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TESTIMONY OF
THOMAS B. COCHRAN, PH.D.,
BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
OF THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
ON THE U.S. BREEDER REACTOR PROGRAM

March 4, 1981

My name is Thomas B. Cochran. I am a Senior Staff Scientist with the Natural Resources Defense Council, a national non-profit environmental organization with a membership of approximately 40,000. NRDC and I have long been concerned about the U.S. fast breeder reactor program and, in particular, the Clinch River Breeder Reactor. I hold a Ph.D. in physics from Vanderbilt University and am the author of a 1974 critique of the breeder published by Resources for the Future. I served on the ERDA Steering Committee in 1977 which reviewed the liquid metal fast breeder reactor program, including the Clinch River project. I also was a member of DOE's Ad Hoc Committee on Nuclear Non-Prolifreation (NASAP/INFCE) from 1977-1979; and I am presently a member of DOE's Energy Research Advisory Board.

The specific question now before the Congress is whether to authorize expenditure in fiscal year 1982 of some hundreds of millions of dollars for the Clinch River Breeder Reactor, as requested by the Department of Energy. In reality, however, the question is whether to push forward during the next several years attempting to develop a commercial plutonium breeder, with total program costs approaching $20 billion. It is, in short, not a question simply of providing further funding to a low key, ongoing program, but rather of making a long-term commitment, at extremely high cost, to a very dangerous technology which would involve massive flows of nuclear weapons material in the commercial sector. NRDC believes that such a commitment would be an enormous mistake at this time or in the foreseeable future.

There are several important facts to keep in mind about the Clinch River Breeder Reactor (CRBR):

- First, the primary purpose of any reactor is to generate electricity. The additional purpose of the breeder is to create plutonium, an alternate fuel for uranium. Such an alternate fuel is important only insofar as it is economical. Despite the complexity and higher capital cost of the technology which is employed, it simply represents a sophisticated method of heating water with nuclear weapons material.

- Second, the plutonium breeder will not reduce American dependence on oil, foreign or domestic, by a single drop. At present, only about 10% of our electricity is generated by burning oil, and much of that is for peak demand, often in smaller and older plants. This use of oil will be reduced by conversions of existing plants to coal as required by the national fuel conversion policy and by the replacement of the older plants with new ones using other fuels. Large oil-fired generating plants will not be built in the future in the United States. New baseload nuclear plants may compete with coal, but not oil.

- Third, the need for the plutonium breeder is dependent on the need for electric generating capacity and, more importantly, on the growth in demand for the existing light water reactor (LWR) technology. At the time the CRBR was proposed, electric power demand was growing at 7 percent per year. There has been a dramatic reduction in electrical growth since the 1973 Arab oil embargo. Last October the Electric Power Research Institute -- never known for underestimating electric growth rates -- projected electrical requirements in the year 2000 would be 5.9 $\pm$ 1.0 trillion kwh,[1] just over one-half the estimate made by ERDA 6 years earlier in defense of its breeder program.[2] Similarly, ERDA in late 1974 had projected 1200 gigawatts (GWe) in nuclear power by 2000. DOE's last published estimate was 160 to 200 GWe. A more reasonable figure is 120 GWe, a full factor of ten below the old ERDA figure used in support of the breeder.

- Fourth, the claimed economic advantage of the plutonium breeder over the presently used LWR is based on the now lost hope that recycling of the plutonium and uranium fuel through reprocessing would be significantly cheaper than mining and enriching uranium and that this savings would offset the higher capital cost of the breeder plant. The cost advantage of the breeder, if any, thus rests on the relative cost of the fuels as compared to the capital cost difference of the two reactors.[3]

1/ EPRI, 1981-1985 Overview and Strategy, Oct. 1980, pp. 30-31. EPRI projects an average annual electrical growth rate of 4.4 $\pm$ 0.8 percent between 1979 and 2000.

2/ ERDA, Proposed FINAL EIS on the LMFBR Program, WASH-1535 (December 1974), Vol. IV, p. 11.2-9. ERDA projected total energy requirements of 195 quads in 2000 and 359 quads in 2020, 50 percent and 65 percent, respectively, of the total energy supplied by electricity in 2000 and 2020.

3/ The economic woes of the plutonium breeder derive in large measure from the fact that the capital cost of a nuclear plant today represents about 70% of the generating cost while the uranium fuel at today's prices ($25-30/lb U_3O_8) represents only about 10% of the total. Thus, when the capital cost of the breeder relative to the LWR becomes large -- present reality -- it becomes virtually impossible to offset this difference with projected savings in the breeder fuel cost.

The best economic data on breeders today derives from French experience and has been gained through construction of their 1200 MWe (commercial size) Super Phenix reactor. The French are now estimating that the Super Phenix will cost 2.3 times the cost of a French LWR. The "target" of the French breeder program is to bring the cost of "mature" breeders down to 1.75 times the cost of a French LWR. At this cost differential, the plutonium breeder would drive electricity generating prices up by about 40-50 percent. Uranium would have to rise to more than \$150/lb U_3O_8 -- some 5 times the current price[4] -- before breeders would be competitive with LWRs.[5] If uranium utilization efficiency in LWRs is improved by 50 percent, which is likely to occur during the LMFBR development period, the uranium break-even price would climb to about \$300/lb. At these prices, the breeder is unlikely ever to be economical.

When you consider the \$20 billion cost of a U.S. breeder R&D program, it is virtually impossible to construct any realistic assumptions that justify spending several hundred million dollars on breeder R&D this year. In fact, to make the LMFBR appear competitive much before 2030, one must make extreme

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4/ With lack of reactor sales, the uranium market is sagging and prices can be expected to go still lower.

5/ This assumes that economies of scale will materialize in the breeder fuel cycle -- a highly unlikely event in that breeders will not be introduced into the market rapidly enough to justify the financial risks associated with constructing large supporting fuel cycle facilities.

assumptions regarding each of several key variables: breeder capital costs, uranium prices, electrical demand, nuclear growth, and the social discount rate. The nuclear industry would call this possibility a Class 9 accident -- so remote a possibility as to be not worthy of further consideration.

- Fifth, a rationale for development of the breeder reactor has been the concern over a potential shortage of uranium fuel for conventional light water reactors. Properly framed, this concern is subsumed in the issue above, that is, when and at what price of uranium will the plutonium breeder become economical. It is perhaps worth noting that with each new estimate by DOE the uranium resource base has been increasing, not decreasing. DOE now projects 3.2 million tons of proven resources and probable resources at less than $100/lb and 4.9 million tons when speculative resources are included.[6] Even the lower figure exceeds the lifetime fuel requirements of 500 LWRs of current design, or double this number if advanced LWR designs were pursued.

6/ DOE, "An Assessment Report on Uranium in the United States of America," NURE, GJO-111(80)(Oct. 1980). These estimates are at the 50% probability level.

- Sixth, the design of the Clinch River Breeder Reactor, developed nearly a decade ago, is out of date. To reduce cost and technological risk, it was decided at that time to minimize changes from basic design parameters used in the Fast Flux Test Facility, a 1960 vintage breeder technology.[7] The design has been widely acknowledged, even by the architect-engineering firm for the Clinch River Project, to be inappropriate and obsolete.[8]

- Seventh, the European and Japanese plutonium breeder programs are experiencing serious difficulties in moving toward commercial development. The French breeder program, with the 1200 MWe Super Phenix under construction, is recognized as the strongest of the Western breeder programs. The French commitment to two 1500 MWe Super Phenix Mark II breeders in early 1980 has slipped to 1983-1985 in recognition that French breeders are costing more than twice as much as French LWRs. The plutonium breeder programs in the U.K., the F.R.G., and Japan appear to be "on hold."[9] In judging development in these

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7/ FFTF is a 400 Mw_t liquid metal fast reactor at Hanford, Washington, designed to test advanced breeder fuel designs.

8/ Statement of Dr. Edward Teller, quoted in 123 Cong. Rec. H9692, Sept. 20, 1977; Confidential memorandum of Burns and Roe, Inc., quoted in the testimony of NRDC before the Subcommittee on Nuclear Regulation of the Senate Committee on Public Works, July 11, 1977.

9/ The U.K., with a 300 MWe breeder demonstration plant, has decided to postpone a decision on its follow-on breeder until at least 1985. Japan has built a very small reactor, and construction of the 300 MWe Monju demonstration plant continues to be delayed. The overall Japanese breeder program has not only slipped ten years, but the government has lowered the industry share for the next machine from 50 to 20 percent, [footnote continued on next page]

foreign programs, one must carefully distinguish the rhetoric from realities.

- Finally, the plutonium used and produced by the plutonium breeder, including the CRBR, is directly usable in nuclear weapons. The fresh breeder mixed-oxide fuel, containing 13 to 25 percent plutonium, can be fashioned directly into a nuclear bomb without chemical processing.[10] If a more sophisticated (higher yield) nuclear weapon is desired, a country or sub-national group could, at a cost of $1-2 million, chemically separate a bomb's worth (10 kg) of plutonium from fresh breeder fuel in three to seven days' time.[11] Unlike alternative reactor fuel cycles, the CRBR type poses the maximum risk of nuclear weapons proliferation by countries, and the maximum risk of theft or diversion by criminal or terrorist groups. The amount of plutonium loaded into commercial-size

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[footnote continued from previous page]
further evidence of the deteriorating economic position of breeders. A Committee of the FRG's Parliament voted last year to complete the 300 Mwe Kalkar demonstration plant but postponed the decision on whether it will operate. Kalkar has experienced substantial cost overruns, and its scheduled operating date has slipped 7 years to 1985-86. The Dutch and Belgian governments have indicated a strong unwillingness to increase their respective shares of the project. Their unwillingness and that of the German Government and industry have placed the Kalkar reactor in financial jeopardy (Nucleonics Week, Nov. 20, 1980, pp. 5-6). The FRG, which gets 10% of its electric energy from nuclear, has had a *de facto* nuclear moratorium on reactor licensing since 1975, and the government is experiencing serious public acceptance problems with all aspects of its commercial nuclear program.

10/ DOE, Nuclear Proliferation and Civilian Nuclear Power; Report of the Nonproliferation Alternative Systems Assessment Program (NASAP), DOE/NE-0001/2 (June 1980), Vol. II, p. 2-43.

11/ *Ibid.*, p. 3-43. Time assumes 30 operating personnel with 2-4 weeks training during the construction phase. 10-20 weeks would be required to obtain 100 kg of plutonium.

breeder reactors annually would be sufficient to construct several hundred nuclear weapons (approximately the size of the nuclear weapons stockpiles of the U.S. or USSR in the early 1950s).

The new Administration, in the brief time it has been in office, has insisted that all government programs be carefully scrutinized and weighed to determine whether the costs of the program outweigh the expected benefits. Furthermore, it has insisted that the litmus test for energy programs is their viability in a free market economy. The CRBR Project is intended to provide demonstration of a technology for commercial use. Therefore, it must be judged in terms of its commercial value.

Applying these criteria, it is obvious that the CRBR project is not economically justifiable. A thorough and convincing analysis of the project in free market terms was prepared by David Stockman in 1977, and I have attached a copy of this analysis to my testimony and request that it be included in the record. As Mr. Stockman correctly concluded, "the breeder cannot compete with existing nuclear technologies within the time frame contemplated by its advocates without continuing massive subsidies."

Mr. Stockman pointed out that the case for commercial use of the breeder reactor in the next several decades is predicated on two false assumptions: (1) that demand for electrical energy will grow at the high rate of the 1960s, and (2) that uranium resources will be exhausted and no new supply found, even at much higher prices. We have seen electric energy growth decline sharply since 1973 in response to increased costs. There is no reason to think that the trend will reverse itself. There is also no reason to believe that the availability of uranium will follow a different pattern than that for every other fuel -- that is, that new sources will be found and developed when it is economical to do so. In short, when the market price rises, exploration and development will be stimulated. Therefore, to look at presently provable reserves as the outer limit of the resource, or the "prudent planning base," particularly in view of today's depressed uranium market, is wholly unrealistic.

Once these false assumptions are eliminated, we can then determine the real costs of the breeder reactor. It is now undisputed that the capital costs of the breeder reactor are far higher than originally anticipated and far higher than those of a light water reactor. Moreover, there is every reason to expect, based on the experience with the light water reactors, that the costs of breeder reactors will actually be much higher than presently predicted and that its competitive position vis-a-vis the light water reactor will further erode.[12]

12/ Mr. Stockman pointed out that between 1967 and 1973 the cost of electricity from light water reactors had risen nearly 200%. In addition, the cost of the Fast Flux Test Facility was over ten times greater (current dollars) than was projected. Consequently, there is every reason to believe that Clinch River will cost far more than the roughly $3 billion presently estimated. Thus, the present comparisons of capital costs are very optimistic.

Even at present projections, the breeder reactor cannot compete economically with the light water reactor. At the higher costs which are almost inevitable, price competition will be impossible. Thus there will be no market justification for the employment of this technology, unless the time comes, if it ever does, that the economic factors have changed radically.

Moreover, consistent with the philosophy of the new Administration, it would be far more appropriate to turn to the private sector, the industries which will use and benefit from the new technology, at least to participate on a realistic basis in its development. The fact that industry participation is now down to about 11% of the CRBR cost and zero for the balance of the breeder program reveals the shaky economic ground upon which Clinch River rests. There is simply no reason why the federal government should pay virtually the total costs of a demonstration technology which its proponents claim will be economically viable.

It is often argued that the breeder reactor is necessary for true energy independence because the technology all but eliminates reliance on finite uranium resources. This is a simple, appealing argument, but it requires one to ignore the following facts. Our energy security problem derives from liquid fuels -- oil, not electricity. The U.S. is not a net importer of uranium, and two of our closest allies, Canada and Australia, have huge uranium reserves. Spending $20 billion on the breeder will not place the U.S. any closer to energy independence. Indeed it would divert scarce federal R&D funds from much more promising alternatives to imported oil.

In theory, if the plutonium breeder could be perfected technically -- that is, if a high breeding gain could be achieved in advanced reactor designs and if low plutonium inventories could be achieved in the fuel cycle relative to the reactor -- then the state of nuclear fuel independence still could not be reached until about 2050. In the interim, it would be far cheaper to stockpile uranium.

Using the French "target" -- a plutonium breeder costing 1.75 times as much as an LWR -- the breeder would cost $900 million more than today's reactors. For this amount, one could purchase 15,000 tons of U_3O_8 at current prices. This is 2.5 times the lifetime fuel requirements of today's LWR and 5 times the requirements of an advanced LWR design that could be marketed sooner than the breeder.

Even if one made the wrong free market choice -- that is, deployed the breeder rather than improving the LWR and stockpiling uranium -- the breeder would increase the electricity available by only a percentage point or two in the event of a hypothetical uranium shortage in 2020. For this level of independence, the nuclear industry would have us build a huge commercial fuel cycle based on nuclear weapons material. Each large commercial nuclear fuel reprocessing plant (processing fuel from some 50 plutonium breeders) would be churning out upwards of 10,000 atomic bombs' worth of plutonium annually, an amount exceeding the entire plutonium inventory in the U.S. weapons stockpile. In five years the throughput of just one of these plants would have exceeded the entire U.S. nuclear weapons material inventory invested in some 26,000 nuclear weapons. This kind of energy security we don't need.

It is also argued in favor of the CRBR that other nations are developing breeder technology and will "get ahead" of the United States. First, as noted previously, the pace of breeder development, even in France, is slowing markedly; in other countries, it appears to have come to a virtual halt. The inexorable problem of economic viability seems to have caught up with these projects. Second, we would hope that at least one lesson might have been learned from the long SST/Concorde debate and its denouement: that just because a project is technologically possible is no reason to do it. It is obvious that the United States made the right decision not to proceed with supersonic commercial airplanes, instead going for the more economical wide-bodied jets like the 747. The French and the British made a disastrous decision to proceed with Concorde. The advanced LWR could be the 747 of the American nuclear industry, with half the uranium consumption of today's models. Instead of pursuing the this technology with a federal R&D cost approximately one-tenth that of the breeder, DOE's Nuclear Division, this Committee, the Congress, and now the Reagan Administration have systematically gutted every program that appears to compete with the breeder.

The choice here is clear. On the one hand, the U.S. can recapture the reactor market -- what there is left of it -- by improving the LWR. On the other hand, we can invest billions of federal dollars and build the CRBR, thereby demonstrating to the world that we can build in 1990 what the French built in 1973 -- a very expensive demonstration plant that can heat water with nuclear weapons material.

There are even better choices. In this regard, it is worth comparing the proposed increases in funding of the breeder reactor with the massive cuts proposed in the conservation and solar programs of the Department of Energy. These programs directly reduce American dependence on foreign energy supplies. Conservation through improving energy productivity can meet our energy problems faster and cheaper than any new program for increasing energy supplies. Despite this, the DOE industrial conservation program, with its proven cost effective track record, is being eliminated by the Administration while the breeder budget is being increased. Even solar can produce central station commercial electric energy long before the breeder reactor. Conservation and, in some regions, solar are already competitive economically with central station electric plants. In these circumstances, it makes absolutely no sense to commit massive subsidies to a breeder reactor program with runout costs approaching $20 billion when it is so clearly inferior to other energy opportunities available at this time.

In short, the commitment to the Clinch River Breeder Reactor is a huge economic boondoggle, a massive public works project to boost the morale of an almost comatose industry.

The Clinch River Breeder has become a symbol in the fight by some DOE and nuclear industry leaders to insure the survivability of the nuclear option. Wiser men in the nuclear industry realize that the U.S. would have a stronger breeder program if the CRBR were abandoned in favor of the "bigger, better" breeder. I find it truly remarkable that many in the nuclear industry are willing to destroy the breeder program to preserve the symbol.

In closing, let me note that, even assuming the CRBR made sense technically, and that there was any hope that it could lead to a commercially successful technology, it is incomprehensible that the Administration should propose increased federal funding <u>now</u>. The needy in this country are being told that in the interests of "economic recovery" they must accept billions of dollars of cuts in basic human service programs -- decreased food stamp allowances, increased rent contributions for subsidized housing, and cutbacks in child nutrition programs. Can the CRBR really be viewed as more deserving of federal support than these basic human services? The Administration's breeder philosophy parallels that of former Pakistani Prime Minister Bhutto, who once said that his country would develop atomic weapons "even if we have to eat grass."

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September 17, 1977

CONSERVATIVE ECONOMICS AND FREE MARKET PHILOSOPHY
SAY "NO" TO THE CLINCH RIVER BREEDER PROJECT

As a member of the Energy and Power Subcommittee, I worked to defeat the Administration's National Energy Plan on the grounds that it was anti-free market in nearly every respect.

Along with most of our Republican colleagues, I advocated decontrol of oil and natural gas prices because I believe the market will furnish additional supplies in response to higher prices. I opposed bureaucratically administered conservation programs because I believe the free market is the best means of achieving conservation. As prices rise, businesses, households, and other energy users substitute lower cost factors--insulation, improved engineering efficiency, and other capital improvements--for energy, thereby lowering demand and costs. I also opposed the Administration's red-tape-ridden coal conversion program. The market system will lead to increased coal use by utilities and industry as the Btu cost of gas and oil rises without the costly "help" of a Washington bureaucracy.

Until a few months ago, I assumed that the Clinch River Breeder project was a good idea. It promised vast amounts of energy free from foreign control. But after a careful, in-depth review of the economics of the project, I have come to the conclusion that it is <u>totally incompatible</u> with our <u>free-market approach to energy policy</u>.

The case for the Clinch River project and early breeder commercialization has been constructed almost without reference to the principles that we applied in the earlier energy debate. It ignores the dynamic resource adjustment process that will take place in the energy market during the next three decades. As a result, it overstates future demand for electric power and understates the expanded supply of uranium that will be generated by higher prices. This lack of market reference in the case for the breeder obscures the clear cost advantage of sticking with conventional nuclear power over the next thirty years. The breeder cannot compete with existing nuclear technologies within the time frame contemplated by its advocates without continuing massive subsidies.

The precedent set by continuing the Clinch River project will be one of increasingly deeper government involvement in the development, marketing, and commercialization of alternate energy sources and massive federal subsidies to underwrite future national energy costs. Today it is the nuclear breeder lobby looking for a large, uneconomic subsidy. Tomorrow it will be the solar power gang, then the windmill freaks, and so on in a never ending stream of outstretched palms.

As I said in my previous Dear Colleague, I believe that government support for basic scientific research, laboratory experimentation, and pilot scale demonstrations is a laudable and appropriate policy. But government should not become involved in the provision of subsidies for the commercialization of new energy technologies that cannot pass the market test of competitiveness with alternatives on a price basis. The breeder reactor will not pass this test until well into the next century, if ever.

If your view is similar to my initial reaction, you assumed that the vote on Clinch River was a struggle between the pro-production forces and the anti-growth Doomsday squad that has done so much damage to our energy situation already. It is not. Ironically, it is a test of whether, as Republicans, we will consistently adhere to the free-market views on energy policy that we so forcefully advocated during the debate on the energy bill earlier this session.

I hope that you will carefully consider the attached memorandum and vote in favor of the Brown amendment to cut back the funding for Clinch River.

With all best wishes, I am

Yours very truly,

Dave

DAVE STOCKMAN
Member of Congress

Enclosure

DAS/nr

THE MARKET CASE AGAINST THE CLINCH RIVER BREEDER PROJECT

I. Uranium Supply, Demand for Electricity, and Power Costs: Two Nuclear Technologies in Competition.

The issue of whether to continue heavy federal subsidies to the Clinch River project is fundamentally a question of energy costs, not one of quantity or supply adequacy. Clearly, we must make large additions to our electrical generating capacity between now and early in the next century. Due to dwindling fossil fuel supplies, an increasing share of this additional capacity must be nuclear. The market case against early breeder commercialization, as distinguished from the anti-growth and anti-nuclear arguments, does not deny either of these propositions.

But it does focus on a very specific and important question regarding the appropriate choice of nuclear technologies and the timing of their introduction into the commercial market. The question is, within the time frame under consideration-- roughly the period from 1990 to 2010/15-- which nuclear technology offers the prospect of adequate electric power production at the lowest cost: the conventional light-water cooled reactor or the proposed breeder-plutonium fuel cycle?

Either of these nuclear power variants can fill our electric needs. The question presented by the Brown amendment is which will be the best bargain for the economy, electric customers, and the Federal treasury.

This question cannot be answered apart from the dynamics of the marketplace and its complex interaction of electric power demand, uranium ore supply, and the comparative capital and fuel cycle costs of the two technologies.

No one has seriously argued that the breeder is competitive or ought to be added to our electric energy supply system so long as there is an adequate supply of low-cost uranium. Current figures indicate that the capital cost of the breeder will be from $100 to $200 greater per kilowatt of capacity than for conventional light-water reactors. Similarly, at current uranium prices, the once-through fuel cycle of the conventional reactor is also cheaper due to the high cost of separating, reprocessing, and refabricating spent reactor fuel, as required by the breeder.

However, at such time as our supply of low-cost uranium is depleted and the price rises to levels perhaps three or four times above historic uranium prices, the comparative economics change. The breeder fuel cycle becomes cheaper because it does not require fresh uranium ore. Eventually, these fuel cycle savings more than off-set the higher capital costs of the more complex breeder reactor design and technology. Under these conditions the breeder variant would displace the light water reactor as the lowest cost source of nuclear electric power.

In a normal product market, the interaction of supply and demand would determine this threshold point, and thereby determine whether 1990, 2020, or any point in between, is the appropriate date for the introduction of the commercial breeder. However, the market for advanced nuclear electric technologies (and indeed advanced energy technologies of all types) is heavily influenced by extensive Federal involvement in research, development, and demonstration.

In the present case, this involvement is appropriate due to the unusual national security implications of civilian nuclear power and due to the clear national economic benefits which result from public financing of research and development activities that would have prohibitively long pay-back periods in the private sector, especially in the risk-averting utility industry.

But development of energy technology options should not be confused with their marketing and commercial introduction. An essential principle of the market approach to energy policy is that when the stage of commercialization or near commercialization is reached, the market choice mechanism must take over and development subsidies must largely end. Therefore, the only justification for any continued funding of the Clinch River project is the hard economic judgment that under foreseeable conditions, the market would select the breeder during the 1990's as the lowest-cost form of nuclear electric power production.

Advocates of the Clinch River project have recently shifted their justification in an attempt to avoid this crucial test, and are soft-pedalling the former argument that Clinch River is the first stage in an integrated commercialization program. But even a cursory review of the nature and scope of the timetable proposed by the Science Committee demonstrates that the Clinch River Project cannot be severed from the overall timetable for early commercialization.

The new argument is that the Clinch River project offers a kind of energy "insurance policy," or a scaled-up R & D option on which a commercialization choice can be made in the late 1980's--after the project is in operation. But this argument ignores economic and political realities. The Clinch River project will cost at least $2.7 billion. In conjunction with the other elements of the breeder development program, it will generate a vast industrial support and supply infrastructure among private companies engaged in all phases of reactor design, component manufacture, and plutonium fuel cycle support. The development of this infrastructure is in fact one of the central goals of the project.

The notion that after the government and private firms have invested billions of dollars in developing a commercial breeder industry infrastructure, it will somehow be easier to make a decision on commercialization is absurd. All of the expenditures on the project and its infrastructure will have become sunk investments. It would make no sense to write off all of this investment and put the breeder reactor on the shelf for two or three decades until economic conditions become more favorable, should that be the conclusion of the Clinch River test. What will happen is that the breeder will develop still greater institutional momentum. As difficult as the decision to defer breeder commercialization is today in the face of clear and convincing evidence, it will become still more difficult at the so-called "commercialization decision date" in the 1980's.

What about the "insurance policy" argument? It may seem attractive to support the Clinch River project despite its very unfavorable economics against the risk of unpredicted deterioration in the world uranium market. But uranium is not the only fuel source facing the prospect of depletion of low-cost reserves. Supply uncertainties are at least as strong for conventional sources of natural gas and crude oil. If we adopt the "insurance policy" rationale, the Federal government should make a commitment to very heavy subsidies for commercial scale synthetic crude, oil shale, geopressurized gas, and coal gasification plants as well--just to provide an "insurance policy" for other vital energy sources. This kind of logic obviously leads very rapidly to a non-market based energy supply system, something that I fervently hope is not our goal.

In light of these considerations, it is clear that the time to make the choice between accelerated or deferred commercialization of the breeder is now. The following sections demonstrate quite clearly that market conditions will not be conducive to breeder introduction until well into the next century.

II. There Is No Such Thing As Free Energy.

The preceding makes clear that the breeder is an advanced technological variant of current reactor and fuel cycle design, not the energy equivalent of a perpetual motion machine. Contrary to the popular image, it does not "breed" more energy than it consumes; rather, the breeder facilitates a more complete extraction or recovery of the energy potential of uranium ore than is possible with current technology. This enhanced recovery, however, comes at a substantial premium in reactor capital investment and fuel reprocessing facilities.

For this reason, the widely advertised fact that the enrichment tailings left over from the conventional nuclear process contain the energy equivalent of a trillion barrels of oil is of little significance divorced from the context of economic costs. For one thing, this huge, dramatic number represents electric-generation input equivalents, not end-use energy available to the economy. Given the inherent thermal conversion inefficiency of electric power generation, the end-use value is something in the order of only 300 billion barrels of oil equivalent.

More importantly, incomplete energy recovery from fuel resources is by no means unique to the uranium 235 fueled light water reactor; the extraction and conversion process for nearly every fuel in use in the economy today exhibits the same pattern.

On the average, almost two-thirds of the crude oil in a given reservoir is left in the ground because the costs of a higher rate of recovery are prohibitive. In fact, since the beginning of the petroleum age in the United States, nearly 300 billion barrels of oil have been left in the ground due to the economic limits of recovery.

Similarly, until recently most U.S. coal seams have been deep-mined, yet the typical "room and pillar" method of extraction has left considerably more than half of the available coal behind. The amount of energy in this unrecovered coal is the equivalent of another 300 billion barrels of oil.

A proposal to launch a massive Federal subsidy program to re-open abandoned mines and wells, or to encourage much higher rates of recovery from currently producing properties, would not be given serious consideration at the present time. Yet the much bally-hooed stored uranium tailings are no different in principle. The desirability of enhanced BTU recovery from any fuel is essentially a matter for the market to decide; physical potential is a thoroughly inadequate justification for a large subsidy program.

III. Future Electric Power Demand and Market Adjustment.

The linchpin in the case for subsidized breeder commercialization has been enormous projected increases in electric power demand during the next three decades. As recently as 1974, for example, the ERDA mid-case estimate showed a need for 2,200 gigawatts of generating capacity by the year 2000--a figure which represents generating capacity more than four times greater than available today.

Under this demand scenario, a minimum of 1,000 gigawatts of nuclear capacity would have been absolutely essential (this compares with 40 gigawatts of nuclear capacity on-line at present). Nevertheless, even at this high level of nuclear supply, coal-steam capacity would have had to increase four-fold to make up the difference. Obviously, under these electric demand conditions, known and even speculative supplies of low-cost uranium would have been inadequate, making early breeder commercialization imperative.

In truth, however, these demand projections represent an inexcuseable ignorance of market dynamics. Rather than being sophisticated economic projections, these numbers were merely mechanical extrapolations of the electric power consumption growth rate that had prevailed for the previous decade or so, about seven percent per year.

Yet this high electric consumption growth rate--nearly double the average growth in GNP--was made possible by a single key economic factor that even in the early 1970's should not have been viewed as indefinitely sustainable: a steadily declining real price of electric power.

Between 1945 and 1970, for example, the constant dollar cost of residential electricity dropped from 11 cents per kilowatt hour to only 2.5 cents per kilowatt hour; similarly, industrial rates were reduced by more than one-half during the same period. The result of this unique combination of steeply declining unit prices and rapidly growing total consumption was that the share of GNP devoted to purchased electricity remained almost constant at 2 percent during the entire post-war period.

It is clear today that declining real prices for any energy source, including electricity, are a thing of the past. Indeed, average electricity rates in constant dollar terms have already increased by 34 percent since 1972.

Due to huge additional costs for environmental controls, rising costs of utility financing and capital, and sharply increasing utility fuel costs, a substantial continuing rise in real electric rates over the next 20 or 30 years is highly probable. Indeed, one recent study by ERDA's Institute for Energy Analysis indicated that real electricity prices will increase by more than 60 percent by the year 2,000.

Yet assuming a seven percent growth rate in electrical consumption (as per earlier ERDA demand studies) in combination with the undeniable prospect of something in the order of a 50-60 percent increase in electric rates (as per recent ERDA price studies) produces an entirely absurd proposition: namely, that the fraction of GNP devoted to the purchase of electric power would jump from its historic 2 percent level to more than 15 percent! Even at a more modest 5 percent annual consumption growth rate, the mathematical outcome is nearly a 10 percent share of GNP going to electrical purchases.

There is little reason to believe that the economy would permit such a drastic shift in resource allocation to occur. The residential market, which has been a source of differentially high growth in recent decades, provides a good case in point.

This sector is now nearly saturated with basic appliances, as symbolized by the Census Bureau's decision to discontinue its questions on basic appliance ownership because levels have reached 99 percent. In addition, the stabilization of the population growth rate indicates a much lower rate of new household formation than in previous decades. There is also a strong prospect of large increases in household thermal efficiency in both space conditioning and appliance applications, spurred by mandatory efficiency standards, the likelihood of strong solar penetration, and of course simply by rising power rates. For these reasons it is probable that aggregate household consumption of central station power will grow very modestly, if at all, during the next few decades.

The process of factor substitution will greatly constrain the rate of industrial and commercial power growth as well. To take one specific instance, it is almost certain that the two and one-half decade long decline of industrial co-generation, during which co-generated power declined from almost 20 percent of industrial use to 10 percent, will be sharply reversed, thereby constraining demand for purchased central station power.

As a result, an average electrical consumption growth rate in the three percent range seems highly probable in the decades ahead. Even this would mean an increase in the central station electricity share of GNP to nearly 5 percent by the year 2,000, assuming a 60 percent increase in real prices.

Since the long-term growth rate for real GNP is roughly in the 3 percent range, this would imply a 1:1 growth ratio between electrical consumption and GNP, a sharp contrast with the 2:1 ratio implicit in the pro-breeder scenarios.

There is already strong evidence accumulating that this sharply reduced growth rate in central electric power is likely. During the last two years of strong economic recovery and high real GNP growth, electrical consumption has increased only at a 1:1 ratio with GNP. This contrasts markedly with the pattern during previous decades in which even strong cyclical recovery years exhibited electrical consumption growth rates far in excess of GNP.

IV. Meeting Electric Demand Under a Realistic Market Scenario.

The foregoing considerations make clear that rather than in excess of 2,000 gigawatts of electric capacity by the turn of the century, the more probable estimate is in the range of 1,000 gigawatts (based on a three percent average growth rate instead of seven). On the basis of current trends, it is likely that even 350 gigawatts of nuclear electric capacity is an optimistic estimate of the nuclear share of this total capacity requirement.

Two strong considerations support this estimate. First, there is little reason to believe that there would be serious restraints on achieving roughly 650 gigawatts of non-nuclear capacity. Presently, for example, hydro-electric accounts for 65 gigawatts. The Interior Department projects that this will reach nearly 100 gigawatts by 1985. In addition, it is almost certain that a minimum of 5 percent of capacity will have to be fired with liquid or gaseous fuels (perhaps synthetics) because it is simply economically prohibitive to use large coal or nuclear fired plants for peak-shaving purposes.

This leaves a requirement for baseload coal capacity in the range of 500 gigawatts. Presently, there are 250 gigawatts of coal capacity in place. According to current surveys, another 100 gigawatts of coal capacity is either under construction or planned through 1985. Thus, over the remaining fifteen years of the century only another 150 gigawatts of capacity would be required, an average of 10 coal-fired plants per year.

These coal fired capacity estimates imply annual coal production of slightly over 1.2 billion tons per year, even after allowing for substantial increases in direct industrial use. Since the Carter Administration has targeted this production level for 1985--15 years earlier--there is little reason to think that there would be serious supply constraints.

The second reason to believe that nuclear capacity would not exceed 350 gigawatts under a realistic demand scenario is simply the lagging rate of light water nuclear plant additions in the past three years. The 350 gigawatt figure for the year 2,000 implies that 14 new 1,000 megawatt units will become operational during each of the next 22 years.

Yet in 1975, there were only <u>two</u> new orders for nuclear plants; in 1976 there were only <u>three</u>; and this year there have been <u>none</u>. Moreover, during the same period there have been 18 units cancelled representing nearly 20,000 megawatts of nuclear capacity. Compared to the 5,500 megawatts of new orders, this means that just since 1975 there has been a <u>net decline</u> of nearly <u>14,000 megawatts</u> of nuclear capacity ordered for the 1980's.

Certainly it is to be hoped that Congress will act soon to streamline the present disasterously complicated and prolonged licensing process, and that the intense social and political opposition to nuclear power generation will be overcome. Nevertheless, the experience of the past few years makes clear that the required annual addition rate of 14 nuclear plants will be difficult to achieve, and that 350 gigawatts of nuclear capacity by the year 2000 is indeed a conservative reference target for analyzing uranium supply and prices.

V. Uranium Supply and Prices: Bureaucratic vs. Market Perspective

The second critical question regarding early breeder commercialization concerns future prices and supplies of uranium ore. Specifically, is there likely to be a sufficient supply of low-cost uranium ore to support the lifetime requirements of 350 gigawatts of nuclear capacity, thus permitting a deferral of breeder commercialization program until after the turn of the century?

The answer to this question depends first of all upon future enrichment practices. Uranium oxide contains roughly .7 percent U-235, but the extent of enrichment extraction of this fissionable material can range from 57 percent (.3 tails assay), to between 87 and 100 percent

(.1- 0 tails assay). For this reason, projections of uranium oxide requirements are very sensitive to assumptions about enrichment methods and the tails assay.

Specifically, the lifetime requirements of the 350 gigawatts of nuclear capacity projected previously would be 2.5 million tons, assuming .3 tails; 2.2 million tons, assuming .2 tails; and 1.8 million tons, assuming .1 tails. The high tails assay thus produces uranium ore requirements nearly 40 percent greater than under the low assay.

Traditionally, U.S. enrichment facilities have operated at a .2 tails assay. But in 1973 this was temporarily increased to .3 in response to what appeared to be a growing shortage of enrichment capacity relative to projected rapid growth in the nuclear power market. The effect of this change was to increase the apparent uranium oxide requirements for current and planned light water reactors by 26 percent.

However, it is likely that the future trend will be toward increasing rather than declining extraction of fissionable material from our uranium supplies. The anticipated shortage of enrichment services capacity has become extremely unlikely because of the serious slowdown in reactor deployments and because of the active enrichment capacity expansion program now underway.

Another factor determining the level of extraction efficiency is the cost of enrichment services relative to the cost of uranium. As the price of raw uranium rises relative to the price of enrichment, the percentage of U-235 that can be economically extracted from raw ores increases. Thus even assuming that there are no breakthroughs in enrichment technology, the proportion of useable fuel that can be extracted from raw uranium will rise over the next decades.

The biggest potential increase in extraction efficiency will come from new technologies, however. These new processes promise to radically reduce the amount of U-235 left in the tailings. The most promising new technology from a theorectical standpoint is laser isotope separation. This process may be capable of extracting nearly 100 percent of the U-235 from uranium ore, thus vastly expanding the amount of fuel that could be produced from our uranium supplies. The tailings piles that breeder advocates point to as a huge potential source of energy could be used to produce fuel for light-water reactors if laser isotope separation becomes commercially viable.

Another promising variant in enrichment technology is the gas centrifuge. Current U.S. enrichment plants use immense quantities of electricity. When all three plants are operating at full capacity, they use nearly as much electricity as the entire state of Minnesota.

But because these plants had access to the very cheap electric power produced by the TVA, the cost of enrichment remained within reasonable limits. Now that even TVA power has become significantly more costly, less electricity-intensive enrichment technologies such as the centrifuge may be able to lower the cost of enrichment services. This will permit a higher rate of extraction.

Both of these new enrichment technologies are under intense development. The Administration requested more than $50 million in FY 1978 for advanced isotope separation techniques. A gas centrifuge plant is planned for construction within the next decade as an expansion of the Portsmouth, Ohio enrichment facility.

In light of these almost certain improvements in enrichment efficiency, it would be prudent to assume a maximum uranium oxide requirement of 2.0 to 2.2 million tons to meet the lifetime fuel needs of the 350 gigawatts of capacity projected above. It is necessary to make some very unreasonable and non-market oriented assumptions to show that uranium supplies in these magnitudes will not be available in the decades ahead.

Before proceeding to a discussion of current reserve estimates, two frequently encountered red herrings need to be disposed of. The first is that the current "proved" reserves of uranium only total 680,000 tons, or roughly one-third of the supply requirement indicated above.

However, the term "reserves" refers only to uranium resources that have been specifically located and delineated by drilling and other engineering techiques. Placing resources into this category thus requires mining companies to make substantial investments. These investments will obviously not be profitable unless these reserves can be produced in the relatively near future. Thus, the widely quoted reserve number actually represents a "<u>production inventory</u>" and has little to do with the potential resource base, the relevant concept for decision-making purposes.

The most apt analogy is the case of natural gas, for which proven reserves now stand at about 200 trillion cubic feet. Were this taken as the potential resource base and were production to continue at current rates we would reach <u>absolute depletion</u> in 1987. Even the most conservative analysts of the natural gas industry have not suggested this extreme possibility.

For one thing, natural gas, uranium and almost every other extractable resource has a clear "<u>extension</u>" pattern in which economically delineated reserve levels imply a somewhat fixed "new find" rate in adjacent deposits or reservoirs within prevailing price ranges. Current ERDA estimates put these uranium extension reserves, the most conservative category of resource base expansion, at <u>1.1 million</u> tons. This, in combination with what has previously been termed the production inventory, amounts to nearly 1.8 million tons of known reserves, a figure nearly equal to the lifetime supply requirements given above.

Unfortunately, advocates of early breeder commercialization have used this figure (1.8 million tons) as the "prudent planning base" for calculation of breeder economics. But this is clearly a bureaucratic expedient rather than an economics based estimate, because it implies nearly a zero elasticity of supply beyond presently identified reserves. As will be shown more fully below, this assumption has even less credibility than that employed by proponents of continued regulation of natural gas.

The other item in the red herring category is the frequently recited fact that current spot market prices are in the $40 per pound range. But the spot market for uranium ore is extremely thin as most uranium is purchased under long-term contracts. As a result, the spot market price is highly volatile and can be highly affected by short-run demand conditions. In fact, the present high spot market price is a temporary aberration reflecting the surge in short-term demand induced by recent changes in ERDA enrichment practices, ERDA contracting procedures, and the massive abrogation of supply contracts by Westinghouse in late 1975.

A more reflective indicator of long-term price trends is the price for 1980's delivery contained in contracts written during the past year. These are almost entirely under $20 dollars per pound in real terms.

To return to the critical question of long-run supply it is clear as a matter of resource economics that the "prudent planning base" estimate of roughly 2 million tons used by breeder advocates is in fact, not only imprudent but actually nonsensical. By definition, proved and probable (extensions) reserves essentially represent <u>past exploration activities</u>. Therefore, to assume that this figure embodies the producible uranium supply for the indefinite future implies that either there will be absolutely no additional exploration for new uranium deposits in the coming decades or that the marginal cost of new reserves will escalate upward on nearly a vertical path.

The relatively brief history of the uranium mining industry offers no support whatever for either of these assumptions. Two trends tell the story. First, after the government-supported launching of the uranium mining industry in the early fifties, there was a persistent and steady decline in real prices--from $28 per pound in 1954 to less than $9 per pound in 1973. Yet despite this sharp drop in prices, exploration activity and production moved sharply upward. From 1950 to 1960 annual production increased nearly twenty-fold, and low-cost ($15 per pound and under) proved reserve levels rose from a negligible 3,000 tons to nearly 200,000 tons in 1960. By 1975 this category of the lowest cost reserves had again more than doubled to 430,000 tons. Resource base estimates (as distinguished from proved and probable reserves) were expanded in a similar manner.

Thus, in order to accept the prudent planning base estimates as the limit of future producible uranium supplies, it is necessary to assume that an industry that has been characterized by declining marginal costs, rapidly expanding reserve additions and drilling productivity rates that increased by nearly 6 percent annually for two decades will precipitously reverse course and careen down a path of sky-rocketing marginal costs and vanishing exploratory drilling productivity. The fact, however, is that even during the last three years of demand-induced market instability, drilling productivity in the low-cost reserve categories (under $30 per pound) has actually increased substantially, indicating continuity with past trends.

ERDA currently places the potential resource base, which includes both current reserves and future discoveries, at 3.7 million tons--a level nearly twice that necessary to sustain the 350 gigawatt scenario developed above. But these are of necessity extremely conservative figures because they embody geologic data gathered by an industry whose exploratory activities have been constrained by historic $10 per pound prices to the very lowest-cost uranium formations.

It is clear, however, that the breeder will not be competitive at a uranium price below $75 to $100 per pound. Under these conditions there is little doubt that as long-term prices rise above the extremely low historic levels additional geologic data will be gathered permitting a substantial expansion of the potential resource base, and therefore, future uranium reserves and production.

The final environmental impact staement on the breeder, for example, estimated that with the addition of new geologic data derived from increased search for higher-cost deposits, the potential resource base at prices of $50 per pound is nearly 9 million tons--over four times the level necessary to sustain the 350 gigawatt scenario.

VI. The Magitude of the Cost Penalty for Breeders: Uncertain But Growing

The third reason why the breeder will not be commercially viable if introduced on the accelerated schedule proposed by the Science Committee is that the current projected cost differences between breeders and conventional reactors, both for the capital cost of the plant and for the fuel cycle facilities, are almost certain to widen in the years ahead.

When the Clinch River plant was originally proposed in the late 1960's, the projected cost of the plant was only $500 million, or about $1400 per kilowatt of generating capacity. By the time the project received its original authorization in 1973, the cost had gone to $690 million, or $2000 per kilowatt. Today, ERDA estimates a completion cost of $2.3 billion, or more than $7000 per kilowatt. Some experts have speculated that the cost may well go to $3 billion by the time construction is completed, since construction has not yet begun and experience with the Fast Flux Test Facility has been that most of the increases occur during construction.

At $7000 per kilowatt, Clinch River will cost more than ten times as much as current light water plants per unit of capacity. Of course, the cost of Clinch River includes many first-time exepnses, and other costs associated with the prototype status of the plant that make a direct comparison unjust. But this factor of ten represents the improvement that will have to be made in the economics of building breeders in order to make them competitive with light-water reactors. The increases in the cost of building Clinch River have been reflected in the increases in the estimated cost of later commercial breeders, however.

In a 1974 study supporting the rapid commercialization timetable, ERDA calculated that breeders would cost $100 per kilowatt more than conventional reactors at their 1995 commercial introduction date, and that this difference would be eliminated in thirteen years. The most recent ERDA projections show a cost difference of $145 per kilowatt initially, declining to $50 after thirteen years. This reduction in the cost of breeders is absolutely essential to the commercial success of the development effort on the present timetable, yet the history of the light-water reactor and the great unknowns in breeder and reprocessing technology make the likelihood of achieving cost reductions - of the requisite magnitude almost nil.

As commercial technologies mature, process costs almost invariably decline. One notable exception to this rule has been the light-water cooled nuclear power reactor. By the end of 1967 after nearly ten years of commercial operation, the cost per kilowatt of LWR's had reached about $180 (1975 dollars). By 1973, the average cost had increased to $475 per kilowatt of capacity. Thus, even after setting aside the 34 percent increase in general price levels during this six year period, the real cost of light-water capacity rose nearly 200 percent.

The reason for the high rate of cost increases for nuclear plants was primarily regulatory and contractor design changes to meet safety and environmental problems, though of course some of it is attributable to the differentially high inflation rate of the construction industry in general. We simply did not know all therewas to know about these facilities, however, and consequently the regulatory mechanisms for internalizing costs in the plants resulted in the continual addition of new, unpredicted cost factors.

This process seems to be nearing an end for the light-water cooled reactor. The latest ERDA projections for the cost of building reactors for delivery in the early 1980's is $667 per kilowatt in 1976 dollars. This represents a rate of real increase of only about 2 to 3 percent annually, well below the levels of the previous decade. The implications of this stabilizing trend in the cost of conventional reactors for the competitive position of the breeder are enormous. The breeder has yet to go through <u>any</u> of the licensing and development processes that produced the great escalations in the cost of building light-water reactors. Yet the inherently greater technological complexity of of the breeder, the large number of materials and design engineering problems that remain unsolved and for which the basic research is not complete, all indicate a high probability that the cost difference between breeders and conventional reactors will widen, not narrow. Even on the basis of current knowledge, some experts have predicted a gap of over $200 per kilowatt well into the beginning of the next century if we proceed on the present timetable. At this level, uranium prices would have to be four times higher than current projections to make the breeder cost-competitive.

In addition to the risk of cost escalations from plant construction costs, the breeder also faces a great risk of escalations from increases in the cost of reprocessing. This is a risk that is completely absent from the once-through uranium fueled light-water reactor, and consequently a particularly sensitive part of the competitive equation.

Experience in reprocessing light-water fuel has been dismal. The private plant at Barnwell, South Carolina, originally projected to cost $250 million, will cost over $700 million--if it is ever completed. Its private sponsors have backed out of the project as uneconomical, and our now attempting to secure a huge federal subsidy to operate the plant as a "demonstration" project.

The likelihood that breeder fuel preprocessing will encounter even more serious problems than current reprocessing efforts is great, yet the cost figures used in the economic analyses relied upon by the backers of Clinch River have been extrapolations from experience with spent light-water reactor fuel. The accuracy of these extrapolations is open to serious question because of two major technical differences between reprocessing spent LWR fuel and reprocessing breeder fuel.

The plutonium content of spent breeder fuel will be approximately 40 times greater than that contained in spent LWR fuel. Thus a breeder fuel reprocessing facility will have to have contend with the safety problems associated with keeping this substantially larger proporation of plutonium from reforming into a critically-sized accumulation. In addition to the plutonium related problems, the breeder reprocessing plants will have to contend with fuel that has been irradiated at a higher temperature than present LWR fuel. This, combined with embrittlement caused by the higher neutron irradiation levels to which the breeder fuel has been exposed, will make the fuel more difficult to process. The West Germans have reported considerable difficulty in the handling of fuel from high temperature gas cooled reactors on an experimental basis, which may well be an indication of the problems that will develop with breeder fuel.

The bottom line, then is quite clear. Due to the inherent risk of nuclear technology, and to strong public attitudes (increasingly embodied in regulatory policy) insistent upon nearly absolute risk reduction, there is no basis for assuming "learning curve" cost reductions for new nuclear technologies.

The last decade of experience with the light-water reactor, which is an inherently less risky and less complex technology, has demonstrated this unequivocally. Therefore, the most reasonable assumption is that the currently projected capital cost and fuel cycle disadvantage of the breeder relative to conventional reactors will widen, rather than narrow. In that event, only drastic, highly improbable long-term changes in the uranium market would make the breeder a competitive option.

VII. Conclusion

Under the following conditions the breeder will not be competitive until well into the next century:

1) Electric demand grows at only half the 1960's rate and the maximum share of year 2000 capacity required to be filled by nuclear-electric generation is on the order of 300-400 gigawatts;

2) There is a reasonably assured supply of at least 2.5 million tons of low-cost uranium ore (under $50 per pound);

3) Reactor cost differentials between the breeder and conventional plants are $100 or more, with similar differences in fuel cycle costs.

This analysis of the relevant economic markets makes clear that all of these conditions can be readily met. For that reason, early commercialization of the breeder will result in large economic losses to society in addition to a lengthy list of non-monetary risks in the safety, environmental and international relations-proliferation areas. Therefore, no further subsidization of the Clinch River project, an integral step in the early commercialization program, can be justified.

DAVE STOCKMAN
Member of Congress
September 17, 1977