43,044

JAN 19 1982

Supporting Research and Technical Analysis
Energy Supply Research and Development - Operating Expenses
Energy Supply Research and Development - Plant and Capital Equipment
(Tabular dollars in thousands. Narrative material in whole dollars)

	FY 1981 Appropriation	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Basic energy sciences (BES)				
Nuclear science 1/ 2/				
Operating expenses	$ 20,468	$ 22,674	$ 22,674	$ 30,644
Capital equipment	830	860	860	1,556
Subtotal 2/ 3/	21,298	23,534	23,534	32,200
Materials sciences 2/ 3/				
Operating expenses	89,083	96,194	96,194	108,700
Capital equipment	7,100	7,960	7,960	8,510
Construction	300	600	600	3,000
Subtotal 3/	96,483	104,754	104,754	120,210
Chemical sciences 3/				
Operating expenses	59,717	63,675	63,675	70,000
Capital equipment	4,140	4,940	4,940	5,510
Construction	3,200	0	0	400
Subtotal	67,057	68,615	68,615	75,910
Engineering, mathematical and geosciences				
Operating expenses	24,100	25,000	25,000	31,050
Capital equipment	1,760	1,900	1,900	1,920
Subtotal	25,860	26,900	26,900	32,970
Advanced energy projects				
Operating expenses	6,350	7,400	7,400	8,300
Capital equipment	300	320	320	290
Subtotal	6,650	7,720	7,720	8,590
Biological energy research				
Operating expenses	7,250	8,500	8,500	9,500
Capital equipment	400	410	410	370
Subtotal	7,650	8,910	8,910	9,870
Program direction				
Operating expenses	2,500	2,900	2,900	3,100
Subtotal	2,500	2,900	2,900	3,100
Total				
Operating expenses	209,468	226,343	226,343	261,294
Capital equipment	14,530	16,390	16,390	18,156
Construction	3,500	600	600	3,400
Basic Energy Sciences	$227,498	$243,333	$243,333	$282,850

1/ Reflects transfer with comparability adjustment of Low Energy Nuclear Research activity to Nuclear Physics program and transfer in FY 1983 of the Stanford Synchrotron Radiation Laboratory (SSRL) from the National Science Foundation to the Nuclear Science subprogram. The shift of the SRRL results in an increase of $6,800,000 in the budget request for FY 1983. Funding associated with the SSRL in FY 1982 is $5,850,000.

2/ Reflects internal Basic Energy Sciences adjustments for full HFIR operational responsibility.

3/ Reflects internal Basic Energy Sciences adjustments for full HFBR operational responsibility.

Authorization: Section 209, P.L. 95-91

Summary of Changes

FY 1982 Appropriation enacted	$ 243,333
Built-in increases and decreases:	0
FY 1983 Base	$ 243,333
Program increases and decreases	
Basic Energy Sciences	
Provide cost-of-living to maintain core program and provide for selected expansions in basic research programs in:	
Nuclear Sciences	$+ 1,866
Materials Sciences	+ 12,756
Chemical Sciences	+ 6,545
Engineering, Mathematical and Geosciences	+ 6,820
Advanced Energy Projects	+ 870
Biological Energy Research	+ 960
Program Direction	+ 200
Increase resulting from the transfer of the Stanford Synchrotron Radiation Laboratory from the National Science Foundation to the BES Program	+ 6,800
Construction funding for the improvements to the Weapons Neutron Research Facility	+ 2,700
FY 1983 Budget Request	$ 282,850

Basic Energy Sciences

The Office of Basic Energy Sciences (BES) is responsible for the long-term, high risk research in the agency. The chief purpose of the program is to provide the fundamental scientific base on which identification and development of the Nation's future energy options depend. The major product of the BES program is knowledge that is relevant to energy exploration, production, conversion and use, and that product becomes a part of the body of data on which the applied technologies rest.

To carry out the program, BES plans, supports and administers energy related research in the physical and biological sciences, engineering and applied mathematics. The strategy is to:

- Provide critical knowledge and information, and develop a base of new scientific talent through support of highly competent researchers in energy related areas;
- Provide for, and support operation of unique, specialized research facilities;
- Maintain liaison with other programs within the agency, other Federal agencies, and the scientific, academic and industrial communities.
- Cooperate with the scientific and technological communities to identify needs and opportunities for research in areas likely to contribute towards solution of long range energy problems; and
- Promote early applications of the results of basic research.

To implement this strategy, four distinct but complementary kinds of activity must continue to be supported. These are:

- o Maintenance of the existing strong core program;
- o Expansion of research in newer emerging priority areas identified as having great potential importance to energy, yet which are not covered in the core program;
- o Maintenance and operation of existing unique facilities and operation of new state of the art facilities as they come on-line; and
- o Replacement of obsolete equipment, and addition of new equipment and capital facilities needed to insure that BES supported scientists remain at the forefront of science.

In the FY 1983 agency request, the Basic Energy Sciences request is for $282,850,000. Of this request, $261,294,000 is for operating expenses; $18,156,000 is for capital equipment; and $3,400,000 is for construction.

The Basic Energy Sciences program has been responsive to the greatly increased requirements for research resulting, first, from the formation of the Energy Research and Development Administration (ERDA) in 1975, and next, the establishment of DOE in 1977. Each transition resulted in broadened responsibilities for research. External advisory groups have repeatedly recommended increased funding for basic research support and have often called for BES to be given a larger role in developing the needed technology base for the different energy supply and conservation options. While BES has sought to meet such recommendations and its increased responsibilities, it has not been able to do so to the extent recommended because of resource limitations. Budget needs for each of these four kinds of activity create conflicting demands affecting the overall balance of the BES program. The agency request as discussed herein is necessary to address these demands.

At the funding level requested, most of the ongoing core programs of basic research can be maintained, although some reductions will still be required in the larger BES subprograms to meet major facility commitments. The core program has, during the past four years, been impacted by growth in new areas and facility commitments. Further sacrifices in the core program to support emerging priority areas will be detrimental to achieving our long-range goals.

Some program expansion is planned for the newer subprograms of Biological Energy Research, Advanced Energy Projects, and Engineering, Mathematical and Geosciences, which comprise about 20% of the total BES program.

Basic Energy Sciences has a heavy involvement in scientific facilities (e.g. Oak Ridge Electron Linear Accelerator at ORNL, National Synchrotron Light Source at BNL, Combustion Research Facility at Sandia-Livermore, High Flux Isotope Reactor at ORNL, and High Flux Beam Reactor at BNL); many areas of modern science require large and costly facilities without which the research simply cannot be done. Operating costs for major scientific facilities for FY 1983, exclusive of the costs of research using them, are expected to reach 17% of the BES operating budget. Additional funding sought in this budget request is mainly to operate our major facilities near their FY 1982 levels of operation. Facility operation in FY 1983 will still remain less than optimum for three newly constructed facilities, the Combustion Research Facility, Intense Pulsed Neutrton Source, and the National Synchrotron Light Source. Facilities operation is heavily impacted by escalating power costs well above the inflation projection for FY 1983, by low levels of nuclear fuel inventories, and by increasing costs for newer facilities as they come on-line.

The large facilities in the BES program are unique in the United States, and in some cases, in the world. The neutron facilities at ORNL and BNL present an excellent example. Although the national research effort involving neutron scattering and diffraction is supported almost exclusively by BES, the applications are far broader than energy. In this case, BES is filling a larger national role, a fact that is often not recognized.

The budget for Basic Energy Sciences includes a number of programmatic changes which involve internal program shifts of funding and management responsibility and also involve external shifts with other parts of the Government. The Basic Energy Sciences program for the first time has assumed full budget and management responsibility for the Stanford Synchrotron Radiation Laboratory (SSRL) in FY 1983. Previously this facility was funded by the National Science Foundation. This facility will be funded under Nuclear Science, the BES subprogram most closely associated with the High Energy Physics Program, which shares involvement and operational expenses at the same facility complex. Another major shift involves the transfer of all low energy nuclear physics research to the Nuclear Physics Program. Finally, the budget for BES includes shifting of operational funding for research reactors to specific subprograms within BES. Previously several subprograms funded facility operational costs of research reactors, whereas now the operational cost of these major facilities will be included in one subprogram. The Nuclear Science Program will now provide the BES portion of the operating budget for the High Flux Isotopes Reactor and the Material Sciences Program will budget for the High Flux Beam Reactor.

The research at each of the above facilities will continue to be funded by the program or subprogram which is conducting the research.

The need for improved equipment continues to be a chronic problem; as the frontiers of science are extended, researchers deal more and more with phenomena involving infinitesimal time periods, miniscule concentrations of reacting species, or entities with only transient existence. Measurement under extreme conditions of temperature and pressure also is a major problem area.

In addition to the capital equipment needs are the demands to continue construction of forefront facilities for advanced basic research. Construction funds are requested for Improvements to the Weapons Neutron Research (WNR) Facility at LANL, for Accelerator Improvement Projects at BNL and ANL, and for General Plant Projects at the Ames Laboratory and the Notre Dame Radiation Laboratory. The timing of the WNR Facility construction is critical in FY 1983 because it is directly tied to related Defense Programs' construction going on concurrently.

Further detail of this request is given below as the seven major subprograms of Basic Energy Sciences are discussed. The seven subprograms are: 1) Nuclear Science; 2) Materials Sciences; 3) Chemical Sciences; 4) Engineering, Mathematical and Geosciences; 5) Advanced Energy Projects; 6) Biological Energy Research; and 7) Program Direction.

	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Nuclear Science	$ 23,534	$ 23,534	$ 32,200

The objectives of the Nuclear Science subprogram are: 1) to provide a base of nuclear data to meet the long range needs of the fusion and fission energy technologies, nuclear waste management program, and the weapons technology program; 2) to improve our knowledge of the chemical and physical properties of the actinide elements; and 3) to assure the availability for research programs of isotopically enriched samples of the elements.

The request for the Nuclear Science subprogram includes $30,644,000 for operating expenses and $1,556,000 for capital equipment. Three major shifts of programmatic responsibility have been made in this subprogram. The first transferred the low energy nuclear research activity from this subprogram and more appropriately aligned it into the Nuclear Physics program, which is funded from the General Sciences appropriation. The second shift consolidated under the subprograms' responsibility for meeting the ER operating costs of the High Flux Isotope Reactor (HFIR) at ORNL. Previously, the operating costs of the HFIR were met thru funds provided by each ER user program

(Materials Science, Nuclear Science and Magnetic Fusion Energy, as examples) and each non-ER user (such as Nuclear Regulatory Commission, Isotope Production, etc.). Non-ER users will continue to pay their share of the operating costs. The adjustments made have been accounted for in this request. The third shift involved the transfer of operational funding for the High Flux Beam Reactor at BNL to the Materials Sciences subprogram. Similar to the HFIR shift users will continue to be responsible for actual research conducted at the facility.

An additional program shift which involves this subprogram is the addition of the Stanford Synchrotron Radiation Laboratory to the BES program. $6,800,000 ($6,344,000 operating and $456,000 capital equipment) of the requested increase is to provide support for the Stanford Synchrotron Radiation Laboratory (SSRL) transferred to the Department of Energy from the National Science Foundation beginning in FY 1983. This transfer is part of the Administration's efforts to improve management and planning for natonal user facilities by assigning a single agency the lead responsibility for operating a particular facility. In addition, the shift also brings support for the two major synchrotron radiation user facilities into a single appropriation. The SSRL is a national users' research laboratory associated with the High Energy facility known as the Stanford Positron Electron Asymmetric Ring (SPEAR). In addition to serving the HEP program, the SPEAR facility provides synchrotron radiation to SSRL for research in materials and chemical sciences, physics, engineering, biology and their basic and applied subfields.

The SSRL utilizes radiation emitted by electrons circulating in the SPEAR storage ring of the Stanford Linear Accelerator Center (SLAC) supported by the High Energy Physics Program. When SPEAR is operated for high energy physics research, the synchrotron radiation produced is used by SSRL at no cost to SSRL. However, under these conditions the radiation produced is frequently only of marginal quality for SSRL based research and, further, it markedly changes in character as the SPEAR operating specifications are changed to suit high energy physics research needs. When SPEAR is operated solely for the purpose of producing radiation according to specifications determined by SSRL, the SSRL must reimburse SLAC for the operating costs of SPEAR. Currently 50% of the operating time of SPEAR is available and has been used for the production of synchrotron radiation for SSRL at a cost of $1,550,000 in FY 1981. This cost is estimated at $1,851,000 in FY 1982 and $2,603,000 in FY 1983. The $3,741,000 balance of the operating costs in FY 1983 is required for general operation, user support and development of instrumentation of beam lines.

The radiation available through SSRL is extremely intense, highly polarized, well focused, and is pulsed on a nanosecond time scale that makes new and qualitatively different experiments possible which impact chemistry, physics, materials science and biology. Over 600 users from the scientific community have carried out experiments at SSRL. Currently there are 242 proposals to use SSRL involving 488 different users and nearly 100 graduate students.

At present SSRL has 15 experimental stations capable of simultaneous operation with two more coming on stream at the end of the year. Additionally the National Institutes of Health have established at SSRL a Biotechnology Resource Center which provides for wet chemistry and biological samples for study using synchrotron radiation.

The SSRL maintains a core staff of 41 FTE scientists, engineers, and technicians to operate the facility, to assist users, and to develop new experimental techniques and instruments to carry out research using this facility. Review of proposals and scheduling of experiments is carried out with the assistance of a Proposal Review Panel consisting of scientists from institutions other than Stanford University and a Science Policy Board. Twenty-two percent of the users come from industrial laboratories, 22 percent from U.S. National Laboratories, 45 percent from U.S. universities and the remainder from not-for-profit and foreign institutions.

Within the Nuclear Sciences subprogram, $9,160,000 is requested for the Nuclear Data Measurements and the Nuclear Data Compilation and Evaluation activities. These activities are a coordinated effort to develop a long-range nuclear data base measured to accuracies required by the fission energy, fusion energy, waste management, and weapons technologies and organized into formats most easily used by scientists and engineers in these technologies. Besides its main purpose to serve the agency's nuclear energy technologies, this data base also provides systematic input for use in the Nuclear Physics program's basic research effort. The accurate measurement and evaluation of nuclear parameters in support of energy technologies is a difficult and highly skilled activity. The instrumentation, techniques, and expertise developed and maintained by Nuclear Data Measurements and Nuclear Data Evaluation and Compilation is a unique national asset. The excellence of participating scientists and facilities is internationally acknowledged through requests for data and personnel exchange.

In FY 1983, the Nuclear Data Measurements activity will be directed primarily toward the long term needs of the agency's fission and fusion programs, with effort being divided almost equally between the two areas. High-priority needs for nuclear data in support of fusion energy are identified by the Office of Fusion Energy in cooperation with Nuclear Data Measurements staff. Actual measurements are coordinated by a working group that includes representatives from three national laboratories, two universities, and one industrial laboratory. Fusion energy technology requires neutron cross section measurements at higher energies than does the fission energy technology and often for different materials. The largest program of measurements is conducted at the Oak Ridge Electron Linear Accelerator (ORELA). Here accurate, high-resolution measurements can be made across the entire energy range of interest to fusion, from neutron energies of 0.01 eV to 15 MeV (the nominal energy of the primary DT-fusion neutrons); and even to 50 MeV or more for the interpretation of results obtained in fusion materials test experiments. In fact, a series of measurements of total cross sections has just been completed over an energy range of 2 to 80 MeV. These are needed for calculations of the shielding design for a large neutron source suitable to test materials planned for fusion reactor use; adequate data exists below 2 MeV (measured previously to meet LMFBR project requirements). The Office of Nuclear Energy has recently identified a new set of long-range reactor nuclear data needs which require the unique measurement capabilities of ORELA. This work is now and will be the central component of Nuclear Data Measurements efforts in support of fission energy technologies. In addition, the Office of Nuclear Energy supports and directs its own near term measurements at ORELA; the Nuclear Data Measurements activity of BES supports all costs of ORELA facility operations. In response to Nuclear Energy needs, Nuclear Data Measurements has just completed a major measurement effort at Oak Ridge, where five years of painstaking work have resulted in a new, definitive determination of the average number of neutrons emitted per fission for the spontaneous fission of Californium-252. This important standard has been determined to an unprecedented accuracy (an assigned uncertainity of less than 0.2%) and may prove to have a significant impact on light water reactor fuel cycle costs. The FY 1983 operating expenses requested for Nuclear Data Measurements activity is $5,800,000, an increase of $25,000 over the FY 1982 level.

The Nuclear Data Compilation and Evaluation activity is responsible for most of the total National effort in this area. All work is coordinated by the National Nuclear Data Center (NNDC) at Brookhaven. Other program participants in NNDC are the Office of the Assistant Secretary for Nuclear Energy, the Office of Fusion Energy, and the Electric Power Research Institute. In addition to its long-standing responsibility for neutron cross-section data, NNDC also now has responsibility for the compilation and evaluation of nuclear structure and decay data. This latter work is conducted in cooperation with a network of United States data centers and, with the help of the International Atomic Energy Agency, a network of European centers plus one in Japan. The FY 1983 operating expenses request for the Nuclear Compilation and Evaluation activity is $3,000,000, an increase of $100,000 over the FY 1982 level.

About 20% of the Nuclear Science subprogram funds support the Heavy Element Chemistry research effort. This effort is comprised of a broadly-based study of the fundamental chemical and physical properties and behavior of the actinide elements, which represent the "end of matter" at the heavy end of the Periodic Table of the elements and thus constitutes a unique area of study. These fundamental studies determine the trends of properties and behavior from one element to the next and provide tests and guides for scientific principles and models in this highest-mass region of matter. A thorough understanding of the actinides is also of central importance to the agency mission of nuclear energy technology development. This program supports studies of the thermodynamic stability of actinide materials in candidate solid waste hosts, the oxidation-reduction behavior and chemical nature of actinide ions in aqueous solutions found in the environment, and the chemistry of the absorption mechanism of actinides on geologic materials. Particularly noteworthy in the area of actinide solution chemistry is the recent advancement in our ability to detect the actinide species. Laser excitation of these species leads to the emission of fluorescence light which provides information not only on the concentration of the dilute species but also on its oxidation and chemical states. New studies in electro-chemical research on actinides in aqueous solutions containing the environmentally important carbonate and bicarbonate ions have shown that uranium, neptunium, and plutonium exhibit quite different chemical behavior from each other and that these species will have different tendencies to migrate in or be adsorbed out of aqueous environmental media. The area of actinide solid state chemistry is centered around the chemical formation of solid compounds and the determination of their structures and thermodynamic stabilities. Studies of laboratory preparations of uranium and plutonium in perovskite-type mixed oxides, which is also a naturally-occurring mineral structure, are providing information on the stabilities of the important +4 and +6 oxidation states of these actinides. Mixed oxide is one of the several candidate host materials for nuclear waste storage. Other areas of research supported by this program include studies of the electronic and magnetic properties of actinide metals, compounds, and ions; the volatilities and high temperature stabilities of metals, compounds, and vapor species; and the chemical reactions of actinides with organic materials. In the continuing program it is planned to emphasize those fundamental studies of actinide research that are germane to the problems of waste management and environmental behavior.

Funds requested for Heavy Element Chemistry in FY 1983 total $4,313,000, an increase of $158,000 over FY 1982.

The remaining portion of the Nuclear Science subprogram supports a service-oriented activity which provides for the production, separation, and purification of the high atomic number actinide elements. These are produced by irradiating curium-loaded targets in the High Flux Isotope Reactor (HFIR) followed by chemically processing the targets in the Transuranium Processing Plant (TRU) to extract and purify the actinide samples. These samples are allocated to investigators engaged in agency research programs. In addition, these funds provide for the electromagnetic separation of stable isotopes for a Research Materials Collection (RMC) of samples used for loans for non-destructive research in agency energy technology programs. These efforts constitute the Western World's only source of isotopic research samples in significant quantity. In the past, the RMC also has provided a source for "loan" of stable isotopes to the sales program to meet critical needs for medical, industrial, and research purposes.

Beginning in FY 1983, Nuclear Science has been assigned full responsibility for the reactor operational costs for all ER programs using the HFIR at ORNL. From the funding provided in the request, TRU will continue to be operated. Funds requested in FY 1983 to support the total isotopic research materials production activity amount to $11,187,000. This increase of $1,343,000 over FY 1982 includes funds for the added responsibility of HFIR support referred to earlier. The additional funds for operation of HFIR will, at best, provide for a constant level of operation. Comparable funding was provided by other ER or BES groups in FY 1981 and FY 1982; downward adjustments of their FY 1983 budget requests have been made.

The $1,556,000 requested in capital equipment funding for FY 1983 will provide for much needed improvements in the nuclear data programs ($360,000), in heavy element chemistry and isotope preparations ($740,000), and in the Stanford Synchrotron Radiation Laboratory facility ($456,000). The Nuclear Data Measurements activity is carried out mainly at the national laboratories, which require capital equipment funds for most of their instrumentation purchases and for fabrication of experimental equipment. The Nuclear Data Compilation and Evaluation activity requires these funds for the purchase of small items of computer equipment essential to execution of its mission. These requested funds will also provide for a much needed upgrade in the actinide and stable isotope production facilities. To a large extent, the equipment in these facilities is very old, some of it dating back to the Manhattan Project of the early 1940's.

	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Materials Sciences	$104,754	$104,754	$120,210

The objective of the Materials Sciences subprogram is to increase understanding of phenomena related to materials and properties of materials which will contribute to meeting the needs of present and future energy technologies. Such needs include:

- Developing new or substitute materials;
- Learning to tailor properties of materials to satisfy defined needs;
- Learning to predict materials problems and service life of materials; and
- Improving the ability to attack successfully unforeseen materials problems emerging in advanced energy systems.

In order to meet this objective, Materials Sciences places emphasis on selected generic areas of fundamental importance and on areas where problems either are known to exist or are anticipated. Some of the research is directed at a single energy technology (e.g., photovoltaic materials for direct conversion of solar energy into electricity), whereas other research is applicable to many technologies (e.g., embrittlement of structural materials due to the presence of hydrogen) and still other research has more fundamental implications underpinning all materials research (e.g., mechanisms of atomic transport in solids).

Among the many accomplishments in this program during the past year are the following: (1) theoretical calculations showing that fundamental properties of solids can be predicted from the properties of constituent atoms alone, an important step along the way to enabling the design of new materials with prespecified properties for particular energy applications; (2) development of a new process for the recovery of uranium from in-situ leach liquors that replaces the current batch process using ammonium hydroxide which had been virtually prohibited by EPA restrictions; and (3) a new method for fabricating a class of materials called intermetallic compounds which have excellent corrosion resistance for possible energy applications but heretofore have seen limited use because of their brittleness.

Coordination of the agency's applied materials development efforts with the Materials Sciences subprogram takes place primarily through the Energy Materials Coordinating Committee (EMaCC). Materials Sciences Research Assistance Task Forces and less formal contact among staff members round out the coordination efforts in the agency. The program utilizes workshops and reports of its Council on Materials Science (a non-Governmental body with representatives from academia, industry, and agency laboratories) to help focus on critical issues. Interagency communication and coordination are handled primarily through the Committee on Materials (COMAT), an interagency body comprised of senior representatives from appropriate Governmental agencies, and through an Interagency Materials Group.

Because of its unique system of national laboratories and their capabilities, the agency is able to respond to National needs for an aggressive materials research program by provision and development of advanced research facilities such as the National Synchrotron Light Source and electron microscopes which at the same time serve the broader needs of the nation. Currently, a major part of the Materials Sciences operating budget is used to support materials research at the national laboratories. Approximately twenty percent of the funds going to the laboratories are required to pay for the operation of large facilities which serve scientists outside the laboratory complex and in other research fields as well. Facilities in FY 1983 will continue to require an increasing fraction of the subprogram budget as the demand for capabilities increase and as they acquire operating capability in transition from the construction stage. Nonetheless, facility operations need to be constrained in order to prevent major reductions in laboratory-based programs which, however, will suffer some program termination. In providing facility services to the broader community, the agency catalyzes research supported by others, the results of which are important to the agency.

The budget request for Materials Sciences is $108,700,000 in operating expenses, $8,510,000 in capital equipment, and $3,000,000 for construction. Construction funds are for improvements to the Weapons Neutron Research Facility ($2,700,000) at Los Alamos National Laboratory which is an integral part of the Proton Storage Ring project supported by Defense Programs, and for General Plant Projects at the Ames Laboratory and the Notre Dame Radiation Laboratory ($300,000). The timing of the WNR facility construction is important in FY 1983 because it is being done in parallel with other construction going on at the facility. The general purpose projects continue to be important so that laboratory facilities can be maintained, as major world class facilities.

The requested operating expenses represents an increase of $12,506,000 over the FY 1982 level. Facility commitments, both new and old, have put large long term budgetary commitments on this subprogram. Materials Sciences is either the major or a significant supporter of several world-class research facilities including the National Synchrotron Light Source and the High Flux Beam Reactor at BNL, the Intense Pulsed Neutron Source at ANL, the high voltage electron microscopes at ORNL, ANL and LBL and the atomic resolution microscope at LBL. Beginning in FY 1983, the Materials Sciences subprogram will assume full responsibility for the operational costs ($6,300,000) associated with the High Flux Beam Reactor (HFBR) at BNL. Almost $1,700,000 of the increase sought reflects this additional responsibility and is required to maintain the FY 1982 level of operation. The same adjustments apply as described for HFIR in the Nuclear Science subprogram narrative. An increase of $1,200,000 is required for the operational costs of the National Synchrotron Light Source, for a total budget request of $6,000,000 from the Materials Sciences subprogram for NSLS in FY 1983. (Additional operating costs are provided by the Chemical Sciences subprogram). The effective increase in subprogram operating expenses is actually less than the projected cost-of-living increase.

The funds provided in this request will allow the subprogram to partially meet much of these facility and national commitments; however, some of the ongoing research in other areas of importance will still be required to be either cutback or terminated. The higher-priority areas such as nuclear waste isolation, surface modification, interfaces, structural ceramics, condensed matter theory, and rapid solidification will be emphasized at the expense of other research, e.g., fracture, solar energy absorption fluids, nanometer machining, low temperature calorimetry and preparation of pure materials.

Specifically, the request will allow Materials Sciences to more effectively utilize the major facilities while maintaining the same university fraction in the subprogram. In the remaining core research, reductions will be required primarily at the national laboratories (approximately 20 scientific manyears). With regard to the major facilities, the NSLS will operate slightly above the FY 1982 level or 53% of the optimum level, the neutron based research will be maintained at the FY 1982 level and the microscopes will receive marginal additional support.

The capital equipment request of $8,510,000 provides a critically needed $550,000 increase over FY 1982. The major share of this increase is required for the building of beam lines at the National Synchrotron Light Source at the Brookhaven National Laboratory, and for advanced analytical electron microscope equipment. Other needs include the replacement of neutron spectrometers at research reactors at Brookhaven and Oak Ridge National Laboratories, construction of a spectrometer at the Los Alamos National Laboratory for use at the WNR, and ancillary equipment for efficient utilization of the high voltage electron microscopes. Throughout the entire program is the need to replace wornout and outdated equipment and to provide on a selective basis advanced equipment necessary to enable new research directions.

	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Chemical Sciences	$ 68,615	$ 68,615	$ 75,910

The objective of the Chemical Sciences subprogram is to expand our knowledge base in the chemical and related sciences, in those areas most likely to lead to new ideas and improved processes for the development and use of domestic energy resources. These additions to knowledge produce both short- and long-term impacts. The accomplishments of the past year include the following: a) a new laser-based technique originating at the Combustion Research Facility for detecting minute but important quantities of atoms and radicals in flames, b) a new photochemical reaction which when combined with a known thermal reaction could lead to a cyclical system for using heat and sunlight to decompose water to hydrogen fuel, c) a discovery, of considerable scientific interest and of potential importance to synfuels production, that palladium catalysts can convert carbon monoxide and hydrogen either to pure methane or pure methanol simply by changing the catalyst's silica support, and d) an advance of importance to the strategic materials problem and the reprocessing of nuclear wastes, the discovery of a new class of chemical extractants which may be altered to recover and purify specific valuable elements, such as palladium from nuclear waste solutions.

The strategy of the Chemical Sciences subprogram is to support a process-oriented array of topics ranging from energy-related phenomena involving liquids, gases and plasmas to the chemical makeup and behavior of solids such as coal, chlorophyll and catalysts, and to properties of submicroscopic particles such as molecules, atoms, ions and electrons. The research results can be critical to decisions on the economic viability of both existing and new technology concepts. Coordination of the Chemical Sciences research with other agency activities occurs at two levels: in the laboratories on a scientist-to-scientist basis, and in headquarters (and with other agencies) on both a conference or committee basis and by individual interactions. Coordination also results from meetings which focus on research accomplishments and energy research needs and which involve both contractors and program staff in topics such as catalysis and solar photochemistry. Research information is exchanged so that newly recognized technological needs are made known to basic researchers and new insights in the chemical sciences are brought to the attention of applied researchers. Chemical Sciences headquarters staff and senior scientists in its program also serve as advisors and resource people to the agency technology staffs.

Within the requested operating expenses, $43,615,000 is for the Fundamental Interactions activity, at $4,386,000 above FY 1982. This is intended to cover the increased costs of operating new facilities (see below), to support reasonable levels of research using them and to maintain the best of the ongoing research in solar energy-related photochemistry, combustion, surface chemistry, fusion-related ion physics and highly advanced chemistry of broad value to knowledge of energy phenomena. The balance of the requested operating funds, $26,385,000, is for the Processes and Techniques activity, at $1,939,000 above FY 1982. This is needed to maintain the efforts of leading researchers in very basic coal chemistry, catalysis, enzyme chemistry of biomass substances, separations for recovery of valuable metals from spent fossil and nuclear fuels and broadly influential advanced studies in such areas as analytical chemistry and chemical thermodynamics.

The request for Chemical Sciences is $70,000,000 for operating expenses while the request for capital equipment funds is $5,510,000. In addition, $400,000 for accelerator improvement projects to upgrade ANL's Dynamitron accelerator and BNL's National Synchrotron Light Source is required.

The request for operating expenses represents an increase of $6,325,000 (9.9%) over the FY 1982 level. Nevertheless, termination of some projects will again be forced by commitments for support of the operation and research use of new facilities. The level of direct support of university research would be maintained, in addition to continuing assistance by National Laboratories to university chemists' research. New initiatives at the National Laboratories would be possible only through further cutbacks in ongoing projects. Research at the two major new facilities involving Chemical Sciences will be supported, though at limited levels. These are the Combustion Research Facility (CRF) at Sandia-Livermore and the National Synchrotron Light Source (NSLS) at BNL. In addition to supporting some of the research at NSLS and most of the research at the CRF, the Chemical Sciences subprogram provides the entire facility cost of maintaining the CRF and over one-third of that for the NSLS. The Chemical Sciences increase requested for operation of these facilities is $1,300,000.

The CRF's unusual laser diagnostic capabilities have raised great interest among researchers in industry (including fuels and automobiles) and at the university and government laboratories. Collaborations are strong. Improved understanding of combustion phenomena is expected, with consequent improvements in fuel flexibility, tailoring of fuels and diminution of pollutants. At NSLS, uniquely powerful light pulses of monochromatic ultraviolet and x-ray photons are similarly attracting the high interest of chemical scientists. They foresee new advances in many areas such as gas phase chemistry including combustion, catalysis for coal conversion, and atmospheric molecular clusters for understanding linkages among pollutants, carbon dioxide and the solar energy global balance.

The Chemical Sciences subprogram also includes the nation's leading basic research in several areas. The research efforts in photochemistry have a direct bearing on solar energy, especially the possibility of wet solar cells using cheaper materials. The research on coal chemistry and catalysis will provide knowledge from which may come better or cheaper synthetic fuels or chemical process feedstocks. Studies on atomic physics of highly charged ions should help prevent their poisoning of fusion plasmas. Included also are needed research efforts in areas of chemistry basic to: nuclear waste separations, biomass conversion of liqid fuels via enzyme catalysis and other routes, energy-efficient separation of valuable metals from low-grade resources, efficient and clean combustion of various fuels and detection and measurement of harmful byproducts of energy processes. Equally important are the fundamental research efforts having chemical and physical energy phenomena as their theme but without immediately identifiable, related technologies. Occurring in disciplinary areas like chemical physics, radiation chemistry, thermodynamics, thermophysics and analytical chemistry, much of this research relies on the special facilities found in DOE's national Laboratories. Electron linear accelerators, ion accelerators, superconducting nuclear magnetic resonance spectrometers, very advanced molecular beam machines and differential speed-of-light fiber optics are among these.

The capital equipment request of $5,510,000 is $570,000 above the FY 1982 request. This is urgently needed to continue equipping the CRF and NSLS while replacing some of the outdated equipment vital to the highly advanced Chemical Sciences research. Trillionth-second instrumentation for solar energy-related photochemistry, more powerful lasers in new spectral regions for combustion research and small, special-purpose laboratory equipments are some of the needed items. An important part of these funds would help initiate a unique capability for using synchrotron radiation in forefront chemistry involving collaboration with and support by industry.

In construction, the $400,000 for accelerator improvement projects is urgently needed for two projects. One $300,000 project involves further enhancement of the capabilities of the Argonne Dynamitron, where world-leading atomic physicists have established a significant new experimental approach to measure structures of molecular ions and to advance further the ability for theoretical prediction of molecular structure and dynamic behavior. Such advances are dependent on improvements in the accelerator and associated instrumentation. The other project requires $100,000 for important additions to the

performance characteristics of the NSLS. The already well developed cooperation of BNL scientists with visiting user scientists has led to recognition and definition of valuable modifications. Among these is a high-field wiggler, an inserted pair of electromagnets which the circulating electrons traverse in such a way as to produce additional high intensity photons of desired energies.

	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Engineering, Mathematical and Geosciences	$ 26,900	$ 26,900	$ 32,970

The research objectives of the Engineering, Mathematical and Geosciences subprogram are:

- To provide conceptual foundations in the engineering disciplines for energy technology improvement;
- To advance mathematics and computer sciences in areas limiting energy technology development, thereby providing new capabilities for quantitative prediction of the behavior of complex systems and processes; and
- To develop knowledge and understanding in the geosciences for the location, identification, evaluation and utilization of energy resources.

The strategy of the subprogram is to enlist outstanding researchers in the disciplines it covers to work on tasks chosen for their long-term importance to meeting our Nation's energy needs. The research is carried out by scientists and engineers throughout the Nation in universities, agency laboratories, and private industry. Priorities are established through extensive interaction with the research and technological communities expert in the engineering, mathematical and geosciences, building on the well documented studies of the Energy Research Advisory Board, the agency's comprehensive review of its own technology base activities, and studies by the Engineering Societies Commission on Energy, Inc., National Academy of Sciences and others. Identified priorities are widely disseminated to the relevant research communities, and careful selection is made from the heavy flow of unsolicited proposals received each year.

The request for FY 1983 is $31,050,000 for operating expenses and $1,920,000 for capital equipment for Engineering, Mathematical and Geosciences, an increase of $6,050,000 for operating expenses and $20,000 for capital equipment, over funds appropriated in FY 1982. The substantial increase reflects the high value and priority attached to areas covered by this subprogram in the recent detailed assessments of long term energy research needs.

The Engineering Research activity was started in 1979 to help resolve the numerous serious engineering issues arising from efforts to meet U.S. energy needs. The activity funds fundamental research on broad, generic topics in energy-related engineering less specific and predictable than the shorter term engineering research sponsored by the agency's technology programs. Special emphasis is placed on projects whose successful conclusion is likely to affect more than one energy technology. Representatives of industry, universities and national laboratories as well as the leading members of appropriate professional associations and interested technology programs in the agency have made significant contributions to the priority setting process for this new program.

At present, the funds are allocated to the following high priority research areas:

- Mechanical Sciences - including tribology (basic nature of friction reduction phenomena), heat transfer, and solid mechanics (continuum mechanics and crack propagation).
- Systems Sciences - including process control and instrumentation.
- Engineering Analysis - including non-linear dynamics, thermophysical properties of fluids, and engineering combustion.

These areas are of critical importance to energy technologies both in the short- and long- term.

The request of $5,350,000 in operating funds for Engineering Research represents a $1,450,000 increase from FY 1982. At this level it will be possible to strengthen selectively the highest priority long-term research aimed at better energy production and utilization. The strategy will be to continue funding several modest programs of very high relevance, accelerate efforts in instrumentation and in modelling of complex systems, and enlarge the scope of research on thermophysical and thermochemical engineering data.

For the mechanical sciences area in FY 1983, $1,900,000 is requested, an increase of $300,000. This increase will be used to strengthen research on the fundamental aspects of tribology, heat transfer processes in energy related systems, and on continuum mechanics, all essential to improving plant efficiency and durability. An interesting example of work underway in tribology concerns a very practical problem. An important drain on automobile efficiency is the rolling friction of tires—typically upwards of 10% of the engine horsepower is lost here. Currently supported research aims at a sound experimental basis for a new theory of viscoelastic composites; it will be used to predict the internal rolling friction in a tire of a given design. Eventually it should be possible to determine the best tire design which maximizes car mileage without deteriorating tire life, traction, or safety — the three traditional tire performance criteria.

For the systems sciences area in FY 1983, $1,850,000 is requested, an increase of $650,000. This increase will be used to accelerate research on instrumentation for measurements of basic engineering quantities (flow rates, temperature, pressure and chemical composition) in a hostile environment, and on initiating efforts in modeling of complex systems. In the latter area, it is vitally important to develop predictive capabilities for the scale-up of pilot process plants. Short of building a sequence of plants with ever increasing sizes a reasonable far less expensive alternative will be the use of computer simulatons based on a good understanding of the physical and chemical processes involved. More realistic simulations are essential before this alternative can be widely applied. The research to be initiated will be targeted on new methodologies for handling scale-up problems. Recent achievements in systems sciences include a demonstration that reliable but low cost adaptive controls (so called resilient controls) for highly integrated process heat distribution systems can be implemented in process plants, with a resulting reduction in costly standby, often redundant heat distribution capacity.

For the engineering analysis area in FY 1983, $1,600,000 is requested, an increase of $500,000. High priority is accorded to research topics which fill gaps in urgently needed fundamental data and understanding essential for long-range advances in energy processes and systems. Attention is focused on areas which have an interdisciplinary impact. The longer time-frame for project support complements the shorter range focus required in the DOE and industrial technology programs. In FY 1982, a small project was started in this area to collect certain basic thermophysical and thermochemical engineering data, which are badly needed for the emerging synfuels industry and for the economic exploitation of geothermal resources. Such data will have a significant economic impact. However, the perceived risk inherent in this basic research is so high, and the payoff date is so distant that industry cannot be expected to invest in it. The requested increase will be used primarily to enlarge this high priority, low cost, high benefit area of research.

The Applied Mathematical Sciences activity supports approximately 200 mathematicians, statisticians, and computer scientists at thirty universities and ten national laboratories working on fundamental problems in the development of mathematical models of energy systems.

In areas such as magnetic fusion, nuclear reactors, weapons design, and combustion processes, where experimental tests are difficult, expensive, or even impossible, studies of mathematical models are the best method of advancing our knowledge of the underlying physical processes. Analytical studies put these models on a sound mathematical basis and computational studies provide the means for accurate simulation of the properties of these systems.

Traditionally the agency supported community has been the major user of large scale scientific computers in research and development of energy systems and related scientific data bases. Understanding the fundamental mathematical and computational properties of complex models is vitally important, for these form the basis for design and engineering criteria for future energy systems. Since its inception in the late 1950's, the Applied Mathematical Sciences program has been the sole source of support for basic research in applied mathematics and computer science for work related to the mission of the agency and its predecessor agencies.

The Applied Mathematical Sciences program emphasizes three aspects of the modeling process:

1. The analytic and computational techniques for formulating and implementing models of energy systems from first principles;

2. The statistical and computer science techniques for manipulating and analyzing large data bases associated with these models;

3. The development of algorithms, languages, and architectures for future generations of computers capable of solving more realistic models.

The request for operating funds for Applied Mathematical Sciences, $13,850,000, represents an increase of $2,250,000 over FY 1982. These funds will help reverse the deterioration of applied mathematics and computer science departments in the universities and will enable additional research on the difficult problems in the energy area.

Approximately $1,500,000 of the requested increase will be targeted for laboratory-university-industry exploration of the most promising parallel computer architectures, known as ultracomputer, data flow, restructurable, and hypercube. The high performance systems work concentrates on techniques for using hundreds or thousands of inexpensive microcomputers in parallel to solve complex systems of equations at rates ten to a hundred times faster than the best computers available today. Experimental and theoretical work in FY 1981 demonstrated that such systems are feasible and are probably the only practical way to solve real problems in one time and three space dimensions. A coordinated effort including university, national laboratory, and industry researchers was started last year with a series of workshops and collaborative projects. In FY 1983 there is an opportunity not only to continue that effort but to organize a strong, nationwide effort that will help ensure U.S. leadership in scientific computing and computational modeling of physical processes. The enhanced 3 or 4 year effort will form the base on which industry will build commercially available systems by the end of the decade.

Approximately $750,000 of the increase will be targeted for analytical and numerical studies of the structure of nonlinear equations describing chaotic phenomena in plasmas, fluid flow, combustion processes, and quantum mechanical systems. The nonlinear dynamics effort shows great promise in understanding the nature of turbulence and chaotic motion. FY 1981 was a year of great advancement in understanding of the most complex, but most important, physical processes. New theoretical advances brought insight into the structure of combustion flame fronts, for example - processes previously spoken of as "random" phenomena and treated only as averaged quantities. Recently several "universal" constants were discovered that provide insight into the behavior of certain classes of dynamical systems common to many energy system models.

At the requested level, research projects in statistics and operations research, applicable to optimization and analysis of large econometric and power grid models, will be maintained at current effort. Several specific changes are planned. For example, work in seismic profiling will be terminated because industry is assuming a major role in developing these techniques.

Recent accomplishments include full implementation of methods for computing fluid flow for the important problems of swirling flow in engine cylinders and of fingering two-phase flow in tertiary oil recovery. The new methods are based on improved insight into the mathematical properties of equations governing highly unstable flows. This work, carried out at Lawrence Berkeley Laboratory and at the Courant Institute at New York University, provides practical solutions to problems which previously had no satisfactory solutions. These techniques are being adopted on a trial basis by industry.

The agency's support for Geosciences research is based on the fact that all energy resources are found in the earth or the sun and all wastes from energy processes are returned to the earth and its atmosphere. The program is conducted in close consultation with NSF and USGS and with panels of the National Academy of Sciences. The objective of the Geosciences program is to develop a quantitative, predictive understanding of the energy-related aspects of geological, geophysical and geochemical processes in the earth and at the solar-terrestrial interface. This understanding and knowledge base is needed in order to provide for the long-range requirements of U.S. efforts in energy resources recognition, evaluation and utilization.

In FY 1983 the agency geosciences program will place special emphasis on (1) long range research pertaining to the geological isolation of nuclear wastes, (2) studies in organic geochemistry relating to fossil fuel recovery and the disposition of energy-related chemical wastes, and (3) studies pertaining to the magma-hydrothermal part of the interagency Continental Scientific Drilling Program. The request for the geosciences totals $11,850,000, an increase of $2,350,000 over FY 1982, covering work in both the geology and geophysics area and in the geochemistry area.

$1,100,000 of the requested increase will be used to augment an integrated effort in nuclear waste isolation, half under geology and geophysics and half under geochemistry. This brings to $2,900,000 the Geosciences part of the broader BES research effort relating to nuclear waste isolation. The nuclear waste isolation problem is critical to the future of the nuclear industry. Although disposal programs are at an advanced stage, problems concerning second and third generation repositories remain unresolved, and will be addressed in this program. Examples of these problems are (a) local change of stress with subsequent development of new fracture systems providing pathways for the migration of nuclear wastes; (b) interaction between waste container, rock, and fluids in the rock; and (c) concentrations, diffusion rates and element migration of nuclear wastes from a disposal site into its surroundings. Nuclear wastes derive also from mining uranium ores and the problems of safely containing the mill waste must also be addressed. Long-term monitoring of a disposal site is another major problem requiring resolution. These problems are important both to industrial and defense applications of nuclear energy.

For the geology and geophysics area in FY 1983, $7,960,000 is requested, an increase of $1,300,000 including $550,000 for the nuclear waste isolation research described above. The topics covered in this area are rock mechanics, geodynamics, advanced geophysical techniques, resource definition and utilization and solar-terrestrial relations. A notable accomplishment last year was the invention and use of a downhole seismic source which produces chains of pulses of either compressional or shear waves. This new source avoids damage to the borehole common to currently used explosive techniques. Industrial inquiries indicate that unusually fast technology transfer for oil field applications is likely.

During FY 1982 the Magma Energy Research Project, a major effort in geology and geophysics aimed at determining the scientific feasibility of extracting energy from magma bodies has been completed successfully. Scientific feasibility has now been demonstrated and the project is being phased out. The $300,000 released by the completion of this project will be reallocated into the Continental Scientific Drilling Program (CSDP).

$750,000 of the increase requested for geology and geophysics plus the reallocated $300,000 is required for the agency portion of the national CSDP. The CSDP is a cooperative interagency program utilizing drilling and other geophysical techniques with carefully delineated roles for participating agencies. It is aimed at developing an understanding of the underlying structure, dynamics and chemical processes of the North American Continent. The resulting knowledge will be important in predicting deposits of energy and mineral resources, in establishing a scientific base of information relevant to nuclear waste isolation, and to the assessment of hazards associated with the siting of major energy-related facilities. Studies are under way to examine the potential of the Valles Caldera in the Jemez Mountains as a possible site for deep drilling and a multi-institution consortium has begun investigations of a young silicic caldera, the Long Valley-Mono Craters magma-hydrothermal system. The Mono Craters area is at the border between two tectonic provinces, the Sierra Nevada and the Basin and Range. A fundamental question is why heat flow is low in the Sierra Nevada province and suddenly jumps up in the Basin and Range. The critical location of Mono Craters may be an important key to understanding the evolution of the North American Continent and has a clear bearing on the mineral and energy resources of the Southwest. To minimize the high cost of drilling, it may be possible in the CSDP to use or deepen holes drilled by the agency's technology programs, by other government agencies, or by industry, and thereby to maximize the scientific returns from these "holes of opportunity" at minimal additional costs. Work completed so far includes the establishment of a drill-hole data base for holes drilled for the Federal Government.

For the geochemistry area in FY 1983, $3,890,000 is requested, an increase of $1,050,000 including $550,000 for the nuclear waste isolation research described above. The topics covered in this area are rock-water interactions, geochemical migration, organic geochemistry and thermodynamics of minerals, brines and magmas. A typical accomplishment from work extending over the past several years is a new capability for prediction of brine properties over a broad range of conditions with a minimum of special experimental measurements. This result is proving highly valuable for evaluating possible migration from waste repositories and is finding use in the fields of desalination, industrial waste treatment, materials corrosion, solution mining and hydrothermal ore deposition.

$500,000 of the increase requested for geochemistry will be used to start research projects in organic geochemistry. A workshop was held during this past year under the auspices of the National Academy of Sciences Committee on Geochemistry. This workshop identified priorities among the many fruitful lines of research in organic geochemistry. A fuller and more fundamental understanding of the organic chemical processes taking place in the earth in the migration, diagenesis and maturation of fossil energy resources is considered essential for effective exploitation of such resources and is fundamental to the understanding of processes pertaining to organic wastes. The rapid development of sophisticated instrumentation for identifying and quantifying organic compounds on molecular, elemental and isotopic levels can be applied to problems dealing with the origin, spatial and temporal distributions, and fates of carbonaceous materials.

The capital equipment request for Engineering, Mathematical and Geosciences of $1,920,000, represents an increase of $20,000 over FY 1982. These funds are required to provide for the instrumentation essential for effective engineering and geosciences research and for specialized applied mathematics and computer science research computing facilities. The requested capital equipment funds are 6.0% of the operating funds, which experience has shown to be a severely constrained level but sufficient to meet the highest priority needs and maintain a fully effective research program.

	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Advanced Energy Projects	$ 7,720	$ 7,720	$ 8,590

The objective of the Advanced Energy Projects subprogram is to explore the feasibility of novel, energy-related concepts which evolve from basic research, but are at an early stage of scientific definition such concepts, though involving a high degree of risk, must have the potential for an eventual high pay-off. Also supported is exploratory research on concepts that do not fit easily into the existing agency program structure. An area of major programmatic attention is the transfer of successful projects to proper technology programs; a number of such transfers have already been accomplished.

The mode of operation for this interdisciplinary, and relatively new, subprogram is to support individual projects for a limited time only; it differs from other subprograms in that it does not fund ongoing, evolutionary research. The technological spectrum of projects supported is very broad, ranging from new approaches to uranium retrieval and separation, through completely new methods of solar energy concentration and collection, to ultrasonic coal grinding. Close contact is maintained with DOE technology programs to ensure proper coordination. Projects are selected on the basis of unsolicited proposals received from researchers at universities, industrial laboratories (especially small R&D companies) and national laboratories. Currently, thirty-six projects are being supported, which allows a turnover rate of about twelve projects a year. New funds will be used to support forefront ideas on such topics as direct heat-to-electricity conversion; recovery of uranium from seawater; new photovoltaic materials, especially organic; new methods of solar energy collection and concentration (e.g., holographic concentrators); new methods of accelerating particles; and research aimed at developing x-ray lasers.

The various funding levels translate directly into the number of projects which this subprogram will be able to start each year; that is, the number of new concepts, out of the many submitted in any given year, which will have a chance of being explored in some depth. Within the request, the Advanced Energy Projects subprogram is requesting $8,300,000 in operating expenses and $290,000 in capital equipment funds. This represents primarily a cost-of-living increase and allows for no increase in the number of novel energy concepts explored. Four years of previous experience indicate an average annual funding level of $230,000 per project and a three-year period of support; hence, this request will provide for twelve new projects displacing those that will terminate after three years of support in FY 1983.

	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Biological Energy Research	$ 7,720	$ 7,720	$ 8,590

The implementation of future innovative biotechnologies for the production of fuels and chemicals depends upon the development of a sound understanding of the biological principles involved. Thus the Biological Energy Research subprogram objectives are to generate the fundamental data and conceptual understanding in the microbiological and botanical sciences requisite to formulating strategies for enhanced biomass productivity, for novel and improved fermentations and for biosystems capable of saving energy.

The strategy of this relatively new effort in Biological Energy Research is to support studies that are not only scientifically meritorious but likely to contribute to the longer term development of entirely new or greatly improved biotechnologies relating to energy. The program performers are primarily at universities. The subprogram is aimed at building the base of understanding of the physiology, biochemistry and genetics of microorganisms and plants required for the future exploitation of the techniques of genetic manipulation, cell culture and others for energy purposes.

The subprogram focuses on understanding the limits to biomass productivity in green plants, how plants adapt to suboptimal conditions of growth like those encountered in the utilization of marginal lands and waters, and the mechanisms of microbial conversion of various biomass forms. Of special interest are the anaerobic microorganisms, which grow in the absence of oxygen and which are able to carry out fermentations with high efficiency. Other microorganisms of interest include the thermophilic species which have optimal growth and conversion rates at high temperatures. An integral part of the subprogram is the development of genetic information which may ultimately be used to produce new or improved microorganisms and plants which will facilitate the production of fuels or petroleum conserving chemicals or will yield biotechnologies capable of conserving energy.

Specific areas for emphasis include:

- Genetics of anaerobic microorganisms;
- Fermentations and other conversions mediated by thermophilic organisms;
- Microbial degradation of cellulose and other biopolymers;
- Adaptation mechanisms of plants to stress;
- Plant growth regulation mechanisms; and
- Control of genetic expression in plants and microorganisms.

A few recent research accomplishments provide examples of the relevance of this effort to the energy mission of the Department.

A mutant of the bacterium, Butyribacterium methylotrophicum, which was isolated at the University of Wisconsin, is capable of converting the waste gas, carbon monoxide, into valuable products. This conversion occurs without the addition of other energy sources. Such a conversion could form the basis of a bioprocessing system for treating coal pyrolysis gas mixtures into commercially valuable larger molecular weight chemicals such as acetic acid.

At Michigan State University, there has been a critical reexamination of an earlier discovered technique for saccharifying (breaking down into sugars) cellulose using hydrogen fluoride. The results of experiments suggest that the technique gives higher recoveries of fermentable sugars at lower energy cost than any of the acid hydrolysis methods. This should also translate into lower economic costs as well. The work has been done at laboratory scale and there is need to perform scaled up experiments.

Microorganisms have been selected which are capable of degrading organic sulfur and nitrogen contaminants of petroleum to water soluble compounds which may be washed free of the fuel. The mechanism of breakdown is controlled by genetic material carried in plasmids (small pieces of DNA) which may offer the possibility to transfer the function to other microorganisms. The work, which was carried out at the University of Georgia, could provide the basis for a biotechnology for the desulfurizatuion and denitrification of high-sulfur petroleum.

The request for operating funds in the request for the Biological Energy Research subprogram is $9,500,000, an increase of $1,000,000 over FY 1982. The capital equipment request is $370,000, a decrease of $40,000 over FY 1982. The rate of growth for the BER program since its inception as a subprogram in BES in FY 1979, has been consistently lower than the original program plan. A program of approximately $20 million after roughly five years of growth was visualized as being requisite to build an information base to exploit optimally the potential of biological systems relating to energy.

The additional funds would provide for both cost-of-living and some modest growth in this program of fundamental biological research oriented towards energy matters. A number of new projects can be initiated in important research areas in the microbiological and plant sciences. Most of these projects may be expected to be university based. Funding at this level would allow the subprogram, in a restricted way, to follow through in several neglected areas identified as needing more research attention, e.g., genetics of anaerobic microorganisms, biochemistry of degradation of lignocellulose, physiological genetics of plants and molecular aspects of stress in plants. However, this level would still result in turning down some excellent proposals which could relate to future energy biotechnology development. This modest increase would also signal the research community that the agency considers the options of future biotechnologies of significance to energy development.

	FY 1982 Appropriation	FY 1983 Base	FY 1983 Request
Program Direction			
Operating Expenses	$ 2,900	$ 2,900	$ 3,100
Total	$ 2,900	$ 2,900	$ 3,100
Full-Time Permanent full-time equivalents (Other than Full-Time Permanent FTE's)	52 (4)	52 (4)	52 (4)

Program Direction

The FY 1983 budget request for Basic Energy Sciences Program Direction is $3,100,000, an increase of $200,000 above the FY 1982 level. These funds are required to provide for the salaries, benefits, travel and related expenses associated with the 56 full-time equivalents required to administer and support the program. The staffing requirements remain constant relative to FY 1982. The increased funding is to provide for normal increased personnel costs such as within-grade and merit increases, benefits, and support associated with programmatic increases.

Basic Energy Sciences is a broadly diversified program responsible for mission-oriented research, the chief purpose of which is to provide the fundamental scientific and engineering base on which the Nation's future energy options depend. Its staff must possess expertise covering many subfields in the areas of chemistry, physics, engineering, metallurgy, geosciences, biology, mathematics and computer sciences, as well as in administration, procurement and financial management. The staff is responsible for development, direction, and management of complex technical programs, each involving one or more of the scientific areas mentioned above. Their activities include assessing scientific needs and priorities of the program, developing long-range program plans, technical review of proposals from laboratories and universities, and monitoring the progress of ongoing university contracts, laboratory programs, and construction projects.

It is extremely important to appreciate the diversity and scope of the research effort involved in the Basic Energy Sciences program in order to understand the need for and justification for Federal staffing. In FY 1982 as an example, 1,200 research projects will be underway at either agency laboratories or at more than 150 colleges or universities in 45 states. Since these tasks must be evaluated, monitored, and molded into a unified energy research program, it is obvious that each BES program official has a considerable number of projects to oversee. These research projects together with over 30 workshops, over 100 major meetings and working groups require continuation of the current staffing level for this program.

In FY 1983, programmatic increases primarily in Materials Sciences and to a lesser degree in the Chemical Sciences and Engineering, Mathematical and Geosciences subprograms will require greater involvement of staff in monitoring and evaluation activities. Materials Sciences is a significant supporter of several world-class research facilities, carrying the largest responsibility for small angle neutron scattering operational costs associated with the High Flux Beam Reactor at BNL. The Chemical Sciences subprogram also includes the Nation's leading basic research in several areas. Greater utilization of the major facilities and expanded university based programs in both the Materials and Chemical Sciences subprograms are planned. The Engineering effort will maintain and strengthen the highest priority long-term research aimed at better energy production and utilization. The Mathematical effort will be aimed towards providing improvements in solving the mathematical models of physical systems relevant to energy research. Management of these and other smaller programmatic increases within Basic Energy Sciences requires continuation of the current staffing level.

Program Summary

The budget request for the Basic Energy Sciences program is $282,850,000. The research cuts across all major technologies and has a high potential for long term payoff. Effective conduct of research in the Basic Energy Sciences calls for 1) continued support of the ongoing core research program with limited increases in newer, emerging priority areas; 2) replacement of obsolete equipment and maintenance and operation of existing facilities; and 3) addition of new capital facilities and the provision of adequate support for their operation and research at them. This third aspect merits more detailed discussion because of its significance.

Operations and research at the BES facilities represent a significant share of the BES budget request. As noted in the table which follows facilities comprise about 25% of the budget request in FY 1983. These facilities, as discussed throughout this budget, affect almost all areas of research in BES, represent a significant share of the increased funding in FY 1983, and are national resources to the larger scientific community.

There are three primary reasons for BES to develop and maintain scientific facilities:

1. Facilities such as nuclear reactors, electron microscopes and particle accelerators permit research which could not otherwise be done. These one-of-a-kind facilities are often expensive and provide research capabilities which cannot be duplicated by any other means but which are absolutely essential for advanced research vital to forefront energy technologies.

2. The availability of BES facilities continues to be a resource for the technology programs, e.g. nuclear, fossil and conservation -- capability that would not otherwise be available, and the need for which would not have been foreseen; in addition several facilities serve medical, industrial or applied research needs that could not currently be otherwise met.

3. More broadly, scientific advances are critical to the nation's scientific and technological future; operation and support of these unique BES facilities are a national trust and they are made available to a broad spectrum of the scientific community on the basis of scientific merit. It is crucial for the nation to provide the facilities necessary to advance scientific knowledge. BES facilities are important contributors to this scientific advancement. It is also important to appreciate that BES has a long history and in-depth expertise in the management of large research facilities.

Advancement of scientific knowledge, particularly in those areas likely to provide new knowledge and insights in fields of science related to energy, is the principal reason for BES's continued involvement with large facilities. These facilities include nuclear reactors, the Combustion Research Facility, synchrotron light sources, an Intense Pulsed Neutron Source and electron microscopes available only at agency National Laboratories. The cost of facility operations and BES research support at these facilities is shown in Table I.

Table I "User" facility operations costs and per cent of total BES operation budget.

	FY 1981	FY 1982	FY 1983
Facility operations (BES)	$24.1M (11%)	$30.8M (13%)	$43.4M (17%)
Support of research (BES)	17.1M (8%)	19.9M (8%)	22.3M (8%)

The availability of large, unique facilities plays a significant role in U.S. world leadership in many fields of science. In recognition of their uniqueness and multi-purpose nature, a number of the facilities have been designated as "user" facilities. Their primary use is for conduct of BES funded energy related research but BES also encourages selected use of these facilities as a national trust available to a broad spectrum of the scientific community. Facilities are available to qualified scientists, irrespective of their organizational association, if their research is suitable for performance at the facility is of high scientific quality, and if the results are to be published in the scientific literature. As a result, a significantly large effort of research of programmatic interest to the agency is carried out at these facilities than would otherwise be possible.

Other programs also use BES facilities and fund research which is specific to their needs. These other research programs include the Nuclear Regulatory Commission, Nuclear Energy, Magnetic Fusion Energy, and Biomedical and Environmental Research.

Direct expenditures by other groups contribute towards the continued operation of these facilities. These added funds do not directly supplement the BES programs but in general they do reduce overall unit costs because of economies of scale. The BES budget request assumes continued non-BES operational support for the facilities concerned. Thus economy of scale advantage offered by joint support could result in a budget short fall if the non-BES support is not forthcoming.

The major facilities are large, expensive, unique, and have long lead times for construction. Most also pose safety and physical protection requirements which would normally be difficult for some of the current users to meet without sharing the costs involved. The early lead time and extensive planning that has gone into the BES facilities preceded, in many cases, the awareness by the users that such facilities would be important to them in the future. The very existence of these facilities has a significant impact on the directions which researchers will pursue.

FY 1983 CONGRESSIONAL BUDGET REQUEST

CONSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Sciences

(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General plant projects, various locations

2. Project No. 83-E-303

3. Date A-E work initiated: 1st Qtr. FY 1983

3a. Date physical construction starts: 2nd Qtr. FY 1983

4. Date construction ends: 4th Qtr. FY 1984

5. Previous cost estimate: None
Date:

6. Current cost estimate: $ 300
Date: 9/81

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1981	FY 1982	FY 1983	FY 1984
Prior Year Projects	xxx	$ 590	$ 0	$ 0	$ 0
FY 1981 Projects	$ 300	200	100	0	0
FY 1982 Projects	300	0	200	100	0
FY 1983 Projects	300	0	0	200	100

8. Brief Physical Description of Project:

This project is required to provide for minor new construction, other capital alterations and additions, and for buildings and utility systems. Where applicable, the request also includes the cost of installed capital equipment integral to a subproject. Funding of this type is essential for maintaining the productivity and usefulness of agency-owned facilities. Since it is difficult to detail this type of project in advance, a continuing evaluation of requirements and priorities may be expected to result in additions, deletions, and changes in the currently planned subprojects. In general, the estimated funding for each location is preliminary in nature, and is intended primarily to indicate the relative magnitude of the requirements. No significant R&D program is anticipated as a prerequisite for design and construction of the subprojects under consideration.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: General plant projects, various locations 2. Project No. 83-E-303

8. Brief Physical Description of Project (cont'd):

The currently estimated distribution of FY 1983 funds by office is as follows:

Ames Laboratory	$ 275
Notre Dame Radiation Laboratory	25
Total project cost	$ 300

9. Purpose, Justification of Need for, and Scope of Project:

The following are examples of the major items of work to be performed at the varous locations:

Ames Laboratory $ 275

Requirements include for example: extension of the energy management control system to the Applied Science Center ($132,000); upgrading roof at the Applied Science Center ($53,000); extension of the metering program for utilities ($46,000); upgrading cooling system in the computer area from refrigeration to chilled water ($33,300).

Notre Dame Radiation Laboratory $ 25

Requirements include minor building modifications to properly house staff members and to make optimum use of laboratory research space.

10. Details of Cost Estimate

See description, item 8. The estimated costs are preliminary and, in general, indicate the magnitude of each program. These costs included engineering, design, construction and inspection.

11. Method of Performance

Design will be on the basis of negotiated architect-engineer contracts. To the extent feasible, construction and procurement will be accomplished by firm fixed-price contracts and subcontracts awarded on the basis of competitive bidding.

FY 1983 CONGRESSIONAL BUDGET REQUEST

CONSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Sciences

(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and Location of Project: Improvements to weapons neutron research facility, Los Alamos, New Mexico

2. Project No. 83-E-301

3. Date A-E Work Initiated: 1st Qtr. FY 1983

3a. Date physical construction starts: 3rd Qtr. FY 1983

4. Date Construction Ends: 3rd Qtr. FY 1985

5. Previous Cost Estimate: None
Date:

6. Current cost estimate: $2,700
Date: 9/81

7. Financial Schedule

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1983	$ 2,700	$ 2,700	$ 2,700	$ 2,200
1984	0	0	0	400
1985	0	0	0	100

8. Brief Physical Description of Project

The existing Weapons Neutron Research (WNR) facility can handle up to 20 microamperes of 800-MeV protons from the Clinton P. Anderson Meson Physics Facility (LAMPF) for the production of neutrons. This project provides improvements to the WNR to allow utilization of up to 100 microamperes of protons.

In order to transport these larger currents to the WNR, the proton beam transport line will require modifications. Some of the magnetic elements of the proton beam transport system from LAMPF to the WNR must be replaced with units of larger aperture in order to reduce the beam losses and the resultant radiation fields and activation of components.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and Location of Project: Improvements to weapons neutron research facility, Los Alamos, New Mexico

2. Project No. 83-E-301

9. Purpose, Justification of Need for, and Scope of Project (cont'd):

There are other pulsed neutron sources built or under development in England, Japan, and the Argonne National Laboratory. There is good coordination amonst these programs.

If these improvements to the WNR are delayed, then the research projects that require the higher neutron fluxes will be delayed. Similarly, if this project is not authorized, then these same research projects cannot be accomplished and the full capability of the PSR will not be realized.

This project is not in a security area and will have no security guard impact.

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, Design and Inspection		$ 520
1. Facility at about 15% of construction costs, item b.1	$ 70	
2. Special facility equipment at about 40% of item b.2	450	
b. Construction Costs		1,615
1. Shielding and cooling system upgrading	480	
2. Special facilities equipment	1,135	
c. Demolition and Salvage		40
Subtotal		$2,175
d. Contingency at approximately 24% of above costs		525
Total Project Cost		$2,700

11. Method of Performance

Facility design and inspection will be performed under a negotiated architect-engineer contract. Construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bidding. The Laboratory will design and install the special facilities equipment.

12. Not Required

13. Not Required

FY 1983 CONGRESSIONAL BUDGET REQUEST

CONSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Physics

(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No. 83-E-302

3. Date A-E work initiated: 1st Qtr. FY 1983

3a. Date physical construction starts: 1st Qtr. FY 1983

4. Date construction ends: 1st Qtr. FY 1985

5. Previous cost estimate: None
Date:

6. Current cost estimate: $400
Date: 9/81

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1983	$ 400	$ 400	$ 400	$ 200
1984	0	0	0	200

8. Brief Physical Description of Project:

This project provides for additions and modifications for upgrading the Argonne Physics Division's Dynamitron accelerator and the National Synchrotron Light Source.

9. Purpose, Justification of Need for, and Scope of Project

Funds are requested to tailor the capabilities of these two large and very different research machines to well defined research needs.

Dynamitron $ 300

The Dynamitron accelerator in Argonne's Physics Division, installed in 1968 for Nuclear Physics, has in recent years become primarily employed for studies in atomic physics. Principal studies are on the interactions and dissociations of fast molecular-ion beams in matter and on beam-foil spectroscopy. The scientific excellence of this work is outstanding and has succeeded in attracting a steady stream of visiting scientists and students. To obtain maximum benefit from the 1980-1981 voltage improvement (5 MV) and to keep the accelerator competitive with more modern machines, modifications are needed. The main tasks involved are a) replacement of the rectifiers in the accelerator with modern types having significantly higher voltage and current ratings; b) improvements to the SF_6 insulating gas handling system; and c) purchase and construction of components for ion sources to produce molecular ions and highly stripped monatomic species.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No. 83-E-302

9. Purpose, Justification of Need for, and Scope of Project (cont'd) $ 100

National Synchrotron Light Source

As this major and unique facility reaches operational status, the already well developed cooperation of BNL scientists with visiting user scientists has led to recognition and definition of valuable modifications. Among these is a high field wiggler, an inserted pair of electromagnets which the circulating electrons traverse in such a way as to produce additional high-intensity photons of desired energies.

10. Details of Cost Estimate

	Item Cost	Total Cost
A. Dynamitron		$ 300
1. System Improvements	$ 300	
B. National Synchrotron Light Source Facility		$ 100
1. High field wiggler components	$ 100	
Total Project Cost	$ 400	$ 400

11. Method of Performance

Design, engineering and inspection will be performed by laboratory staff. To the extent feasible, construction and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bidding.