Spending Our Great Inheritance; Then What?

by Walter Youngquist

During more than 500 million years, geological processes accumulated a rich bank account for us **n** oil. The "account" actually was set up as numerous accounts **n** some large, some small **n** in various parts of the world. In 1859, Col. E. L. Drake initiated the modern search with his now-famous well near Titusville, Pennsylvania. Soon the hunt spread across the United States and then around the world. With increasingly sophisticated equipment to read the clues about where this inheritance was hidden, we have been increasingly successful in finding it.

Just how successful have we been? How much of this oil inheritance have we found and how much is left to find? In their article, "The End of Cheap Oil," published in the March 1998 issue of *Scientific American*, exploration geologists Colin J. Campbell and Jean H. Laherrére of Petroconsultants in Geneva noted that the world has consumed more than 800 billion barrels of oil and has discovered or has in reserve another 850 billion barrels. They estimate that only about 150 billion barrels remain to be discovered. Apparently, we have been very successful in our search, having already consumed, by their estimate, nearly half of the world's ultimate resource of about 1,850 billion barrels of oil.

Now that we're close to having consumed half the world's oil, how soon will we reach peak production? This question has been the subject of discussion for many years, with various forecasts of the peak of world or regional oil production offered. Many have already proved wrong. One estimate, however, was correct. In 1956, as Campbell and Laherrére point out, Shell Oil geologist M. King Hubbert predicted that the United States would peak in oil production around 1970. His forecast was widely ignored or scoffed at by the general public, and by many geologists, but Hubbert was right on the mark.

When the future of oil is discussed, the common question asked is "How long will oil last?" This is the wrong question. Insignificant amounts of oil will probably be produced in the year 2100 and perhaps beyond. The critical date is when the peak of oil production is reached and the world's demands can no longer be supplied. From then on, there will be less and less oil to divide, in contrast to the current happy situation where we have more and more to divide. It is probable that the decline of world oil production will affect more people in more ways than any other event in human history.

Because various estimates of the date of world oil peak production have been wrong, it is sometimes assumed that forecasts such as Hubbert's will be wrong. This may be true, but the question is "How wrong?" With many more production-based data points now available than in the past, production curves are becoming well established.

The peak of world oil discoveries passed in the 1960s, so the downward trend of that curve has already been established. Simply continue the classic bell curve and you'll find a representation of the total amount of available oil.

The theoretical graph of the production life of a finite resource indicates approximately 30 years from peak of discovery to peak production. Applying these

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curves to oil, with new technology such as horizontal drilling, 3-D seismic, and improved secondary recovery methods, we can predict that peak production (after the world oil discovery peak in the mid-1960s) will occur in about 40 to 45 years. But Campbell and Laherrére state: "Barring a global recession, it seems most likely that world production of conventional oil will peak during the first decade of the 21st century." Their estimate agrees with what many others, myself included, have said. In his article, "Crude Oil and Alternative Energy Production Forecasts for the Twenty-first Century: The End of the Petroleum Era," J.D. Edwards sets the peak at 2020 – a more optimistic forecast than others, but still clearly within sight.

As an interesting sidelight to the time of peak, Chevron Corporation in 1997 announced the discovery of an oil field offshore of Angola. They stated it could hold as much as a billion barrels, and appeared to be the largest find the company had made in the last 10 years. A billion-barrel oil field is indeed a prize. But in "An Analysis of U.S. and World Oil Production Patterns Using Hubbert Curves," a paper recently submitted for publication, Albert A. Bartlett calculates that adding a billion barrels to the world oil supply would move the peak of world oil production back just 5.5 days! His assessment indicates the magnitude of the world's current oil appetite and how difficult it is becoming to feed it. Important regions that have seen their maximum time of production include the United States (1970), North America (1984) and the former Soviet Union (1987).

Individual countries (other than the United States) that have already peaked in oil production include Libya (1969), Iran (1973), Romania (1976), Trinidad (1977), Brunei (1979), Peru (1981), and Egypt (1993). The list of producers on permanent decline is growing and will eventually include the Persian Gulf nations, which now hold the bulk of the world's remaining oil. The difference in oil-well production between the United States and Saudi Arabia is striking: average daily production per well in Saudi Arabia is about 5,600 barrels; average U.S. daily production per well is 11.3 barrels.

Out of the Oil Business

Whatever forecast of the world oil production peak is accepted, there are two overriding facts: The world is now consuming about 26 billion barrels of oil a year, but in new field discoveries, we are finding less than 6 billion barrels a year. The date of the peak of world oil production is important, but also important is the sobering fact that it will occur within the lifetimes of most people living today – and much sooner than is generally expected. There is little time left to begin to adjust lifestyles and economies to the coming post-petroleum era.

The United States can no longer write those big checks against its oil bank account. Oil reserves have declined from a maximum of 39 billion barrels in 1970 to the present 22 billion barrels, and total daily production has dropped in that same period from more than 9 million barrels a day to 6.4 million barrels. We now import more oil than we produce. So we have increasingly been writing our oil-supply checks against the accounts of others – chiefly the Persian Gulf countries, Nigeria, Mexico, and Venezuela. But when world oil production peaks, the oil checks that all of us can write must become smaller and smaller. Eventually, those checks will be insignificant, relative to world needs. We will have spent our oil inheritance. Then what?

Alternative Energy Sources

If the public briefly thinks of oil as a finite resource, the popular placebo is: "The scientists will think of something." Just what have we thought of up to now? The chart below answers that question.

ALTERNATIVE ENERGY SOURCES

Renewable

Wood/other biomass
Hydropower[1]
Solar
Wind
Tidal
Ocean thermal energy conversion (OTEC)

Non-renewable

Oil sands/heavy oil
Gas hydrates
Shale oil
Coal
Nuclear fission, fusion[2]
Geothermal[3]

1. Renewable only to life of reservoir.
2. If ever accomplished, may be regarded as renewable, since fuel supply is huge.
3. So far, all electric quality reservoirs are in declining

production.

This is essentially the complete alternative energy spectrum. There are no indications in the foreseeable future of other significant energy sources.

The question is how well can these sources individually or collectively replace oil? The topic is large, but some salient facts can be noted. The world uses about 72 million barrels of petroleum a day. Just replacing that volume with an equivalent energy source becomes a huge task. Petroleum equivalents can be made from coal, but doing so on any significant scale would involve the largest mining project the world has ever seen.

There are 2 trillion barrels of kerogen (not oil) in the Colorado Plateau oil shales. But trying to modify kerogen into oil has cost oil companies billions of dollars in experimental projects. All have been abandoned, leading to the expression: "Shale oil – fuel of the future – and always will be." The Athabasca oil sands of Canada contain 2 trillion barrels of oil (real oil). Today some 500,000 barrels a day are produced. Scale this up 10 times and you have 5 million barrels a day. The problems to achieve that scale are enormous, and 5 million barrels a day must be measured against the 19 million barrels a day used by the United States and the 72 million barrels a day used worldwide. Oil sands will help, a little, for a time.

Renewable Resources

Ethanol is a net energy loss – it takes 70 percent more energy to produce than is obtained from the product itself. Other biomass resources show, at best, very low net energy recovery. In their comprehensive study, "Feasibility of Large-Scale Biofuel Production," Mario Giampietro, Sergio Ulgiati, and David Pimentel write: "Large-scale biofuel production is not an alternative to the current use of oil and is not even an advisable option to cover a significant fraction of it."

The two most popularly suggested energy alternatives, wind and solar, suffer because they're undependable, intermittent sources of energy, and the end product is electricity. We have no way to store large amounts of electricity for use when wind and sunshine are not with us. Geothermal and tidal energy are insignificant energy sources in total but can be locally important. Nuclear energy can be a large power source if the safety aspects can be guaranteed (and this may be possible), but again, the end product is electricity. There is no battery pack even remotely in sight that would supply the energy needed to effectively power bulldozers, heavy agricultural equipment such as tractors and combines, or 18-wheelers hauling freight cross-country.

Can electricity be used to obtain hydrogen as a fuel from water? It can, but hydrogen is difficult to store and dangerous to handle. And there is no energy system now visualized to replace kerosene jet fuel, which propels a Boeing 747 about 600 miles an hour nonstop on the 14-hour trip from New York to Capetown (currently the longest plane flight). We continue to seek the holy grail of energy – fusion – but containing the heat of the sun at 10 million degrees Centigrade is still only a far-off hope.

A Gap

Which brings us back to the peak date of oil production. Even if we assume that alternative sources could somehow fill the gap left by the departure of oil, the time frame needed to put these into sufficient production to replace oil as it declines clearly indicates a large gap at best. The British scientist and statesman Sir Crispin Tickell has defined our situation well: "We have done remarkably little to reduce our dependence on a fuel [oil], which is a limited resource and for which there is no comprehensive substitute in prospect." All alternative energy sources must be drawn upon, but oil will be sorely missed.

We are consuming what is, in many ways, an irreplaceable resource. We have all seen the bumper sticker on huge recreational vehicles: "We are spending our children's inheritance." That RV, and the more than 600 million gasoline- and diesel-powered vehicles now in the world are doing just that – as they guzzle oil.

We are most fortunate to be living in a brief, bright interval of human history made possible by an inheritance from half-a-billion years of oil-forming Earth processes. We rarely give thought to the greatly depleted balance in the oil account we are leaving to future generations. When checks can no longer be written against that inheritance, world economies and lifestyles will undergo great changes. Life will go on, but it will be quite different from the present. Most people living today will see the beginning of those times.

Fortunately, as Campbell and Laherrére state, oil production will not decline abruptly. We are simply about to run out of the cheap oil we have enjoyed. This gives us time to develop as many alternatives as possible and to think about changing consumption patterns and lifestyles

(such as increased use of mass transit), to arrange for a "soft landing," in the post-petroleum era. However, with the peak of world oil production now clearly in sight, the time to begin to make adjustments is now. •