Book Review by Joseph Coates from *Technological Forecasting and Social Change*

Energy Needs, Choices, and Possibilities, Scenarios to 2050

The Global Business Environment, *Shell International 2001, 60 pp.*

The shell game was a common swindle, familiar on the streets of New York. The idea is simple, The swindler, standing at a table, places a pea under one of three half walnut shells and then moves the shells about at a rapid pace. The interested viewer places a bet that he can tell where the pea is. After close attention, he usually loses and never quite understands why.

The Royal Dutch Shell Group has its own Shell game, in the form of scenarios that are produced every few years and used internal to the company to stimulate discussion and promote planning. Recently, they have been offered to the public to broaden understanding of energy futures and to stimulate feedback. The Shell game, i.e., the scenarios produced, is much like the New York shell game in that one reads the scenarios with close attention to detail. They have a great deal of scope and plausibility, present relatively tight-knit arguments, and come to conclusions which you, the reader, may find certain, likely, plausible, or possible and then act accordingly, "accordingly" being the equivalent of placing your bet.

The similarity stops there. The Shell game is surely not a swindle, but a marvelously effective presentation of how, in this case, the energy situation might look in 2050. There is a clear explanation of what scenarios are about:

> Scenarios are a tool for helping managers plan for the future—or rather for different possible futures. They help us focus on critical uncertainties. On the things we don't know about which might transform our business. And on the things we do know about in which there might be unexpected discontinuities. They help us understand the limitations of our 'mental maps' of the world - to think the unthinkable, anticipate the unknowable and utilize both to make better strategic decisions. (p. 6)

The report is in four parts. The first is a general introduction to energy choices and context. The second part is a scenario emphasizing dynamics as usual, "A world where social priorities for 'clean,' 'secure,' and ultimately 'sustainable' energy shape the system." The third presents a quite different scenario in which consumer preferences drive toward a hydrogen economy. A small fourth section draws some conclusions. A wrap-up of one page is a tight summary of statistics and conversion factors.

The high points of the scenarios are the well-done and informative graphics throughout, many of which are to my mind unique, at least as graphic presentations.

The foreword states three fundamental challenges over the next 50 years:

- Giving all people access to the benefits of efficient, commercial energy from which nearly a fifth of us are still excluded.
- Meeting the expanding and shifting energy needs of an urbanizing world as economic development raises the living standards of billions of people.
- Preventing the pollution that damages 'health, blights environments, and threatens vital natural systems.

Each of the scenarios addresses in its own way the same seven questions:

- When will oil and gas resources cease to meet rising demand, and what will replace oil in transport?
- Which technology will win the race to improve the environmental standards of vehicles?
- How will demand for distributed power shape the energy system?
- Who will drive the market growth and cost reduction of renewable energy sources, and how will energy storage for intermittent renewables like solar and wind be solved?
- How might a hydrogen infrastructure develop?
- How will emerging economies like China and India balance rapidly growing energy needs with rising import dependence and environmental effects?
- Where will social and personal priorities lie and how will these affect energy choices?

The report is chock full of interesting points. For example, gross domestic product in terms of purchasing power parity at a US $3000-per-year income has demand for industrialization and personal mobility taking off. At US $1O,OOO, demand slows as the main spurt of industrialization is completed. At US$15,OOO, demand grows more slowly than income as services dominate. At US $25,OOO, economic growth requires little additional energy. Following the pattern of 3.5% growth per year in the past half-century, average global per-capita income will be US $20,000 in 2050. Then consumer preferences will be reflected in the increasing need for cleanliness, environmental and health considerations, and growing value placed on flexibility, time-saving, and avoiding disruption.

Two other big factors in energy futures are liberalized markets and global energy demand. The report sees on a per capita basis demand being satisfied about 15% above present European Union consumption. The scenario background then goes on with other considerations to form the context for the scenarios.

Energy resources, new technology, and social-personal priorities are laid out as shaping issues.

If you were using this book in a group context, a classroom, or a think session, I would stop at this point in the book and have the group create their own scenario in terms of the considerations and parameters mentioned above, to compare with those later in the text.

The first scenario anticipates substantial improvements in the efficiency of vehicles involving hybrid engines and other configurations, and a boom and then a bust in the employment of renewables: The energy system is seen to be diverse and complex in terms of fuels and the technologies for generating and employing them. Electrical energy becomes the dominant energy carrier. The critical point is made in the scenarios that electricity is not an energy source but an energy carrier, carrying energy created from basic sources such as coal, oil, and nuclear. The scenario anticipates an oil scarcity so that by 2040 there will be an expansion in bio-fuels.

The second scenario, on, the spirit of the coming age, emphasizes a breaking of paradigms. Cars are powered by fuel cells, being cleaner, quieter, and higher-performance and having all kinds of electrical services, including digital communication, pre-entry heating and cooling, and in-car entertainment. They have a charming picture of what looks like a bicycle being powered by fuel cells, with the seat of the bicycle resting above the hydrogen container. The details of the production, generation, and distribution of hydrogen are adequately covered in terms of the limited scope of the report. Chinese leapfrog into a hydrogen economy and we, eventually, from the growing use of the fuel cells as heat and power sources create an expanding demand for hydrogen that leads to a new infrastructure.

In this brief review, I can only note that the authors cite five common features to the scenarios:

1. the important role of natural gas as a bridge fuel over at least the next two decades and the importance of reducing supply security fears;
2. the disruptions that oil markets will face as new vehicle technologies diffuse;
3. the shift towards distributed or decentralized heat and power supply for economic and social reasons;
4. the potential for renewables to be the eventual primary source of energy and the importance of robust energy storage solutions;
5. the difficulty of identifying winning services or technologies in a period of high innovation and experimentation (p. 58).

The document is well worth reading and working with by anyone with early to substantial understanding of energy futures. It serves its purpose well as a stimulant to thinking. Following are a couple of points to consider that I see are unfortunate with regard to the Shell concept of scenarios, and then some specifics on content worth noting. The writers and company policy is to not have the Shell scenarios labeled as forecasts. Yet why would a global corporation of enormous scope and sophistication put forward scenarios that were not plausible, or at least possible? They seem to want to have it both ways, by making the scenarios meet criteria of context and plausibility, yet denying them to be forecasts. They are obviously trying to get away from the question of how likely each scenario is. That evasion muddies the waters and confuses the reader as to what the functions, use, and reliability of the scenarios are. They are only stimulating and interesting and worth our time if they have some substantial plausibility.

The second point is that the material is extremely well written, easy to follow, and straightforward, but it is oh-so-corporate bland. There is no life to it, no sense of the influence of people on the decision process, nothing but the abstract politics of what might evolve, how the decisions might come about, and by whom. There is nothing about the human and social side of changing attitudes leading to social and economic change. A further difficulty, quite understandable from an enormously large corporation fundamentally, is being hooked on the free market system as the primary means of generating, distributing, and using energy.

Third, the scenarios are not nonnative. It could be invaluable to Shell to try its hand at creating a scenario of its desirable future and how to get there.

Some miscellaneous comments on the Shell paper may be worth considering. In the energy supply forecast, the scenarios ignore gas hydrates. These are complexes formed from a molecule of methane being surrounded by a cage of water molecules. They form naturally at proper conditions of pressure and relative cold. Some estimates are that the known deposits of gas hydrates are five or more times greater than the total known reserves of petroleum and natural gas together. The introduction of heat breaks up the complex and the methane bubbles free. Methane is the main component of natural gas. Gas hydrates could radically alter the future energy picture by adding decades to our carbon fuel supply, presumably at some increment in cost, which in turn would lead to conservation measures. On the other hand, the availability of gas hydrates becomes irrelevant if we have to move to radical energy alternatives to carbon sources because of greenhouse warming.

It was good to see the scenario give a nod of warning about methanol, otherwise known as methyl alcohol, as a potential fuel by citing possible health problems. Years ago, the Brookings Institution had a report out on new automotive fuels that was rather positive on methanol. I called one of the two authors and pointed out that methanol was a neurotoxin and was widely known, particularly during the

prohibition era, for causing blindness in people who mistook it for ordinary drinkable ethyl alcohol. The response to my call was so much disbelief that I was effectively dismissed by her attitude proclaiming me to be a nut case. I later contacted the Environmental Protection Agency (EPA) and pointed out that methanol was a neurotoxin, and the response to that was even more bizarre. They were aware of its toxicity but believed that by the time methanol came in as a significant fuel, the electronic controls in the automobile would be such that no car would ever be out of tune. I asked what percentage of cars was out of tune then and what special mechanism was going to police the nation in the future to be sure all cars are in tune. We did not end that conversation on a cordial note.

The scenarios assume that atmospheric carbon dioxide will stabilize at about 550 ppm by volume, substantially higher than the present concentration. There is no discussion that would be either assuring or disquieting on what the effects of that might be on the biota, on the growth of plants, on the respiration of animals, and so on. In our species, one of the factors controlling the rate of breathing is the concentration of carbon dioxide in the blood, presumably at some substantially higher atmospheric concentration than today's, there would be adjustment problems.

A last point: The report, neither in contextual background nor in scenario one, addresses the question of whether with a suitable stimulus the automobile industry could, in a reasonable time period, develop greatly improved internal combustion engines ("improved" miles per gallon of fuel). There is no reason to believe that the automobile industry has exhausted the possibilities for new engines or materials research that would allow one to raise the operating temperatures of current engines substantially higher and thereby make them more efficient.

Energy Needs, Choices and Possibilities, Scenarios to 2050
is available from the Shell company Web site:

www.shell.com