ATOMIC ENERGY IN THE UNITED STATES IN 1992

by Commissioner C. Larson of the AEC

Prophesying future technological developments takes boldness over the short term and also, and especially, over the long term. The twenty years projected by Director General Eklund allows time for unforeseen breakthroughs to occur and for their applications to move completely through the innovation cycle to the market. Thus, for example, the scientific discoveries by Hahn, Strassmann, Fermi, Joliot, and Szilard in the late 1930's led to the momentous event in 1942 when Fermi and his co-workers successfully demonstrated the first nuclear chain reaction in a large mass of uranium. Within less than 20 years, this historic occasion became the basis for today's many uses of nuclear energy.

So, with this reservation understood, I will attempt a look toward the year 1992 and the developments we might expect in the atomic energy field.

The largest civilian use of atomic energy today is in the production of electricity. Of course atomic energy has also found many other applications in areas such as agriculture, medicine, industry, and space exploration. It is quite likely that dramatic increases in new and current uses will take place in the years ahead. Already the importance of these applications have revolutionized certain fields of research. Within twenty years, laboratory reactors and radioisotope fuelled power generators should be improved for better and wider application. The use of radioisotopes in fields other than medicine is expected to grow rapidly. Satellites powered with atomic energy aimed at improving our means of communication and our understanding of the earth's environment will increase in number. We may also see the use of underground nuclear explosions for in-situ recovery of natural gas and other valuable resources within this time period. Although breakthroughs in these and other areas may occur, the expected rapid increase in the world demand for energy and the ability of the atom to respond to that demand lead me to the belief that the generation of electricity will continue to be the overwhelmingly dominant application of atomic energy.

Many variables affect the demand for energy and its projected rate of expansion. Approximately 25% of the energy the United States is consuming today is delivered to the user in the form of electricity. About 3% of this electrical energy is generated from nuclear sources. Of the total use of energy in the United States, petroleum supplies about 44%, natural gas 33%, coal 18%, water power 4% and nuclear fission about 3/4 of one percent. The remainder is from such sources as burning wood, wind, the sun, the tides, the earth's heat and animal and human work.

As the use of energy has increased in recent years, the United States has come to depend more and more on imports, especially oil and natural gas. These imports are counter-balanced to some extent by exports of coal and uranium enriching services. However, the net monetary outflow is now more than two billion dollars a year and growing rapidly. Therefore, our choice of energy options in the years to come will be influenced strongly by the desire to avoid unnecessary growth in our dependence on imported fuels.

The use of energy may be constrained by a growing national consensus that we must choose future courses that minimize adverse effect on public health, public safety, and the environment. I believe nuclear power will be able to meet this challenge – more adequately than most fossil fuels. Thus it follows that the growth of nuclear power will be fostered by this trend.

The cost comparison of various fuels is obviously an important consideration. The cost of conventional fossil fuels is projected to increase substantially while that of nuclear fuels is less

A specially adapted laser gun is being "fired" at Oak Ridge
in an unusual research programme on problems of air pollution... U.S.A.E.C.

likely to rise. As electrical utilities in the United States considered these costs in the past few years, they turned increasingly to nuclear power. When we extrapolate on the basis of present trends and the factors I have just mentioned, we arrive at projections that the United States demand for electricity over the next two decades will increase by a factor of at least three, and that the portion of our electricity supplied by nuclear energy will increase to about 50%. Thus the amount of electricity produced by nuclear energy could multiply by a very large factor.

But before we accept these projections, let us examine some of the assumptions on which they are based. One is that the demand for energy will continue to grow as it has in the recent past. The second is that new major sources will not enter the energy-supply business in the 20-year period. We cannot conclude with any strong degree of confidence that either of these assumptions will remain valid.

On total demand, the environmentalists and others have asked a significant question: Do we really need the vast amounts of energy we are consuming and is it inevitable that our consumption will continue to grow at the historical rate? The United States is just beginning to study this question in detail.

The first tentative answers appear to indicate that some actions to conserve energy and to curtail its rate of growth are feasible and perhaps even desirable. However, programmes like increased insulation of buildings, improved energy-efficiency in transportation of people and goods and policies to foster energy conservation in industrial practices could have substantial cumulative effect by 1992. But even if such effort should meet with success, we should keep in mind that economic progress, especially among those Americans who do not yet fully enjoy the benefits of our economy, will exert continued upward pressure on total energy demand. In addition, we will probably consume increased amounts of electricity in mass transportation and in our programmes to clean up the environment. Thus we should not anticipate substantial results over the short term and at best we may only be able to slow the rate of growth in energy consumption.

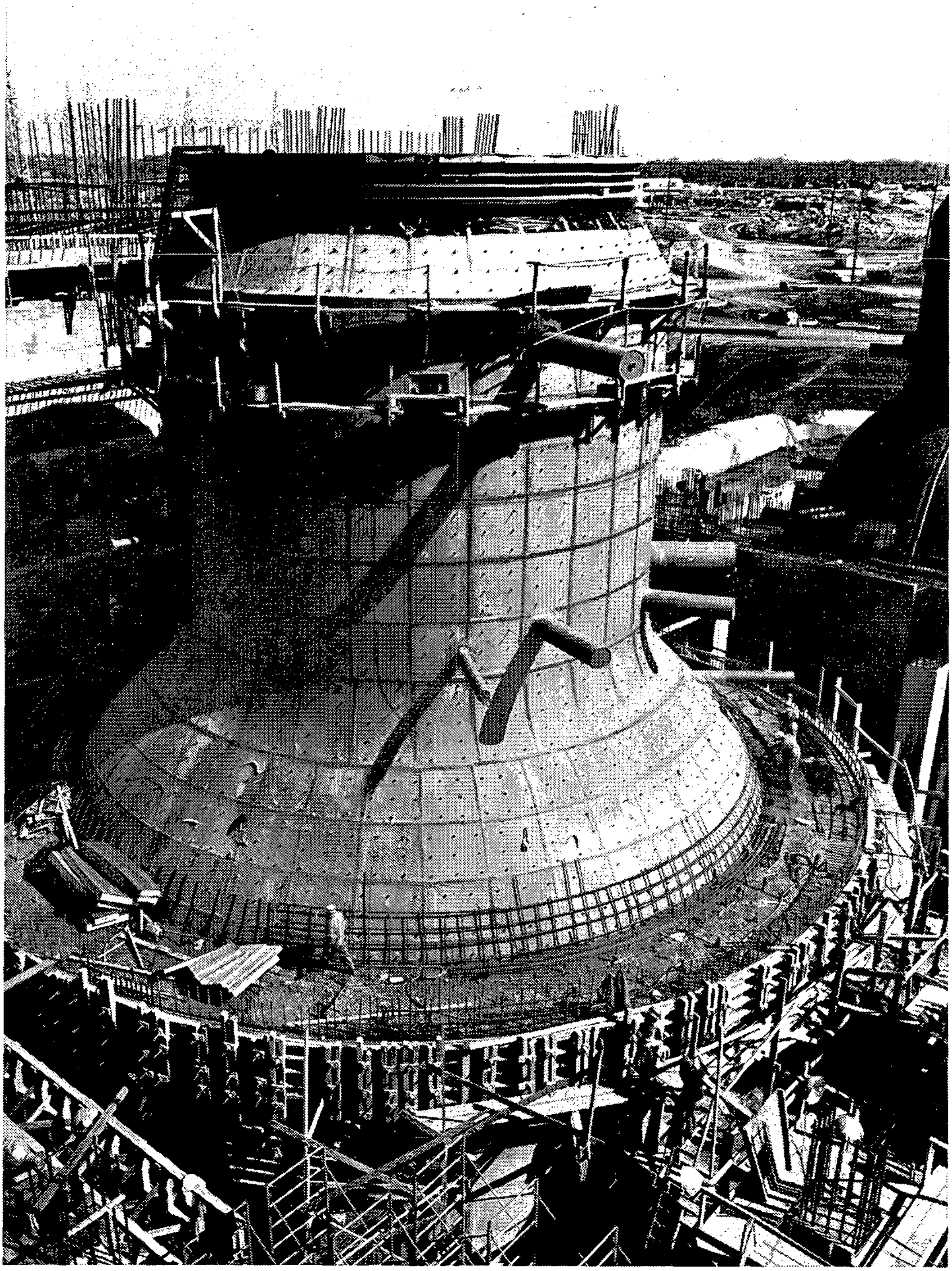
The second assumption, regarding the major sources of energy, depends on the progress of research and development and on government policies affecting energy. Over the past year and a half, the United States has been engaged in a considerable expansion of our non-nuclear energy R & D efforts, with support both from the government and from the utility industry. We have also begun to adjust our energy policies to encourage further domestic production of oil and gas. I believe these tendencies will be extended further. I will not be surprised if the total U.S. research and development effort along these lines in the next 20 years turns out to be quite substantial.

Historically, the lead times have been quite long for the introduction of new technology in a major way in the energy supply industry. But if some of the research and development efforts and policy changes are successful, significant advancements may be possible in the energy market by 1992. Let me mention a few such possibilities:

- Conversion of our abundant coal supplies into sulfur-free gas that would be delivered to non-polluting steam power plants and into homes for space heating, or into liquid fuels that would be used in transportation.
- Development of new or improved methods of extraction of fuels from the extensive reserves of oil, shale oil and natural gas, including, in some cases, the use of nuclear explosions to stimulate recovery.
- Various means of utilizing geothermal, solar, and even tidal energy.

In addition, 20 years of progress in techniques of converting, storing and transmitting energy may well effect substantial changes in the relationships among all energy sources.

However, it is clear that nuclear energy has reached its present stage of development because of substantial investments we have made over the past 25 years. Present orders for nuclear power will result in a tenfold increase in the 1970's. I believe this momentum will carry into



The Tennessee Valley Authority construction of the first nuclear power reactors to be proposed in the 1000 Mwe. range. This is the Browns Ferry Nuclear Plant, on the Wheeler Reservoir of the Tennessee River, Alabama...

the 1980's. It appears inevitable that nuclear power will be required to expand very substantially by 1992. It follows therefore that we must proceed with the work needed to make that result possible.

Let us therefore examine the efforts in fission and fussion power.

POWER FROM FISSION

The United States today has contractual commitments of about 150 power plants with total capacity of about 130 million kilowatts electrical. When all of these plants are on line, by about 1980, that capacity will be equal to about 35% of our present electrical generating capacity. Of these commitments, 95% are for light water reactors – 62% for pressurized water and 33% for boiling water. The remaining 5% are high-temperature gas-cooled reactors. In this period of rapid expansion we are placing heavy emphasis on programmes to achieve higher levels of standardization, with the objective of improvements in safety, reliability and economics. Standardization will also shorten licensing reviews, provide for efficiency of labour and reduce maintenance problems.

Meanwhile, improved technology in heat rejection techniques such as dry cooling will help to minimize the environmental problems, in addition, methods may be indroduced to use rejected heat for beneficial purposes, such as food production in agriculture and aquaculture, as well as urban and industrial applications. Also during this period, biological research can be expected to result in continued progress toward identifying and understanding the effects of energy generation on man and his environment. With this increased knowledge, we will be better able to make wise decisions regarding the most effective use of all energy sources.

The next major development step is the breeder reactor, which will achieve maximum utilization of fission fuels.

The practical consequences of the breeding process are indeed startling. Even in the unlikely event that the cost of uranium ore were to rise to $500 per pound. The uranium costs in a breeder reactor is less than 0.1 cent per K.W. HR. There are sufficient uranium supplies at $500 per pound in shales, granites and even sea water to supply our electric energy for many thousands of years. It is also interesting to note that the uranium that has been depleted in U-235 from gaseous diffusion plants will, by the year 2000, fuel 1000 breeder reactors of 1000 megawatt capacity for over 500 years.

In his energy policy message to the United States Congress in June, 1971, President Nixon assigned top priority to the breeder programme. Congress has responded by appropriating necessary funds, and the utility industry, principally the Tennessee Valley Authority and the Commonwealth Edison Company, have undertaken to build a liquid metal fast breeder reactor (LMFBR) in cooperation with the Atomic Energy Commission. This focus on the breeder is consistent with the approach being followed by all other major industrial nations.

The first LMFBR, a demonstration plant of about 400 megawatts electrical capacity, is cheduled to be operating by 1980 near Oak Ridge, Tennessee.

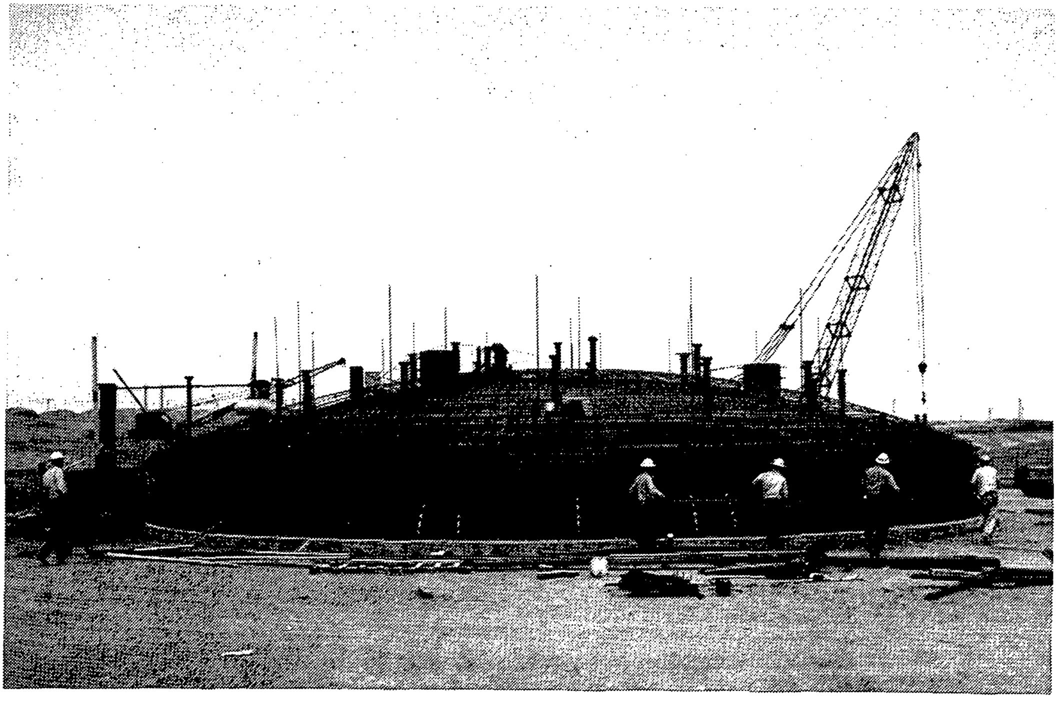
The president has announced his support of a second plant of advanced design, which may have a higher power level. Commitments on this plant may occur by 1975. The introduction of the breeder on a large scale could occur by the latter 1980's. Thus by 1992, we should expect to see the breeder making a major penetration of the market.

By 1992, regional and perhaps national power plant siting plans will probably be in effect, assuring that all types of plants will be located where environmental effects can be minimized. Further, we may see nuclear parks emerging as a preferred concept of operation: That is, nuclear fuel fabrication, chemical reprocessing and waste storage all at the same general location.

The volume of high-level radioactive wastes will grow as nuclear energy becomes a more important source of electricity. The permanent isolation of high-level radioactive wastes from

Rubbish which has low level radioactive contamination is loaded into a box, and dumped into a burial pit, at the Atomic Energy Commission's Hanford Works. It is being hosed to prevent possible spread of contamination by an errant breeze... Battelle-Northwest

Reinforcing steel is shown prior to pouring concrete for the dome portion of one of the million-gallon storage tanks for radioactive wastes at the Hanford Works. The tanks are buried under several feet of earth... Battelle-Northwest



man's environment will be achieved within the next 20 years. Primary emphasis is being placed on the near term development of engineered surface storage with construction beginning in the late 1970's. By 1990 we expect the high-level radioactive wastes to be safely isolated either in these engineered surface storage facilities or in other more sophisticated repositories.

POWER FROM FUSION

There are several potential advantages to power from fusion which continue to spur the worldwide effort to learn how to generate power through controlled thermonuclear reactions. The fuel is almost unlimited and therefore very inexpensive. Combustion products would not be released to the atmosphere. Fusion reactors would be inherently safe. The radioactivity problem would be substantially reduced, and high thermal efficiences would be possible.

As a result of progress in recent years and the excellent state of international co-operation in this field, American researchers feel increasing confident that the scientific feasibility of fusion power will be demonstrated by the early 1980's either by the magnetic confinement or the laser fusion method. This would probably be followed by a period of development of experimental power reactors. By 1992, we might well be able to gain some insight into economic feasibility, but it is doubtful that fusion will deliver competitive electric energy in this century.

By 1992, the options provided by atomic energy should, and I think will, provide significant alternatives in the constant struggle to meet world energy demands. We will be able to introduce new technologies and formulate new policies that will enable us to make vastly improved use of the available resources. We will, for example, achieve major improvements in the efficiency of using and producing energy and in curtailing waste. And if in the next 20 years the nations of the world adopt a centralized and global approach, we can not only meet the worldwide energy needs, but also be well on the way toward settling many of the energy and ecological problems which confront the world today.