1. The Past: Historical Perspectives

If, then, you ask me to put into one sentence the cause of . . . recent, rapid, and enormous change, and the prognosis for the achievement of human liberty, I should reply, It is found in the discovery and utilization of the means by which heat energy can be made to do man's work for him.

Robert Millikan (1940)
Nobel Prize Winner, Physics

The Arab oil embargo of 1973 and subsequent increases in the price of petroleum products have focused public attention on America's dependence on energy. Even beyond this so-called energy crisis, experts now warn of impending shortages not only of petroleum but of all natural resources. Representative of the thinking of this now popular neo-Malthusian gloom-and-doom school are Ehrlich's *The End of Affluence*, Watt's *The Titanic Effect*, Meadows's *Limits to Growth*, Daly's *Toward a Steady State Economy*, Melman's *Our Depleted Society*, and the Ford Foundation's *A Time to Choose.*

The common theme of these books is compelling: the world's supply of natural resources is finite; the exponential extrapolation of trends in resource consumption shows the world running out of resources in the next century; therefore, we must conserve or face extinction. These authors marshall considerable evidence to show that, indeed, there are physical limits to growth.

How might decision makers and concerned citizens evaluate these pessimistic forecasts? Because the future does not yet exist, it is rather difficult to assess objectively whether energy and other resource shortages will lead the world to imminent doom as the experts predict.

One way of evaluating future forecasts is to look at historical precedents to gain at least some perspective—no matter how flawed the past might be as a mirror of the future. The first thing evident when reviewing the historical data is that in isolation energy has had little effect on social change. The discovery of fire without doubt raised man an additional notch above the apes, and the use of the sun's rays to nourish crops clearly was and is essential for life, but it has only

been when man has used technology to harness energy that significant social change has occurred.

The use of the hoe to increase the efficiency of the first farmers and the later use of the ox before the plough to increase man's puny muscle power geometrically were prerequisites of the most profound of all social changes: the transformation of human society from nomadic bands of hunters and gatherers to settled communities of cultivators of crops and domesticators of animals. Once settled at the fork of some African or Asian river, early man began his ascent to civilization. Eventually, however, he discovered that he needed more than animal energy. He then built a waterwheel. But the shallow, slow-moving river could not for long match his rising expectations of the power he needed. At some time lost to history, he then built a dam on the river. This process—higher energy needs → new technology → even higher energy needs—has been escalating ever since.

Thus, the first perspective gained from history is that *energy is scarce or abundant only relative to available technologies*, which is a rather basic point unfortunately overlooked in the *Limits to Growth* and other recent energy studies.

History is similarly instructive on other fronts. A second perspective well worth consideration is that *a minor technological breakthrough can have profound social and political implications.* Medieval historian Lynn White has provided the quintessential documentation of this point.[1] In the sixth century Northwestern Europe was little more than a battleground for constantly warring tribes over whom no one political power could exert hegemony. It was not until the reigns of Carolingians—Martel, Carloman, and Pepin—that political order under a strong central monarchy was established. Remarkably, the device that facilitated the establishment of a feudal system in France was the simple stirrup. Until the Carolingians introduced the stirrup, warfare in Europe had been conducted by bands of men running around the countryside wielding swords and axes or shooting arrows—a rather inefficient way to bring about political order. What was needed was a kind of medieval tank—the armed knight on horse-

back. But without a stirrup, a heavily armed knight with both hands on a broadsword could be knocked off a horse by even a mild gust of wind. In such a precarious position, fighting was simply out of the question. If both hands were not on the reins, the knight had to hold himself on the steed with his feet. With the introduction of the simple stirrup, the Carolingians came to be served by an efficient fighting machine. Martel then reorganized his realm along feudal lines to make it possible to support great numbers of mounted fighters. He seized church lands and distributed them to his vassals on condition that they served him, their liege, as knights. According to White, the duty of knight's service thus became the touchstone of feudalism.

The knights needed land as a kind of logistical lifeline to support their chivalrous duties. They needed land to raise and feed their many horses, to support a retinue of retainers, and the wealth it created to provide the leisure time for a warrior's lengthy apprenticeship.

White writes that change in the number and mix of people engaged in a basic endeavor (such as agriculture, war, factory work) modifies the whole of society: population, wealth, political relationships, leisure and cultural expression. In sum, it is White's thesis that in medieval France the introduction of a simple technological device, the stirrup, created

> a new form of Western European society dominated by an aristocracy of warriors endowed with land so they might fight in a new and highly specialized way. Inevitably this nobility developed cultural forms and patterns of thought and emotion in harmony with its style of mounted shock combat and its social posture; as Denholm Young has said: "It is impossible to be chivalrous without a horse."[2]

The introduction of the heavy plough in Northern Europe several centuries later had an impact on society as great as that of the stirrup. This rather sophisticated plough opened up the richest lands for cultivation and made possible the surplus food needed for population

growth, urbanization, specialization, and the growth of leisure.[3] Eventually it created the necessary conditions for the germination of petty capitalism. Significantly, the plough needed eight oxen to pull it through the rain-heavy soil of Germany and other northern countries. This led to a cooperative manorial economy in Northern Europe as opposed to the individualistic economy that developed in Southern Europe where one ox could pull the plough through the dry sun-baked soil. White cites other examples of technology influencing social change: In the seventeenth and eighteenth centuries, Turnip Townshend and other agronomists developed root and fodder crops that produced surplus food that freed additional labor from the fields for work in the factories of the industrial revolution.[4]

It might seem from this evidence that human history is determined by technological change—that once a breakthrough is made, man will inevitably adopt it and, in the process, have his society changed by it. Not so, says White. This is a third important perspective to be gained from history: *man is free to choose among available technologies and free to use them in different ways.* The stirrup, for example, had been known for centuries and in many different cultures, but for some complex reason it was the Carolingians who adopted it in Europe and it was they who saw its warfare and political potential. White explains that

> As our understanding of the history of technology increases, it becomes clear that a new device merely opens a door, it does not compel one to enter. The acceptance or rejection of an invention, or the extent to which its implications are realized if it is accepted, depends quite as much upon the conditions of a society, and upon the imagination of its leaders, as upon the nature of the technological item itself.[5]

White's historical interpretations cast the "inevitability" of some of the more pessimistic future forecasts into considerable doubt.

Another significant perspective to be gained from history is that

transitions from one form of energy to another—even those involving the depletion of a major source of energy—are not necessarily fraught with disaster. For example, during the twelfth and thirteenth centuries, men became frustrated by the constraints of animal power and began in earnest to attempt to harness natural forces to provide energy. They used windmills, water mills, treadmills, gravity, magnetism, and mechanical devices such as the cam, the crank, and the flywheel. They even developed a one-cylinder internal combustion engine—the cannon. (White argues that their success is attested to by the ruling of Pope Celestine III in the 1190s that windmills must pay tithes.)[6] Medieval man even searched for a perpetual motion machine—with obvious parallels to our own almost alchemistic hopes for fission breeders and fusion reactors. In 1260, Roger Bacon forecast that

> Machines may be made by which the largest ships, with only one man steering them, will be moved faster than if they were filled with rowers; wagons may be built which will move with incredible speed and without the aid of beasts; flying machines can be constructed in which a man . . . may beat the air with wings like a bird . . . machines will make it possible to go to the bottom of seas and rivers.[7]

Through a combination of futuristic dreaming and practical engineering, man has historically been able to use technology to meet his energy needs—which are really escalating wants or desires. However, from time to time there have been dislocations in the process. In the sixteenth century, the price of hardwood for fuel dramatically increased throughout Europe, because the demand for fuel was increasing at the same time as alternative use of hardwood for ship construction and furniture was on the rise.[8] The response to this early energy crisis was the development of technology to use coal as a replacement for wood as a basic energy source. Significantly, this change required new inventions to be able to smelt iron using coal rather than wood as the fuel. At the time these innovations may not have seemed important, but they laid the technological groundwork for the coming

industrial revolution—an enormous transformation that could not have been fueled on wood.

In the last century, another energy crisis occurred when the whale oil needed to light the lamps of America grew increasingly scarce. Although there may have been some panic at the time, it has been forgotten now. What is recalled is the resourceful way in which Americans began to exploit their previously neglected reserves of petroleum.[9]

The last historical perspective offered here is that *although changes in the availability of a particular form of energy do not necessitate crises, they often do portend significant social change.* For example, the population of Britain had remained at a more or less steady 11 million for many decades before Watt invented the steam engine. Once the steam engine was powering the industrial revolution, Britain experienced a concomitant population explosion.[10] More dramatically, the rather peaceful switch from whale oil to petroleum in the United States led to an era of unprecedented prosperity and mobility for the nation—and to freeways, urban sprawl, pollution, and the often noted fact that Americans were then able to be sired, born, raised, and die in Detroit's contribution to Western civilization.

In summary history tells us that energy does affect social change—if not as simply or as predictably as some commentators have assumed, yet perhaps more positively and more controllably.

The Future as History

Interestingly, futures forecasters use many of the same methods as historians for analyzing questions of social change.[11] Futures forecasting is often criticized as being unscientific or unreliable because it is based on such scanty evidence that each futurist arrives at his own unique vision of the future. But as Karl Popper points out, historians are in the same boat: "There is no history of mankind, there is only an indefinite number of histories of all kinds of aspects of human life."[12] There are as many views of history as there are historians. The cause of the decline and fall of Rome has been proved

by historians to have been the result of everything from lead poisoning to buggery—and there is no sign of consensus on cause (or even that Rome fell) even though historians are all presumably dealing with the same facts. As futurist David MacMichael writes

> history is not the record of what happened but is the process of thinking about what happened. There can be as many histories as there are thinkers. . . . Basically, anyone is entitled to review the evidence, to introduce new evidence, and come to new or different conclusions about the meaning of a past event. . . . It can be argued that the historical process is a means for the production of alternative pasts.[13]

But it is often objected that there are no data about the future. We might respond that there are little or no data about Paleolithic man, either. Yet working with little more than a fragment of a jawbone, archaeologists nevertheless "scientifically" recreate his way of life. For certain periods of classical Rome all that remains are a couple of diaries and an official document or two, yet historians have documented an entire era on such evidence.

The argument is not that we know as much about the future as we know about the past. Rather, we probably know less about the past than we often assume, and we have better information about the future than we have been willing to admit. In some respects, there are considerable data about the future, as MacMichael demonstrates: demographic data can in some cases be reliably projected as far as fifty years into the future. Capital investments, too, are unlikely to change—machines, factories, buildings will not be destroyed until they have been depreciated. Existing freeways, railroads, bridges, and canals are likely still to be in place twenty years from now. Trust funds, retirement funds, and other investments are not terribly liquid. Military and other capital construction schedules and plans often extend ten to fifteen years. And some scheduled events—such as elections and conventions—have a high probability of occurring.[14]

The secret of good futures forecasting is the same as the secret of good historical analysis: using one's data imaginatively and well.

Summary

Before examining the current data available about the future of energy and social change, let us quickly review our history lessons:

- Energy is scarce or abundant only relative to available technologies.
- A minor technological breakthrough can have profound social and political implications.
- Societies are free to choose among available technologies and free to use them in different ways. Society is not determined by available technologies.
- Transitions from one form of energy to another—even those involving the depletion of a major source of energy—are not necessarily fraught with disaster.
- Although changes in the availability of a particular form of energy do not necessitate crisis, they often do portend significant social change.

What have these historical lessons taught us about the future? Is the current energy situation parallel to the historical transition from hardwoods to coal, or the substitution of petroleum for whale oil? Is there a "stirrup" in our future? In response, these lessons anticipate the argument that follows in this report: in the short run, changes in energy availability will not lead to significant new technologies; hence the effects on society will not be revolutionary. In the long run, new technologies will be required, and these technologies (which turn out to be surprisingly undramatic) may transform Western economies and societies. But significantly it is not at all a sure thing that people in these societies will choose to adopt the relatively simple technological changes required to transform for the better the quality of their lives.