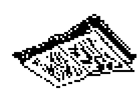
A Useful Primer on Oil and Energy

Book Review by John Attarian

In this concise book for non-specialists David Goodstein, vice provost and physics professor at the California Institute of Technology, explains the science underlying our energy situation. Goodstein aims at enabling readers to understand not only our problem, but also "the opportunities and limitations nature has provided" – that is, what we can and can't do about it. He succeeds admirably.

For millennia we used energy then produced by the sun – plant, animal, wind, and so on. About two centuries ago we switched to, and became dependent upon, energy-rich but finite fossil fuels. "Obviously," Goodstein observes, "we have unintentionally created a trap for ourselves." If we turn to coal and natural gas as conventional oil extraction declines, we may preserve our way of life until these too run out, approximately by the century's end. By that time, the resultant increase in atmospheric carbon dioxide may make Earth uninhabitable. "Even if human life does go on, civilization as we know it will not survive, unless we can find a way to live without fossil fuels."

Out of Gas: The End of the Age of Oil
by David Goodstein
New York and London: W. W. Norton, 2004
140 pages, $21.95 hardcover



Goodstein does well at explaining M. King Hubbert's famous prediction that America's annual oil extraction would peak and decline, and the application of Hubbert's approach to world oil extraction, which will probably peak in this decade. He also explains that unconventional, heavy oil is hard to extract and may not come on stream fast enough to offset the oil shortage; that natural gas and coal are also depleting; and that nuclear fission is useful only for power plants and very large ships and submarines.

Economists argue that high oil prices will make other fuels competitive and that substitutes will replace oil. Goodstein gives this argument short shrift. For one thing, an oil shortage "can be immediate and drastic," whereas replacing the huge infrastructure of oil products' manufacture and distribution may take decades. Moreover, the inflation caused by high oil prices may inflict so much economic damage that we may be unable to replace oil – an important point many pundits miss.

Huge new oil discoveries aren't likely, Goodstein warns, and even if they happen, they won't help much. Finding another field equivalent to Saudi Arabia's 87-billion-barrel Ghawar would delay the peak by only a year or two. A major issue, he rightly stresses, is how fast the gap between oil supply and demand will grow once the peak is passed. He estimates its growth at 5 percent a year, meaning that ten years after the peak we must have sufficient substitutes available to replace *half* the oil we now use, or 10 to 15 billion barrels a year, which he warns will be very difficult. Conservation could alleviate our situation, but powerful interests are resisting it.

Goodstein handily demolishes various myths, such as the belief that fossil fuels will last for hundreds of years, which is based on the ratio of reserves to current production. This ratio ignores the growth in consumption of fuels and thus greatly overstates how long they will last.

Having made these useful points, Goodstein turns to describing energy itself (kinetic, potential, thermal, etc.), how the law of conservation of energy was discovered, electricity, entropy, and how the greenhouse effect influences our climate. By trapping enough solar energy to warm Earth's surface,

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greenhouse gases make life possible, but burning fossil fuels has increased the atmospheric concentration of carbon dioxide by about 30 percent, from 275 parts per million before the industrial era to 370 ppm today. Continued fossil fuel burning may raise it to 550 ppm by century's end, with possibly dire consequences. "Could it be that Hubbert's peak will save us from destroying our planet?"

"The crisis may not hit until the next decade or the one following, but hit it will."

Goodstein also explains how heat engines such as steam engines work, turning heat (thermal energy) at high temperature into work and shedding some heat at low temperature in order to keep operating, and contrasts them with electric motors, which, not needing to discard heat, are far more efficient. Batteries, however, have limited storage capacity. As for fuel cells, hydrogen is not an energy source and must be produced by burning fuels. With current technology, generating a given volume of hydrogen "would require consuming in heat engines about six times as much fuel as the hydrogen would replace." In this light, the "hydrogen economy" doesn't look so promising.

So what can we do? Goodstein ably surveys proposed technical fixes. Putting carbon dioxide in the oceans to avert overheating the planet might endanger marine life. Nuclear fission's energy potential is constrained by finite uranium supplies, and plutonium, which breeder reactors can generate from uranium, is easily made into weapons. Energy from nuclear fusion remains elusive, as does large-scale use of wind and solar power. Goodstein concludes that "the best, most conservative bet for ameliorating the coming fuel crisis is the general improvement of existing technologies" to use fuels more efficiently. He also looks to as-yet-undeveloped technologies such as safe breeder reactors, more efficient fuel cells, and better means of generating hydrogen. Developing them requires a massive commitment to research that we have yet to make.

But what if the Hubbert peak school is wrong? British Petroleum's web site shows world-proved oil reserves growing from 0.7 trillion barrels in 1981 to 1 trillion barrels in 1991 to 1.03 trillion in 2001. These figures seemingly debunk the Hubbert school — but Goodstein correctly observes that they reveal a collapsing rate of growth in proved reserves, a consequence of declining oil discovery. He concludes "There is no doubt at all that the essence of the Hubbert peak view is correct."

Peak prediction is inexact, so the crisis may not hit until the next decade or the one following, but hit it will. We can probably cope with it if we apply ourselves. Unfortunately, as he points out, our national and international leadership is reluctant to admit that the problem exists.

Throughout, Goodstein's prose is lean and lucid. His understanding of the energy situation is excellent, and his calm tone and impeccable scientific credentials lend him credibility. While his discussion of energy conservation, entropy, and so on could perhaps be better integrated with the discussion of oil depletion, it is nevertheless outstandingly clear. For the general reader with little or no knowledge of scientific principles and the energy problem, *Out of Gas* is probably the best place to start. •

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His newest on-line essay, "Small Islands: Harbingers of Earth's Ecological Fate," is posted at the site for Ethics in Science and Environmental Politics (ESEP) and can be accessed free of charge at http://www.int-res.com/articles/esep/2004/E48.pdf.

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