

THE THIRD WAVE

BY ALVIN TOFFLER

THE THIRD WAVE, SELECTED EXCERPTS

Living Batteries

The precondition of any civilization, old or new, is energy. First Wave societies drew their energy from "living batteries" -- human and animal muscle-power -- or from sun, wind, and water. Forests were cut for cooking and heating. Waterwheels, some of them using tidal power, turned millstones. Windmills creaked in the fields. Animals pulled the plow. As late as the French Revolution, it has been estimated, Europe drew energy from an estimated 14 million horses and 24 million oxen. All First Wave societies thus exploited energy sources that were renewable. Nature could eventually replenish the forests they cut, the wind that filled their sails, the rivers that turned their paddle wheels. Even animals and people were replaceable "energy slaves."

All Second Wave societies, by contrast, began to draw their energy from coal, gas, and oil -- from irreplaceable fossil fuels. This revolutionary shift, coming after Newcomen invented a workable steam engine in 1712, meant that for the first time a civilization was eating into nature's capital rather than merely living off the interest it provided.

This dipping into the earth's energy reserves provided a hidden subsidy for industrial civilization, vastly accelerating its economic growth. And from that day to this, wherever the Second Wave passed, nations built towering technological and economic structures on the assumption that cheap fossil fuels would be endlessly available. In capitalist and communist industrial societies alike, in East and West, this same shift has been apparent -- from dispersed to concentrated energy, from renewable to non-renewable, from many different sources and fuels to a few. Fossil fuels formed the energy base of all Second Wave societies.

The Commanding Heights

On August 8, 1960, a West Virginia-born chemical engineer named Monroe Rathbone, sitting in his office high over Rockefeller Plaza in Manhattan, made a decision that future historians might some day choose to symbolize the end of the Second Wave era.

Few paid any attention that day when Rathbone, chief executive of the giant Exxon Corporation, took steps to cut back on the taxes Exxon paid to the oil-producing countries. This decision, though ignored by the Western press, struck like a thunderbolt at the governments of these

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.

MAX PLANCK (1858-1947),
FORMULATOR OF THE
QUANTUM THEORY
WHICH HAS LAID A NEW
BASIS FOR PHYSICS, IN HIS
SCIENTIFIC
AUTOBIOGRAPHY.

countries, since virtually all their revenues derived from oil company payments.

Within a few days the other major oil companies had followed Exxon's lead. And one month later, on September 9, in the fabled city of Baghdad, delegates of the hardest-hit countries met in emergency council. Backed to the wall, they formed themselves into a committee of oil-exporting governments. For fully thirteen years the activities of this committee, and even its name, were ignored outside the pages of a few petroleum industry journals. Until 1973, that is, when the Yom Kippur War broke out and the Organization of Petroleum Exporting Countries suddenly stepped out of the shadows. Choking off the world's supply of crude oil, it sent the entire Second Wave economy into a shuddering down-spin.

What OPEC did, apart from quadrupling its oil revenues, was to accelerate a revolution that was already brewing in the Second Wave techno-sphere.

The Sun and Beyond

In the earsplitting clamor over the energy crisis that has since followed, so many plans, proposals, arguments, and counter-arguments have been hurled at us that it is difficult to make sensible choices. Governments are just as confused as the proverbial man in the street.

One way to cut through the murk is to look beyond the individual technologies and policies to the principles underlying them. Once we do, we find that certain proposals are designed to maintain or extend the Second Wave energy base as we have known it, while others rest on new principles. The result is a radical clarification of the entire energy issue.

The Second Wave energy base, we saw earlier, was premised on non renewability; it drew from highly concentrated, exhaustible deposits; it relied on expensive, heavily centralized technologies; and it was non diversified, resting on a relatively few sources and methods. These were the main features of the energy base in all Second Wave nations throughout the industrial era.

Bearing these in mind, if we now look at the various plans and proposals generated by the oil crisis we can quickly tell which ones are mere extensions of the old and which are forerunners of something fundamentally new. And the basic question becomes not whether oil should sell at forty dollars per barrel or whether a nuclear reactor should rise at Seabrook or Grohnde. The larger question is whether any energy base designed for industrial society and premised on these Second Wave principles can survive. Once asked in this form, the answer is inescapable.

Through the past half-century, fully two thirds of the entire world's energy supply has come from oil and gas. Most observers today, from the most fanatic conservationists to the deposed Shah of Iran, from solar freaks and Saudi sheiks to the button-down, briefcase-carrying experts of many governments, agree that this dependency on fossil fuel cannot continue indefinitely, no matter how many new oil fields are discovered.

History is instructive. Technologies introduced at critical junctures almost always generate a great leap in economic development. In the 19th century in the United States it was construction of the transcontinental railway. In the 20th century, three developments -- electric power, the automobile, and the interstate system -- gave birth to new industries and accelerated job production.

JOHN NAISBITT,
GLOBAL PARADOX

Statistics vary. Disputes rage over how long the world has before the ultimate crunch. The forecasting complexities are enormous and many past predictions now look silly. Yet one thing is clear: no one is pumping gas and oil back into the earth to replenish the supply.

Whether the end comes in some climactic gurgle or, more likely, in a succession of dizzyingly destabilizing shortages, temporary gluts, and deeper shortages, the oil epoch is ending. Iranians know this. Kuwaitis and Nigerians and Venezuelans know it. Saudi Arabians know it -- which is why they are racing to build an economy based on something other than oil revenues. Petroleum companies know it -- which is why they are scrambling to diversify out of oil. (One president of a petroleum company told me at a dinner in Tokyo not long ago that, in his opinion, the oil giants would become industrial dinosaurs, as the rail roads have. His time frame for this was breathtakingly short -- years, not decades.)

However, the debate over physical depletion is almost beside the point. For in today's world it is price, not physical supply, that has the most immediate and significant impact. And here, if anything, the facts point even more strongly to the same conclusion.

In a matter of decades energy may once more become abundant and cheap as a result of startling technological breakthroughs or economic swings. But whatever happens, the relative price of oil is likely to continue its climb as we are forced to plumb deeper and deeper depths, to explore more remote regions, and to compete among more buyers. OPEC aside, an historic turn has taken place over the past five years: despite massive new discoveries like those in Mexico, despite skyrocketing prices, the actual amount of confirmed, commercially recoverable reserves of crude oil has shrunk, not grown -- reversing a trend that had lasted for decades. Further evidence, if needed, that the petrolic era is screeching to a halt.

Meanwhile, coal, which has supplied most of the remaining third of the world energy total, is in ample supply, though it, too, is ultimately depletable. Any massive expansion of coal usage, however, entails the spread of dirty air, a possible hazard to the world's climate (through an increase of carbon dioxide in the atmosphere), and a ravaging of the earth as well. Even if all these were accepted as necessary risks over the decades to come, coal cannot fit into the tank of an automobile nor carry out many other tasks now performed by oil or gas. Plants to gasify or liquefy coal require staggering amounts of capital and water (much of it needed for agriculture) and are so ultimately inefficient and costly that they, too, must be seen as no more than expensive, diversionary, and highly temporary expedients.

Nuclear technology presents even more formidable problems at its present stage of development. Conventional reactors rely on uranium, yet another exhaustible fuel, and carry safety risks that are extremely costly to overcome -- if, indeed, they ever can be. No one has convincingly solved the problems of nuclear waste disposal, and nuclear costs are so high that until now government subsidies have been essential to make atomic power remotely competitive with other sources.

**At every crossway
on the road that
leads to the future,
there stands 10,000
men to guard the
past.**

AUTHOR UNKNOWN

Fast breeder reactors are in a class by themselves. But while often presented to the uninformed public as perpetual motion machines because the plutonium they spew out can be used as a fuel, they, too, remain ultimately dependent upon the world's small and non-renewable supply of uranium. They are not only highly centralized, incredibly costly, volatile, and dangerous, they also escalate the risks of nuclear war and terrorist capture of nuclear materials.

None of this means that we are going to be thrown back into the middle ages, or that further economic advance is impossible. But it surely means that we have reached the end of one line of development and must now start another. It means that the Second Wave energy base is unsustainable.

Indeed, there is yet another, even more fundamental reason why the world must and will shift to a radically new energy base. For any energy base, whether in a village or an industrial economy, must be suited to the society's level of technology, the nature of production, the distribution of markets and population, and many other factors.

The rise of the Second Wave energy base was associated with society's advance to a whole new stage of technological development. And while fossil fuels certainly accelerated technological growth, the exact reverse was also true. The invention of energy-thirsty, brute technology during the industrial era spurred the ever-more-rapid exploitation of those very fossil fuels. The development of the auto industry, for example, caused so radical an expansion of the oil business that at one time it was essentially a dependency of Detroit. In the words of Donald E. Carr, formerly an oil company research director, and author of *Energy and the Earth Machine*, the petroleum industry became "a slave to one form of internal combustion engine."

Today we are once more at the edge of an historic technological leap, and the new system of production now emerging will require a radical restructuring of the entire energy business -- even if OPEC were to fold its tent and quietly steal away.

For the great overlooked fact is that the energy problem is not just one of quantity; it is one of structure as well. We not only need a certain amount of energy, but energy delivered in many more varied forms, in different (and changing) locations, at different times of the day, night, and year, and for undreamed-of purposes.

This, not simply OPEC's pricing decisions, explains why the world must search for alternatives to the old energy system. That search has been accelerated, and we are now applying vast new resources of money and imagination to the problem. As a result we are taking a close look at many startling possibilities. While the shift from one energy base to the next will no doubt be darkened by economic and other upheavals, there is another, more positive aspect to it. For never in history have so many people plunged with such fervor into a search for energy -- and never have we had so many novel and exciting potentials before us.

It is clearly impossible to know at this stage which combination of technologies will prove most useful for what tasks, but the array of tools

**All great truths begin
as blasphemies.**

GEORGE BERNARD SHAW

and fuels available to us will surely be staggering, with more and more exotic possibilities becoming commercially plausible as oil prices climb.

These possibilities range from photovoltaic cells that convert sunlight into electricity (a technology now being explored by Texas Instruments, Solarex, Energy Conversion Devices, and many other companies), to a Soviet plan for placing windmill-carrying balloons in the tropopause to beam electricity down to earth through cables. New York City has contracted with a private firm to burn garbage as fuel and the Philippine Islands are building plants to produce electricity from coconut waste. Italy, Iceland, and New Zealand are already generating electricity from geothermal sources, tapping the heat of the earth itself, while a five-hundred-ton floating platform off Honshu island in Japan is generating electricity from wave power. Solar heating units are sprouting from rooftops around the world, and the Southern California Edison Company is constructing a "power-tower" which will capture solar energy through computer-controlled mirrors, focus it on a tower containing a steam boiler, and generate electricity for its regular customers. In Stuttgart, Germany, a hydrogen-powered bus built by Daimler-Benz has cruised the city streets, while engineers at Lockheed California are working on a hydrogen-powered aircraft. So many new avenues are being explored, they are impossible to catalog in a short space.

When we combine new energy-generating technologies with new ways to store and transmit energy, the possibilities become even more far-reaching. General Motors has announced a new, more efficient auto mobile battery for use in electric cars. NASA researchers have come up with "Redox" -- a storage system they believe can be produced for one third the cost of conventional lead acid batteries. With a longer time horizon we are exploring superconductivity and even -- beyond the fringes of "respectable" science -- Tesla waves as ways of beaming energy with minimal loss.

While most of these technologies are still in their early stages of development and many will no doubt prove zany impractical, others are clearly on the edge of commercial application or will be within a decade or two. Most important is the neglected fact that big breakthroughs often come not from a single isolated technology but from imaginative juxtapositions or combinations of several. Thus we may see solar photovoltaics used to produce electricity which will, in turn, be used to release hydrogen from water so it can be used in cars. Today we are still at the pre-takeoff stage. Once we begin to combine these many new technologies, the number of more potent options will rise exponentially, and we will dramatically accelerate the construction of a Third Wave energy base.

This new base will have characteristics sharply different from those of the Second Wave period. For much of its supply will come from renewable, rather than exhaustible sources. Instead of being dependent upon highly concentrated fuels, it will draw on a variety of widely dispersed sources. Instead of depending so heavily on tightly centralized technologies, it will combine both centralized and decentralized energy

The cosmic age will bring a dawn of knowledge not yet envisioned. It will dwarf all our present knowledge and ideas and, through its vastness, may even bring men closer together on their own planet.

WERNHER VON BRAUN

production. And instead of being dangerously over reliant on a handful of methods or sources, it will be radically diversified in form. This very diversity will make for less waste by allowing us to match the types and quality of energy produced to the increasingly varied needs.

In short, we can now see for the first time the outlines of an energy base that runs on principles almost diametrically opposed to those of the recent, three-hundred-year past. It is also clear that this Third Wave energy base will not come into being without a bitter fight. In this war of ideas and money that is already raging in all the high technology nations, it is possible to discern not two but three antagonists. To begin with, there are those with vested interests in the old, Second Wave energy base. They call for conventional energy sources and technologies -- coal, oil, gas, nuclear power, and their various permutations. They fight, in effect, for an extension of the Second Wave status quo. And because they are entrenched in the oil companies, utilities, nuclear commissions, mining corporations, and their associated trade unions, the Second Wave forces seen unassailably in charge.

By contrast, those who favor the advance to a Third Wave energy base -- a combination of consumers, environmentalists, scientists, and entrepreneurs in the leading-edge industries, along with their various allies -- seem scattered, under-financed, and often politically inept. Second Wave propagandists regularly picture them as naive, unconcerned with dollar realities, and bedazzled by blue-sky technology.

Worse yet, the Third Wave advocates are publicly confused with a vocal fringe of what might best be termed First Wave forces -- people who call not for an advance to a new, more intelligent, sustainable, and scientifically based energy system, but for a reversion to the pre-industrial past. In extreme form, their policies would eliminate most technology, restrict mobility, cause cities to shrivel and die, and impose an ascetic culture in the name of conservation.

By lumping these two groups together the Second Wave lobbyists, public relations experts, and politicians deepen the public confusion and keep the Third Wave forces on the defensive.

Nevertheless, supporters of neither First nor Second Wave policies can win in the end. The former are devoted to a fantasy, and the latter are attempting to maintain an energy base whose problems are intractable -- in fact, insuperable.

The relentlessly rising cost of Second Wave fuels works strongly against the Second Wave interests. The skyrocketing capital cost of Second Wave energy technologies works against them. The fact that Second Wave methods often require heavy inputs of energy to eke out relatively small increments of new "net" energy works against them. The escalating problems of pollution work against them. The nuclear risk works against them. The willingness of thousands in many countries to battle the police in order to stop nuclear reactors or strip mines or giant generating plants works against them. The tremendous rising thirst of the non-industrial world for energy of its own, and for higher prices for its resources, works against them.

The resistance to a new idea is proportional to the square of its importance.

BERTRAND RUSSELL

If man is to survive in peace with his fellows, he must develop further understanding of life itself and the energies surrounding life. Then he may have a better understanding of his place in the Universe.

DR PATRICK FLANAGAN

In short, though nuclear reactors or coal gasification or liquefaction plants and other such technologies may seem to be advanced or futuristic and therefore progressive, they are, in fact, artifacts of a Second Wave past caught in its own deadly contradictions. Some may be necessary as temporary expedients, but they are essentially regressive. Similarly, though the forces of the Second Wave may seem powerful and their Third Wave critics feeble, it would be foolish to bet too many chips on the past. Indeed, the issue is not whether the Second Wave energy base will be overthrown, superseded by a new one, but how soon. For the struggle over energy is inextricably intertwined with an other change of equal profundity: the overthrow of Second Wave technology.