kaufmann of Boston University. “I have trouble seeing it increase more. It's a wake-up call.”

Optimists remain. Some experts still see production from new frontiers, such as Kazakhstan, the deep waters off Brazil, and the oil sands of Canada, pushing production above the current plateau in the next few years. But time's running out to prove that newly discovered fields and new technology can more than compensate for flagging production from the rapidly aging fields beyond OPEC.

Running to stay in place

There's no debate about the reality of the 6-year-and-counting plateau of non-OPEC production. Output stagnated at about 40 million barrels a day beginning in 2004 after rising from an earlier plateau in the early 1990s, one induced by a low price for oil. But prices have been anything but low lately. They have gone from about \$35 a barrel early in the past decade to double and nearly triple that. Normally, higher prices would encourage more production, but not this time. Since 2004,

The hard way. Depletion of conventional oil fields outside of OPEC is driving the mining of oil sands in Alberta, Canada.

“there's been a tremendous increase in price, yet this is all we get for it, stable production,” Kaufmann says. “It's quite stark.”

The problem up to this point, all agree, has been increasing difficulties extracting conventional oil. That's the easiest oil to get at, oil that freely flows out of a well of its own accord or with a minimum of encouragement, such as pumping it out or pushing it out with water. Production of conventional oil from any one well or field typically increases, peaks, and then goes into decline. Larger producing regions behave the same way. Production from the United States, once the world's largest oil producer, peaked in 1970 as rising output from newly discovered fields failed to compensate for declines in old fields. Mexico's production peaked in 2004 as its huge, aging Cantarell field went into steep decline. North Sea production peaked in 1999, just 28 years after starting up.

The same pattern now seems to be emerging across much of the world. “We believe—and pretty much everybody else believes—that non-OPEC [conventional] production has plateaued,” says oil analyst Michael Rodgers, a partner with PFC Energy in Kuala Lumpur. “Arguing that you're going to get continued and sustained growth of conventional oil is a very hard case to make.” PFC Energy has just done a complete reassessment of the prospects for non-OPEC conventional production, he says. As in most oil outlooks, a country-by-country or even field-by-field survey of what producers are planning for the next 5 to 10 years was combined with an educated guess of how much oil remains to be discovered in each region.

That forecast of added production is balanced against how fast production from existing fields is declining. In the past decade, analysts have realized that rather than the 2% to 3% per year decline once assumed, production from existing fields is declining 4% to 5% per year. Some believe the depletion is even faster. The balance between added and declining production, in the PFC Energy assessment, is a plateau, though the plateau may undulate from year to year. “You

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bring on a [new] 100,000-barrel-a-day field,” Rodgers says, “and somewhere else you’ve lost a 100,000-barrel-a-day field.”

Tough oil to the rescue?

But what about unconventional oil, the hard-to-get-at oil that’s only extractable using the latest in high technology? There’s the oil beneath kilometers of seawater far offshore of the U.S. Gulf Coast, Brazil, and West Africa. It wasn’t reachable until development of the necessary deep-water drilling and production technology. There is also the oil—more like tar—that is so viscous that steam must be piped underground to thin it before pumping it out. In Alberta, Canada, huge shovels just dig up the “oil sands” so it can be trucked to oil-extraction plants. And American drillers have lately taken to drilling into rock formations that would normally only dribble oil and fracturing the rock with high-pressure fluids in order to wrest worthwhile amounts from the rock. That’s how drillers have been “fracking” stingy natural gas formations (*Science*, 25 June 2010, p. 1624).

Such unconventional oil is out there in abundance, everyone agrees, and more will be produced than in the past. However, some major oil companies as well as other analysts don’t see unconventional oil boosting non-OPEC production much in the next 20 years. In their most recent annual energy outlooks to 2030, both ExxonMobil and BP—two of the world’s largest independent oil companies—forecast that non-OPEC production will more or less hold its own, no better. “It’s quite an accomplishment to keep non-OPEC supply flat level,” says analyst Kyle Countryman, who as a member of ExxonMobil’s energy and economics group in Dallas, Texas, helped put the outlook together. Adds his colleague, group manager Robert Gardner: “We’re not optimistic we’ll see a significant increase in unconventional liquids.”

The problem with unconventional oil is that, by definition, it is hard to extract. “It’s a matter of timing,” Gardner says. “It depends on the pace of technology development.” And even after the essential technology is developed, unconventional oil will still be difficult—as well as expensive—to extract, limiting the rate at which it can be produced. All in all, “technology matters, economics matters, but geology really does matter,” says oil analyst David Greene of the U.S. Department of Energy’s Oak Ridge National Laboratory in Tennessee. “Progress in technology is not fast enough to keep up with depletion” of oil reservoirs. Oil analyst Richard Nehring of Nehring Associates in Colorado Springs, Colorado, is more optimistic about prospects

on oil’s frontiers and how fast some kinds of unconventional oil can be brought online, but he still finds that “non-OPEC will be stable or at the very best slowly increasing” over the next couple of decades.

Optimism not dead

“We’re a little more bullish about non-OPEC than some others,” says Peter Jackson of Cambridge Energy Research Associates (CERA) in London. Along with the U.S. Energy Information Agency (EIA), CERA sees real promise in underdeveloped oil provinces such as offshore Brazil and Kazakhstan. Likewise, if prices stay high, unconventional oil will contribute substantially, both find, especially the Canadian oil sands. Beyond the next few years, “we’re seeing a gradual increase in non-OPEC supply,” Jackson says.

Such optimism has not always served forecasters well. In 2005, Jackson and his CERA colleague Robert Esser of the New York office predicted that “global oil production capacity is actually set to increase dramatically” up to 2010. It didn’t; both OPEC and non-OPEC oil production remained steady. Likewise, in its 2005 outlook, EIA projected a jump in non-OPEC production by 2010 if prices were high, which they mostly were. But 2010 production was about 40 million barrels per day, right where it was in 2005.

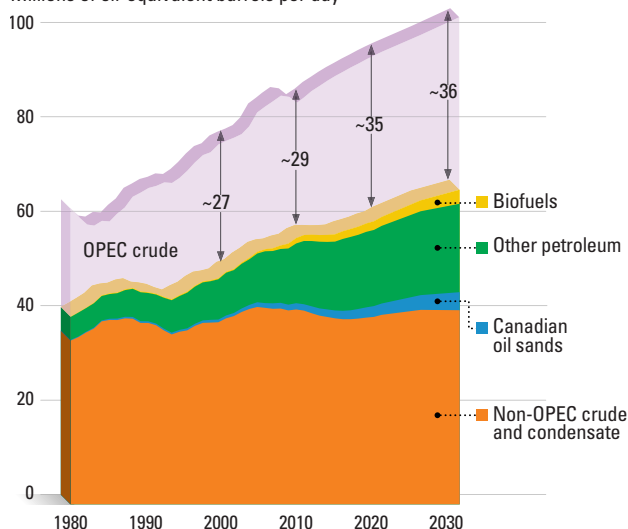
So what if the pessimists turn out to be realists and non-OPEC producers can’t answer the call for more oil? Demand will increase in this decade, mainly from developing countries like China and India as populations grow and incomes rise. That rising



A remaining hope. Some analysts see untapped oil fields in frontier areas, such as offshore Brazil (*above*), pushing up non-OPEC production.

Liquids supply

Millions of oil-equivalent barrels per day



Running flat out. An ExxonMobil outlook has non-OPEC oil (orange plus blue) plateauing. Natural gas–derived liquids (green) and biofuels (yellow) will help, but OPEC (purple) must pitch in.

demand might be met by several sources. In decreasing order of reliability, production of another sort of petroleum liquid, natural gas liquids (NGLs), is expected to increase. NGLs are the lighter-weight hydrocarbons that condense from natural gas when it cools. The expected increase in global natural gas production—at least half of which would come from OPEC—would lead to increased production of NGLs.

OPEC would, it is fervently hoped outside of the cartel, be willing and able to boost its output of conventional oil. ExxonMobil has OPEC production rising from about 29 million barrels per day today to about 36 million barrels per day in 2030. That would increase OPEC’s share of oil production even further, but Kaufmann, among others, expects that OPEC will see an opportunity to make more money from its oil by curbing production and driving prices up. That would tend to encourage production of liquid biofuels, but whether output could be ramped up quickly enough to bring relief remains unclear. The clearest outcome, according to Greene, is likely to be continued or even greater volatility in the price of oil with all the economic downsides that would entail.

Perhaps the most sobering outcome of a non-OPEC plateau might be reminding everyone that even planet-scale resources have their limits. And that when you are consuming them at close to 1000 gallons a second, the limits can catch you unaware. The next 5 years, assuming oil prices remain on the high side, should show who the realists are.

—RICHARD A. KERR