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The Nuclear Power Deception

Part I -- History: Nuclear Power Propaganda and Reality

"...you had uranium in the rocks, in principle, an inexhaustible source of energy -- enough to keep you going for hundreds of millions of years. I got very, very excited about that, because here was an embodiment of a way to save mankind. I guess I acquired a little bit of the same spirit as the Ayatollah has at the moment."

--Alvin Weinberg, former head of the Oak Ridge National Laboratory and nuclear reactor designer, 1981[15]

I am sure we are agreed that the ultimate survival of America is dependent on intellectual vigor and on spiritual deeprooting -- not on specific devices which are always for the moment. The atom has no ethics of its own any more than it has politics. The future of the scientists' America, and yours and mine, lies fundamentally with education -- that which is taught to the young in our schools -- that which is taught throughout life in the media of general communication by the contemporary writers. Fundamental are respect and zeal for scholarship, a lively regard for moral values, and a love of truth. And of these the last is, of course, the greatest.

--Lewis Strauss, AEC Chairman, 1954[16]

Chapter 1: Romance with the Atom

All forms of transportation will be freed at once from the limits now put upon them by the weight of present fuels....

Instead of filling the gasoline tank of your automobile two or three times a week, you will travel for a year on a pellet of atomic energy the size of a vitamin pill ... The day is gone when nations will fight for oil....

The world will go permanently off the gold standard once the era of Atomic Energy is in full swing ... With the aid of atomic energy the scientists will be able to build a factory to manufacture gold.

No baseball game will be called off on account of rain in the Era of Atomic Energy. No airplane will by-pass an airport because of fog. No city will experience a winter traffic jam because of snow. Summer resorts will be able to guarantee the weather and artificial suns will make it as easy to grow corn and potatoes indoors as on a farm.

--David Dietz, Science writer, 1945[17]

The control of fire was central to the development of cities -- that is, of civilization. Its use on a large scale directly and indirectly, through diverse carriers of energy such as steam, is the foundation of modern industry and commerce. In the eighteenth and nineteenth centuries, steam power enabled the centralization of manufacture by the use of mechanized transport to draw huge quantities of raw materials, such as cotton and jute, as well as food from around the globe into the world's new manufacturing centers in Europe. The first fuel to be used on a large scale for industry and transport was coal; it continues to occupy a large place in the world's energy supplies today. In the late nineteenth century it was joined by petroleum; in the twentieth natural gas was added to the fossil fuel mix.

The potential for the application of energy to transform life for vast numbers of people was demonstrated in the second part of the nineteenth and first half of the twentieth centuries in a number of radical and graphic ways. Electric lights illuminated the night. Rapid travel over large distances became commonplace, first via railroad and steamships and then also via trolleys, buses, and cars. This mechanized mobility was symbolized by Phileas Fogg, Jules Verne's nineteenth century fictional voyager, who went around the world in eighty days and returned home *punctually.* Farm mechanization reduced the need for farm labor; cities grew; occupations and specializations multiplied.

In the cities, automobiles and street cars rapidly replaced horse drawn carriages. And the domestic scene was transformed, for those who could afford it, by central heating and numerous appliances that reduced the burdens of physical labor. The possibility that life for ordinary people around the world could one day be very comfortable, even luxurious, was no longer theoretical -- it was being practically realized everyday by large numbers of people of European origin and also by a small minority in the colonized countries. The prospect that such a life would be available to all seemed to depend on nothing more than human ingenuity in the application of science and technology and on the availability of sufficient natural resources, chief among which were fuels.

But these historic changes also carried the seeds of misery and destruction. Consolidation of farms threw people off the land. Machines threw people out of work. In many of the countries that were colonies of Europe, the destruction of cottage industries actually reduced the proportion of people working in non-agricultural occupations. At the same time, there was little work to be had on the land. From time to time, as in the 1930s in the United States, there were vast and sudden displacements of people from farms to urban areas, accelerating trends started by industrialization. Indigenous cultures, whose knowledge of the natural environment is, in many ways, still unparalleled by science were destroyed around the world. Unemployment became a permanent feature of the world economy.

Despoilation of the environment was occurring on a scale as grand as the huge industries that were springing up. Air pollution was, in many places, literally breathtaking. For instance, in London the air often got so bad that episodes of smog came to be called "peasoupers" after their resemblance to pea soup: visibility was typically reduced to a few yards. Thousands of people died of respiratory diseases as a result of the London "peasouper" of 1952. The public outcry accompanying the deaths and suffering led to the initiation of unprecedented pollution control regulations in Britain. The general recognition of potential damage to the entire atmosphere due to a build up of carbon dioxide from fossil fuel burning was still about three decades away, however.[18]

As the exploitation of resources and the trade in them became global, so did the wars for their control. To a considerable extent, these global wars had their roots in the dependence of western economies on cheap imported primary commodities and in the competition between them for these resources. After World War I, oil rapidly became the most crucial strategic primary commodity. Much of the prelude to World War II, including the Japanese bombing of Pearl Harbor, many of battles during that war, and much of the wartime strategy of the antagonists revolved around the control of oil resources that had become the lifeblood of the war machine.[19]

By the middle of the twentieth century, with the colonies in Asia and Africa on the verge of political independence, people throughout the world were seeking to achieve the level of material standards of living that had already become a reality for a substantial minority of people in western Europe and the United States and would soon be realized by a majority. But would there be enough resources for all, given the already high and rising levels of consumption in Europe and the United States and the dependence of western economies on imported primary commodities, especially oil?

Einstein's discovery early in the twentieth century that matter and energy were equivalent, expressed by the famous equation $E = mc^2$, came in the middle of this immense and unprecedented technological, political, economic, and military ferment. H.G. Wells, in *The War of the Worlds,* wrote about bombs that might destroy cities and entire civilizations. But there were also visions of unlimited amounts of energy for everyday life. Einstein's equation showed that a small amount of matter was theoretically equivalent to a huge amount of energy: just one gram of matter, if completely converted to energy, was equivalent to roughly 3,000 metric tons of coal. [20]

If only some way could be found to change matter into energy, the days of deprivation would be over! The Pharaohs needed slaves to do their bidding. Modern life would not need to be cruel to be affluent. Small bits of dead matter could take the place of slaves and everybody could be happy ever after -- at least so far as material matters were concerned. Life would be free of drudgery. Convenience and creativity would flourish in the ample leisure time that everyone would enjoy.

In the late 1930s, the *fission* of uranium -- that is, the splitting apart of its nucleus into smaller nuclei of light elements -- was discovered and the possibility of converting matter into energy on a large scale started to move from the realm of science fiction and improbable theory to reality

The practical harnessing of fission energy required the splitting of a large number of uranium atoms -- in a controlled sustained way for nuclear power production, or all at once for a bomb. The Hungarian scientist Leo Szilard had realized well before fission was discovered in the laboratory in 1938 that a nuclear *chain reaction* would be the basis for nuclear energy production, whether commercial or military. In such a reaction, each fission would generate another without any external inputs, so that once initiated, fission reactions would continue until some other factor intervened to stop them.

Uranium appeared capable of sustaining a chain reaction because each fission released more than one neutron, a neutral particle that could penetrate the outer parts of an atom to reach its tiny nucleus. After the experimental demonstration of fission in Germany in late 1938 and its confirmation in the United States in 1939, the main question that remained was: could a nuclear chain reaction be realized in practice? If so, a large sustained release of energy could be achieved. The requirement for achieving a nuclear explosion was even more stringent since each fission would have to generate more than one fission in a very short time. In this way, the number of fissions would multiply very rapidly, resulting in a huge explosive release of energy.

The first chain reaction took place in an "atomic pile," as nuclear reactors were initially called, at the University of Chicago in December 1942. However, a minimum amount of nuclear material, called a *critical mass*, was necessary to sustain a chain reaction. The most basic physics questions had been answered. The immense engineering job of making nuclear energy a practical reality for explosive or commercial applications remained.

It was thought early on that the widespread use of nuclear energy would be complicated by an important resource limitation. While heavy elements could be fissioned to yield energy, only one element that occurred in nature in substantial quantities could sustain a chain reaction. That element was uranium. There was a further difficulty. It was discovered that only one naturally-occurring isotope of uranium, called uranium-235, could sustain a chain reaction (see box below). However, about 99.3 percent of natural uranium consists of uranium-238, which cannot sustain a chain reaction. Uranium-235 is only about 0.7 percent of natural uranium. Still, just one gram of uranium-235, when completely fissioned, yielded as much energy as 3 metric tons of coal, which is more than annual average household energy requirement for home heating in the United States.

Isotopes of elements

Elements occur in variants called isotopes. All isotopes of an element have essentially identical chemical properties, which are determined by the number of protons in the nuclei of the element's atoms. Protons have positive electrical charges. The number of protons in a nucleus is normally equal, at ordinary temperatures, to the number of electrons that surround the nucleus in that atom. But the nuclei of elements can also contain varying numbers of neutrons, which are electrically neutral particles slightly heavier than protons, and far heavier than electrons. Changing the numbers of neutrons in the nucleus changes the properties of the nucleus and the overall weight of the atoms of an element. Variants of an element whose nuclei have the same number of protons but different numbers of neutrons are called isotopes of that element.

Some heavy nuclei are rendered highly unstable and split apart after absorbing a slow neutron, having essentially no kinetic energy. Such isotopes are said to be fissile. Other heavy nuclei require incoming neutrons (or other particles) to have a large amount of energy before they will split apart. These isotopes are *fissionable*, but not fissile. In general, fissile isotopes are required to sustain chain reactions, and hence to build nuclear reactors or nuclear weapons. Uranium-235 is essentially the only naturally-occurring fissile material.[21] Uranium-238 is fissionable but not fissile.

But uranium-238 was soon found to possess another remarkable property that made it seem at least as important a substance as uranium-235. When uranium-238 absorbs a neutron, it is transmuted, in two steps, to a fissile element that is present in nature only in the minutest quantities: plutonium-239 (see Appendix A). This meant that a nuclear reactor could be used to do two things at once. First, it could generate energy by fissioning uranium-235 in a chain reaction. Second, it could at the same time convert non-fissile uranium-238, which was 140 times more plentiful than uranium-235, into fissile plutonium-239. There is so much uranium-238 in nature that it could, if converted to plutonium-239, far outstrip fossil fuels as an energy source. Limitless energy supply seemed within the reach of mankind, a prospect that gave rise to fervent, almost religious declamations by scientists about the deliverance of mankind.

The first nuclear engineering achievements were made by the U.S. military's crash program to develop the atom bomb during World War II, known as the Manhattan Project. Uranium-235 provided the explosive energy in the bomb that destroyed Hiroshima; plutonium-239 powered the Nagasaki bomb. The Manhattan Project also showed that it was possible to build large nuclear reactors, to produce plutonium in them, and subsequently to chemically separate the plutonium from fission products and the remaining uranium.

As the United States entered the post-war era, millions of Americans believed that their lives or the lives of soldiers personally near and dear to them had been saved because the atom bombings of Japan had ended the war early. U.S. leaders saw in nuclear weapons the potential to move the world in a political direction of their choosing. The immense technological feats that the U.S. had accomplished during World War II were exemplified most dramatically for all (including Stalin) by the Manhattan Project. Now they would be applied to making the United States by far the most militarily powerful country in human history and also to the material salvation of mankind. Nuclear energy was in the center of that military and economic prospect. America's romance with the atom had begun. 22

But before commercial nuclear energy could save mankind, some problems, seemingly mundane, remained. They would come to dominate the fate of nuclear power. The devil, it turned out, was in the details:

- Nuclear fission gave rise to lighter isotopes of elements, called fission products, that were generally far more radioactive than uranium-235. As a result, the more energy that was generated from a batch of fuel, the more radioactive the fuel became. Severe accidents in nuclear reactors could produce a great deal of harm, and waste disposal from nuclear power would be a serious problem.
- Neutrons, essential to creating chain reactions, also made reactor vessels and other parts intensely radioactive. This could make reactor maintenance and repair as well as disposal of used reactors far more difficult and costly than with conventional power plants.
- The intense radioactivity and high temperatures inside nuclear reactors meant that it would be difficult, complex, and expensive to build, test, and operate them for continuous power production.
- Except in rare ores, uranium was a trace material, and it would take a large amount of ore to produce relatively small amounts of reactor fuel, especially given that uranium-235 was only about 0.7 percent of natural uranium. Further, uranium ore was always mixed with other radioactive materials that would be discharged as waste in large quantities.

- Plutonium produced in nuclear reactors could be used to make nuclear weapons, if separated from spent fuel. Safeguarding plutonium presented challenges that were not encountered with fossil fuels.
- The technological and resource base needed for nuclear weapons was to a very large extent the same as that needed for nuclear power. Thus, the problem of preventing proliferation of weapons while using nuclear power as an energy source would be a crucial security issue.

These problems seem clear enough in hindsight. But how many were apparent in the early days? Was the romance with the atom a case so intense that it blinded engineering judgment? Was it propaganda waged for economic or military purposes? Or was it a mixture of both?