



A CAUTIONARY TALE FOR OIL COMPANIES NAVIGATING THE ENERGY TRANSITION



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Executive Summary

Many voices are urging investors and the petroleum industry to sharply reduce upstream investment because climate change policies and new fuels and technologies mean that oil demand will go into sharp decline. But the industry has repeatedly received strategic advice in the past that proved mistaken, including the diversification fad in the 1970s, synthetic fuels in the 1980s, and hydrogen in the 1990s. Many in the industry embraced these concepts and tens of billions of dollars were lost as a result, explaining why some are shy about adopting the current consensus strategic advice, most of which, as before, comes from outside the industry.

The lessons to be drawn from history include:

- Consensus can be horribly wrong, whether of the industry, government, academia and/or think-tanks;
- Investments that require government action (taxes, subsidies and/or regulations) are risky, as political decisions are unpredictable and policies unreliable;
- Uneconomic investments justified on the grounds of intangible or hard-to-quantify benefits are risky.

Progress towards an energy transition appears to be significantly lagging the optimistic projections and any reduction in government mandates and subsidies could make many investments unprofitable, and at least some elements of the energy transition appear to be driven by irrational exuberance.

Introduction

Years ago, I wrote a paper on oil company strategy called “Shoulder Against Shoulder” which was a reference to the ancient Greek development of the phalanx, whose value lay in part with putting the soldiers together, shoulder against shoulder, which gave them added courage to face the terror of battle.

Similarly, it seems that for oil companies, multi-billion dollar investments in a volatile industry are terrifying enough to encourage companies to follow each other's strategies. Losing money while doing what everyone else does is excusable, but having losses after insisting that others were wrong would leave one exposed to criticism from your boss, the board and/or investors.

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(The same imperative causes many oil price forecasts to seek to be within the consensus, despite the repeated failure of the consensus, as I described in 1992's "The Fog of Commerce.")

Now there are strong pressures on the oil industry to alter its long-term focus and strategy away from oil and gas and towards renewable energy. Sometimes this falls under the name ESG for Environmental and Social Governance. Arguably, ESG is an evolved form of the earlier Socially Responsible Investment, where investment in industries like tobacco and alcohol was eschewed on moral grounds. ESG is claimed to be not just preferred morally but financially as well, lowering risk to companies from investments that will ultimately prove unprofitable.

Thus, it is argued that oil and gas deposits will become stranded assets and investors should shy away from them. As a 2021 CarbonTracker report says,

“Even in a slower, ‘well below 2 degrees’ pathway, asset stranding risk via unsanctioned assets is severe. Using a least cost model, we find that a majority of companies would see at least half of their business-as-usual investments on currently unsanctioned assets at risk of stranding under a low carbon scenario (SDS).”¹

This relies on the thinking that peak oil demand is here or reasonably close, based on the combination of climate change policies and rapidly evolving technologies that will make petroleum increasingly obsolete. The World Economic Forum described this view as:

“Rapid [change] advocates argue that solar and wind are already cheaper than fossil fuels for the generation of electricity and that electric vehicles (EVs) are about to challenge internal combustion engines (ICEs) on price, that the barriers to growth are soluble for the foreseeable future, and that these disruptive new energy technologies will continue to enjoy exponential growth. They anticipate the rise of new technologies, such as green hydrogen, to lead to further waves of change.”²

The Strategic Trajectory

Any given company faces a unique set of challenges, but there are also broad concepts from economics and management science that are informative, usually for the better. Understanding factors like marginal costs, price elasticities, and oligopoly can serve as background to establishing a strategy, but there are more general themes that influence the thinking of executives, often misdirecting them. This is especially the case when the theories and predicted strategic environments come from outside the industry, and indeed, from non-professionals.

There are fads and fashions that should be ignored, such as the earlier crazes for ‘power ties’ and ‘power lunches’ which were aimed at advising executives how to act to improve how they were perceived. Other ideas, like ‘quality circles’ or ‘the learning corporation’ were more generally applicable and often useful, even if not always applied correctly.

But the subject of this piece will be the efforts to guide the petroleum industry through the energy transition which is thought underway now, as concern grows about climate change and new energy technologies encroach on the market for oil and gas, increasing pressure on

companies to change their strategic focus. Some of that pressure is politically or ideologically driven, but much of it comes from the investment community.

The history of such advice, however, provides a cautionary tale. As now, outsiders have frequently sought to advise the oil industry on strategic direction, but most of them—and indeed many industry executives—are not very familiar with the industry’s history. Two particular periods, the 1970s/80s and the 1990s/2000s, will be examined.

The 1970s: Oil is a Sunset Industry, Diversify!

Certainly, companies with expertise in offshore oil drilling and production have a comparative advantage in constructing offshore platforms with wind turbines but, as one executive commented, an oil company has no particular expertise in solar power and should not be expected to prosper in the field.

This is reminiscent of Exxon’s president’s comments after the failed investment in a word processor manufacturer. From my 2016 book “The Peak Oil Scare:”

“In the fall of 1984, after 10 years and at least a US\$500 million investment, the world’s largest company concluded that oil and office products do not mix. Exxon says it pulled the plug on its Exxon Office Systems...”³

That investment and others like it were made in accordance with Wall Street’s insistence in the late 1970s that the industry diversify away from a ‘sunset industry,’ since everyone knew that, as Jimmy Carter put it in 1977, “The oil and natural gas we rely on for 75 percent of our energy are simply running out.” The CEO of Mobil said, at roughly the same time, “The oil business has come to maturity, and with this maturity comes a new set of challenges...oil companies have no other choice. They must diversify or go the way of the buggy-whip makers.” Rawleigh Warner, Mobil CEO 1977.⁴

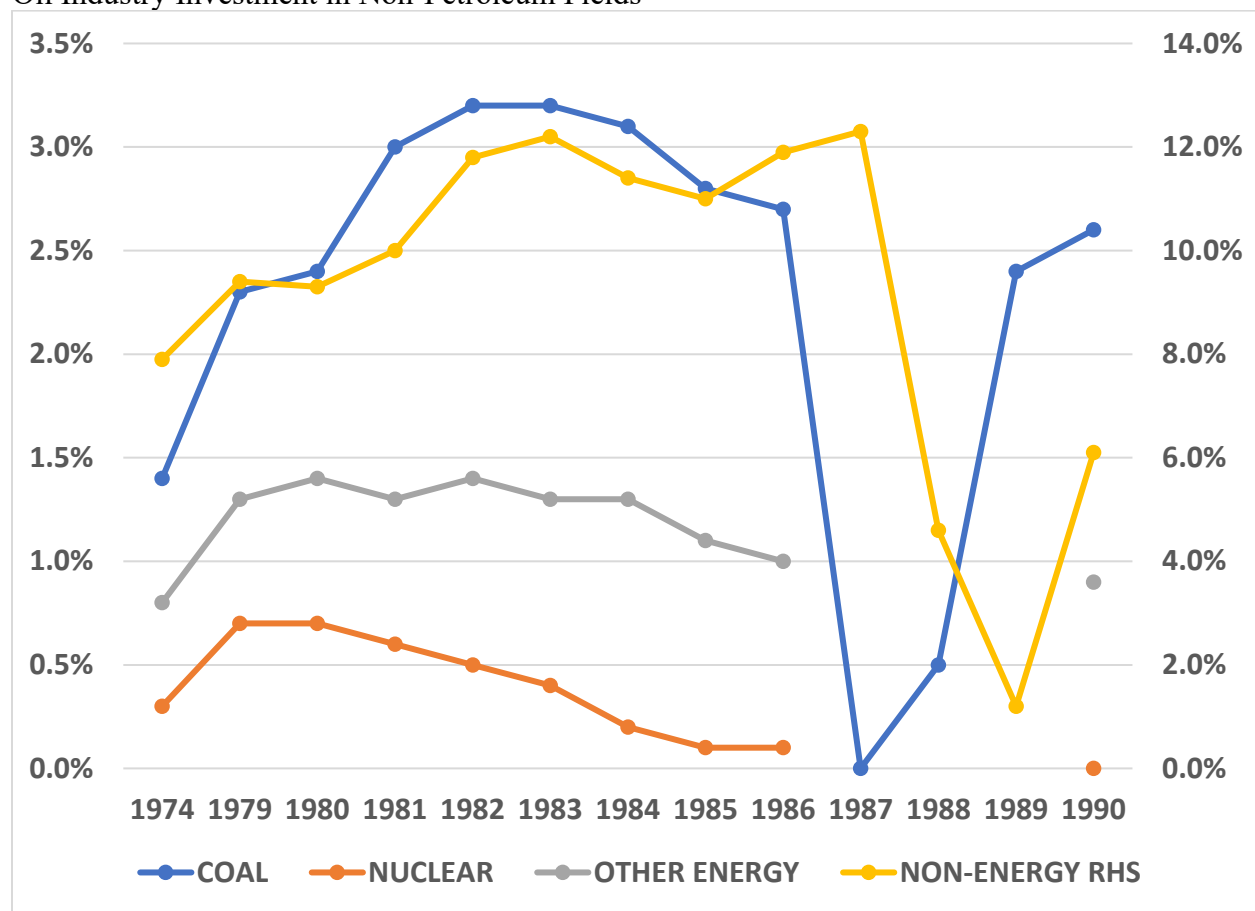
Mobil’s purchase of department store Montgomery Ward was symbolic of this trend, but so was Exxon’s purchase of an electric motor manufacturer and an office equipment supplier. And many companies made energy investments outside the petroleum sector, including in coal and uranium, seeing both as being the future energy source of choice. ARCO plunged into the solar power industry:

“In what appeared to be the largest single private investment ever made in solar energy, the Atlantic Richfield Company agreed yesterday to pay Energy Conversion Devices of Troy, Mich., \$25 million to accelerate development of substances that, among other things, convert sunlight into energy.”⁵

“As part of a companywide restructuring in 1989, Arco sold its pioneering Arco Solar Inc. unit, headquartered in Camarillo, to Siemens Solar Industries for \$35.9 million.”⁶

Figure 1 shows the share of net additions to property, plant and equipment (PP&E) made by the oil industry in non-petroleum sectors in the late 1970s and 1980s, taken from Department of Energy data. (Non-energy does not include chemicals, and ‘other energy’ is primarily renewables.)

Figure 1
Oil Industry Investment in Non-Petroleum Fields



Source: EIA, Performance Profiles of Major Energy Producers, various issues.

Some of this reflected encouragement from the International Energy Agency and others to develop new energy sources, including coal. Exxon developed a massive coal mine in Colombia and set up its own nuclear division; in 1979, Gulf Oil opened the largest uranium mine in the U.S. in New Mexico, although it closed by 1989 due to depressed prices.⁷ Phillips Petroleum actually invested in nuclear fusion research “as a hedge against depleting oil supplies,” based on an inventor’s idea for an approach cheaper than large-scale magnetic containment.⁸

But also, a number of companies invested in synthetic fuels, thought to be the only possible source of major new liquid fuels. Exxon attempted to develop the Old Colony Shale project in Colorado, losing billions of dollars, while Mobil built a gas-to-liquids plant in New Zealand—but didn’t lose money because the government, anticipating huge profits for ever-soaring oil prices, purchased it from them. The former project was abandoned, the latter has served as an occasional supplier to the methanol market.

At the time of these investments, oil prices were expected to soar and those who disagreed were considered misguided. As Robert Stobaugh and Daniel Yergin put it in the seminal book *Energy Future*, “But then, in late 1981 and early 1982, U.S. consumers, encouraged by some *unknowing*

writers and economists, began to believe that OPEC members were no longer able to hold up oil prices and that all of America's energy problems were over. This misperception, which was encouraged by the desire for a simple view and a simple solution, obscured the nature of the energy situation."⁹ [emphasis added]

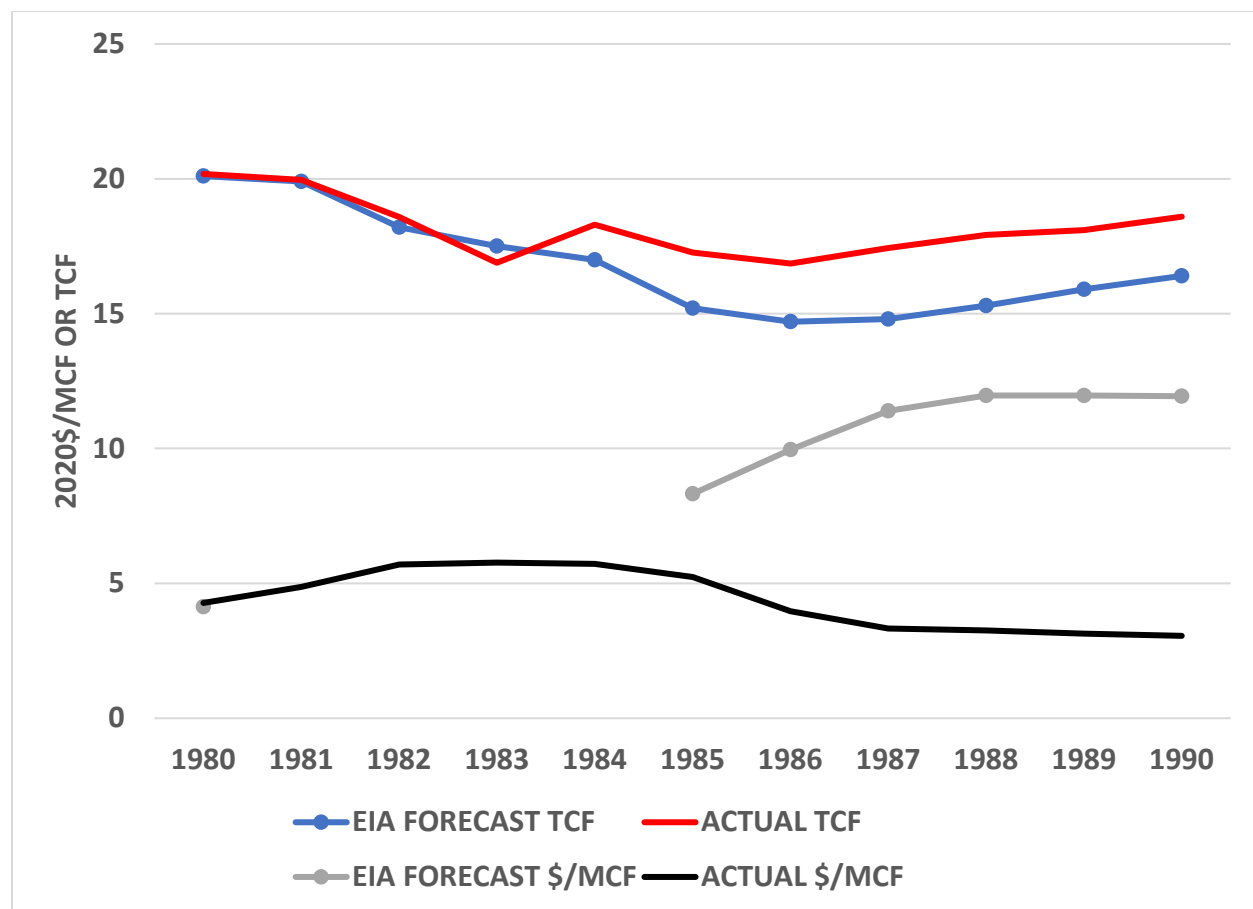
Similarly, the International Energy Agency, in its first post-1979 report on the long-term future of energy, 1982's *World Energy Outlook* said, "From the mid-1980s onwards, however, the oil market is likely to gradually move towards a basic disequilibrium again as growing world oil demand will meet stagnating production." (p. 25)

And at Stanford University's Energy Modeling Forum #6 in 1980-82, the average price forecast from ten computer models of the world oil market was \$125 in 1990 and \$190 in 2000. (Actuals were \$45 and \$42) Only one model (which I assisted on) showed any decline in prices, and that for only five years. So, while it might be argued that the oil industry understood oil supply and demand better than outsiders, in fact, they found it hard to resist the overwhelming consensus.

The reality was that demand for OPEC oil fell by 50% from 1980 to 1985 and prices not only didn't recover as so many predicted but collapsed by 40% in 1986. Natural gas, whose decontrol combined with conservation created a multi-year glut, was confidently predicted to become ever scarcer. Figure 2 shows the U.S. Department of Energy's official 1980 forecast for U.S. natural gas supply and price, compared to the actual. They thought supply would drop by 25% before recovering, even while prices slowly tripled. In reality, production fell slightly with lower demand while prices rose by 25% then fell by 50%.

Figure 2

EIA 1980 Forecast for U.S. Natural Gas Supply and Price



Source: Energy Information Administration, Annual Energy Outlook, (1980).

Within a few years, nearly all of those non-petroleum investments had been sold off, usually at losses approaching 90% of the original capital. Wall Street firms like Standard and Poors in 1984 noted “Diversification out of the oil business has been disastrous for most of the majors....”¹⁰ Of course, the same firm said in 1980, “Diversification into alternative energy fields should offer promising new opportunities for increasing profitability.”¹¹

This experience appears to explain why some firms, like ExxonMobil, have resisted calls to reduce their involvement in petroleum in favor of renewable energy and why they have sometimes been skeptical of not only Wall Street advice but that of the expert consensus about the future of the industry.

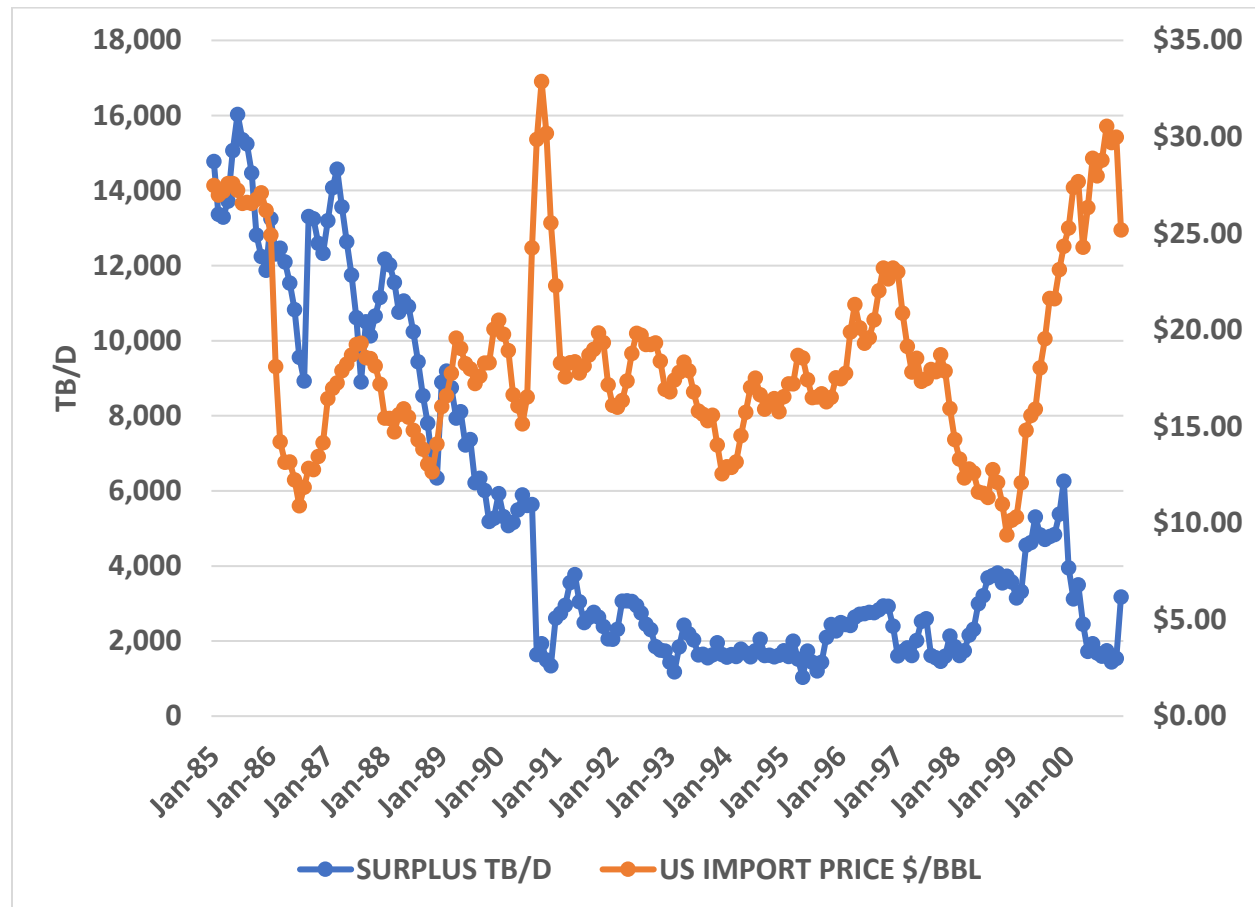
The 1990s: New Fuels and Technologies

A new round of investment advice arose in the 1990s. This was a period when geopolitical effects on the oil industry were minimal and although surplus capacity in OPEC was minimal (Figure 3), prices remained moderate at roughly \$30 per barrel. Even the 1990 Iraqi invasion of

Kuwait, which removed 4 mb/d from the market, barely moved prices. Soaring production in the North Sea and investment in Canada's oil sand fields put pressure on the market and prices briefly dropped to \$18/barrel (2020\$) in 1998.

Figure 3

OPEC Surplus Capacity in 1980s/90s



But during this period, there were three specific and three general themes regarding the future of the petroleum industry, representing thinking both within and without the industry as to the optimal strategy but which, as in the 1970s/80s, proved misguided—at least to date.

Individual Ideas

One of the lowlights of the 1990s for the energy industry was the spectacular rise and fall of Enron, which was thought ushering in a new era of 'virtual' corporations as opposed to the old 'brick-and-mortar' industry, echoing earlier arguments about oil being a 'sunset' industry. As a Bloomberg 2001 story described, "Vertically integrated behemoths like ExxonMobil Corp. (XOM), whose balance sheet was rich with oil reserves, gas stations, and other assets, *were dinosaurs to a contemptuous Skilling*. 'In the old days, people worked for the assets,' Skilling mused in an interview last January. 'We've turned it around--what we've said is the assets work for the people.'¹² [emphasis added] For some years, the company and its leadership were

considered to be visionary, winning numerous awards and dominating the media, before it became apparent that, despite some notable successes, the company descended into fraud.

And there was the much heralded, and much criticized, effort by British Petroleum to rebrand itself as 'Beyond Petroleum.' The *New York Times*, describing a 2002 presentation by CEO Lord John Browne, said, “you might be forgiven for assuming the man at the podium was not an oil baron, an industrialist, an extractor of fossil fuels from the tender earth but an environmentalist of the high church calling for the abolition of hydrocarbons.”¹³ In fact, BP’s overall business changed only minimally and the campaign—and CEO—were undone by the Deepwater Horizon disaster.

The third case comes later and is more selective, in that the person involved didn’t promote a strategy for the industry as a whole but simply his own business plan. Legendary oilman T. Boone Pickens announced the Pickens Plan in 2008. The core of the plan was developing wind resources to displace natural gas in power generation, which would allow that fuel in turn to displace petroleum in transportation, either as compressed or liquified natural gas.

As Pickens said, “Natural gas is not a permanent solution, it is a critical bridge fuel to immediately slash our oil dependence, buying us time to develop new technologies that will ultimately replace fossil fuels in transportation.”¹⁴ His wind power development failed due to the difficulty of gaining approval for long-distance power transmission lines and government support for natural gas vehicles remained minimal.

None of these made a lasting mark on the petroleum industry. Enron collapsed and its idea of a ‘virtual’ company with minimal hard assets has largely disappeared, though oil companies still rely on contractors for many jobs. And some oil companies are now moving into other energy fields, especially renewable, but oil and gas continue to dominate their businesses—at least to date. Finally, wind power has increased globally as well as in the U.S., but natural gas is also booming, albeit more as backup to renewable power than for use in the transportation sector.

New Technologies

Yet during this period, three developments occurred that made some fear for the future of the industry, with ARCO CEO Mike Bowlen saying “We’ve embarked on the beginning of the Last Days of the Age of Oil.”¹⁵ Two of these involved competition for the internal combustion engine, and one, the fear that world oil supplies were scarcer than thought.

First up: the mid-1990s announcement by Ballard Power that it had developed new, cheaper fuel cells caused a flurry of interest in the technology, including in the oil and auto industries. Rocky Mountain Institute’s 2005 report *Winning the Oil Endgame* included remarks such as:

- “My personal opinion is that we are at the peak of the oil age and at the same time the beginning of the hydrogen age.” Herman Kuipers Shell 2000.
- Texaco CEO Peter Bijur commented in the 1990s: The days of the traditional oil company are numbered, in part because of emerging technologies such as fuel cells. . .”
- BP Managing Director Chris Gibson-Smith said in 1998: “[W]e’ll evolve from a world of hydrocarbon dependency to a mixture of hydrocarbon and alternative energies use.

Vast quantities of liquid hydrocarbons (oil and gas) will be left behind in the ground, just as solid hydrocarbons (coal) are being left behind today.”

- In 2000, Ford Chairman William Clay Ford, Jr., said “. . . I believe fuel cells will finally end the 100-year reign of the internal combustion engine . . . Fuel cells could be the predominant automotive power source in 25 years.”
- Jurgen Schrempp, Chairman of the Board of Management of Daimler-Chrysler said the company would be a market leader and later predicted sales of 100,000 hydrogen fuel cell vehicles in 2005.

This stance by Daimler-Chrysler was remarkable, as *The Economist* noted, “The firm that brought the world the petrol-engined car 100 years ago is about to launch the product most likely to kill it.”¹⁶

Needless to say, the optimism about the competitiveness of hydrogen fuel cell vehicles proved seriously misplaced, as even today, a quarter century later, sales are in the four figures and the total fuel-cell vehicle stock in 2021 was 51,600, below what Daimler thought would be annual sales in 2005.¹⁷

The next threat to the gasoline powered engine came from cellulosic ethanol, which has been heavily promoted as the new substitute liquid fuel for about a quarter-century, again after technical progress was reported in the mid-1990s. In that case, the breakthrough came with the use of recombinant DNA to improve yields and lower costs. In 1999, Richard Lugar and R. James Woolsey argued in *Foreign Affairs*, “Recent and prospective breakthroughs in genetic engineering and processing, however, are radically changing the viability of ethanol as a transportation fuel...Cellulosic ethanol is a first-class transportation fuel, able to power the cars of today as well as tomorrow, use the vast infrastructure already built for gasoline, and enter quickly and easily into the transportation system.”^{xvi}

This was echoing an *Atlantic Monthly* article by Charles B. Curtis and Joseph J. Romm, “Mideast Oil Forever,” in which they noted: “In 1994 research sponsored by the DOE created a genetically engineered organism that enhances the fermentation of cellulose, increasing the rate of conversion and the yield of ethanol. This achievement, described in the journal *Science*, was named *one of the hundred most significant technological advances* of the year by *R&D* magazine. This and other federally supported research has brought the cost of making ethanol from \$3.60 a gallon fifteen years ago to about \$1.00 a gallon today. If biofuels R&D were funded at current levels for five to ten years, ethanol from fast-growing dedicated crops, crop waste, and wastepaper could be produced for as little as sixty to seventy cents a gallon by 2005.” [N.B. \$1.15/gallon in 2020\$. Emphasis added]

The enthusiasm for a fuel that could be domestically produced led to Congress revising its mandated ethanol blending into gasoline to include a requirement that 10.5 billion gallons or 800 tb/d of cellulosic ethanol be used by 2029.¹⁸ In fact, current production of cellulosic ethanol is so low data is not reported by the government. Even now, nearly two decades after it was predicted to be cheaper than conventional fuel, the IEA reports it is still two to three times that.¹⁹

Finally, the 1998 *Scientific American* publication of the article “The End of Cheap Oil” heralded a widespread belief that world oil production would soon peak and begin declining because of geological scarcity. Substitutes were said to be not readily available and writers predicted enormously higher oil prices, economic damage if not collapse, and even an end to salmon deliveries to inland markets.

The basis of these arguments were that, first, oil production in an area followed a bell curve, allowing for precise forecasts of supply. Second, problems in the industry such as an aging workforce, the need to drill deeper and in more hostile environments, and political antagonism to foreign investment in oil production, were said to preclude increasing oil production.²⁰

The problem was that oil production rarely follows a bell curve and use of it resulted in laughably pessimistic predictions. Yet numerous people repeated it as ‘scientific’ without doing the most simple fact-checking. And the problems facing the industry are serious but are not new and have generally been dealt with successfully. Typical of the ignorance were comments like “Steep falls in oil production means the world now needed to replace an amount of oil equivalent to Saudi Arabia’s oil production every two years...”²¹ Not explained: Didn’t the industry always have to replace oil production declines?

In fact, three decades earlier, President Carter had said nearly the same thing: “...that just to stay even we need the production of a new Texas every year, an Alaskan North Slope every nine months, or a new Saudi Arabia every three years. *Obviously, this cannot continue.*” [emphasis added] Which is telling for the fact that he thought it ‘obvious’ that it couldn’t continue even though it had been doing so for years.

Jeremy Leggett was among those who thought that peak oil required changes in the petroleum industry. “Today, rather more whistleblowers are saying that another incumbency, the oil and gas sector, has its asset assessment fundamentally wrong... [Art Berman] looks at the resulting disaster in the balance sheets of oil and gas companies, and expects the bankruptcies to start any time soon. [John Dizard](#) has also warned of this particular bubble, in the Financial Times.”²² In fact, bankruptcies occurred because a glut of oil and gas caused prices to collapse, not because supply couldn’t keep growing. Numerous others argued that peak oil was simply another reason to accelerate the energy transition from fossil fuels.

Fortunately, most in the oil industry did not take the peak oil warnings seriously. Aside from occasional industry executives, only one CEO, Christophe de Margerie of Total, accepted the basic premise, arguing that production would never surpass 85 mb/d, later revised to 95 mb/d and then 100 mb/d.²³ *Time* magazine claimed he “jolted oil executives at a London conference” with his views, but it doesn’t seem any were swayed by them.²⁴ Unlike executives in the 1970s, he did not, however, try to direct his company away from petroleum but rather intensified his search for new sources.

For all the attention paid to peak oil by various groups from the German military to Virgin Atlantic, it does not appear to have made any headway towards influencing industry strategies or investments; Randy Udall’s claim that “there’s a rapidly growing list of oil industry professionals who have called attention to the peak oil challenge”²⁵ references a handful of

people, many with executive not research experience. Still, the wide attention this issue received it serves as an excellent example of how bad research can prosper and how many can be absolutely certain about something that is inherently uncertain.

That certainty is, itself, a signal that arguments should be treated with skepticism, as are efforts to silence those who disagree. That was the case of the population explosion, seen as an existential threat to humanity and those who disagreed were thus seen as dangerous.²⁶ The few who contradicted the 1970s consensus that oil and gas were ‘simply running out’ and prices could only go up where, as described above, derided more than silenced, although the peak oil controversy saw loud complaints that ‘deniers’ were given media coverage.

The Road from Here

Of course, past performance is no guarantee of future failure, as the brokers say. Oil and gas couldn’t be produced from shale until George Mitchell’s engineers figured out how to do it. And electric vehicles are far more capable today than a quarter-century ago. However, the signs of declining or even peaking oil demand are extremely tentative and mostly reflect short-term developments like the pandemic and recent price spike.

Soaring reliance on renewables is likely to continue, but to be more of a challenge to coal consumption than oil; natural gas will remain important as a backup and as well as a substitute for coal. Electric vehicles might, indeed, move out of their market niche to become mass market items, but even if the share of EVs sold reaches 40% in 2030, as the IEA’s Sustainable Development Scenario projects, then oil demand would still decline by only about 10%.

And another threat will be familiar with many with long experience in the oil industry: a changing regulatory landscape. It is entirely possible that the consensus around the future of the energy industry is completely wrong. As Larry Goldstein and I pointed out earlier, there are a number of ways in which the current policy impetus towards net zero greenhouse gas emissions could be reversed, including financial strains leading to reduced support for financial subsidies, a temporary global cooling that discourages climate change policies, and resistance to diversion of land to low-intensity renewable power production.

And while a major portion of the public often embraces bad science (see the many awards Paul Ehrlich has received from incurious groups that like and thus believe his message), others can be brought around as issues clarify. Writers like Michael Shellenberger, Steven Koonins, Alex Epstein and Bjorn Lomborg might be scorned by climate change activists, nonetheless have detailed analysis and a large arsenal of facts that might ultimately turn the public away from the more extreme warnings about fossil fuel usage.

Given all this, should oil companies attempt to transform themselves from traditional petroleum producers to something more like BP’s proposed “Beyond Petroleum?” And as the current situation shows, the oil industry can actually come under attack for not producing enough—even from those arguing for a net zero future.

Probably the best approach is similar to the ‘least cost’ strategy—focusing on the low-hanging fruit, which brings the best returns, whether it’s economic savings/profits or reduced emissions.

The petroleum industry by its nature emits significant amounts of methane and carbon dioxide, the former primary unintentionally. The advances in methane detection meant that it has become much more economical to detect even relatively minor leaks and reduce them, primarily through maintenance. Further, investing in efficient machinery used in the oil fields will often pay off in fuel savings, and the industry has worked for decades to minimize energy use, and thus emissions, in the refining sector.

Other possibilities include development and deployment of carbon capture and sequestration technology, which doesn't appear to be commercially viable as of yet, but might easily become so in the future. Advances in biofuel technology could indeed result in a substitute for liquid fuels that can be deployed in existing infrastructure, as could hydrogen.

Which makes it important to acknowledge the biggest threat to the petroleum industry's future, the possibility of a new, much improved battery that can provide both backup power for intermittent renewables and make battery electric vehicles much more competitive than now. Such does not appear imminent, to put it mildly, but as Yogi Berra would say, "It's always the things you don't expect that surprise you."

Sources:

Campbell, Colin J. and Jean Laherrere, “The End of Cheap Oil,” *Scientific American*, March 1998.

Curtis, Charles and Joseph B. Romm, “Mideast Oil Forever?” *Atlantic Monthly*, April 1996.

Dalman, Axel and Mike Coffin, “Adapt to Survive: Why oil companies must plan for net zero and avoid stranded assets,” Carbontracker Initiative, September 2021.

Epstein, Alex, *Fossil Future: Why Global Human Flourishing Requires More Coal, Oil and Natural Gas—Not Less*, Portfolio, 2022.

International Energy Agency, *World Energy Outlook*, various editions.

Koonin, Steven E., *Unsettled: What Climate Science Tells Us, What it Doesn’t, and Why It Matters*, BenBella Books, 2021.

Lovins, Amory, et al., *Winning the Oil Endgame*, Rocky Mountain Institute, 2005.

Lugar, Richard and James Woolsey, “The New Petroleum,” *Foreign Affairs*, January/February 1999.

Lynch, Michael C., *The Peak Oil Scare and the Coming Oil Flood*, Praeger, 2016.

Lynch, Michael C., “Shoulder Against Shoulder: The Evolution of Oil Industry Strategy,” *Journal of Energy and Development*, Volume XIX, number 1, 1995.

Lynch, Michael C., “Bias and Theoretical Error in Long-Term Oil Market Forecasting,” in *Advances in the Economics of Energy and Natural Resources*, John R. Moroney, ed., JAI Press, 1994. (Originally published in 1992 as an M.I.T. working paper, “The Fog of Commerce: Bias and Theoretical Error in Long-Term Oil Market Forecasting.”)

Shellenberg, Michael, *Apocalypse Never: Why Climate Alarmism Hurts us All*, Harper, 2020.

Stobaugh, Robert and Daniel Yergin, eds., *Energy Future: The Report of energy project at the Harvard Business School*, 3rd edition, 1983.

Tupy, Marian L. and Gale L. Pooley, *Superabundance: The Story of Population Growth, Innovation, and Human Flourishing on an Infinitely Bountiful Planet*, Cato Institute 2022.

World Economic Forum, “The Speed of the Energy Transition: Gradual or Rapid Change?” September 2019.

¹ Dalman, Axel and Mike Coffin, “Adapt to Survive: Why oil companies must plan for net zero and avoid stranded assets,” Carbontracker Initiative, September 2021, p. 4. SDS refers to the IEA’s Sustainable Development Scenario.

² World Economic Forum, “The Speed of the Energy Transition: Gradual or Rapid Change?” September 2019, p. 6.

³ Richard B Schmitt and Laurie P Cohen, “Exxon’s Flop in Field of Office Gear Shows Diversification Perils,” *Wall Street Journal*, , September 3, 1985

- ⁴ Rawleigh Warner, "Petroleum Faces Transition Period," in *Petroleum 2000: Oil & Gas Journal*, August 1977.
- ⁵ Anthony Parisi, "ARCO Pays 25 Million to Speed Solar Plan," NYT 1/16/80.
- ⁶ Michael Parrish, "Siemens Unit Sues ARCO for \$150 Million," Los Angeles Times, March 2, 1993.
- ⁷ http://nmenvirolaw.org/images/pdf/Ex_E.pdf
- ⁸ http://books.google.com/books?id=275R3CWhKjcC&pg=PA203&lpg=PA203&dq=Phillips+petroleum+fusion&source=bl&ots=75YBpMVGD0&sig=YP5XOxO3hSvB70oAoz_q7_lpGjk&hl=en&sa=X&ei=5TiUfGREYqN0QHmkIC4Bw&ved=0CDkQ6AEwAg#v=onepage&q=Phillips%20petroleum%20fusion&f=false **Fusion: The Search for Endless Energy**; By Robin Herman
- ⁹ Stobaugh and Yergin, p. 273.
- ¹⁰ Standard and Poors Industry Surveys, 11/15/84, p. 58.
- ¹¹ Standard and Poors Industry Outlook 8/7/80, Section 2, p. 63
- ¹² [The Fall of Enron - Bloomberg](#)
- ¹³ Frey, Darcy, "How Green is BP?" New York Times Magazine December 8, 2002.
- ¹⁴ <http://pickensplan.com/the-plan/>
- ¹⁵ Quoted in Lovins et al op cit.
- ¹⁶ "At Last, the Fuel Cell," *The Economist*, October 23, 1997.
- ¹⁷ International Energy Agency, *Global EV Outlook 2022*, p. 33.
- ¹⁸ [Alternative Fuels Data Center: Renewable Fuel Standard \(energy.gov\)](#)
- ¹⁹ <https://www.ica.org/reports/biofuels>
- ²⁰ This is a simplified description. Much more detail can be found in Lynch (2016) op. cit.
- ²¹ Romm, Joseph, "Michael Lynch, Wrong on Oil Prices for Over a Decade, is Wrong About Peak Oil," 9/26/2009, https://www.huffpost.com/entry/michael-lynch-who-predict_b_269877
- ²² Leggett, Jeremy, "Monbiot says he was wrong on peak oil but the crisis is undeniable," The Guardian 7/4/2012. <https://www.theguardian.com/environment/blog/2012/jul/04/monbiot-wrong-peak-oil>
- ²³ <https://www.resilience.org/stories/2008-01-15/peak-oil-jan-15/>; <https://energydigital.com/utilities/total-chairman-and-ceo-christophe-de-margerie>; <https://global.mongabay.com/news/bioenergy/2007/11/total-chief-warns-for-peak-oil.html>. Respectively for 85, 95, and 100 mb/d.
- ²⁴ In:
http://www.time.com/time/specials/packages/article/0,28804,1954176_1954175_1954172,00.html#ixzz0dFIJX8EJ
- ²⁵ <https://www.resilience.org/stories/2009-09-03/michael-lynch-daniel-yergin-denizens-peak-oil-denial/>
- ²⁶ Superabundance, op. cit.