DOE: R&D, WASTE MANAGEMENT, ENVIRONMENTAL RESTORATION, AND ADMINISTRATION

Solar and Renewable Energy. Federal research efforts span a broad spectrum of research into solar thermal, photovoltaic, wind, ocean, geothermal, and hydroelectric power systems and applications. Most of the line items presented in the main DOE spreadsheet which follows this text are self-explanatory. The following items bear further explanation.

Solar International Programs. Supports trade groups that support exports of solar and renewable energy technologies. Spending has been allocated based on the ratio of DOE spending on solar and renewable energy technologies. ('92 Budget Request, v. 2, 73).

Solar Program Support. Includes overhead related to both solar and renewable energy.

Biofuels Energy Systems. Research benefits a number of biofuels, including wood, ethanol, and methanol, as well as hydrogen and waste-to-energy. ('92 Budget Request, v. 2, 54-64).

Electric Energy Systems. Research into electro-magnetic field effects, electricity reliability, and electrical system materials and devices, all of which benefit the electrical sector. Spending has been allocated based on the current mix of fuels used to generate electricity. ('92 Budget Request, v. 2, 123).

Energy Storage Systems. This research focuses on stationary battery development and primarily benefits renewables such as solar and wind, which are intermittent sources of power. Half of this spending is allocated to wind and solar. The other half is allocated to the current mix of fuels used to generate electricity, since the development of power storage will enable them to build capacity to average demand rather than peak demand, a significant costs savings. ('92 Budget Request, v. 2, 134).

Transportation Sector. Research on vehicle batteries is allocated to the electricity sector since batteries are a main roadblock to broader use of electric vehicles.

Nuclear Energy Research and Development. Research continues into a variety of reactor types, some of which have no known potential applications to commercial power development. While space reactor power systems will likely have commercial applications at some point, the potential earth uses are not what are driving R&D. Therefore, we do not count the expenditures as subsidies to the commercial sector.

Light Water Reactors. Spending supports research on small scale (600 MW vs. 1200 MW in current generation) advanced LWRs with passive safety features, as well as technological and licensing support for life extensions to the existing reactors. ('92 Budget Request, v. 2, 151).

Advanced Reactor Research and Development. Efforts are focused on two new types of reactors: modular high temperature gas reactor (HTGR) and the advanced liquid metal reactor (ALMR). Both reactors have improved passive safety features, and the ALMR reactor fuel cycle is projected to significantly reduce radioactive wastes per unit of power. (DOE, 39; '92 Budget Request, v. 2, 155).

Facilities. Supports spending on testing facilities for nuclear power systems for commercial,space, and defense purposes. Spending has been allocated on the basis of the commercial fission sector portion of total DOE nuclear R&D.

Advanced Radioisotope Power Systems and Space Reactor Power Systems. Since the current users are NASA and the Department of Defense, no portion of this spending has been allocated to commercial fission. ('92 Budget Request, v. 2, 164).

Program Direction. Program overhead has been allocated in proportion to commercial nuclear R&D as a percent of total nuclear R&D.

Civilian Radioactive Waste Research and Development. Funding to continue the remaining cooperative agreement for at reactor storage of spent nuclear fuel, the phaseout of remaining generic research on spent fuel storage, demonstration projects for utilities, and annual reporting requirements. (DOE, 29; '92 Budget Request, v. 2, 196).

Environment, Safety, and Health. Activities center around ensuring that current DOE program and cleanup efforts comply with the relevant environmental regulations. Expenditures relate to both the commercial and defense sectors. Therefore, spending is first allocated between defense and commercial sectors, and then to the other fuels based on their share of DOE spending.

Environmental Audit. "Comprehensive, independent, Headquarters oversight of the Department's line management efforts to ensure compliance with all applicable environmental requirements and to reduce areas of existing environmental risk." (V. 2, 215). Baseline audits include UMTRAP, FUSRAP, SFMP, and Power Marketing sites.

Environmental Guidance and Compliance. Assure department-wide understanding of, and compliance with, the relevant environmental regulations impacting operations. Tasks include review of legislation and regulations, as well as the development of internal policies. Examples include developing rules on radiation protection of the public and the environment, and technical reviews of radiation standards.

NEPA Oversight. Ensures DOE compliance with the National Environmental Policy Act. Includes program reviews as well as reviews of Environmental Impact Statements.

Quality and Safety. Provide independent internal oversight of quality and safety of DOE programs.

Safety Appraisals. Independent oversight to ensure that DOE's non-nuclear safety responsibilities are properly fulfilled.

Safety Integration. Conducts training courses, disseminates safety information, assesses safety performance, and evaluates health and safety performance of managers at nuclear and non-nuclear facilities.

Health Physics and Industrial Hygiene. Establishes policy, guidance, standards, and procedures of the protection of workers and public from operations involving radioactive or hazardous materials. (V. 2, 234).

Epidemiology and Health Surveillance. Study design and implementation of populations as affected by energy generation and use.[25]

Planning and Information Resources Management. On-line reporting and information resources to help carry out DOE plans.

Capital Equipment. Includes equipment for office automation, radiation protection, and DOE's national response capability.

Environmental Analysis. The Office of Environmental Analysis assesses the impact of energy decisions and policies on the environment. Research includes global warming, stratospheric ozone, acid rain, and transboundary pollutants (focusing on VOC emissions from mobile sources, fueled by oil). Other spending has been allocated by overall share of DOE spending.

Nuclear Safety Oversight. Office reporting directly to the Secretary of Energy that oversees all Agency nuclear safety issues. Previously titled the Office of Nuclear Safety. Deals with defense-related cleanups; no allocation to fission.

Liquified Gaseous Fuels Test Facility. Facility is used by industry to conduct spill tests of liquified gaseous fuels and other hazardous and toxic materials. Although users have been charged for using the facility since April 1985, prices have not been set to recover the original capital costs. ('92 Budget Request, v. 2, 315).

Biological and Environmental Research.

Areas applicable to energy include: "health effects of exposure to radiation and hazardous substances; new measurement concepts and dosimetry to better characterize such exposures to humans and the environment; environmental research, including subsurface microbiology; radon; and research into the effects of carbon dioxide buildup in the atmosphere." (DOE, 50).

"BER supports research designed to identify, measure, and characterize energy-related contaminants, such as radiation and toxic chemicals; to model and predict their transport, conversion, and fate in the environment; to mitigate their ecological effects; and to understand their potential effects on human health." (DOE ann. rept., 179).

Environmental Research

Atmospheric Science. Studies focused on acid precipitation, the role of organics in acid production and the role of atmospheric organics in global atmospheric changes, and modeling of air transport, primarily as related to radiation.

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[25] Due to problems with DOE's epidemiological data, such as that it "had not effectively overseen its health programs, lacked credibility in its health effects research activities because it restricted public involvement and independent assessment of its research data, and did not standardize the collection of pertinent data on the health of its workers," DOE has transferred portions of the research to the Department of Health and Human Services and consolidated other parts into the Office of Health within the Office of Environment, Safety, and Health. (US General Accounting Office, Nuclear Health and Safety: Efforts to Strengthen DOE's Health and Epidemiology Programs, February 1991. GAO/RCED-91-57).

Marine Transport. Study of ocean dynamics, especially as related to the role of the ocean in carbon absorption (an important problem with respect to global warming).

Terrestrial Transport. Study of behavior and mobility of organic chemicals (such and petroleum) and organic-chemical-radionuclide mixtures in the soil, and the use of microorganisms for clean-up. Areas also studied include the location and transport of natural radon, and its mobility into homes. Spending is allocated to oil, fission, and efficiency.

Ecosystem Functioning and Response. Remote sensing and local study of ecosystems to collect data DOE will use to predict ecosystem resiliency to disturbance and climate change. One of the three projects focuses on the Arctic Tundra and is related to oil drilling activities there. Spending is allocated on the basis of global warming contribution.

Analytical Technology and Dosimetry Research. Radiological characterization and development of the Chernobyl database.

Health Effects. Goal is the development of scientifically sound method to evaluate the adverse health effects from exposure to radiation and chemical agents similar to those produced in DOE programs.

Human Health Research. Health effects research on exposure to radiative and chemical agents associated with the energy sector.

Epidemiology. Study of injuries and accidents, and evaluation of published studies relating to areas of interest. In the absence of better data, we have allocated this evenly among all fuels with emissions (coal, oil, gas, fission, biomass, geothermal).

Radiation Effects Research Foundation. Continuation of studies of Japanese atomic bomb survivors. Partly benefits fission through understanding gained on radiation effects; partly also for military purposes.

Biological Research. While some of this research is so basic so as to have no energy-related applications, we assume that 50% is targeted work with near- to mid-term benefits.

Radiation Biology. Studies of radiation damage to biological systems. Primarily benefits fission, although a small portion, primarily on radon, also benefits efficiency. Of the share allocated to energy, we assign 3/4 to fission and 1/4 to efficiency (for the radon work).

Chemical Toxicology. Adverse impacts of energy-related chemicals on humans. Study is currently focused on inhalation risks. Lacking better data, we distribute spending equally among fuels with air emissions: coal, oil, gas, fission.

Radiological and Chemical Physics. Study of physical reactions between radiation and matter and chemicals and matter. The energy fraction of this line item is also arbitrarily distributed equally among coal, oil, gas, and fission.

General Life Sciences. Research "contributes to the base of fundamental biological knowledge that is required for the effective study and interpretation of energy-related health effects...This program applies modern molecular biology to the study of radiation and chemical health effects and also exploits unique

Departmental facilities for structural biology and genome research." ('92 Budget Request, v.2, p. 344). Spending on genome research has been deleted from energy-related totals.

Carbon Dioxide Research. Study of the relationship between carbon dioxide and global warming and for general climate modelling. Funding is allocated based on relative contributions of greenhouse gases. ('92 Budget Request, v. 2, 356).

Program Administration and Facilities Operations. Overhead allocated based on the relative fuel shares of the Biological and Environmental Research Program.

Fusion

Magnetic Fusion Energy - Confinement Systems. Test systems to confine a fusion reaction. DOE is currently supporting a number of technologies.

Magnetic Fusion Energy - Applied Plasma Physics. Study of the underlying physics of fusion reactions to allow for improved plasma confinement and better ignition and reactor designs.

Magnetic Fusion Energy - Development and Technology. Activities encompass design and technology development for the International Thermonuclear Experimental Reactor.

Inertial Fusion Energy. Alternative confinement technique which uses implosion rather than magnetic fields to confine the reaction.

Antares Laser Research Program. Began in 1983 and terminated in 1985 due to technical problems. The project sought to demonstrate the feasibility of fusion by using intense laser or particle beams to heat and compress targets containing small masses of thermonuclear fuel. (GAO, Nuclear Science: Factors Leading to the Termination of the Antares Laser Research Program, June 1990. GAO/RCED-90-160).

Program Direction. Overhead, allocated in total to fusion.

Basic Energy Sciences. Supports research at national laboratories, universities, industry, and other government agencies on evolving technologies and technological improvements. We estimate that at least 50% is directly applicable to energy systems. Of this portion, we arbitrarily allocate evenly among fission (high temperature alloys, metal embrittlement); efficiency (ceramics, new materials, superconductivity); and fossil electric (high-temperature alloys). Budget data were not detailed enough for a more precise allocation.

Materials Sciences.

Metallurgy and Ceramics Research. Areas include high temperature superconductors (efficiency), energy-related high temperature alloys (fission, thermal-electric, efficiency) and ceramics (efficiency), and bonding properties between different materials. Also includes research on the effects of radiation on materials (fission).

Solid State Physics Research. High temperature superconductivity (supply efficiency) and study of physical structure of a variety of materials.

Materials Chemistry Research. Superconductivity, material tailoring, insulators (efficiency).

Facilities Operations. Support of national user facilities, pre-construction R&D for the 1-2 GeV and the 6-7 GeV light sources. Ames Laboratory funding does not kick in until 1991.

Chemical Sciences

Chemical Sciences Research. Projects include study of photochemical reactions (solar, hydrogen), dynamics of combustion (fossil efficiency), behavior of atomic particles exposed to strong electrical and magnetic fields (fusion), structure and chemical reactivity of coal (coal), heavy element studies (fission). Isotopic separation of stable isotopes benefits nuclear medicine, not energy. (DOE '92 Budget Request, v. 2, pp. 427 - 437; DOE '88-'89 Ann. Rept., 170, 171). Lacking better data, the energy share of spending is shared evenly between solar, hydrogen, efficiency, coal, fusion, and fission.

Facilities Operations. Support for major user facilities and the restart of the High Flux Isotope Reactor. Allocated in the same proportion as chemical sciences research.

Applied Mathematical Sciences. Given the agenda presented below, we assume that at least 50% of the research is applicable to particular energy types in the near- to mid-term. Objectives are "(1) to expand the knowledge of the fundamental mathematics, computational sciences, and computer science principles necessary to model the complex physical phenomena involved in energy production and storage systems and basic sciences, and (2) to explore new computational algorithms and computer architectures necessary for investigating these mathematical models." ('92 Budget Request, v.2, 439). Projects include modeling of energy conservation (efficiency), turbulent combustion (fossil, biomass), global climate modeling (fossil), structural biology, materials properties, physical modeling, and environmental modeling.

Areas of DOE supercomputing efforts include neutron transport and scattering, radiation transport, compressible flow and shock waves, instabilities and turbulence, combustion and explosion, chemical kinetics, propagation of elastic waves, the flow of oil in reservoirs, multi-phase flow, design and safety of nuclear fission reactors, plasma physics and fusion, propagation of laser beams, the design of efficiently aerodynamic shapes and combustion chambers, meteorology and climatology. (Lax, 3).

Lacking better data, we allocate the energy-portion of spending evenly among efficiency, oil, gas, coal, biomass, fission, and fusion.

Engineering and Geosciences. As with the other research areas, we assume that 50% is somewhat targeted towards particular energy sectors, and that the other half is so basic as to have no near- to mid-term applications.

Engineering Research. Broad range of activities including thin films, optical theory, chaos theory and nonlinear systems, combustion. Benefits accrue to a variety of areas. For example, research of the energetics of pulverization led to more efficient grinding of coal, ores, and rock. Studies in multi-phase flow benefits oil and gas recovery, and pipeline transport. Optical concentration has led to the evolution of a solar furnace. ('92 Budget Request, v.2, 444, 445; '88-'89 Annual Report 171).

Geosciences Research. Much effort focuses on better imaging and processing of the earth's geological makeup. The main beneficiary fuels are oil, gas, and geothermal. Study of wave-guide effects improves knowledge of underground geology and seismic activity, with benefits to fuel extraction from better imaging, and plant siting away from areas of seismic activity. Seismic activity is a large concern primarily with the siting of fission facilities. ('92 Budget Request, v. 2, 446; '88-'89 Ann. Report, 172).

Advanced Energy Projects. High risk projects that "have a potential payoff of a magnitude sufficient to open new vistas for the Nation's energy posture." (Budget Request, v. 2, 449). "Subjects studied by researchers at universities, national laboratories, and industrial laboratories span the full spectrum of Departmental non-defense interest..." While high risk, the projects are directly tied to particular forms of energy. We conservatively ascribe 50% to the relevant energy forms. Research presently includes:

- Unconventional approaches to superconductor development (supply efficiency)
- Cold-fusion, and muon-catalyzed fusion (fusion)
- New sources of "coherent electromagnetic radiation" (electricity)

Energy Biosciences. "The research focus of the Energy Biosciences subprogram is to understand the fundamental mechanisms of how plants produce biomass and the mechanisms of biological transformation of crude, abundant biomass into other useable forms." ('92 Budget Request, v. 2, 453). Includes plant genome studies done with USDA plant science centers that will "lead to improved plant (biomass) productivity." ('92 Budget Request, v. 2, 455). All of this line item is treated as a subsidy to biomass energy.

Major User Facilities. Serve both defence and commercial purposes. Allocated to energy in proportion to the commercial share of overall DOE spending.

National Synchrotron Light Source at Brookhaven National Laboratory. Advanced research with synchrotron radiation, used for vacuum ultra-violet and X-ray scattering and spectroscopy. Used by biologists, chemists, solid-state physicists, metallurgists, and engineers.

High Flux Beam Reactor at Brookhaven National Laboratory. Produces high flux neutron beams used by nuclear and solid-state physicists, chemists, and biologists.

Intense Pulsed Neutron Source at Argonne National Laboratory. Pulsed neutrons serve the physics, materials, chemical and life sciences.

High Flux Isotope Reactor at Oak Ridge National Laboratory. A multipurpose reactor used for the production of isotopes, and also used for materials sciences, nuclear chemists, and radiation damage research. Funding also goes to the Radiochemical Engineering Development Center (previously called the Transuranium Processing Plant), which was built to recover the transuranium elements from irradiated targets in the reactor.

Stanford Synchrotron Radiation Laboratory at Stanford University. Use of synchrotron radiation for basic and applied research in chemistry, physics, biology, and materials sciences.

Manual Lujan, Jr. Neutron Scattering Center at Los Alamos National Laboratory. Used by materials scientists, as well as the use of intense pulsed neutrons by the physics, materials, chemical and life science researchers. Also uses the proton storage ring facility which is budgeted under Defense Programs.

Combustion Research Facility at Sandia National Laboratory - Livermore. Study of combustion and combustion systems (such as internal engines). The commercial share of this facility is allocated equally between oil, gas, efficiency, and coal.

Advanced Scientific Facilities. Primarily the construction of 1-2 GeV and the 6-7 GeV Synchrotron Radiation Source facilities.

Energy Research Analyses. DOE oversight function of basic research programs in order to ensure coordination and lack of duplication in agency efforts.

University and Science Eduction. Broad-based internship programs are excluded.

Direct support for Nuclear Engineering Research Programs.

University Reactor Fuel Assistance. Provides support for the fabrication and shipping of nuclear fuel for university-based research and training reactors.

University Research Instrumentation. Helps universities pay for state-of-the-art instrumentation costing over $100,000. The purpose is to give students experience using the equipment.

Advisory and Oversight Program Direction. Oversight and analysis of DOE energy research programs. Allocated based on overall funding mix.

Multi-Program Energy Laboratories - Construction. Funds line-item construction projects for rehabilitation, upgrade, and replacement of facilities.

Supporting Services

In-House Energy Management. Surveys and studies facilities for energy-efficiency improvements. As with direct purchases of energy services by government agencies for their own consumption, these expenditures on efficiency services are not counted as a subsidy to efficiency, but are addressed in the Direct Interventions chapter.

Technical Information Management Program. Oversees the management, control, and dissemination of research results arising from the Agency's multi-billion dollar research program.

Policy and Management

Energy Research. This budget item provides the staffing resources to support the Director of Energy Research.

Nuclear Energy. Staff and funding to carry out the management functions of nuclear energy program policy development, program planning, resource management, program assessment, and international collaboration.

Energy Supply, Research, and Development. Staffing and funding to support the Assistant Secretary for Conservation and Renewable Energy. Also oversees the AK, SE, and SW Power Administrations. Split equally between efficiency, renewables, and electricity.

Environmental Restoration and Waste Management

Since environmental restoration is a measure of problems with past practices, the best allocation mechanism would be cumulative expenditures. As a proxy, we use the spending mix in 1989.

Corrective Activities - Non-Defense. Components include operating expenses associated with remediation and construction costs to bring DOE facilities into compliance with current laws. Items classified as nuclear energy in the DOE budget justification are allocated between fission and fusion, based on the spending mix in their current nuclear energy program. ('92 Budget Request, v. 2, 593 et seq). Items classified as "Energy Research" are allocated based on the current portion of DOE's non-nuclear budget.

Environmental Restoration. Waste site cleanup of "DOE and authorized non-governmental facilities and sites that are no longer part of active operations. This activity includes Remedial Action efforts to assess and clean up waste at inactive sites, and decontamination and decommissioning of surplus nuclear facilities for reuse or totally unrestricted release." (DOE, 27). Lacking historical data on the commercial versus defense shares of past DOE spending, we use the cost allocation for the commercial share of cleanup of the uranium enrichment facilities, assuming that uranium shipments correlates fairly well with spending. (See the Uranium Enrichment Enterprise section of this report for additional information).

Remedial Action, Decommissioning and Decontamination and Formerly Utilized Sites Remedial Action Project (FUSRAP). Containment, cleanup, and management of old DOE (and predecessor agencies) commercial research and production sites. These facilities seem to include both defense and commercial locations. (DOE ann. rept., 147-49).

Uranium Mill Tailing Remedial Action Project. Funds a uranium mill tailings stabilization and control program at 24 sites and about 5,000 adjacent properties.

Uranium Mill Tailings Groundwater Restoration Project. Aquifer restoration at 24 mill tailing sites, as necessary.

Shippingport Decommissioning. Funding to decommission the Shippingport fission reactor.

Waste Management - Non-Defense, Operating Expenses.

Low-Level Waste Program. Establish a reliable nationwide system for management of low-level radioactive waste.

Fast Flux Test Facility. Transferred from Nuclear Energy R&D in FY90.

Waste Management - Defense/Non-Defense Mixed

Continuity of Base Waste Management Operations. Self-explanatory.

Waste Minimization. Work to minimize wastes resulting from DOE operations by sponsoring workshops and seminars. Since classified under the nuclear section, we assume this does not contain non-nuclear cleanup efforts.

West Valley Demonstration Project. Solidification (vitrification) of high-level radioactive waste, as well as all of the steps needed to get the waste to the point of solidification (retrieval, shipping, etc.). Part of the project also studies management of LLRW and mixed-wastes.

Waste Treatment, Storage, and Disposal. Handling costs from radioactive, hazardous, or mixed wastes from the research laboratories.

General Science and Research[26]. This general science research is less concrete than much of the other DOE research efforts. While we feel that some of this research is targeted enough to consider as funding a particular energy source, we do not have the information on which to make such judgments at this time. Therefore, with the exception of a portion of nuclear physics and the SSC, we do not count any of this spending as a subsidy to the energy sector.

High Energy Physics. Focused on understanding the nature of matter and energy. Included particle accelerators, colliding beam devices, large particle detectors. This category was not allocated, awaiting additional information.

Superconducting Super Collider. Built to explore the extremely high energy TeV mass region, the SSC could have benefits to electrical transmission efficiency, and transportation. DOE estimates the total project cost at $6.351 billion. The National Journal estimates total cost at $8 billion. Project funding is 2/3 federal, 1/3 other (private, Texas, foreign). "Supercollider bailout," National Journal, 6/9/90, p. 1417; DOE '92 Budget Request, v. 3, p. 63). We allocated an arbitrary 20% of this item to reflect the driving force of electrical transmission efficiency in motivating the effort.

Nuclear Physics. Activities include basic research in nuclear physics and the construction and operation of particle accelerators and detectors as well as accurate measurement of nuclear measurement for evaluating cold fusion (Paul 3). In fact, '[m]ost of the gains in using nuclear energy for both military and civilian purposes have come through applying the results of careful experimental measurements, augmented by derivations from basic theory." (DOE ann. rept., 88-89, p. 198). DOE supports 85 percent of U.S. basic research in nuclear physics. (DOE '92 Budget Request, v. 3, 66).

Data on nuclear properties and cross sections for improvements of reactor and other technologies came from DOE efforts. "Examples here are neutron and nuclear data for the design of a next generation of nuclear reactors which burn away the long-lived actinide radioisotopes in reactors by changing them into shorter-lived radioactive waste, and for the reliable prediction of heat generated in the core after shut down." (Paul, Peter, 3). We conservatively ascribe 20% of this spending to fission (15%) and fusion (5%).

Continuous Electron Beam Accelerator. Total cost is estimated at $265m.

Relativistic Heavy Ion Collider. With a total cost of about $397m, this collider is used to create quark-gluon plasma, which currently has no practical applications. (Paul, Peter, 1,2).

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[26]Recent investigations have found that some of the DOE laboratories are exceeding the allowed 2% of operating budget which may go to exploratory R&D, where researchers at the lab, rather than DOE directorate, determines the research project. R&D funding that was used for exploratory R&D rather than targeted R&D totaled $49.1m in 1984, $60.3m in 1985, $77.8m in 1986, $94.1m in 1987, and $98.4 in 1988. (US GAO, Energy Management: Better DOE Controls Needed Over Contractors' Discretionary R&D Funds, December 1990, p. 25. GAO/RCED-91-18).

Other Construction projects and modifications. 8.5m

Operating Expenses. Allocated in the same proportions as the nuclear physics capital expenses.

General Science Program Direction. Overhead allocated on the basis of the mix of spending for General Science and Research.

Fossil Energy Research and Development.

Coal R&D. Generic research on coal combustion above and beyond DOE coal spending through the Clean Coal Program. Aimed at control of acid rain precursors, combustion systems, fuel cells, underground coal gasification, surface coal gasification. Fuel cell research focuses on coal-based fuels. Research on coal combustion systems and surface coal gasification (an necessary input for combined-cycle systems) is split evenly between coal and efficiency.

Gas R&D. The focus of gas research and development is on unconventional gas recovery, such as from gas shales and tight sands.

Petroleum R&D. Research efforts are centered on advanced extraction techniques benefitting oil, gas, and oil shale, as well as enhanced oil recovery techniques and technology development for oil shale.

Program Direction and Management Support. Categories of spending include Program Direction for Headquarters and for DOE's Energy Technology Centers, a Federal Inspector for the Alaska Natural Gas Pipeline, plant and capital equipment purchases, and cooperative research and development activities with the Western Research Institute and the University of North Dakota's Energy and Environmental Research Center.

Environmental Restoration. Funds cleanup at DOE fossil energy sites.

Western Superfund Site. DOE share of Western Superfund site caused by pilot project exploring solvent-refined coal. (v. 4, 122). Spending is allocated to coal.

Rock Springs Site. Cleanup related to oil shale activity (v. 4, 122). Spending is allocated to oil.

Rocky Mountain Underground Coal Gasification Site. For cleanup of operations related to underground coal gasification. (v. 4, 122). Spending is allocated to coal.

Fuels Programs. The Office of Fuels Programs oversees energy imports and exports and power plant conversions.

Efficiency

Buildings Sector. Research and development of efficiency technologies primarily used in buildings. Areas include passive solar construction techniques, windows and insulation technologies, and lighting efficiency. The Federal Energy Management Program, which finances energy-efficiency retrofits in other government agencies, is not classified as a subsidy to efficiency for the same reasons that DOE direct procurement of such energy services were not counted above: they represent a demand decision, not a subsidy.

Industrial Sector. DOE efforts in the industrial sector focus on ways to convert industrial wastes into energy products. All of these projects seek improved industrial energy efficiency through use of waste materials or through replacing production processes with more efficient ones. Research on municipal solid wastes utilization is attributed to waste-to-energy systems rather than to efficiency.

Transportation Sector. Research in the transportation sector centers on alternative transport fuels as well as more efficient locomotion. Spending on alternative fuels is treated as a subsidy to those fuels. Spending on improved efficiency of existing systems is attributed to efficiency.

Alternative Fuels Utilization. Beneficiary fuels are synthetics, alcohol, and natural gas, and electricity. Synthetic fuels are methanol and diesel produced from coal. Research focuses on emissions, combustion systems, and demonstration projects. Since the DOE budget justification mixes multiple projects under one total cost, this category was simply split equally among the beneficiary fuels.

Electric and Hybrid Propulsion Development. Since research efforts focus on alternative transportation systems rather than on improved efficiency, subsidies are allocated to electricity.

Multi-Sector Conservation Activities. Focusing on cross-cutting energy efficiency technologies.

Utility Sector. Efforts focus on integrated resource planning to facilitate more extensive use of demand-side management and reduction of peak power demand. While this spending has been allocated entirely to efficiency, it is important to note that implementing integrated resource planning benefits the cheapest energy option regardless what it is. The fact that the creation of integrated resource planning currently benefits primarily efficiency is simply due to economics.

Technical and Financial Assistance. This area funds information transfer as well as grants to states or municipalities to adopt cost-effective renewable energy and energy efficiency technologies. The bulk of the funding in this area goes to a weatherization assistance program which, in partnership with the States, weatherizes the homes of low-income residents. For promotion of renewable energy products overseas, 1/2 of the International Market Development funding is allocated to renewables. Similarly, one-half of the Information and Communications budget is so allocated for support of the Conservation and Renewable Energy Information Referral Services and the Regional Biomass Energy Program.

Policy and Management - Office of Conservation and Renewable Energy. Funds management costs and salaries for the operations of DOE's conservation and renewables programs.

Emergency Preparedness. Emergency preparedness expenditures are utilized to assess risks from energy supply disruptions and to evaluate and develop ways to respond. The primary areas of vulnerability are the transportation sector, the electrical power grid, and oil and gas pipelines.

Economic Regulation. Funding for the Economic Regulatory Administration, the body responsible for enforcing the Emergency Petroleum Allocation Act of 1973 and collecting oil overcharge funds in response to price gouging as defined by the Act. Also funded is the Office of Hearings and Appeals which is responsible for adjudicating appeals to ERA rulings.

Geothermal Resource Development Fund. Loan guarantees for loans made to qualified geothermal projects. Fund is essentially defunct, other than monitoring "disposition of collateral from a defaulted project."

Alternative Fuels Production. Expenditures under this program ended for the most part in 1989. Activity in this account is related to the Synthetic Fuels Corporation, for DOE operation of the Great Plains coal gasification plant after the private owner defaulted on a DOE-guaranteed loan. (OMB '91, A-675). Expenditures are allocated to coal.

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DEPARTMENT OF ENERGY: ATOMIC ENERGY DEFENSE ACTIVITIES

Activities Benefitting the Commercial Sector

Background

It is clear that without much of the early work on military applications of nuclear power, the commercial sector would never have evolved. For example, while the Atomic Energy Commission (AEC) divided early R&D into commercial and military sectors, both were critical in the development of light water reactors. "The civilian program used information and expertise developed in the more experimental military program. Further, the reactor prototype developed in the military program became the foundation for some of the AEC's later civilian reactor work as well as the basis for the commercial light water reactor." (Bowring, 16).

While there was significant spillover, to claim that military research directly subsidized the commercial sector is somewhat problematic since most of the military research would likely have occurred whether or not there were a commercial sector. However, it is likely that the staggering costs associated with military nuclear development led to an extensive search for ways to spread these costs over a broader base of recipients. Commercial nuclear power provided such an outlet.[27]

Some spending classified as "defense-related" does, in fact, directly benefit the commercial sector while at the same time using technology in excess of that needed to meet the military's requirements. One example is the $3.6 billion tritium facility planned for Idaho Falls, ID. Although ostensibly used solely for military purposes, the choice of reactor design relies on new, essentially untested, "fail-safe" reactors rather than the already refined light-water technology. As such, this expenditure seems, at least in part, to be a research expenditure for the commercial sector.[28]

For items clearly benefitting both the defense and commercial sectors, an arbitrary 5 percent of spending was allocated to the commercial sector as a first guess at the true level of support.

Current Spending

Materials Production. A small portion of the materials production budget supports the production of nuclear materials for use in civilian research and commercial applications, among others (DOE '92 Budget Request, v. 1, 175). It is unclear whether this accrues to energy research or other activities.

Naval Reactors Development Program. The tie between the naval reactor development program and the commercial sector continues today. As stated in the DOE Annual Report:

> The technology developed in the Naval Reactors Development program is directly applicable to, and an inherent part of, DOE's nuclear fission energy program. This program has been the source of much of the technology for the civilian nuclear energy industry." (DOE, ann rept., 297).

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[27] Joseph Bowring reasoned that a portion of the costs of military R&D were subsidies to commercial fission, and estimated their magnitude at $1,081 million (1989$) between 1950 and 1964. (Bowring, 31).

[28] Elmer-Dewitt, Philip. "Nuclear Power Plots a Comeback," Time, January 2, 1989, p. 41.

Technology Transfer. Many of the technologies developed for the nuclear weapons program have applications in other fields of national defense and industry. DOE and DOE research laboratories try to transfer these developments whenever possible (given national security constraints) to potential government and industrial users.

> Areas where the DOE weapons program has made and continues to make important contributions to the Nation's technology base include materials sciences, computer sciences and applications, and atomic and nuclear physics. For example, SNL [Sandia National Laboratory] recently has been transferring an average of approximately 50 research and development projects per year to industry." (DOE ann. rept, 268, 269).

Examples of energy-related technology transfers include:

- Computer codes originally developed to study the two-and three-dimensional hydrodynamics of nuclear weapons to electric utilities and well-drilling firms.
- Low-power hybrid circuits for nuclear instrumentation, a computer code for engine modeling, and components for a ceramic matrix material that has remarkable strength, as well as information exchange on high temperature superconducting materials. (DOE, ann. rpt. 268, 269).

Cleanup. Some federal facilities, such as the Uranium Enrichment Enterprise, provided services to both the military and the commercial sectors. As a result, responsibility for cleanup of those sites also belongs to both sectors. We were not able to estimate the degree to which the commercial sector benefitted from primarily-defense facilities that now face large cleanup bills.

Technology Development. This area includes applied research and development of methods to clean radioactively-contaminated soil and groundwater; handle and process radioactive wastes; incorporate waste minimization into production processes; and decommission concrete and metal structures. Although of immediate importance for the DOE military cleanup, the techniques and technologies are equally applicable to DOE sites serving commercial needs and commercial reactors. (DOE '92 Budget Request, v. 1, 587-629).

Waste Transportation and Site Management. Research into radioactive waste management which benefits the commercial sector to the same degree as technology development, shown above. ('92 Budget Request, v. 1, 644).

Sources

U.S. DOE. Fiscal Year 1991 Congressional Budget Request. Volumes 1-5. Reprinted in the House Appropriations Hearings, 1990.

U.S. DOE. Fiscal Year 1992 Congressional Budget Request. Volumes 1-4. DOE/CR-0001.

U.S. DOE. The Secretary's Annual Report to Congress, 1988-1989. DOE/S 0010(89).

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric General	Electric Fission	Electric Oil	Electric Coal	Electric Gas	Electric Hydro	End-Use Effic.	Electric Biomass	Wind	Solar	Geotherm.	Supply Effic.	Other Renew.	Fusion	Biomass-Non-Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
SOLAR AND RENEWABLE ENERGY																								
Solar Building Technology Research		2.3										0.0			0.0								2.3	All solar, off-grid
Photovoltaic Systems		35.1													15.1								20.0	PV Grid/Non-grid capacity
Solar Thermal Energy Systems		14.5													14.5									All solar grid
Wind Energy Systems		8.8												8.8										Wind
Ocean Energy Systems		4.1																4.1						Other (ocean)
Solar- Technology Transfer		2.4													1.4								1.0	Solar Mix from above
Resource Assessment		0.8													0.5								0.3	Solar; moving into wind later
Solar Energy Program Direction		4.4													2.5								1.9	Solar
Geothermal Energy Systems		19.3														19.3								Geothermal
Hydropower Energy Systems		0.0									0.0													Hydropower (spending in '91)
Sub-Total		91.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8	33.9	19.3	0.0	4.1	0.0	0.0	0.0	0.0	25.6	
<u>Allocated Overhead</u>																								
Solar International Programs		1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	Spending mix in this section
Solar-Program Support		1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.4	Spending mix in this section
Biofuels Energy Systems																								
Thermochemical Conversion		1.5											1.5											Biomass
Hydrogen Research		3.0																3.0						Other (hydrogen)
Municipal Solid Waste		0.0																0.0				0.0		Other ren. (waste-to-energy)
Transport - Feedstock Development		0.0																		0.0				Biomass
Transport - Biochemical Conversion		2.1																		2.1				Biomass (ethanol)
Transport - Thermochemical Conversion		0.0																		0.0				Biomass (methanol)
Transport - Hydrogen		0.0																0.0						Other (hydrogen)
Terrestrial Crops		3.7																		3.7				Biomass (methanol and ethanol)
Sub-Total		10.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	3.0	0.0	5.8	0.0	0.0	0.0	
Total before overhead		104.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	9.0	34.9	19.8	0.0	7.2	0.0	5.8	0.0	0.0	26.3	
<u>Allocated Overhead</u>																								
Capital Equipment		0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	Spending mix in this section
Technical & Fin. Assist.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Spending mix in this section
Reg. Prog.: Tech. Transfer		2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7	0.4	0.0	0.1	0.0	0.1	0.0	0.0	0.5	Spending mix in this section
Electric Energy Systems		24.3	0.0	0.0	0.0	0.0	4.6	1.4	13.6	2.3	2.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Current Electricity Mix
Energy Storage Systems		11.9	0.0	0.0	0.0	0.0	1.1	0.3	3.3	0.6	0.6	0.0	0.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1/4 solar; 1/4 wind; 1/2 electricity mix
Total - Solar and Renewable Energy		143.4	0.0	0.0	0.0	0.0	5.7	1.7	16.9	2.9	2.9	0.0	1.5	12.2	38.7	20.4	0.0	7.4	0.0	5.9	0.0	0.0	27.0	
NUCLEAR ENERGY R&D	347.5																							
Light Water Reactors		26.5					26.5																	Fission
Advanced Reactor R&D		70.0					70.0																	Fission
Total Direct Fission		96.5					96.5																	
Total Direct Nuclear R&D	347.5																							
Fission share of Nuclear R&D	27.8%																							
Facilities	139.6	38.8					38.8																	Commercial power share of nuclear R&D
Program Direction	8.5	2.4					2.4																	Commercial power share of nuclear R&D
Civilian Radioactive Waste R&D	2.5	2.5					2.5																	Fission
Totals		140.1	0.0	0.0	0.0	0.0	140.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ENVIRONMENT, SAFETY, AND HEALTH	93.0																							
Total DOE Defense spending in FY89	8,119																							
Tot. DOE spend. before revenues	15,300																							
Percent non-defense	47%																							

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric. General	Electric. Fission	Electric. Oil	Electric. Coal	Electric. Gas	Electric. Hydro	End-Use Effic.	Electric Biomass	Wind	Solar	Geotherm.	Supply Effic	Other Renew.	Fusion	Biomass-Non-Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
Environmental Audit	17.0	8.0	1.2	0.3	0.1	0.2	3.0	0.0	0.0	0.0	0.0	0.7	0.2	0.0	0.2	0.1	0.5	0.1	1.3	0.0	0.0	0.0	0.0	Shares of DOE non-defense spending
Environmental Guidance & Compliance	4.3	2.0	0.3	0.1	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.0	Same, although should be based on
NEPA Oversight	2.9	1.4	0.2	0.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	historical data, not one year.
Quality and Safety	25.9	12.2	1.8	0.5	0.2	0.2	4.6	0.0	0.1	0.0	0.0	1.1	0.3	0.1	0.3	0.1	0.8	0.1	2.0	0.0	0.0	0.0	0.0	Same
Safety Appraisals	12.3	5.8	0.8	0.2	0.1	0.1	2.2	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.1	0.1	0.4	0.0	0.9	0.0	0.0	0.0	0.0	Same
Safety Integration/Compliance	1.1	0.5	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	Same
DOE National Response Capability	7.7	3.6					3.6																	1/2 fission, 1/2 defense (guess)
Health Physics and Indust. Hygiene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	DOE spending mix
Epidemiology and Health Surveillance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Same
Occupational Medicine/Med. Director	0.7	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	Same
Planning and Info. Resources Mgmt	3.2	1.5	0.2	0.1	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	Same
Other																								
Nuclear Policy Development		0.0					0.0																	Fission; present in FY90
Advisory Commission on Nuclear Safety		0.0					0.0																	Fission; present in FY90
Office of Nuclear Safety		0.0					0.0																	Fission; present in FY90
Capital Equipment																								
DOE National Response Capability	2.0	0.9					0.9																	1/2 fission, 1/2 defense (guess)
Radiation Protection		0.5					0.5																	Fission
Sub Total		36.7	4.7	1.2	0.4	0.6	17.1	0.0	0.1	0.0	0.0	3.0	0.8	0.1	0.8	0.3	2.1	0.2	5.2	0.0	0.0	0.0	0.1	
Allocated Overhead																								
Office Automation	0.6	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Share of program area
Program Direction	11.4	5.4	0.7	0.2	0.1	0.1	2.5	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.1	0.0	0.3	0.0	0.8	0.0	0.0	0.0	0.0	Shares of this program area
Environmental Analysis																								
Global Climate Change	3.0	1.6	0.2	0.6	0.3	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					Global warming contribution
Stratospheric Ozone	0.0	0.0																						Ozone depletion contribution
Transboundary Pollutants	0.0	0.0																						Mobile sources (oil)
Acid Rain	0.7	0.7		0.2					0.5															Est. .7 coal-elec., .3 oil
Other	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					Shares of DOE agency spending
Nuclear Safety Oversight		0.0																						Defense-related
Totals		44.9	5.6	2.1	0.8	0.7	19.8	0.1	1.1	0.1	0.0	3.4	1.0	0.2	0.9	0.4	2.4	0.2	6.0	0.0	0.0	0.0	0.1	
LIQUIFIED GASEOUS FUELS TEST FACILITY	1.5	1.1		0.8	0.4																			1/2 oil, 1/4 NGL, 1/4 haz mat. (guess)
BIOLOGICAL AND ENVIRONMENTAL RESEARCH																								
Environmental Research																								
Atmospheric Science	11.4	11.4		1.7			5.7		4.0															1/2 fission, 1/2 acid dep (.35 coal-elec .15 oil)
Marine Transport	5.8	3.2	0.3	1.1	0.6	0.0	0.0	0.1	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					Global Change
Terrestrial Transport																								
Radon Studies	2.4	2.4										2.4					0.0							End-Use Effic
Organics/Radionuclide Transport	8.1	8.1		6.1			2.0																	3/4 to oil, 1/4 fission
Ecosystem Functioning and Response	8.6	4.7	0.5	1.6	0.9	0.0	0.0	0.2	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					Global Warming contribution
Analytical Tech. Dosimetry Research	9.3	7.0					7.0																	3/4 to fission
Health Effects																								
Human Health Research																								
Epidemiology		8.2	2.1	2.1	2.1								2.1											Divided evenly among all fuels with emissions
Radiation Effects Research Fndtn.	17.0	4.3					4.3																	1/4 fission; 3/4 defense
Other		1.5					0.8					0.8												Fission, end-use effic (radiation, radon)
Biological Research																								
Radiation Biology	23.4	11.7	2.9	2.9	2.9		2.9																	3/4 fission, 1/4 efficiency

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric. General	Electric. Fission	Electric. Oil	Electric. Coal	Electric. Gas	Electric. Hydro	End-Use Effic.	Electric Biomass	Wind	Solar	Geotherm.	Supply Effic.	Other Renew.	Fusion	Biomass-Non-Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
Chemical Toxicology	8.4	4.2	1.1	1.1	1.1		1.1																	Divided evenly btwn. coal, oil, gas, fission
Radiological and Chemical Physics	6.5	3.3	0.8	0.8	0.8		0.8																	Divided evenly btwn. coal, oil, gas, fission
General Life Sciences	45.4																							
Less Genome Funding	(17.5)																							
Net - General Life Sciences	27.9	14.0	3.5	3.5	3.5		3.5																	Divided evenly btwn. coal, oil, gas, fission
Carbon Dioxide Research	17.4	8.7	3.7	3.6	1.5																			Energy share of CO2 loading from Holdren
Sub Total - Direct Program		92.5	14.8	24.4	13.3	0.0	28.0	0.3	6.3	0.2	0.0	3.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
<u>Allocated Overhead</u>																								
Program Administration		4.0	0.6	1.1	0.6	0.0	1.2	0.0	0.3	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Shares of above program
Facilities Operations		32.5	5.2	8.6	4.7	0.0	9.8	0.1	2.2	0.1	0.0	1.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Shares of above program
Totals		129.0	20.6	34.0	18.6	0.0	39.0	0.4	8.8	0.3	0.0	4.4	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
FUSION POWER R&D																								
Magnetic Fusion Energy - Confinement Systems		172.7																	172.7					Fusion
Mag. Fusion Energy - Applied Plasma Physics		81.2																	81.2					Fusion
Mag. Fusion Energy - Development and Technology		54.1																	54.1					Fusion
Planning and Projects		1.1																	1.1					Fusion
Inertial Fusion Energy		0.0																	0.0					Fusion
Program Direction		4.6																	4.6					Fusion
Capital Equipment		18.8																	18.8					Fusion
Construction		12.2																	12.2					Fusion
Totals		344.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	344.7	0.0	0.0	0.0	0.0	
BASIC ENERGY SCIENCES																								
Materials Sciences																								
Research	126.1	63.1				21.0	21.0					10.5					10.5							Split evenly between fission, effic., fossil-elect.
Metallurgy and Ceramics Research																								
Solid State Physics Research																								
Pre-construction R&D																								
Materials Chemistry Research																								
Facilities Operations	47.5	23.8				7.9	7.9					4.0					4.0							Split evenly between fission, effic., fossil-elect.
Ames Laboratory	0.0	0.0																						Starts in '91
Chemical Sciences																								
Chemical Sciences Research	84.1	42.1	7.0				7.0					0.0			3.5		7.0	7.0	7.0				3.5	Guess: solar, hydrogen, efficiency, and
Facilities Operations	43.7	21.9	3.6				3.6					0.0			3.6		3.6	3.6	3.6					coal, fission, and fusion.
Applied Mathematical Sciences																								
Mathematical Sciences Research	24.4	12.2	1.7	1.7	1.7		1.7					0.0	1.7				1.7		1.7					Guess: effic., oil, gas, coal, biomass
Energy Sciences Advanced Computation	17.7	8.9	1.3	1.3	1.3		1.3					0.0	1.3				1.3		1.3					fission, and fusion.
Engineering and Geosciences																								
Engineering Research	15.2	7.6	1.5	1.5	1.5							0.0			1.5		1.5							Guess: Oil, gas, coal, solar, effic.: even split
Geosciences Research	17.6	8.8		2.2	2.2		2.2									2.2								Guess: Oil, gas, geothermal, fission
Advanced Energy Projects	14.4	7.2				2.4						0.0					2.4		2.4					Fusion, electricity, effic.
Unconventional approaches to superconductor development																								
Cold-fusion, and muon-catalyzed fusion (fusion)																								
New sources of "coherent electromagnetic radiation" (electricity)																								
High Ion Fusion Accelerator Research (fusion)																								

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric General	Electric Fission	Electric Oil	Electric Coal	Electric Gas	Electric Hydro	End-Use Effic.	Electric Biomass	Wind	Solar	Geotherm	Supply Effic.	Other Renew.	Fusion	Biomass-Non Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
Energy Biosciences	20.4	20.4											20.4											Biomass
Sub Total	411.1	215.8	15.2	6.7	6.7	31.3	44.8	0.0	0.0	0.0	0.0	14.5	23.4	0.0	8.7	2.2	32.0	10.7	16.1	0.0	0.0	0.0	3.5	
Allocated Overhead																								
Program Direction	4.9	2.6	0.2	0.1	0.1	0.4	0.5	0.0	0.0	0.0	0.0	0.2	0.3	0.0	0.1	0.0	0.4	0.1	0.2	0.0	0.0	0.0	0.0	Share of above program
Capital Equipment	31.7	16.6	1.2	0.5	0.5	2.4	3.5	0.0	0.0	0.0	0.0	1.1	1.8	0.0	0.7	0.2	2.5	0.8	1.2	0.0	0.0	0.0	0.3	Shares of above program
Construction	86.6	45.4	3.2	1.4	1.4	6.6	9.4	0.0	0.0	0.0	0.0	3.0	4.9	0.0	1.8	0.5	6.8	2.2	3.4	0.0	0.0	0.0	0.7	Shares of above program
Totals		280.4	19.7	8.7	8.7	40.7	58.2	0.0	0.0	0.0	0.0	18.8	30.4	0.0	11.3	2.9	41.6	13.8	20.9	0.0	0.0	0.0	4.6	
MAJOR USER FACILITIES																								Overall non-defense share of DOE spending
National Synchrotron Light Source	19.3	9.1	1.3	0.4	0.2	0.2	1.7	0.0	0.2	0.0	0.0	1.1	0.3	0.1	0.5	0.2	0.7	0.1	1.8	0.0	0.0	0.0	0.1	Shares of DOE research
High Flux Beam Reactor	14.6	6.9	1.0	0.3	0.1	0.2	1.3	0.0	0.1	0.0	0.0	0.8	0.2	0.1	0.4	0.2	0.5	0.1	1.4	0.0	0.0	0.0	0.1	Shares of DOE research
Intense Pulsed Neutron Source	5.1	2.4	0.4	0.1	0.1	0.1	0.5	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.1	0.1	0.2	0.0	0.5	0.0	0.0	0.0	0.0	Shares of DOE research
High Flux Isotope Reactor	19.0	8.9	1.3	0.4	0.2	0.2	1.7	0.0	0.2	0.0	0.0	1.0	0.3	0.1	0.5	0.2	0.7	0.1	1.8	0.0	0.0	0.0	0.1	Shares of DOE research
Radiochemical Engineering Dev. Cent.	7.1	3.3	0.5	0.2	0.1	0.1	0.6	0.0	0.1	0.0	0.0	0.4	0.1	0.0	0.2	0.1	0.3	0.0	0.7	0.0	0.0	0.0	0.0	Shares of DOE research
Stanford Synchrotron Radiation Lab	10.2	4.8	0.7	0.2	0.1	0.1	0.9	0.0	0.1	0.0	0.0	0.6	0.2	0.1	0.3	0.1	0.4	0.1	1.0	0.0	0.0	0.0	0.1	Shares of DOE research
Lujan Neutron Scattering Facility	4.8	2.3	0.3	0.1	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.1	0.0	0.2	0.0	0.5	0.0	0.0	0.0	0.0	Shares of DOE research
Combustion Research Facility	3.5	1.6	0.4	0.4	0.4							0.2					0.2							Oil, gas, coal, efficiency
Advanced Scientific Facilities	7.7	3.6	0.5	0.2	0.1	0.1	0.7	0.0	0.1	0.0	0.0	0.4	0.1	0.0	0.2	0.1	0.3	0.0	0.7	0.0	0.0	0.0	0.1	Shares of DOE research
Construction																								
1-2 GeV Synch. Rad. Source	22.0	10.3	1.5	0.5	0.2	0.2	2.0	0.0	0.2	0.0	0.0	1.2	0.4	0.1	0.6	0.2	0.8	0.1	2.1	0.0	0.0	0.0	0.1	Shares of DOE research
6-7 GeV Synch. Rad. Source	5.6	2.6	0.4	0.1	0.1	0.1	0.5	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.1	0.1	0.2	0.0	0.5	0.0	0.0	0.0	0.0	Shares of DOE research
Totals		55.8	8.4	2.9	1.6	1.2	10.3	0.1	1.0	0.1	0.1	6.5	1.9	0.6	2.9	1.2	4.5	0.6	11.0	0.0	0.0	0.0	0.8	
ENERGY RESEARCH ANALYSES		3.8	0.6	0.2	0.1	0.1	0.7	0.0	0.1	0.0	0.0	0.4	0.1	0.0	0.2	0.1	0.3	0.0	0.8					Shares of DOE research
Totals		3.8	0.6	0.2	0.1	0.1	0.7	0.0	0.1	0.0	0.0	0.4	0.1	0.0	0.2	0.1	0.3	0.0	0.8	0.0	0.0	0.0	0.0	
UNIVERSITY AND SCIENCE EDUCATION																								
Dr Support for Nuclear Engin. Research Progs		5.9					5.9																	Fission
University Reactor Fuel Assistance		2.0					2.0																	Fission
University Research Instrumentation		0.0					0.0																	Fission
R&D Laboratory Tech. Transfer		1.4					1.4																	Fission
Sub Total		9.3	0.0	0.0	0.0	0.0	9.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Allocated Overhead																								
Advisory and Oversight Program Direction		3.3	0.5	0.1	0.1	0.1	0.6	0.0	0.1	0.0	0.0	0.4	0.1	0.0	0.2	0.1	0.3	0.0	0.7					Shares of DOE research
Totals		12.6	0.5	0.1	0.1	0.1	9.9	0.0	0.1	0.0	0.0	0.4	0.1	0.0	0.2	0.1	0.3	0.0	0.7	0.0	0.0	0.0	0.0	
MULTI-PROG. ENERGY LABS CONSTRUCTI	24.4	11.5	1.7	0.5	0.2	0.3	2.2	0.0	0.2	0.0	0.0	1.3	0.4	0.1	0.6	0.3	0.9	0.1	2.3					Shares of DOE research
Totals		11.5	1.7	0.5	0.2	0.3	2.2	0.0	0.2	0.0	0.0	1.3	0.4	0.1	0.6	0.3	0.9	0.1	2.3	0.0	0.0	0.0	0.0	
SUPPORTING SERVICES																								
In-House Energy Management	19.4	0.0																						Purchase-for-use treated in direct intervention sectio
Technical Information Management Program		16.5	2.4	0.6	0.2	0.3	6.3	0.0	0.1	0.0	0.0	1.5	0.4	0.1	0.4	0.2	1.1	0.1	2.7	0.0	0.0	0.0	0.0	Share of total DOE spending
Policy and Management		0.7	0.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	Share of total DOE spending
Energy Research		2.3									1.2	0.6						0.6						Guess: 1/4 effic., 1/4 renewables, 1/2 hydro
Nuclear Energy		2.3					2.3																	Fission
Energy Supply, Research, and Development		1.6				0.5						0.5						0.5						Efficiency, Renewables, Electricity
Strategic Facil. Util. Program		2.2	0.3	0.1	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.4					Share of DOE spending
Totals		25.6	2.9	0.7	0.3	0.9	9.7	0.0	0.1	0.0	1.2	2.9	0.5	0.1	0.5	0.2	1.3	1.2	3.2	0.0	0.0	0.0	0.0	
ENVIRONMENTAL RESTORATION AND WASTE MGMT.																								
Corrective Activities - Non Defense																								

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric General	Electric Fission	Electric Oil	Electric Coal	Electric Gas	Electric Hydro	End-Use Effic.	Electric Biomass	Wind	Solar	Geotherm.	Supply Effic.	Other Renew.	Fusion	Biomass-Non-Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
Non-def. Envir. Restor & Waste Mgmt		14.7	2.2	0.5	0.2	0.3	5.6	0.0	0.1	0.0	0.0	1.4	0.4	0.1	0.4	0.1	1.0	0.1	2.4	0.0	0.0	0.0	0.0	Share of DOE spending
Operating Expenses: Nuclear		0.5					0.1												0.4					Fission/fusion mix of current spending
Oper. Ex.: Energy Research		0.7	0.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	Share of DOE spending
Constr. Ex.: Envir. Restor. Waste Mgmt		34.1	5.0	1.3	0.5	0.6	12.9	0.0	0.2	0.0	0.0	3.2	0.9	0.1	0.9	0.3	2.2	0.2	5.6	0.0	0.0	0.0	0.1	Share of DOE spending
Construction Ex.: Nuclear		0.2					0.0												0.2					Fission/fusion mix of current spending
Construction Ex.: Energy Research		15.4	2.3	0.6	0.2	0.3	5.8	0.0	0.1	0.0	0.0	1.4	0.4	0.1	0.4	0.1	1.0	0.1	2.5	0.0	0.0	0.0	0.0	Energy Research Expenditures Mix
Environmental Restoration																								
Decommissioning and Decontamination	76.3	35.7					35.7																	DOE decision re. energy shares at
Remedial Action Project (FUSRAP)	22.2	10.4					10.4																	enrichment facilities. See allocation
Remdial Action	206.3	96.5					96.5																	table below
Uran. Mill Tail. Remed. Action Proj	110.8	51.9					51.9																	Same as above
Uranium Mill Tailings Groundwater Restor. Proj		0.0					0.0																	Fission
Shippingport Decommissioning		4.0					4.0																	Fission
Waste Management - Non-Defense, Operating Expenses																								
Low-Level Waste Program	5.0	2.2					2.2																	Utility share of non-def. LLRW
Fast Flux Test Facility		0.0																						Moved from Nuclear R&D in '90, $83m in '91
Sub Total	420.6	266.3	9.5	2.4	0.9	1.2	225.5	0.0	0.3	0.0	0.1	6.1	1.7	0.3	1.6	0.6	4.3	0.4	11.1	0.0	0.0	0.0	0.1	
Waste Management - Non-Defense, Defense mixed: Allocate first by non-defense share of DOE spending, then by basis listed.																								
Base Waste Management Operations	201.7	94.4					94.4																	Commercial share of fission D&D
Waste Minimization	3.6	1.7					1.7																	See allocation table below
West Valley Demonstration Project	66.5	32.3					32.3																	Non-defense share benefits fission
Waste Treatment, Storage, and Disposal	288.9	135.2					135.2																	Non-defense share benefits fission
Allocated first to non-defense shares																								
Waste Mgmt. - Cap. Equipment	51.0	23.9					23.9																	Non-defense share benefits fission
Hanford Waste Vitrification Proj	8.8	4.3					4.3																	Non-defense share benefits fission
Waste Mgmt. - Construction	202.7	94.9					94.9																	Non-defense share benefits fission
Technology Development	51.8	24.2					24.2																	Non-defense share benefits fission
Tech. Devel. - Cap. Equipment	0.8	0.4					0.4																	Non-defense share benefits fission
Program Direction	5.5	2.6					2.6																	Non-defense share benefits fission
Totals	1,301.9	680.1	9.5	2.4	0.9	1.2	639.2	0.0	0.3	0.0	0.1	6.1	1.7	0.3	1.6	0.6	4.3	0.4	11.1	0.0	0.0	0.0	0.1	
GENERAL SCIENCE AND RESEARCH																								
High Energy Physics																								
Operating Expenses	430.9																							??
Construction and Capital Expenses	118.8																							??
Superconducting Super Collider																								
Operating Expenses	82.1	16.4															16.4							Guess: 20% to efficiency (elec. supply)
Construction and Capital Expenses	16.0	3.2															3.2							Guess: 20% to efficiency (elec. supply)
Nuclear Physics																								
Capital Ex. and Construction	71.0	14.2					10.7												3.6					Guess: 15% fission, 5% fusion
Continuous Electron Beam Accelerator																								
Relativistic Heavy Ion Collider																								
Other Construction projects and modifications																								
Operating Expenses	186.9	37.4					28.0												9.3					Guess: 15% fission, 5% fusion
General Science Program Direction	2.6	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	Shares of General Science section
Totals		71.4	0.0	0.0	0.0	0.0	38.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.7	0.0	12.9	0.0	0.0	0.0	0.0	
FOSSIL ENERGY R&D																								
Coal R&D																								
Control Technology & Coal Preparation		48.9	48.9																					Coal

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric General	Electric Fission	Electric Oil	Electric Coal	Electric Gas	Electric Hydro	End-Use Effic.	Electric Biomass	Wind	Solar	Geotherm.	Supply Effic.	Other Renew.	Fusion	Biomass-Non-Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
Advanced Research and Tech. Dev.		25.6	25.6																					Coal
Coal Liquefaction		32.4	32.4														0.0							Coal or synfuels
Combustion Systems		26.7	13.4									0.0					13.4							Coal and effic. (coal)
Fuel Cells		26.5	26.5																					Coal
Heat Engines		22.3	22.3																					Coal
Underground Coal Gasification		1.4	1.4														0.0							Coal or synfuels
Magnetohydrodynamics		37.0	37.0																					Coal
Surface Coal Gasification		21.6	10.8									0.0					10.8							Coal and effic. (coal)
Gas R&D																								
Unconventional Recovery		11.4			11.4																			Gas
Petroleum R&D																								
Advance Extraction & Process Tech		4.2		4.2																				Petroleum
Enhanced Oil Recovery		23.6		23.6																				Petroleum
Oil Shale		10.5		10.5																				Petroleum
Sub-Total		292.1	218.3	38.3	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	0.0	0.0	0.0	0.0	0.0	0.0	
Program Direction and Management Support																								
HQ Prog. Direction		13.5	10.1	1.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0					Shares of Fossil R&D
Energy Tech. Centers Prog. Dir.		50.8	38.0	6.7	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0					Shares of Fossil R&D
Alaska Gas Pipeline Inspector		0.2			0.2																			Gas
Plant and Capital Equipment		21.8	16.3	2.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0					Shares of Fossil R&D
Cooperative R&D		0.0																						Shares of Fossil R&D
Fossil Energy - Environmental Restoration																								
Western Superfund Site		0.0																						Coal
Rock Springs Site		0.5		0.5													0.0							Oil Shale
Rocky Mt. Underground Coal Gas. Site		0.0																						Coal Gasification, 1.9m in '92
Other Actions		0.0																						0.5 in '91
Fuels Programs		2.7	2.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0					Shares of Fossil R&D
Clean Coal Program																								
Operating Expenses	187.8	0.0																						Assessed separately; See CLCOAL.WK1
Totals		381.6	284.6	50.4	15.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.5	0.0	0.0	0.0	0.0	0.0	0.0	
CONSERVATION																								
Buildings Sector	35.6																							
Solar space cond & water heating		0.0																						Solar
Federal Energy Mgmt. Prog.	1.0	0.0																						In direct intervention section
All Other		34.6										34.6												Efficiency
Industrial Sector	30.3																							
Municipal Solid Wastes		0.0											0.0									0.0		Biomass (waste-to-energy), begins FY90
Cogeneration		4.6										4.6					0.0							Efficiency (cogeneration)
All Other		25.7										25.7												Efficiency
Transportation Sector	54.3																							
Alternative Fuels Utilization		2.1	0.5		0.5	0.5							0.0				0.0				0.5			Guess: Synfuels (coal), gas, alcohol, electricity
Electric and Hybrid Propulsion Development		13.8	0.0	0.0	0.0	0.0	2.6	0.8	7.7	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					1989 Electricity Mix
Other		38.4										38.4												Efficiency

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric. General	Electric. Fission	Electric. Oil	Electric. Coal	Electric. Gas	Electric. Hydro	End-Use Effic.	Electric Biomass	Wind	Solar	Geotherm.	Supply Effic.	Other Renew.	Fusion	Biomass-Non-Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
Multi-Sector Conservation Activities		32.3										32.3												Conservation/Efficiency
Utility Sector		0.0										0.0												Conservation/efficiency
Facilities		13.0										6.5					6.5							Effic. (Materials science, sys. modeling)
Tech. and Fin. Asst. to States/Locals		211.0										52.8	29.6	10.1	46.7	19.1	52.8	0.0						1/2 renew (commercialized tech. only);
Sub-Total		375.5	0.5	0.0	0.5	0.5	2.6	0.8	7.7	1.3	1.3	194.9	29.6	10.1	46.7	19.1	59.3	0.0	0.0	0.0	0.5	0.0	0.0	1/4 end-use effic; 1/4 supply effic.
Policy and Management		1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.1	0.0	0.2	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	Above mix
Totals		377.3	0.5	0.0	0.5	0.5	2.6	0.8	7.7	1.3	1.3	195.8	29.8	10.1	47.0	19.2	59.5	0.0	0.0	0.0	0.5	0.0	0.0	
EMEGENCY PREPAREDNESS		6.2		2.1	2.1	2.1																		Oil, gas, electricity
ECONOMIC REGULATION		15.8		15.8																				Oil
GEOTHERMAL RES. DEV. FUND		0.1														0.1								Geothermal
ALTERNATIVE FUELS PRODUCTION		30.8	30.8														0.0							Synfuels (coal gas)
Totals		52.9	30.8	17.9	2.1	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
DOE GENERAL SPENDING - TOTALS		2,756.1	385.4	120.8	49.3	47.7	976.3	3.2	36.3	4.9	5.6	240.1	70.3	23.7	103.9	45.4	166.2	23.9	413.6	5.9	0.6	0.0	32.5	
Total Spending Before Allocations		2,320.6	341.4	86.8	31.8	43.9	880.8	1.0	10.9	1.5	2.5	217.0	60.9	10.1	58.2	22.2	152.6	14.9	379.1	0.0	0.5	0.0	4.6	
Percent Shares	0.0%	100.0%	14.7%	3.7%	1.4%	1.9%	38.0%	0.0%	0.5%	0.1%	0.1%	9.4%	2.6%	0.4%	2.5%	1.0%	6.6%	0.6%	16.3%	0.0%	0.0%	0.0%	0.2%	
ATOMIC ENERGY DEFENSE ACTIVITIES BENEFITTING THE COMMERCIAL SECTOR																								
Materials Production	1,942.7																							Small fraction (5%) to fission
Processing	477.6	23.9					23.9																	Small fraction (5%) to fission
Enriched Material	70.6	3.5					3.5																	Small fraction (5%) to fission
Technology Development	154.6	7.7					7.7																	Small fraction (5%) to fission
Waste Transport and Site Mgmt.	24.0	1.2					1.2																	Small fraction (5%) to fission
Totals		36.3	0.0	0.0	0.0	0.0	36.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOTAL DOE SPENDING, EXCEPT SIDE AGENCIES																								
		2,792.5	385.4	120.8	49.3	47.7	1,012.6	3.2	36.3	4.9	5.6	240.1	70.3	23.7	103.9	45.4	166.2	23.9	413.6	5.9	0.6	0.0	32.5	
Overall Percentage Shares			13.8%	4.3%	1.8%	1.7%	36.3%	0.1%	1.3%	0.2%	0.2%	8.6%	2.5%	0.8%	3.7%	1.6%	6.0%	0.9%	14.8%	0.2%	0.0%	0.0%	1.2%	

DEPARTMENT OF ENERGY: GENERAL SPENDING (FY 1989)

Program	Total Program	Total Energy	Coal	Oil	Gas	Electric General	Electric Fission	Electric Oil	Electric Coal	Electric Gas	Electric Hydro	End-Use Effic	Electric Biomass	Wind	Solar	Geotherm.	Supply Effic.	Other Renew.	Fusion	Biomass-Non-Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid	Allocation Basis
Allocation Bases Reference Tables Used In DOE Budget Assessment																								
Electricity Mix (From ALLOCATION.WK1)						0.00%	19.00%	5.68%	55.82%	9.59%	9.52%	0.00%	0.04%	0.00%	0.00%	0.34%	0.00%	0.00%		0.0	0.0	0.03%		Based on EIA Annual Energy Rev., Monthly Powerplant Rept.

Commercial Share of Uranium Use

Commercial	46.80%	Administrative decision regarding D&D for enrichment services. See Part 3, Uranium Enrichment Enterprise spreadsheets.
Military	53.20%	

Utility Shares of LLRW - by volume, since volume, not radioactivity is likely to be the cost driver for LLRW.

Utility	44.0%	(Duane Chapman, "Decommissioning and Nuclear Waste Policy: Comprehensive or Separable?" The Energy Journal, V. 12, 1991, p. 250)
Other	56.0%	

Utility Shares of HLRW	Vol	Radioactivity	Ave
Utility	2.5%	94.6%	48.5%
Defense and Other	97.5%	5.4%	51.5%

Shares of DOE Research, before Allocations by R&D Mix	Total Program	Total Energy	Coal	Oil	Gas	Electric General	Electric Fission	Electric Oil	Electric Coal	Electric Gas	Electric Hydro	End-Use Effic	Biomass	Wind	Solar	Geotherm	Supply Effic	Other Renew	Fusion	Biomass-Non Grid	Ethanol	Waste-to-Energy	Solar-Non-Grid
Amount		1,935.3	285.9	87.4	42.0	42.8	367.0	3.0	34.6	4.7	4.4	226.3	66.6	22.6	105.1	42.9	152.2	21.9	392.5	5.9	0.5	0.0	27.0
Percent		1,935.3	14.77%	4.52%	2.17%	2.21%	18.97%	0.16%	1.79%	0.24%	0.22%	11.69%	3.44%	1.17%	5.43%	2.22%	7.86%	1.13%	20.28%	0.31%	0.03%	0.00%	1.39%

Fission/Fusion Mix of Overall Spending (Pre-Overhead)	Electric Fission	Fusion
Amount	880.8	379.1
Percent	69.91%	30.09%

	Total Energy	Coal	Oil	Gas	Electric Oil	Electric Coal	Electric Gas
Contribution to Global Climate Change	54.36%	5.33%	18.76%	10.35%	2.14%	16.15%	1.63%

Source: Holdren. See Externality.WK1 for detail on derivation

Distribution of Spending Between Waste Management and R&D and R&D Support Activities

DOE R&D Activities

Item	Amount High	Amount Low
Renewables & Solar R&D	143.4	143.4
Nuclear Fission R&D	140.1	140.1
Liq. Gaseous Fuels Test. Facil.	1.1	1.1
Biolog. & Envir. Research	129.0	129.0
Nuclear Fusion R&D	344.7	344.7
Basic Energy Sciences	280.4	280.4
User Facilities	55.8	55.8
Energy Research Analyses	3.8	3.8
Research Lab Construction	11.5	11.5
General Science & Research	71.4	71.4
Fossil R&D Other Than Clean Coal	351.6	381.6
Clean Coal Program [from CLCOAL.WK1]	190.0	40.0
Conservation Efficiency R&D	377.3	377.3
Waste Related R&D	68.9	68.9
Total	2,199.0	2,049.0
Less Items Deemed Unrelated to R&D within above categories	(73.7)	(73.7)
Net R&D spending	2,125.3	1,975.3

DOE Waste Management and Environmental Restoration Activities

Item	Amount
Envir. Restor. & Waste Mgmt.	680.1
Less Items Deemed to Be R&D:	
West Valley Demonstration Project	(32.3)
Hanford Waste Vitrif. Project	(4.3)
Technology Devel, Capital and Op. Costs	(24.6)
Other Waste Management Spending	1.2
Total Waste Management/Envir. Restoration	620.1

DOE Spending in Neither Category	High	Low
	237.0	237.0

DOE: CLEAN COAL PROGRAM

The Clean Coal Program is a joint federal-private research and development effort to commercialize advanced coal combustion technologies. The research supported by this program is geared to finding ways to reduce pollutant emissions from coal burning more cheaply and, in some cases, to increase the efficiency of coal combustion systems. The program has its roots in the Energy Security Fund, a $750 million fund set aside by Congress in 1984 to establish the Clean Coal Technology Program. Funding is phased in five rounds. In 1987, the program was dramatically expanded to an overall commitment level of $5 billion, of which half would come from the federal government and half from industry. Funding was to be spread over 5 years, through 1992 (see worksheet, Part 3). The program was expanded, in part, due to Canadian concerns over U.S. "exports" of acidic deposition. (GAO/RCED-90-165, 9).

The government built a number of controls into the programs to improve the chance of successful R&D efforts. These included a minimum of 50% private funding, DOE approval of each project and financing plan, and repayment of government investment within 20 years of successful commercialization. Repayment will not occur until about 2015, does not have interest attached to the investment, and is required only if commercialization is successful. As a result, the expected value of this provision is quite limited (see CLCOAL.WK1).[29] Despite the small real value of recoupment provisions, these provisions have been a bottle-neck in the approval of a number of clean coal projects. (GAO/RCED-89-80, 15).

Total federal support for Clean Coal programs in 1989 were estimated in two ways. The high estimate assumes that appropriated funds will, in fact, be disbursed, and ignores timing delays of 1-2 years from contracting problems. Over a 30-year project time frame, this assumption will not introduce significant errors, although the estimate for 1989 is higher than the actual cash paid out. The low estimate counts cash paid out only. Since funding has been delayed rather than canceled, the low estimate is a worse estimate of annualized commitment, since cash disbursements will jump in the coming few years.

Spending has been allocated to two energy types: coal-electric and supply efficiency (from improved efficiency of coal combustion). For Round 1, approved projects and funding amounts were both available. Round 2 projects were available, but funding levels were not. We assume that all Round 2 projects are funded at the same dollar amount for allocation purposes. Rounds 3-5 were not available, and we assume they follow the same weighted average pattern of coal versus efficiency as Rounds 1 and 2. We guessed at the primary beneficiary of the fuels from DOE and GAO data. Fuel flexibility enabled conversion of oil utilities to coal, and therefore benefit coal-electric, not oil-electric. Retrofit technologies, which reduce emissions at existing power plants, include precombustion coal cleaning, limestone injection multistage burners, sorbent injection, gas reburning, advanced slagging combustors, and advanced scrubbers, are all allocated to coal-electric. Fluidized bed combustion and surface coal gasification both increase efficiency and reduce emissions. Spending on these technologies is split equally between coal-electric and supply efficiency. Underground coal gasification is primarily for harvesting "unminable" coal seams rather than creating a clean input for combined-cycle systems (as is the case with other coal gasification technologies), and is therefore allocated all to coal. (DOE).

Due to the uncertainties associated with estimating the expected revenues returned to the federal government from successful commercialization of clean coal technologies, we did not deduct the expected present value of these revenue streams from the current cost of the program. However, our estimates

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[29] DOE requirements that funding for all phases of a project be in place prior to approval also slowed project commencement. This is not surprising since such a requirement eliminates the option to abandon a risky project for the private funders of corporate clean coal project partner, a critical option in venture capital. DOE has since changed this provision to allow successive rounds of financing. (GAO/RCED-89-90, 19).

suggest that about 15% of the present value of current investment is likely to be returned to the government. This amount is dramatically smaller that the expected benefit of the R&D to industry. The Electric Power Research Institute claims that the new technologies will generate $50 billion to $80 billion in annual exports accruing to the entire industry. (Weekly Bulletin, B4).

Sources

"Clean Air: Effect on Coal, Economy," Weekly Bulletin. (Washington, DC: Energy and Environmental Study Conference), March 26, 1990, p. B4.

U.S. Department of Energy. Clean Coal Technology: The New Coal Era. November 1989. DOE/FE-0149.

U.S. General Accounting Office. Fossil Fuels: Commercializing Clean Coal Technologies, March 1989. GAO/RCED-89-80.

U.S. General Accounting Office. Fossil Fuels: Outlook for Utilities' Potential Use of Clean Coal Technologies, May 1990. GAO/RCED-90-165.

U.S. General Accounting Office. Fossil Fuels: Status of DOE-Funded Clean Coal Technology Projects as of March 15, 1989, June 1989. GAO/RCED-89-166FS.

DOE: Clean Coal Program

Part 1: Beneficiary Energy Source for Round 1 and Round 2 Approved Projects

Round 1 Projects	DOE Share ($Millions)	Sponsor Share	Project Purpose	Beneficiary Fuel
Advanced cyclone combuster	0.4	0.4	Emissions Reduction	Coal-electric
Pressurized fluidized-bed combustor	60.2	107.3	Emissions/efficiency	Coal-elect. and supply efficiency (coal)
Limestone injection multistage burner	7.6	11.8	Emissions Reduction	Coal-Electric
Gas reburning and sorbent injection	15	15	Emissions Reduction	Coal-Electric
Prototype commercial coal/ oil co-processing plant	45	180.7	Emissions/Flexibility	Coal-elect. and petroleum
Underground coal gasification	11.8	58.3	Harvesting "unmin-able" coal seams	Coal-electric
Advanced coal gasification combined cycle power gen. plant	87.5	156.3	Emissions/efficiency	Coal-electric and supply efficiency (coal)
Pyropower circulating fluidized bed combustor	19.9	34.2	Emissions/efficiency	Coal-electric and supply efficiency (coal)
Advanced slagging combustor	23.5	25.5	Emissions/ Fuel Flexibility	Coal-electric
Total	270.9	589.5		

Source: GAO/RCED-89-90, p. 36

Round 2 Projects	DOE Share	Sponsor Share	Project Purpose	Beneficiary Fuel
Estimated Total Funding	537	830	GAO/RCED-89-90, 38	
Pressurized fludized-bed combustor			Emissions/efficiency	Coal and supply efficiency (coal)
Coal gasification combined cycle			Emissions/efficiency	Coal and supply efficiency (coal)
Circulating fluidized-bed combustor			Emissions reduction	Coal
Post-combustion dry sorbent injection tech.			Emissions reduction	Coal
Flue-gas desulfurization			Emissions reduction	Coal
Catalytic flue gas removal of SO2 and NOx			Emissions reduction	Coal
Coke oven gas desulfurization			Emissions reduction	Coal
Advanced tangentially-fired techniques to reduce NOx			Emissions reduction	Coal
Low NOx/SO2 burner retrofit for utility cyclone boilers			Emissions reduction	Coal
Advanced wall-fired combustion techniques to reduce NOx			Emissions reduction	Coal
Sorbent injection, selective catalytic reduction			Emissions reduction	Coal
Scrubbing system for SO2			Emissions reduction	Coal
Selective catalytic reduction for NOx			Emissions reduction	Coal
Obsca fuel coal-water slurry			Fuel transport	Coal

Part 2: Funding Allocation to Fuel Types

Round 1	Total Amount	Coal	Supply Effic.	
Coal-electric	56.3	56.3		
Coal-elec. and Efficiency Mix	212.6	106.3	106.3	Split equally between coal and supply effic
Total	270.9	164.6	106.3	
Percent of Total	100.00%	60.76%	39.24%	

Round 2	Total Amount	Coal	Supply Effic.
Total DOE Funding	537.0	498.6	38.4
Number of Projects	14		
# Projects Coal only	12		
# Projects Coal + Coal effic.	2		
Pct. of Proj. to Coal	92.86%		
Pct. to Coal Effic	7.14%		

Weighted Average Mix For Rounds 1 and 2:	Amount	Percent
Total Funding	807.9	100.00%
Coal-Electric	663.2	82.09%
Coal Supply Efficiency	144.7	17.91%

Assume mix remains at the weighted average for rounds 3, 4, and 5.

Part 3: Program Funding Appropriations

High Estimate: Assumes Full Appropriation Spent, and Minimal

NPV of Future Federal Recoveries through Commercialization Rights

Appropriations	1986	1987	1988	1989	1990	1991	1992	Total	Fuel Mix Coal-Elec.	Fuel Mix Coal Effic.
Round 1 Projects	100	150	150					400	60.8%	39.2%
Round 2 Projects			50	190	135	200		575	92.9%	7.1%
Round 3 Projects					450	125		575	82.1%	17.9%
Round 4 Projects						600		600	82.1%	17.9%
Round 5 Projects							600	600	82.1%	17.9%
Total	100	150	200	190	585	925	600	2,750		
Coal-Elec. Portion	60.8	91.1	137.6	176.4	494.8	780.9	492.6			
Coal-Efficiency	39.2	58.9	62.4	13.6	90.2	144.1	107.4			

Source: DOE, p. 7

Low Estimate

Actual Outlays in FY89 — 40.9 — OMB, FY91, A-975

Reflects delays in project start-up and contractual agreements.

Assuming Delays Impact both Round 1 and Round 2 projects, allocation reflects average mix:

Coal-Electric Portion	33.6
Coal-Efficiency	7.3

Part 4: Estimating Value of Recoupment Provisions For Federal Investment

Conditions: Recoup DOE investment within 20 years after commercialization of project technology. (GAO/RCED-89-90, 15).
From operating revenues, licensing fees, or royalties on technology.

GAO Estimates:

Commercial Availability	5-10 years
Significant market penetration	15 years
GAO/RCED-90-165, 24	

Assumptions:	Low Est.	High Est.	
1. Payback to Government	20 years after commercialization for both; investor will delay repayment as long as possible.		
2. Projects Successful in Being Commercialized	100.00%	50.00%	
3. Time until commercial availability	5	10	(Years)

(90% of new businesses fail by their 10th year; about 40% of venture capital investments lose money. Though large firms fail at a lower rate (Timmons, 11,12) R&D failure rates on a project-by-project basis are likely to be higher than the firm failure rate.

Calculations.

	Low	High	
Years until recoupment (Line 3 plus 20 yr. payback period)	25	30	DOE, p. 36
Ave. 30 yr. T-bond rate, '86-'91		8.42%	RATES2.WK1

Federal Investment Year	Amount Invested	Present Value of Expected Repayment Low Est (1)	High Est (1)
1986	100	13.2	4.4
1987	150	19.9	6.6
1988	200	26.5	8.8
1989	190	25.2	8.4
1990	585	77.5	25.9
1991	925	122.5	40.9
1992	600	79.5	26.5
Total	2,750	364	122

(1) PV calculated assuming principal to be repaid is reduced by 50% in the high estimate due to unsuccessful projects, and that this repayment comes after 30 years (versus full principal in 25 years for the low est.)

Part 5: Fed. Support as a Percent of Utility Emissions Reduction Spending

Total Federal Support	2,750.0	
Years of funding	7.0	
Average support/year	392.9	
Average air quality compliance costs for coal utilities	8,000.0	DOE, Clean Coal, 31
Clean Coal Funding/compliance costs	4.91%	
Days of emissions compliance equiv.	18 **	
Estimated annual export value of clean coal technologies once commercialized (Electric Power Research Institute, in Weekly Bulletin, B4).	$50-80 billion	

**Parts 4 and 5 demonstrate the irrationality of utility resistance to federal R&D recoupment provisions.

Part 6: Summary - Clean Coal Program Funding, FY89

	Low Est.	High Est.
Coal	33.6	176.4
Coal Efficiency	7.3	13.6
Present Value of Recoupment Provisions	25.2	8.4

Due to the tremendous uncertainties of predicting project success and the difficulty DOE is having negotiating recoupment agreements, the present value of recoupments are not deducted from current funding.

Sources:

"Clean Air: Effect on Coal, Economy," Weekly Bulletin, March 26, 1990, B4.

Timmons, Jeffry. "New Venture Creation: Entrepreneurship in the 1990s," 3rd Ed. (Boston, MA: Irwin, 1990).

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U.S. GAO. "Fossil Fuels: Status of DOE-Funded Clean Coal Technology Projects as of March 15, 1989," June 1989. GAO/RCED-89-166FS

U.S. OMB. "Budget of the U.S. Government, FY 1991."

DEPARTMENT OF ENERGY: NAVAL PETROLEUM AND OIL SHALE RESERVES

Background

Like the Strategic Petroleum Reserves, the Naval Petroleum Reserves were created to protect national interests from oil supply disruptions. Naval Petroleum Reserves 1 and 3 were established in 1912 and 1915 through executive order of the President. Their purpose was to ensure a source of petroleum for the Navy. With a few periods of intermittent production, the oil reserves were held by the government almost untapped until 1976. NPR-2 has been actively exploited via lease agreements with the private sector since the 1920s. (GAO/RCED-88-151, 8).

The Naval Petroleum Reserves Production Act of 1976, enacted following the Arab oil embargo, initiated extraction in NPR-1 and 2 by authorizing 6 years of oil removal at the "maximum efficient rate." This level of pumping removes the maximum amount of crude without destroying well pressure. At the end of the 6 year period, the President could extend production levels for 3 years at a time. Production was, in fact, extended each three years through at least 1991. (GAO/RCED-88-151, 9).

NPR 1 is 78% owned by the federal government and 22% owned by Chevron. It is the eighth largest domestic producing field. NPR-1 produces oil, natural gas, and natural gas liquids. NPR 2 is already actively leased. NPR-3 is wholly federally owned but is significantly smaller with estimated reserves of 5 million barrels. (GAO/RCED-88-151, 9).

In addition to petroleum reserves, the government maintains a series of oil shale reserves. Although efforts were made to develop these reserves in the early 1980s, there are presently no plans to develop the oil shale reserves further, although there has been some gas development on NOSR-1 and 3. This development was initiated to protect fields from drainage from wells outside the oil shale reserve's boundary, but tapping the same gas deposit. ('90 Annual Report, 37-39).

In addition, approximately $18 million has been expended since 1978 to study and run the oil shale program, and some environmental monitoring is in place due to environmental impacts of past development. ('89 Annual Report, 35). Of the three oil shale reserves, only one seems to be viable economically. Naval Oil Shale Reserve 3 has no commercial oil shale, but provides needed access in order to exploit NOSR-1. NOSR-2 has approximately 4 billion barrels of oil shale in place, but reserves are not concentrated enough given current technology. ('89 Annual Report, 32). A large increase in funding for FY 1991 will be used for maintenance of on-line gas wells and for asbestos clean-up.

Financial Aspects

The petroleum reserves are a net cash generator for the U.S. Treasury. Although we were unable to get data on government capital investments to develop the reserves for DOE (Bradley, 8/27/91), these costs are unlikely to be significant since they were developed so long ago. We treat the oil reserves as government open-market operations. Sales of the oil do cover costs, so the enterprise is clearly not being subsidized on a cost of operations basis. However, the excess revenue is not a tax either, simply a return on a market activity.

There is some evidence that even though the government is earning a return on the NPRs, it is producing oil above least cost and selling it below market prices, activities we do consider subsidies. First, the extraction rate is based purely on the physical production capacity without regard to economics. Second, DOE has a small refiner preference with a goal of awarding at least 25% of the oil from NPR-1 to small refiners, suggesting that oil is not sold to the highest bidder. ('89 Annual Report, 1). In actuality, 53% of the oil produced between November 1981 and March 1987 went to small, independent refiners. (GAO/RCED-88-151, 10). Third, between July 1981 and January 1986, all crude from NPR-3 was sold to DOD rather than on the open market. (GAO/RCED-88-151, 10). Finally, NPR-1 oil could not be exported without special Presidential permission. (GAO/RCED-88-151, 25).

All of these factors together suggest that the reserves, though not directly subsidized themselves, subsidize their customers through below-market pricing. An analysis by Shearson Lehman Brothers in 1987-88 to evaluate the possible privatization of NPR-1 found that selling the reserve would have a net present value benefit of $500 million over keeping the reserves under government ownership. (GAO/RCED-88-151). This estimate incorporates tax revenues on private ownership that the government does not now get as owner as well as operational changes. The high estimate, therefore, implicitly includes NOSR's current tax-exempt status and lack of a required rate of return.

The estimate was based on computer modeling of the market and future production levels,[30] and is therefore sensitive to capital market conditions at the time, discount rates used, and expectations about future oil prices. However, the issue of oil pricing is somewhat mitigated by the fact that lower prices for oil will reduce the government revenues from ownership as well as the purchase price offered, and the net present value of private versus public ownership could remain fairly stable.

Our low estimate of subsidies for the Reserves assume that the government is exploiting the reserves in the same manner as a private owner would, and that sales are not being subsidized. The high estimate converts the Shearson estimate of a $500 million net present value gain into an annualized return, using Shearson's original nominal discount rate of 12 percent and the expected life of the oil reserves. (GAO/RCED-88-151, 21).

<u>Sources</u>

Bradley, Barbara. Naval Petroleum Reserves Program, personal communication, 8/27/91.

United States Department of Energy, Office of Petroleum Reserves. <u>Naval Petroleum & Oil Shale Reserves 1989 Annual Report of Operations</u>. DOE/FE-0170P.

United States Department of Energy, Office of Petroleum Reserves. <u>Naval Petroleum & Oil Shale Reserves 1990 Annual Report of Operations</u>. DOE/FE-0222P.

U.S. General Accounting Office. <u>Naval Petroleum Reserve No. 1: Examination of DOE's Report on Divestiture</u>, August 1988. GAO/RCED-88-151.

[30] Which would likely be <u>lower</u> under private ownership. (GAO/RCED88-151, 24).

DOE: Naval Petroleum and Oil Shale Reserves

Part 1: Estimated Below Market Value of Government Ownership of the NPR-1

	Low Est.	High Est.	
Net Present Value of Under-realization	0.0	521	GAO, p. 16, scaled to 1989$

Part 2: Calculation of Number of Years of Production Remaining at NPR-1

Est. Government Ownership of Future Production (MM bbls crude oil)	265.0	324.0	Federal share of remaining reserves at NPR-1: GAO/RCED-88-151, 18

Annual Crude Oil Production Rate at NPR-1

Year	Mil. Bbl.	Year	Mil. Bbl.
1977	37.0	1983	57.4
1978	43.5	1984	50.5
1979	52.6	1985	47.7
1980	58.3	1986	42.2
1981	62.6	1987	39.8
1982	60.7	1988	39.3

Average Production Rate, 1977-88 49.3 Note 1

Source: 1989 Annual Report of Operations, p. A-1. Includes data through year of valuation only to make estimate internally consistent.

		Years of Reserves Remaining at the Ave. Production Rate Shown Here	
Government Ownership of NPR-1	78.0%		GAO, p. 9
Chevron Ownership of NPR-1	22.0%		
Average Government-Owned Barrels of Crude Produced Per Year			
Annual Ave. Gov't-Owned Crude Production	38.5	6.9	Note 2
Assuming Slower Private Mkt. Harvest	27.0	9.8	This is an illustration only

Notes to Part 2:

(1) Production through 1988 was used since the valuation estimate is from that year.

(2) Since the government owns 78% of NPR-1, 78% of the average historical production rate of 49.3 mil. bbls/year is allocated to the government. This average production rate will exhaust the NPR-1 oil reserves in just under 7 years, given the lower bound estimated size of reserves shown in the beginning of Part 2.

Part 3: Calculation of Annual Benefit to Government by Selling the Reserves

Treating the net present value as the present value of a future annuity, paid for as many years as there are reserves, yields the following results:

	Prod. Rate	Years of Production	Discount Rate (1)	Present Value of Annuity	Annuity Value	
Annuity at Average Production Rate	38.5	6.9	12%	521	140.4	
Annuity at Slower Production Rate	27.0	9.8	12%	521	107.2	Note 2

Notes:

(1) A 12% discount rate was used by Shearson Lehman to calculate the net present value of privatization, and is therefore used here.

(2) The slower production level reflects integration of economic factors into production decisions more than is currently done.

Part 4: Allocation of Subsidy to Fuels

NPR-1 Product Revenues, 1985-89 ($Millions)

	1985	1986	1987	1988	1989	Average	% of Tot. Revenues
Crude Oil	957.2	524.2	498.1	453.4	441.9	575.0	74.03%
Natural Gas and NGLs	286.9	189.0	125.8	138.3	147.3	177.5	22.85%
Other	20.2	24.6	21.1	31.2	24.3	24.3	3.13%
Total	1,264.3	737.8	645.0	622.9	613.5	776.7	100.00%

	Low Est.	High Est.
Below-Market Operations of NPR-1	0.0	140.4
Crude Oil	0.0	103.9
Natural Gas and NGLs	0.0	32.1
Other*	0.0	4.4

* "Other" is ignored since there is no information on what it is.

Sources:

(1) U.S. DOE, Naval Petroleum & Oil Shale Reserves. "Fiscal Year 1990 Annual Report of Operations."

(2) U.S. GAO. "Naval Petroleum Reserve No. 1: Examination of DOE's Report on Divestiture," August 1988. GAO/RCED-88-151.

DEPARTMENT OF ENERGY: STRATEGIC PETROLEUM RESERVES

The Strategic Petroleum Reserve was built to protect the United States from oil supply shocks. Currently, SPR has a 750 million barrel capacity. Although there has been some consideration of creating reserves of finished products, SPR stores only crude oil. Inventories are stored in underground salt caverns at six sites located in the Gulf Coast area and connected to major private sector distribution systems. Most site construction has been completed. Current expenditures go towards increasing the distribution capability, site modifications, and filling the facilities with oil. We count oil purchase and transport costs as inventory that will eventually be recovered through sales. Only inventory holding costs and capital and operating expenses are counted as a subsidy.

It has been argued that SPR is not an energy subsidy, since its stock of oil is a matter of national security. While SPR does support national security, it also greatly benefits the civilians who rely on oil by dampening price shocks, and by substituting in part for other, private, oil inventories held by large consumers or processors of crude. SPR is a direct result of our reliance on oil, and widespread fuel diversification would make it far less necessary.

All federal support for SPR benefits oil.

Petroleum Acquisition and Transport. Involves the purchase of crude oil on the open market and transporting it to storage sites. These costs are aggregated into the carrying cost of inventory on which we impute interest. The actual inventory cost (the aggregate value of historic oil purchases and transport costs) is not counted as a subsidy, since the plan is to sell the oil at some point in the future.

The imputed interest charge used is a 1-year Treasury bill rate in the low estimate, and the prime rate in the high estimate. We chose a short-term rate to reflect the freedom in decision making that the government has with regard to selling or holding the marketable oil inventory -- a situation very different from long-term fixed investments into capital stock. The value calculated here is conservative, since using longer-term interest rates would yield a larger subsidy, and since the weighted average cost of capital for many of the private entities likely to benefit most from the SPR buffer stocks of oil contains equity, and would be higher than the prime rate.

One GAO report (GAO/RCED-89-103) assumes that SPR could be financed at 3%, substantially lower than the rates shown here. This rate assumes that the federal government gives up equity in the oil by sharing the price gains by selling the oil during supply shortages and price shocks. We do not use the GAO figure for a number of reasons. First, it requires giving up equity in the enterprise - something that could be done for virtually any government-owned enterprise in return for cheaper borrowing. Second, while the cost of debt may decrease through such an arrangement, the actual weighted average cost of capital for the enterprise, which includes valuing the equity given up, would likely be higher than straight federal debt.

Storage Facilities Development and Operation. Constructing and operating the storage facilities. Only construction costs are capital expenditures. Data breaking out development and operations were requested a number of times from the SPR program office, but were never received. This data should be obtained to refine future estimates. In the interim, both categories of costs are capitalized, since over the life of the facility, most of these costs are associated with facility construction. Breaking out operating expenses would increase current year estimates slightly since most long-term capital construction had been completed by 1989.

Capital is assumed to enter productive service after 1 year of construction. Interest on construction during this first year has been capitalized. At the point it enters service, an annual capital charge is calculated assuming that the funds invested in infrastructure generate interest costs for SPR at the rates discussed below, and that the capital is depreciated over a 30-year period

The imputed interest on invested capital uses the 30-year Treasury bond rate in the low estimate to reflect the long capital life of the enterprise. The high estimate uses the long term rate for power and gas utility bonds as a proxy for the private market cost of funds. As described in the worksheet notes, the high estimate is likely to be conservative.

Management of SPR Program. Management costs associated with procurement and logistics. Expenses associated with running the facilities are included above under operations.

Offsetting Gains from Fuel Sales. Any sales of petroleum from the reserve offset operating costs. To date, there have been none.

Shipping at Above Market Rates. SPR oil shipments are required to use U.S. vessels which are often more expensive than the market rates. The negative subsidy associated with this requirement is netted from our subsidy estimates in the Maritime Administration section of the report.

Rate of Return and Tax Exemption. Oil consumers gain an additional benefit from the fact that SPR is both tax-exempt and does not require a rate of return. These two factors make its cost of providing a buffer to oil shocks much cheaper than it would otherwise be, and therefore dampen the market incentives to diversify away from oil still further.

Many have argued that SPR will actually make money for the government, since it will release oil for sale during price shocks, at which time the market price will far exceed the original purchase price of the oil. This is unlikely for a number of reasons. First, the purpose of releasing the oil for sale is to reduce price shocks, diminishing the price gains on the government sales. Second, even if the sale price is higher, price gains must be enormous to earn a positive return on funds tied up in SPR capital and inventory for so many years. For example, oil purchased for the inventory at the end of 1977 at $10 per barrel must be saleable for almost $46 per barrel in 1993 to earn a nominal 10 percent average rate of return on SPR during the period.

Sources:

U.S. DOE. FY 1992 Congressional Budget Request, V. 4, p. 249.

U.S. DOE. Strategic Petroleum Reserve Annual/Quarterly Report, Feb. 15, 1990.

U.S. GAO. Strategic Petroleum Reserves: Analysis of Alternative Financing Methods, March 1989. GAO/RCED-89-103.

DEPARTMENT OF ENERGY: STRATEGIC PETROLEUM RESERVE

(Dollars in Millions)

Year	Constants	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
NEW INVESTED CAPITAL															
Storage Facility Development & Ops		160	151.9	134	107	441.3	142.4	222.5	175.7	108.2	0	632.5	463 9	0	300
COST OF CAPITAL (1)															
Weighted Ave. Cost of New Capital		0.00%	0.00%	0.00%	0 00%	0.00%	0.00%	0.00%	0.00%	0.00%	0 00%	0 00%	0.00%	0.00%	0.00%
Annual Interest Charge		0.00%	0 00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0 00%	0.00%	0 00%
Low Est. - Gov't Cost of Capital															
Gov't Cost of Borrowing (30 yr T-bond)		8 45%	8.96%	8.59%	7.78%	10.79%	12.41%	11 18%	12.76%	13 45%	11 27%	9.28%	8.49%	7.75%	7 61%
Interest Rate Subsidy		8.45%	8.96%	8.59%	7.78%	10.79%	12.41%	11.18%	12.76%	13.45%	11.27%	9.28%	8.49%	7.75%	7.61%
Annu. Int. Subsidy on Marginal Invest.		13.5	13.6	11.5	8.3	47.6	17.7	24.9	22.4	14.6	0.0	58.7	39.4	0.0	22.8
High Est. - Corporate Cost of Financing															
Wgtd. Ave. Utility Long Term Rate		9.92%	10.03%	9.74%	9 61%	11.83%	14.25%	12.70%	14.93%	16.31%	13.46%	10 85%	9.30%	8.43%	8 92%
Interest Rate Subsidy		9.92%	10.03%	9.74%	9.61%	11.83%	14.25%	12.70%	14.93%	16.31%	13 46%	10.85%	9.30%	8.43%	8.92%
Annu. Int. Subsidy on Marginal Invest.		15.9	15.2	13.1	10 3	52.2	20.3	28.3	26.2	17.6	0 0	68.6	43 1	0 0	26.8
ANNUALIZED CAPITAL COST															
Estimated Construction Period	1														
Compounding Periods/Year	1														
Low Estimate - Government Cost of Capital															
Effective Annual Interest Rate		8.45%	8.96%	8.59%	7.78%	10.79%	12.41%	11.18%	12.76%	13.45%	11.27%	9.28%	8.49%	7.75%	7.61%
Interest Rates Used:	Gov't Cost of Borrowing (30 yr T-bond)														
Capital Investment Plus Capitalized Interest Entering Productive Use in 1 year		173.5	165.5	145.5	115.3	488.9	160.1	247.4	198.1	122.8	0.0	691.2	503.3	0.0	322.8
Time Shifted to Reflect Actual Year (2)		165.5	145.5	115.3	488.9	160.1	247 4	198.1	122 8	0.0	691.2	503.3	0.0	322.8	0.0
Time Shifted int. to reflect orig. int. (2)		8.96%	8.59%	7.78%	10.79%	12 41%	11.18%	12.76%	13.45%	11.27%	9.28%	8 49%	7.75%	7.61%	0.00%
Estimated Service Life (Depreciation Period)	30														
Annual Pymnt on Marg. Capital/Interest (3)		16 1	13.7	10.0	55.3	20.5	28.9	26.0	16.9	0.0	69 0	46.8	0.0	27.6	0.0
Total Annual Payments on Capital Stream in Productive Use, Low Est. (3)		330.6	314.6	300.9	290.9	235.6	215.1	186.3	160.3	143.4	143.4	74.4	27.6	27.6	0.0
High Estimate - Comparable Private Cost of Capital															
Effective Annual Interest Rate		9.92%	10.03%	9.74%	9.61%	11.83%	14.25%	12 70%	14.93%	16.31%	13.46%	10.85%	9.30%	8.43%	8.92%
Interest Rates Used:	Wgtd. Ave. Utility Long Term Rate														
Capital investment Plus Capitalized Interest Entering Productive Use in 1 year		175.9	167.1	147.1	117.3	493 5	162.7	250.8	201.9	125.8	0 0	701.1	507.0	0.0	326.8
Time Shifted to Reflect Actual Year (2)		167 1	147.1	117.3	493.5	162 7	250.8	201.9	125 8	0.0	701.1	507.0	0.0	326.8	0.0
Time Shifted int. to reflect orig. int. (2)		10.03%	9.74%	9 61%	11.83%	14.25%	12.70%	14.93%	16.31%	13 46%	10.85%	9.30%	8.43%	8.92%	0 00%
Estimated Service Life (Depreciation Period) - Same as in low estimate															
Annual Pymnt on Marg. Capital/Interest (3)		17.8	15.3	12.0	60.5	23.6	32.8	30 6	20.7	0.0	79.7	50.7	0.0	31.6	0.0
Total Annual Payments on Capital Stream in Productive Use, High Est. (3)		375.3	357.5	342 2	330.2	269.7	246.1	213 3	162 7	161.9	161.9	82.3	31 6	31.6	0.0
RECOGNITION OF CAPITAL LOSSES OR DEFAULTS															
Amount of write-off															
Estimated Period of Loss															
Interest on accruals															
Annual Accrual to cover loss		0	0	0	0	0	0	0	0	0	0	0	0	0	0

DEPARTMENT OF ENERGY: STRATEGIC PETROLEUM RESERVE

(Dollars in Millions)

Year	Constants	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
OPERATING COSTS															
Congressional Appropriations															
Management Costs		13 4	12.3	13.4	13.5	17.9	16.4	19.6	20.1	19 4	22.3	18 1	14.7	7 8	14
Inventory (Charged an inventory carrying cost only)															
Petroleum Acquisition & Transport (4)		242 0	438.7	0.0	(13.0)	2,049 6	650.0	2,074 1	3,679.7	3,205.1	(2,022.3)	2,356.5	2,703.5	440.0	0 0
Cumulative Cost of Purchases (Inventory)		15,803.9	15,561.9	15,123.2	15,123.2	15,136.2	13,086.6	12,436.6	10,362.5	6,682.8	3,477 7	5,500.0	3,143.5	440.0	0 0
Carrying Cost Charged (5)		0.00%	0.00%	0 00%	0 00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0 00%	0.00%	0.00%	0.00%
<u>HIGH-END ESTIMATE</u>															
Carrying Cost at Private Rates (Prime Rate) (6)		10.87%	9.32%	8.21%	8.33%	9.93%	12.04%	10.79%	14.86%	18.87%	15.27%	12.67%	9.06%	6.83%	6.84%
Carrying Cost Subsidy (rate)		10.87%	9.32%	8.21%	8.33%	9.93%	12.04%	10.79%	14.86%	18.87%	15.27%	12.67%	9.06%	6.83%	6.84%
Carrying cost subsidy (amount) (7)		1,717.9	1,450 4	1,241.6	1,259.8	1,503.0	1,575.6	1,341.9	1,539.9	1,261.0	531.0	696 9	284.8	30.1	0 0
<u>LOW-END ESTIMATE</u>															
Gov't Carrying Cost (1-yr T-Bill) (6)		8.53%	7.65%	6.77%	6.45%	8 42%	10.91%	9.58%	12.27%	14.80%	12.00%	10.65%	8.34%	6.08%	5 88%
Carrying Cost Subsidy (rate)		8 53%	7.65%	6.77%	6 45%	8.42%	10.91%	9.58%	12.27%	14.80%	12.00%	10.65%	8.34%	6.08%	5.88%
Carrying Cost Subsidy (amount) (7)		1,348.1	1,190.5	1,023.8	975.4	1,274.5	1,427.7	1,191.4	1,271.5	989.1	417.3	585.8	262.2	26.8	0.0
TOTAL ANNUAL COST															
Total Annualized Capital Charge - High Est		330.6	314.6	300.9	290.9	235.6	215.1	186.3	160.3	143.4	143.4	74 4	27.6	27.6	0.0
Total Annualized Capital Charge - Low Est		375.3	357.5	342.2	330.2	269.7	246.1	213.3	182.7	161.9	161.9	82 3	31.6	31.6	0.0
Annual Accrual to Cover Write-offs		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Management Costs		13.4	12.3	13.4	13.5	17.9	16.4	19.6	20.1	19.4	22.3	18 1	14.7	7.8	14 0
Inventory Carrying Cost Subsidy - High est		1,717.9	1,450.4	1,241.6	1,259.8	1,503.0	1,575.6	1,341.9	1,539.9	1,261.0	531.0	696.9	284.8	30.1	0 0
Inventory Carrying Cost Subsidy - Low est		1,348.1	1,190.5	1,023.8	975 4	1,274.5	1,427.7	1,191 4	1,271.5	989.1	417.3	585.8	262.2	26.8	0.0
Total - High estimate		2,061.9	1,777.3	1,555.9	1,564.2	1,756.5	1,807 1	1,547.8	1,720.2	1,423.6	696.7	789.4	327.1	65.5	14.0
Total - Low estimate		1,736.7	1,560.3	1,379.5	1,319 1	1,562.1	1,690.2	1,424 3	1,474.3	1,170 4	601.6	686 1	308.4	66.1	14 0
ENERGY SECURITY															
Year-end inventory (Mil bbls)		577 1	554.7	533.9	506.4	489.3	431.1	361	277.9	199.2	92 6	91.2	49.1	1 1	
Days of Import Protection (8)		81	86	93	95	118	100	93	71	45	17	12	9	1	
		1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976

Notes.

(1) The cost of capital section calculates how much the SPR paid for the use of government funds, versus how much the government paid to borrow funds on the market. We assume a 30-year bond rate, since SPR is a long-term project The high estimate uses the Moody's weighted average cost of capital for new power, light, and gas utilities This rate is a proxy for the cost of funds for large users of petroleum The cost of financing to oil companies (who would be interested in secure oil stocks to protect refinery and marketing operations), would be even higher due to thier greater use of more expensive equity financing

(2) Construction expenditures are generally capitalized until a project begins operation, at which point those expenditures are depreciated. We assume a 1-year lag between construction and operation based on the lag between initial facility construction and initial oil purchases to fill the facility. Since borrowing was done at prevailing rates at the time construction began and not at the time depreciation began, interest rates are also time-shifted 1 year.

(3) This figure equals the annual payment necessary to pay off the new capital (plus capitalized interest) coming on line at government's cost of funds. Summing annual payments for each year's addition to capital infrastructure yields the total annual payment necessary to cover the current total investment. This continues until capital is fully depreciated, which has not yet occured

(4) Total spending to fill the inventory. Funds are added to the value of inventory which must be financed awaiting use or sale. The full purchase price of this inventory is not counted as a subsidy. Negative values in this row reflect cancellation of purchasing authority (recissions).

(5) The carrying cost actually charged is the interest rate that the government actually charged for tying up funds in oil inventories.

(6) The carrying cost charge reflects how much it costs the government to have its money tied up in oil inventory x the total amount invested in inventory. Note that the inventory carrying-cost charge uses a 1-year Treasury bill rate to reflect the liquidity of the inventory, and the frequency with which inventory decisions may be made. Due to the fact that long-term borrowing is generally more expensive than short-term borrowing, using a longer-term interest rate would increase our subsidy estimates. Our high estimate is also conservative in that the prime rate is used as a proxy for the private sector cost of short-term borrowing in the high estimate. Since most of the borrowers use equity as well as debt financing, their cost of capital would be higher than the figure we use

(7) The carrying cost subsidy is equal to the carrying cost rate x the aggregate value of oil inventory (including oil transport costs) held for sale

(8) Days of import protection is equal to the SPR end of year inventory/net petroleum imports.

Sources:

U.S. DOE Strategic Petroleum Reserve Annual/Quarterly Report, 2/15/90, p. 26. DOE/FE-0165.
U.S. DOE FY 1992 Congressional Budget Request, V. 4. 249 (used for 1990 data only).
RATES2.WK1, in Appendix B7 of this report

DOE: URANIUM ENRICHMENT ENTERPRISE

Throughout the life of commercial nuclear power, DOE's uranium enrichment facilities have supplied the power plants with enriched uranium. For years after WWII, DOE was the only source in the world for fuel grade uranium. Although all production went to the military sector until 1969, commercial shipments grew dramatically in the ensuing years. Today, however, the enrichment facilities are under financial pressure from a number of other enrichment providers. Competition has put pressure on DOE's margins. Unrealized expected future demand, along with contracting procedures which placed all of the risk for changing market conditions on DOE, led to overcapacity and take-or-pay power contracts with the Tennessee Valley Authority running into the hundreds of millions of dollars per year.

In addition, extensive research into alternative enrichment techniques and incomplete capital recovery (exacerbated by poor accounting practices) have resulted in unrecovered federal investment running into the billions of dollars. Estimates of the unrecovered investment range from zero to $10 billion, although part of the disparity is due to capital write-offs which some parties argue should not be recovered in any future privatization of the enterprise. For our purposes, since the entire shortfall remains unpaid, the entire portion remains a subsidy to fission power which is reflected in reduced fuel costs.[31] Shortfalls in the accrual for decommissioning and decontaminating the enrichment facilities add still more to the overall level of subsidy. The main categories of subsidization are presented below.

Below Market Purchases of Power. Uranium enrichment is extremely energy-intensive, with electrical power costs comprising 70 to 80 percent of production costs and almost 100 percent of marginal costs. (Smith Barney, 35; '89 Uran. Enrichment Annual Report, 10). Power is supplied by the Tennessee Valley Authority and two other utilities formed solely to supply the enrichment facilities. This arrangement has led to allegations that the enrichment facilities receive power at below market rates.[32]

As shown in our estimate for TVA, power sales to UEE for much of the 1970s (until DOE had to make good on take-or-pay power contracts when demand for enriched uranium stopped growing) were 10-27% less expensive than the wholesale price to municipal and cooperative utilities. (TVA.WK1, 3). Any subsidized power sales are incorporated in the TVA section only to avoid double counting.

Below Market Sales of Enriched Uranium. Despite substantial market power and enormous unrepaid capital, DOE has historically sold enriched uranium far below its competitors.[33] For example, in 1986

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[31]Since DOE supplied enriched uranium to facilities all over the world, a portion of benefits from low cost fuel-grade uranium went to the foreign power sector. The source of this subsidy, however, was financed by the U.S. taxpayer. Through FY 1991, approximately 15% of the SWUs sold went to overseas utilities. This is equal to about 1/3 of the commercial fission share. (Warren, 10/13/92).

[32]Even if TVA does not lose money absolutely, power sales for uranium enrichment could be cross-subsidized by power sales to other sectors.

[33]While economies of scale could explain the ability to undersell competitors, this argument holds true only when fixed costs are being repaid. If fixed costs are not being covered by sales in a market where pricing to recover fixed costs is possible (UEE had a world monopoly for quite some time), selling more simply means losing more of the taxpayers capital investment. Excess capacity in the industry, exacerbated by recent increases in sales from the Soviet Union (Techsnabexport), explains much of the current pricing situation, but this competition did not always exist. With stagnant demand, huge fixed costs, and large unneeded capacity, prices are being cut far below levels necessary to recover sunk fixed plant. Such a scenario generally precedes market exit. However, the U.S. continues to spend money to bring a new enrichment technology, AVLIS, to market with the argument that it will reduce the price of enriched uranium. This perspective ignores the market realities that the producers using the older technologies will continue selling so long as variable costs are covered, rendering the new technology unneeded and more costly at this time. (GAO/RCED-91-88, pp. 38-40).

DOE's product sold for $119/Separative Work Unit (SWU)[34] while its competitors Eurodif (primarily France) and Urenco (Germany, Britain, and the Netherlands), which are also government-owned, sold theirs for $170-$190/SWU.[35] DOE's price was $12/SWU lower than average production costs, even excluding depreciation and a reasonable return on investment. (Montange, 8,11). By 1990, DOE enriched uranium was being sold for $118/SWU, a decline of 28 percent in real terms since 1984. (1989 Uranium Enrichment Annual Report, 9). Since DOE sells both to domestic and foreign buyers, a significant portion of the pricing subsidy (50% in 1979) accrues to foreign buyers.

We account for below-market sales of uranium through our tracking of operating losses and total unrecovered capital only. That is, low prices led to less revenue, which in turn was the major factor in UEE's poor financial performance. No effort has been made to estimate the historical opportunity cost of DOE's pricing strategy.

Unrecovered Government Investment. Unrecovered federal investments are the result of accrued operating losses, customer non-payment, funds invested in the gaseous diffusion enrichment facilities, and terminated research and development into gas centrifuge enrichment technology. Estimates of this loss vary by differing assumptions on the value of the initial plant at the time UEE began commercial operations and the cost of tied up funds to the government, as well as by differing decisions on when to recognize capital write-offs and how much to recognize. The impact of the timing of capital write-offs on the final subsidy estimate is mitigated by the process of amortizing the loss backwards over the period of loss.

For example, if no historical losses have been recognized and written off, the period of loss would run from 1969 (when UEE began commercial production) to our 1989 point of estimation. A larger measured loss (since nothing has been written off yet) would be spread over a longer period of loss, and the annual payment necessary to have covered that loss would be relatively smaller. Recognizing DOE capital write-offs would reduce both the current loss estimate and the period of loss significantly. Since interest was imputed on the unrecovered federal investment, we have amortized losses back using the imputed interest rate as a discounting factor.

While there is much debate over the magnitude of unrecovered investment, Congress, through the Energy Policy Act of 1992, has statutorily capped the value of recoverable federal investment at $3 billion. The remainder of the unrecovered federal investment has been converted to equity claims in the soon-to-be-privatized enterprise. As such, funds may be recovered only through dividends or stock appreciation -- should such stock have any value. (DOE, '92 Bill, 14).

The various estimates are evaluated below, and our rationale for making particular decisions with respect to the inclusion or exclusion of costs is presented.

The Edison Electric Institute (EEI) Estimate

The major difference between the EEI estimate and the others is that EEI considered the recoverable value of the initial plant and working capital to be zero. (Coopers & Lybrand, 24). The

[34] A separative work unit is a measure of the energy required to separate two isotopes of uranium.

[35] Part of this discrepancy emerges because Eurodif and Urenco both sell to domestic consumers at relatively high prices, while offering excess capacity on the U.S. market at substantially lower prices. (GAO/RCED-91-88, 37).

original investment in the three enrichment plants was $2.8 billion. (Bowring, 57). While much of the plant was depreciated prior to commercial use, the book value of the enrichment facilities plus net working capital on January 1, 1969 when service to commercial customers began was $1.5 billion. (Coopers & Lybrand, 24). The EEI estimate was deemed unusable because they valued the initial plant, equipment, and inventory at zero (in contrast to all other evaluators), and therefore have imputed no interest on this tied up capital over the past 20 years. In addition, where imputed interest calculations were done, EEI assumed that interest payments would not start until one year after incurring the expense. (Coopers & Lybrand, 20). We were unable to back out these assumptions to generate an estimate for our calculations.

<u>The DOE Estimate</u>

The main differences between the DOE estimate and the Smith Barney/Coopers & Lybrand, and GAO estimates are in the choice of interest rates used in imputed interest calculations, and in the exclusion of the costs of the abandonment of the gas centrifuge diffusion plant and excess gaseous diffusion capacity (the closure of the Oak Ridge facility). (Smith Barney, 62). Again, whether or not the capital write-offs are included in the recoverable asset base, they still constitute a subsidy to the enterprise since a private entity would have to write off the assets against pre-tax net income, and reflect the losses somehow in pricing or their future cost of capital (if current equity holders lost value future investors would charge a higher risk premium). Accepting both DOE's interest rate decision and past capital write-offs would yield a net subsidy of $3.0 billion over a period of loss from 1986 to 1989. The shorter period of loss more than offsets the lower capital loss figure, yielding higher annual payment estimates than in the GAO figures.

<u>The GAO Estimate</u>

The main difference in the GAO estimate is that GAO does not recognize historic write-offs of defunct assets and investments that DOE recognized in the early 1980s. Their resulting estimate of $10 billion includes four categories that bear adjustment for our purposes (Smith Barney, 62; Coopers & Lybrand, 25-33).

- Unexpended Appropriations: funds allocated but not spent should not be included as a subsidy. (Subtract $0.2 billion).
- Appropriations included in the uranium enrichment budget but not deemed related to the Uranium Enrichment Enterprise. (Subtract $0.85 billion).
- Exclusion of value of in-kind enrichment services provided to the federal government and subtracted from net unrecovered capital. (Subtract $0.8 billion).

These adjustments yield a revised GAO estimate of $8.15 billion ($10b-$1.85b) over a period of loss of 21 years (1969-1989, inclusive).

<u>The Smith Barney/Coopers & Lybrand Estimate</u>

One of the main differences between the adjusted GAO estimate above and the Smith Barney/Coopers & Lybrand (SB/C&L) estimate lies in the interest rate used on outstanding capital. Both methods are rational. The GAO estimate incorporates the annual cost to the government of having its funds tied up in the enrichment facility. The accounting firm assumption of the 1969 long-term bond rate treats the enterprise as a private facility which financed all of its capital needs in the least expensive manner at start-up. The SB/C&L estimate, including what they call "policy decisions" such as capital write-offs, is $4.5 billion. Since the recognition of capital losses in the mid-1980s reflects poor investments from the earlier time frame, the period of loss for the this estimate is 1986-1989. The shorter time frame yields higher annual payments.

Subsidv Accruing to the Commercial Sector

Until 1969, all enriched uranium produced by the Uranium Enrichment Enterprise was used for military purposes. (Coopers & Lybrand, 24). Since that time, a portion of production has continued to go to the defense sector. Although the civilian share of SWUs produced for civilian purposes to total SWUs is almost exactly 50 percent (Montange, 17), using this as an allocation factor would be erroneous since the subsidy calculations begin in 1969, not in the beginning of the enrichment facility life. Therefore, the allocation of costs to the commercial sector (both U.S. and foreign) is based on the 88.7% of SWUs produced since 1969 that went to commercial purposes. (Schmitt, 10/92).

Decommissioning and Decontamination (D&D)

The three enrichment facilities (all based on the gaseous diffusion technology) are extremely old. They were constructed and operated during a time when environmental issues were irrelevant. There are extremely large costs associated with both decommissioning (closing) the facilities and cleaning up the sites. There is also a wide range of estimates regarding the costs of this cleanup.

DOE estimates the total cost of decommissioning and decontaminating the three plants at $3 billion, with $1.404 billion to be paid by commercial customers via enrichment surcharges. This figure for some reason excludes costs such as pre-D&D maintenance and surveillance at the Oak Ridge Gaseous Diffusion Plant and Remedial Actions at all three enrichment plants. (UEE 1989 Annual Report, 35). Since DOE is accruing for these items also, our estimates of D&D shortfalls are net of these additional items.

An additional $2.25 billion charge on the commercial sector to cover enrichment D&D costs via a supplemental charge on nuclear utilities was included in the Energy Policy Act of 1992. The Act created a special $150 million/year inflation-adjusted charge earmarked for enrichment D&D. The charge lasts for 15 years, and is capped at total outlays of $2.25 billion (also adjusted for inflation). (DOE, '92 Bill, 17).

The Uranium Enrichment Enterprise is accruing funds to cover the $3 billion level of D&D costs over the projected lives of the facilities. Provision for closure and cleanup at the Oak Ridge Gaseous Diffusion Plant, which has already closed, is much greater. (FY 1989 Enrichment Annual Report, 35). As mentioned above, additional accruals for pre-D&D activities and remedial action are on-going as well. All of these accruals represent the total of a series of payments in nominal dollars. We convert them to 1989 constant dollars to make them comparable to our other estimates.

Since experience thus far suggests significant clean-up shortfalls if only $3 billion is available, we do not use the DOE estimate for our low estimate of total D&D costs. Alternative estimates of the total D&D cost are much higher than the DOE estimate. Initial site characterization is far from complete and has already found a wide range of problems. Furthermore, "past experience indicates that such costs increase as more information becomes available." (GAO, T-RCED-90-101,10). Problem areas include many leaking underground storage tanks, violations in the use of PCBs, out-of-compliance air emissions with asbestos and radionuclides, and potentially large problems with hazardous wastes. (Smith Barney, 68). Smith Barney estimates the cost of decommissioning the Oak Ridge plant alone could reach as high as $8 billion. Applying this standard to the three plants yields a potential liability for cleanup and decommissioning of $24 billion. (GAO, T-RCED-90-101, 10; Smith Barney, 82).

DOE contractor studies, done by firms involved in the cleanups, have estimated a range of $14 to $29 billion (1989$).[36] The Smith Barney estimate falls within this range. We view the contractor estimate to be far more likely than the current DOE estimate given current experience and the magnitude of unknowns on the site. Our high and low estimates for uncovered D&D costs are reduced by current accruals for D&D and for the recently added decommissioning surcharge. While the period of cleanup has been estimated to be between 25 and 37 years by two engineering firms who estimated the cost of D&D for DOE (TLG, p. 45; EBASCO, figure 5.4-1), we annualize the D&D shortfall over the commercial service of the facilities. This approach is consistent with our annualized estimates in many other program areas. The commercial life of the facilities is 36 years, from 1969 when commercial operations began through 2005 when the last facility is scheduled to close. (EBASCO, 2-1).

We follow the DOE allocation of D&D costs between the defense and commercial sectors in their annual reports. Forty-seven percent of the total D&D shortfall is allocated to the commercial sector. The D&D subsidy estimates on the UEE worksheet are net of special charges levied on nuclear utilities in the 1992 Energy Policy Act.

Gas Centrifuge Facilities. Cleanup costs for the abandoned gas centrifuge facilities are expected to total $187 million. (GAO/T-RCED-89-54, 3). The costs are incorporated in the contractor D&D estimate.

Other Subsidies to the Enrichment Enterprise

Nuclear Regulatory Commission Licensing. Being government-owned, the gaseous diffusion plants are exempt from NRC licensing. The cost of licensing and compliance, according to DOE, ranges between $5 million and $153 million per plant. (Smith-Barney, 87). Although the NRC suggests the lower end of the range is reasonable, the age and size of the facilities, in addition to their pivotal role in nuclear non-proliferation (since they can produce weapons-grade material), suggests the high end is a better figure. While the facilities are currently regulated for safety and compliance by government officials, the oversight appears to be less stringent than that required by NRC. (Smith-Barney, 87-89). Smith-Barney estimates that licensing costs and compliance fees are likely to run in the range of $181 to $379 million, and notes that

> principally due to the seismic issue and today's more restrictive safety criteria (compared to the standards applicable when the plants were built), there is some question as to whether or not the UEE's facilities can be licensed on any schedule at any cost. (Smith-Barney, 87).

The NRC will have oversight for the gaseous diffusion enrichment facilities once they are privatized, under conditions laid out in the 1992 Energy Policy Act. (DOE, '92 Act, 16). Since these costs will be borne through privatization, and since UEE did have some government oversight in the past, we do not ascribe a value to this subsidy here. However, it is clear that the laxer standards for UEE, since it was publicly owned, reduced compliance costs in the past. Had these costs been borne by UEE, rather than by the surrounding population and ecosystem through higher risks of accident or damage, the magnitude of unrecovered costs would likely be higher.

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[36] The contractors were EBASCO Services, Inc., Martin Marietta Energy Systems, and TLG Engineering. The General Accounting Office's audit of annual payments required to cover D&D yielded an estimate of $500 million/year, indexed to inflation, similar to our high estimate. (GAO, RCED-92-77BR, 2).

Insurance. Not being required to purchase environmental liability insurance reduces the costs of operating by placing risk on the taxpayers. In essence, the enrichment facilities are self-insured. Outlays for environmental remediation may be viewed as retrospective premiums. As mentioned at the beginning of this chapter, the impact of retrospective premiums on behavior and risk minimization may not be not optimal. However, financially it is an acceptable proxy since DOE has begun to incur the cleanup costs. Therefore, we treat the subsidy as zero.

Federal government indemnity from other forms of liability, such as for negligence, do confer subsidies to the enterprise. The Price-Anderson indemnification on liability, even for gross negligence, extends this liability subsidy further, to all contractors and suppliers. Subsidies from these programs to UEE could not be quantified.

Rate of Return and Tax-Exempt Status. The government investment, by not requiring a positive rate of return, reduces the cost of providing enriched uranium services for commercial utilities. The tax-exempt status of UEE reduces the cost structure still further. Since UEE competes with other providers of energy services (oil refineries and electric-utilities both upgrade fuel inputs for the final user, an analogous service to uranium enrichment), these factors provide a significant barrier to entry for substitutes.

The private market rate of return required on the Enrichment Enterprise, a multi-billion dollar, high risk investment, is likely to be quite high. Estimating this return is problematic. However, a recent study by the Energy Information Administration calculated that UEE would need to earn between $290 and $1.44 billion (1989$) more than it currently does in order to earn a 15% operating return on the value of depreciated assets. (EIA, 16).[37] The range of values reflects the controversy in measuring the book value of UEE's assets, as discussed in the above on unrecovered federal investment. Since the 15% rate of return is a pre-tax return (EIA, 65), it implicitly includes the value of UEE's tax-exemption as well.

However, it does not include the projected shortfall in D&D funds. Therefore, to generate an upper bound estimate of the subsidy to UEE, the $1.44 billion subsidy from UEE's tax-exemption and rate of return would need to be added to our high estimate of $142 million measuring the annual commercial D&D shortfall. This would yield a total 1989 subsidy of $1.58 billion.

Unsecured Long-Term Power Contracts. The uranium enrichment enterprise, anticipating burgeoning demand for enriched uranium during the 1970s and early 1980s from new power plant construction, entered a number of long-term take-or-pay contracts with the Tennessee Valley Authority for power necessary for enrichment. These contracts led TVA to construct new units. UEE, however, did not make similar requirements to purchase enriched uranium with its nuclear utility customers, for whom the new TVA capacity was ultimately being built. As a result, all risk for changes in market demand for enrichment services rested with UEE, rather than being shared by the beneficiary parties as would likely have occurred in private market transactions. When the market collapsed, UEE was forced to pay (after losing a court battle) TVA $1.8 billion, of which $465 million was due in 1989. (TVA Information Statement, F-15; 1990 Uranium Enrichment Annual Report, 32). Although these payments are already reflected in the UEE losses presented above, they are a good quantification of the subsidies associated with federal government uncompensated risk-bearing for private industry.

[37] This price increase would not be supportable at current market prices. However, it demonstrates that UEE purchased too much capital or did not charge adequate prices when it could have passed them through to the market, or both.

Depreciation Rate of Uranium Stockpile. The enrichment of uranium involves increasing the ratio of $Uranium_{235}$ atoms to other forms of uranium (primarily $Uranium_{238}$), since U-235 is much more fissionable than the other isotopes. (EBASCO, 2-2). As more U-235 is removed from natural uranium to enrich the uranium fuel, the process of removing the remaining, more diluted, U-235 gets progressively more expensive. According to one analyst (Montange, 10/13/92), DOE has used a larger amount of natural uranium, but removing a smaller proportion of available U-235. Since the energy needed to remove U-235 increases as the concentration of U-235 in natural uranium decreases, the approach used by DOE saves money.

However, while the remaining uranium does have some recoverable U-235 remaining, the cost of recovery may be substantially higher than for the first increment. This makes the fuel-value of the semi-depleted stockpile lower. To reflect this lower value, the depreciation of the stockpile value in UEE's books would have to be accelerated rather than straight-line. According to Montange, UEE overstates the value of the stockpile, which is treated as an asset. This improves the apparent operating performance of the facility, partially justifying lower-cost sales of the final product. No subsidy estimate is included for this practice.

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Uranium Enrichment Enterprise

Part 1: Unrecovered Government Investment in the Enterprise

Estimator	Amount (Billions)	Period of Loss Start	Period of Loss End	# Yrs. for Accrual	Discount Rate (1)	Annual Charge (2)	Source
Revised General Acctng. Office	8.42	1969	1989	21	0.0632	202.9	Smith Barney, 61; Coopers & Lybrand, 5,6. See accompanying text
Department of Energy	3	1986	1989	4	0.0632	682.5	Smith Barney, 61; Coopers & Lybrand, 5,6.
Smith-Barney/Coopers & Lybrand	4.5	1986	1989	4	0.0778	1,001.9	Smith Barney, 63; Coopers & Lybrand, 5,6, 27, RATES2.WK1

	Low Est.	High Est.
Annualized Unrecovered Investment	202.9	1,001.9
Commercial Share (see Part 2)	88.27%	88.27%
Net Subsidy to Commercial Sector	179.1	884.4

Notes to Part 1:

(1) Since a significant portion of the unrecovered investment in UEE represents accrued interest on unrepaid capital, the various estimates were discounted using the same methodology employed in the calculation of imputed interest. Thus, DOE (after 1986) and GAO imputed interest based on the historical weighted average rate for all outstanding government debt. Smith-Barney, based on work by Coopers & Lybrand, felt that using the long-term bond rate available in the first year of the investment is more appropriate. The rate shown here for them is the 30-year T-Bond rate in 1986.

(2) The annual charge is the nominal payment needed each year to accrue the unrecovered capital during the period of loss. These payments accrue interest at the rate of the discount factor shown above

Part 2: Derivation of Allocation Between Defense and Commercial Sectors

U.S. URANIUM ENRICHMENT ENTERPRISE SHIPMENTS OF SWU's FY1969-89
(SWU's in Thousands)

Year	Defense Enrichment Services	Civilian Enrichment Services	Year	Defense Enrichment Services	Civilian Enrichment Services
1969	2,580	1,247	1980	845	10,376
1970	2,416	3,265	1981	1,379	10,877
1971	1,845	8,410	1982	1,538	14,155
1972	253	6,173	1983	1,281	14,177
1973	521	7,912	1984	1,710	11,198
1974	346	15,763	1985	1,447	10,060
1975	606	8,366	1986	1,820	8,623
1976	927	11,654	1987	1,777	8,297
1977	1,652	10,917	1988	1,862	10,593
1978	1,332	12,730	1989	1,037	11,923
1979	909	14,661			
			Total	28,083	211,377
		% of Tot. Shipments		11.7%	88.3%

Notes to Part 2:

(1) SWU's refer to "Separative Work Units," the measure of enrichment services.

(2) Prior to 1969, all sales were defense-related. Some of these prior enrichment services were in inventory and may have gone to the commercial sector, although the above numbers do not reflect this. All estimates of unrepaid debt also begin in 1969

(3) Data for 1990 were 541 SWU's to the defense sector and 10,182 to the civilian sector.

Source: Eugene Schmitt, Office of Uranium Enrichment, U.S. DOE. October 6, 1992.

Part 3: Decommissioning and Decontamination (D&D) Cost Sharing

Current DOE Accrual	$Billions	
Estimated Cost for D&D, all 3 plants	3	Summation of nominal past and future payments
Commercial Share	1.404	DOE Administrative Decision
Actual Ratio of Commercial/Defense Shares	46.80%	Note 1

Notes to Part 3:

(1) This estimate is used in the allocations below, and differs from the figure in Part 2 because D&D costs were incurred going back to the beginning of UEE, while the calculation of unrecovered costs began only in 1969. The breakout shown is from the 1989 UEE Annual Report, p. 35

Part 4: Cost Estimates for Decommissioning & Decontamination

	$Billions	
A. DOE Estimated Cost, Nominal Value	3	From Part 3
DOE Accrual, Constant 1989$	2.46	Constant 1989$; From Part 5
Plus current accrual for site remediation not classified by DOE as D&D		
1. Pre-D&D maintenance and surveillance at Oak Ridge	0.43	Constant 1989$; From Part 5
2. Remedial Actions at all Three Sites	0.61	Constant 1989$; From Part 5
Total DOE Accrual*	3.50	

*Although little of this accrual has been paid out in cash, so long as it is reflected in UEE financial statements, the unrecovered federal investment shown in Part 1 would reflect the losses. The additional DOE accruals reflect associated costs to the civilian users of UEE for remediating the sites, but whic for no clear reason are excluded from DOE's total of current D&D accruals. These items are added to the $3 billion total to avoid double counting errors when netting the DOE D&D accrual from contractor D&D estimates below.

B. Smith-Barney Estimate		
Est. Cost of Decommiss. the Oak Ridge Plant	8	1989$; from Smith Barney, p. 82; GAO/T-RCED-90-101, p. 10.
Extrapolation to Cleanup of 3 sites	24	

D. DOE Contractor Estimates	Billions of 1992 Dollars: Lower Bound	Expected	High Est.	Billions of 1989 Dollars*: Lower Bound	Expected	High Est.	Source
Cleaning of Buildings and Equipment	11.27	16.1	24.15	10.38	14.83	22.24	EBASCO Services, Inc., quoted in GAO/RCED-92-BR, p. 2.
Remedial Action, Surrounding Soil and Water	3	3	3	2.76	2.76	2.76	Martin Marietta Energy Systems, quoted in GAO/RCED-92-77BR, p. 2.
Conversion and Disposal of Low Level Radioactive Uranium Waste Streams	1.3	1.9	4.1	1.20	1.75	3.78	Martin Marietta Energy Systems, quoted in GAO/RCED-92-77BR, p. 2.
Total D&D Costs	15.57	21	31.25	14.34	19.34	28.78	
TLG Engineering Estimate	13.9		16.7	12.80		15.38	TLG Engineering, p. 5. Covers same scope as EBASCO study and TLG estimate is inside the EBASCO range.

*Estimates were converted to 1989$ using GDP implicit price deflator data from the "Survey of Current Business," Dec. 1992, p. 33. GDP rather than GNP deflators were used in this instance due to changes in federal data collection which stopped publishing GNP deflators in the early 1990s. The end-of-year 1991 price deflator was used since 1992 data are not yet complete, and since this better reflects prices in early 1992 when the contractors were assembling cost factor inputs for their studies.

E. High and Low Estimates - Most Likely to be Accurate Scenario: Contractor Estimates

	Low Est. (Billions of 1989$)	High Est.	
Total Estimated D&D Costs	14.34	15.38	
Less Current DOE Accrual for D&D	3.50	3.50	See Parts 4A and 6; includes future accruals through enriched uranium sales.
Net D&D Expected Shortfall	10.84	11.89	
Commercial Share	46.80%	46.80%	From Part 3B above.
Net D&D Subsidy to Commercial Fission	6.71	7.20	
Less Special D&D Charge on Utilities	2.07	2.07	The Energy Policy Act of 1992 levies a total of $2.25 billion (real 1992$) in D&D charges over 15 years.
Subsidy, net of special charges	4.64	5.13	
Period of Underaccrual	36	36	Note 1
Estimated Real Interest Rate	0.014	0	Reflects the payout of cash as it is collected; see Note 2.
Annualized Payment ($Millions)	100.0	142.4	Note 3

Notes to Part 3E:

(1) The Enrichment plants are began servicing the commercial sector in 1969, and are scheduled to close in 2005, a period of 36 years.

(2) The 1.4% rate is the historical, inflation-adjusted yield on long-term government bonds between 1925 and 1990 (Ibbotson, 76). The government yield was chosen since the deficit in UEE was financed through government borrowing. The zero rate of interest used to calculate the high estimate reflects the fact that D&D spending will be occuring as the funds are accrued for much of the accrual period. As a result, there may be no unspent collections on which to earn a return.

(3) This is the payment necessary to accrue the funds needed for facility D&D by the end of the planned D&D effort.

Part 5: Conversion of Nominal DOE Accruals For D&D and Related Costs to Constant 1989$

A. Current Nominal Accrual

Year Cost Accrued	D&D Accruals Nominal	1989$	Pre D&D work @ ORGDP Nominal	1989$	Remedial Action Nominal	1989$
1988	415	432	192	200	274	285
1989	58	58				
1990	58	56				
1991	58	53				
1992	58	51				
1993	58	49				
1994	58	47				
1995	58	45				
1996	58	43				
1997	58	41				
1998	58	40				
1999	58	38				
2000	58	36				
2001	58	35				
2002	58	33				
2003	58	32				
2004	58	31				
2005	58	29				
	1,404	1,151				

These payments are DOE's planned accrual of D&D funds over the remaining facility life.

Sources: DOE, UEE Annual Reports, 1988 (pp 30,35) and 1989 (p. 30).

Discount Factor 0.0435 Equal to the cumulative average growth rate in the GNP implicit price deflator between 1950 and 1990.

B. Summary of Adjustments to D&D Inputs Shown in Part 3

Total DOE Accrual	Commercial Share Nominal	Commercial Share 1989$	Total Costs (1989$)	
Percentage of Total Costs Commercial			0.468	From Part 3
D&D	1,404	1,151	2,459	
Pre-D&D Work at Oak Ridge	192	200	427	Adjustments in Part 5A represent commercial share only. These are
Remedial Actions	285	285	610	scaled up to reflect the total cost, the needed input for Part 4E.
Total	1,881	1,636	3,496	

Adjustment of Energy Policy Act UEE Collections to 1989$

	Billions	
Total Collections, Real 1992 $:	2.25	
Total Collections, 1989$	2.07	See note in Part 3D for details on conversion.

Part 6: Summary of Annual Subsidies to Uranium Enrichment

	Low Est. (Millions of 1989$)	High Est.	
Unrecovered Capital	179.1	884.4	
Decommissioning and Decontamination	100.0	142.4	
NRC Licensing	NQ	NQ	See accompanying text for discussion.
Insurance	NQ	NQ	See accompanying text for discussion.
No Required Rate of Return	NQ	NQ	See accompanying text for discussion.
Tax-Exempt Operating Status	NQ	NQ	See accompanying text for discussion.
Total	279.1	1,026.8	

Notes to Part 6:

(1) A low estimate including an imputed rate-of-return was not done because our low estimates include direct costs to the government only. The absence of a rate-of-return, though it does reduce the cost structure of the enterprise, is not a direct cost to the federal government.

(2) "NQ" refers to "Not Quantified."

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DOE: NUCLEAR WASTE FUND

The Nuclear Waste Fund is a supposedly self-financing fund collected from generators of radioactive wastes and used to develop the technologies and facilities necessary to safely dispose of the nation's nuclear wastes.[38] The Fund is financed through a 0.1 cent/kWh fee on nuclear-generated electricity. In return for these payments, plus a one-time levy of $1.452 billion to cover the costs of wastes generated prior to the establishment of the fund in 1983, "utilities are relieved of further financial obligation for waste disposal." (GAO/RCED-90-65,2). Since the facility will also handle some defense-related nuclear wastes, the defense share of the facility has been set at 14.9% if there is one repository built, or 17.3% if there are two. (Nuclear Waste Fund Fee Adequacy, 11/90, 13).

Subsidies from the nuclear waste fund can take five forms: incorrect projections of receipts and facility costs; insolvency of contributors prior to payment; its tax-exempt status; its lack of a required rate of return on invested capital; and uncompensated risk bearing by the public and the States. For the facility cost projections, contributor insolvency, and uncompensated risk bearing, the current cost to nuclear utilities appears to be lower than the actual cost to the country, reducing the current private cost of providing nuclear power. The tax-exempt status and lack of a required rate of return also reduce the current cost to nuclear utilities, increasing the barriers to entry for non-nuclear energy alternatives.

Incorrect Projections of Receipts and Facility Costs

The Fund is intended to recover all costs associated with researching, constructing, and operating the nuclear waste depository, now limited to the Yucca Mountain site in Nevada.[39] Every year, the Department of Energy must estimate whether the current levy is sufficient to meet projected program needs as per the Nuclear Waste Policy Act of 1982. These assessments have, every year, determined that the current levy is, in fact, sufficient to meet facility needs.

This estimate is subject to a great deal of uncertainty, however. First, the estimates assume a program life of 100 years (GAO/RCED-90-65, 10), requiring that assumptions hold over an extremely long time period. This includes assumptions on real interest rates and inflation rates, both very difficult to predict with any accuracy. Since the fee is not indexed to inflation, incorrect inflation estimates can have serious repercussions. In addition, revenues are dependent on how many utilities generate how much electricity (thereby paying into the fund for each unit), over how long a period of time. DOE estimators assume that the average reactor will last 40 years (as of 1987); state regulators assume 30-35 years. DOE estimates assume no decline in performance as reactors get older, and that average industry capacity factor will increase gradually to 65% in 2000 and 70 percent in 2020. The capacity utilization table on the next page suggests that even capacity factors do not always move in a predictable manner. In fact, three government studies in the 1970s, and one in 1985, found dramatic declines in capacity factors as the plants

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[38]The fund was originally earmarked for use only for nuclear waste disposal. Beginning in FY92, $19.7 million/year can be used to pay for Nuclear Regulatory Commission oversight costs of utilities (OMB '92, 4-1154 - 4-1157). In addition, there have been some violations that have recently come to light where money from the Fund has been used for discretionary (self-initiated) R&D by the DOE laboratories. In FY 1988, $1.3m was assessed from the fund for non-nuclear waste uses; in FY 1989, this rose to $1.42m. This amount is deducted from our high estimate of the Nuclear Waste Fund subsidy. (US GAO, Energy Management: Better DOE Controls Needed Over Contractors' Discretionary R&D Funds, December 1990, p. 41).

[39]There is some uncertainty whether there will be one or two repositories. The currently authorized capacity at Yucca Mountain (70,000 metric tonnes) is less than the projected need for disposal capacity (96,000 metric tonnes of waste) -- even if no new reactors are built. (Chapman, 252).

aged.[40] With no new plants built in the U.S. in over a decade, it appears that the industry average capacity factor will decline over time, rather than rising or staying stable as necessary to meet revenue projections. Interestingly, DOE studies after 1985 assume no decline in capacity factors of aging plants, though no study was done to support this revision.

DOE does make projections in a worst-case scenario in which no new reactors come on line to pay into the fund, reducing errors of underestimation in this area.

Historical Capacity Factors of United States Nuclear Reactors

Year	Capacity Factor
1973	53.7%
1974	47.9
1975	56.0
1976	54.9
1977	63.4
1978	64.7
1979	58.5
1980	56.4
1981	58.4
1982	56.7
1983	54.4
1984	56.3
1985	58.0
1986	56.9
1987	57.4
1988	63.5
1989	62.3

Source: "Nuclear Power Plant Operations," Energy Information Administration Monthly Energy Review, February 1990.

[40]U.S. Department of Energy, Update: Nuclear Power Program Information and Data, DOE/NE-0048/8, Feb. 1985, p. 57; and a 1972 study by the Atomic Energy Commission (WASH-1139), a 1975 update by the Energy Research and Development Administration (update to WASH-1139), and a 1970 Sandia National Laboratory study (NUREG/CR-0382 and SAND 78-2359). Cited in Kriesberg, 11/87, p. C-7.

In addition to uncertainty regarding model assumptions, there is uncertainty associated with the actual costs of facility construction. The estimated costs of the Yucca Mountain facility increased approximately $8 billion between 1983 and 1988.[41] (Chappie, 1453).

From the level of uncertainty involved with all aspects of projections it is clear that there is a significant possibility that it will be underfunded. Even DOE's own models show fund shortfalls if average inflation or real interest rates are off by even 1% over the 100 year model period. All net fund estimates include interest earned on the positive fund balance during the earlier years.

Low End Estimate. We assume DOE's model is correct and that there will be no shortfall in the fund, yielding zero subsidy.

High-End Estimate. We assume that GAO's estimates of fund shortfalls, due to the items listed above, is correct. This yields an end of facility life fund deficit of $45.8 billion for a one-repository system and $80.2 billion for a two-repository system (in 1989$). (GAO/RCED-90-65, 39). Using information provided by GAO on the expected duration of fund collections, and the expected life of the facility, this large deficit is converted into annual payments which, if collected during the time the waste fund accepts waste, would provided enough funds to avoid a shortfall. (Our high-end estimate is based on a 1-repository system).

Insolvency of Contributors Prior to Repayment

Although current fees are collected on a current basis, payment of the one-time assessments to fund government handling of waste generated prior to 1983 was not. Utilities were given the option of paying in full by June 30, 1985 with no interest; in 40 quarterly payments with interest; or in a future lump-sum payment (including interest) by January 1998.[42] This payment method gives rise to subsidies through the interest rate charged, and through the potential default on obligations to pay.

Interest Rates. The unpaid balance accrues interest at the government's rate of borrowing until paid in 1998. The cost of capital for these utilities, especially those with insecure financial conditions (see below), would be higher. While the utilities who deferred payment are definitely being subsidized and should be included in our high estimate, we assume that our estimate of the subsidy to the Waste Fund overall would not change, and that the low interest payments are already reflected in the size of the fund deficit at closure.

Default on One-Time Payment. According to the Inspector General of the Department of Energy, 11 of the 17 utilities who chose to defer payments until 1998 are in uncertain financial position and may not be solvent to pay. (DOE/IG-0280 cited in GAO/RCED-90-65, 45). These 11 utilities owe a total of $2.1 billion in interest and principal by 1998. (DOE/IG-0280, p. 1).

Low-End Estimate: Zero; all utilities will pay their debt in its entirety.

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[41]Between 1983 and 1986, estimated cost of building a facility increased by between $2.1 and $10.4 billion (range estimates). This corresponds to a percentage increase of between 9.5 and 45.8%. (GAO/RCED-87-121, 48).

[42]The assessed interest rate is the 13-week Treasury bill rate compounded quarterly between April 7, 1983 and the first payment. Under the option of 40 quarterly payments, once the first payment is made, interest is calculated at the 10-year Treasury note rate in effect at the time. (Office of Civilian Radioactive Waste, 1989 Annual Report, 39). These interest rates are probably significantly lower than the utilities' costs of borrowing.

High-End Estimate: Based on the concerns expressed regarding utility solvency, we assume that only 50% of the amount required will be repaid. This generates an expected loss of $1.05 billion in 1998 at the facility opening. Using the period between 1985 (when utilities could pay in full without incurring any interest charges) and January 1998 when the payment is due, and a discount rate of 6.804% (the average of the monthly average 3-month treasury bill rates between 1985 and 1989 as a proxy for the interest rate on the 40 quarterly payments - see note 42), we calculate the annual payment that would be needed to avoid a shortfall.

Uncompensated Risk Bearing by the American Public

Upon payment into the waste fund, the power plant liability for nuclear waste shipments ends. It is the responsibility of the federal government to package the waste, ship it to the disposal site, dispose it, and monitor the disposal site. All of these activities involve risk; risk of spills, accidents, material loss, exposure of the population to radioactivity, etc. All of these risks are borne by citizens, especially by those on rail or highway transport routes to Yucca Mountain, essentially for free, since the government and all contractors are indemnified under the Price-Anderson Act. (Kehoe, 3,4). With one disposal site in Nevada, but with nuclear plants all over the nation, some of the wastes will be shipped for thousands of miles. It is clear that

> Government responsibility for ultimate waste disposal removes significant uncertainties from those investing in nuclear power production. (Bowring, 63).

The risks are not insignificant, and should be regarded as subsidies. We are, however, unable to quantify them and include them here.

Lack of a Required Rate of Return and Tax-Exempt Status. The lack of any required return on invested capital, along with an exemption from paying federal income taxes, both reduce the costs of handling nuclear waste. These benefits do not exist for competing fuels. Hazardous and combustion waste from coal burning, for example, must be disposed of at facilities which are often privately owned and operated. The disposal prices, unlike that for nuclear waste, must be high enough to provide an adequate after-tax return for the operator. As with uncompensated risk bearing, these subsidies do not appear in our total.

Decommissioning

Decommissioning one or more nuclear waste facilities at the ends of their productive lives is included in the DOE Waste Fund Fee Adequacy Assessments. We assume that the provisions for decommissioning are sufficient and that there is no additional subsidy in this area.

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U.S. GAO. Nuclear Waste: Quarterly Report as of March 31, 1990. February 1991. GAO/RCED-91-55.

U.S. GAO. Nuclear Waste: Status of Actions to Improve DOE User-Fee Assessments, June 1992. GAO/RCED-92-165.

U.S. Office of Management and Budget. Budget of the United States Government, Fiscal Year 1992.

DOE: Nuclear Waste Fund

Part 1: Shortfall in Accrual for the Nuclear Waste Facility Since Fund Initiation

	One Repository System	Two Repository System	
Future Value of Facility Shortfall	44,000	77,000	GAO, 39 - In Constant 1988 Dollars
	45,814	80,174	Inflated to Constant 1989 Dollars

(1) Assumes no new orders for nuclear reactors, capping the reactors paying into the fund at current capacity.

Part 2: Time Frame to Accrue for Shortfall

Beginning of Fund Collection	1983	1983	GAO, p. 9.
No new waste received	2027	2042	GAO, 32.
Projected End of Facility Life	2068	2089	GAO, 25
Years of Fee Collection	44	59	
Years of Administration After Waste Receipt (and fee collection) Ceases	41	47	

Part 3: Calculation of Shortfall At Point Fee Collection Ceases

Rationale. After the facility stops taking new wastes (and fee collection ceases), the remaining costs are primarily administrative according to GAO. These costs are small compared to the costs of facility construction. As a result, the shortfall at this point in time (more than 40 years prior to facility closure) will be almost as big (in present value terms) as at the end of the facility life. We therefore convert the end-of-facility life shortfall into the shortfall in 2027 and 2042, respectively. In addition, the entire deficit must be accrued by the time waste collection ceases since after that point a user fee would be impossible.

A. Discounting End-of-Facility Deficit to the Point at Which New Waste Collection Ceases in 2027 and 2042

Shortfall at Point of Facility Closure	45,814	80,174	From Part 1 above, in 1989$
Assumptions:			
Years between closure and cessation of waste fee collection	41	47	From Part 2 above
Real Rate of Growth of Surplus Funds	0.03	0.03	Note 1
PV of Shortfall in 2027 and 2042	13,635	19,984	

B. Annual Payments Needed to Make up Shortfall by 2027 and 2042

PV of Shortfall in 2027 and 2042	13,635	19,984	
Collection Start Date	1983	1983	
Collection End Date	2027	2042	
Number of Collection Years	44	59	
Real Rate of Interest	0.03	0.03	Note 1
Annual Payment (Millions of 1989$)	153.1	127.0	
Commercial Share of Shortfall	0.851	0.827	Administrative allocation; Nuclear Waste Fund Fee Adequacy, 11/90, 13
Net Annual Subsidy to Commercial Sector	130.3	105.0	Note 2

C. High and Low Estimates

High Estimate	130.3	
Low Estimate	0	Note 3

Notes to Part 3:

(1) While this interest rate is higher than the historical real return on long-term corporate bonds and government securities between 1926 and 1990, we use it since it was the value used in the initial calculations of the Waste Fund shortfall. Since these initial calculations impute interest on the deficit at 3%, using any other discount factor would overstate the current value of losses.

(2) Calculations yield an average annual shortfall. Actual cash inflows and outflows on an annual basis would yield somewhat different results.

(3) Both scenarios shown in part 3B represent only two of the modeling results by DOE and GAO. Depending on the assumptions one makes regarding inflation, costs, and yields over the next 100 years, the Waste Fund may not run a deficit. Our low estimate, therefore, conservatively assumes that there will be no shortfall.

Part 4: Projected Default Rates on One-Time Payments

	Low Est	High Est	
Funds Owed ($Billions)	2.1	2.1	Principal plus interest due in 1998 (DOE/IG-0280, 1)
Date Due	1998	1998	
Date Interest Accrual Began	1985	1985	
Period of Accrual (inclusive)	13	13	Payments prior to 1985 could be paid with no interest charge. Payments due January 1998.
Discount Rate	0.06804	0.06804	Note 1
Implied Annual Accrual to Pay Lump-Sum Payment in 1998	105.6	105.6	
Expected Default Rate	0.00%	50.00%	Guess, based on DOE Inspector General Report
Annual Subsidy, 1-time payment defaults	0	52.8	Note 2

Notes to Part 5:

(1) This discount factor is the average of the monthly average 3-month Treasury bill rates between 1985 and 1989. This is the imputed interest rate used by the government to calculate interest on deferred payments by the utilities included in the total above who plan to pay their 1-time assessment for waste generated prior to 1983 in a lump sum payment in 1998. Since the rate is a nominal one, it incorporates inflation within it.

(2) The individual utilities that defer payment until 1998 receive an additional subsidy by the fact that their debt accrues interest at federal borrowing rates, which are significantly lower than their own. However, the net subsidy to the Waste Fund is unaffected since the interest rate subsidy simply increases the ultimate fund shortfall, and is incorporated in the value we use in Part 1.

Part 5: Summary of Annual Subsidies to the Commercial Users of the Nuclear Waste Fund

	Low Est	High Est	
Facility Shortfall	0.0	130.3	
Expected Defaults on 1-time Pymt	0.0	52.8	
Less Fund Reciepts Used for Non-nuclear Waste Purposes	0	(1.4)	GAO, Dec 1990, p. 41.
Tax-Exempt Status	NQ	NQ	See discussion in text
No Required Rate of Return	NQ	NQ	See discussion in text
Uncompensated Risk Bearing by Population Along Waste Transport Route	NQ	NQ	See discussion in text
Total Quantified Subsidies	0.0	181.7	

Sources:

(1) U.S. DOE, Office of Civilian Radioactive Waste. "Nuclear Waste Fund Fee Adequacy: An Assessment," November 1990.

(2) U.S. DOE, Office of the Inspector General. "Followup Review of Fees Paid by the Civilian Power Industry to the Nuclear Waste Fund," March 26, 1990. DOE/IG-0280

(3) U.S. GAO. "Energy Management: Better DOE Controls Needed Over Contractors' Discretionary R&D Funds," Dec. 1990.

(4) U.S. GAO. "Nuclear Waste: Changes Needed in DOE User-Fee Assessments to Avoid Funding Shortfall," June 1990. GAO/RCED-90-65.

DEPARTMENT OF ENERGY: ENERGY INFORMATION ADMINISTRATION

EIA collects, publishes, and distributes a wide range of data about energy to industry and government. EIA also operates macroeconomic models of energy consumption and supply. Costs are allocated to fuels based on break-outs of activities in the DOE 1992 Budget Justification document (v. 4, 565-581).

Information on Energy. EIA collects and publishes data on oil, gas, coal, nuclear, electric, and alternate fuels. Alternate fuels data contains information both on renewables and on "clean liquid fuels" which include synfuels. Most of the budget line items are self-explanatory. Those which are not straight forward are listed below:

Reserves and Natural Gas Information. Spending was arbitrarily split between oil and gas.

Energy Markets/End Use. Benefits both energy supply (through the provision of important market data) and efficiency (by identifying opportunities for demand reduction). Since conventional fuels are more likely to have alternative sources of information than the smaller, more fragmented efficiency industry, one half of this item was allocated to efficiency, and the other half to the EIA spending mix.

Administration, Support, Statistics. Allocated on the basis of the other EIA spending.

Department of Energy: Energy Information Administration

Program	Total Energy	Coal	Oil	Gas	Electric. General	Electric. Fission	Electric. Oil	Electric. Coal	Electric. Gas	Electric. Hydro	Effic.-nd-Us	Effic.-Supply	Biomass	Wind	Solar	Geotherm.	Other Renew.	Allocation Basis	Carbon Increasing?
OIL AND GAS																			
Petroleum Supply Information	5.2		5.2															Oil	N
Petroleum Marketing Information	4.0		4.0															Oil	N
Reserves & Natural Gas Information	3.9		2.0	2.0														1/2 oil, 1/2 gas (arbitrary)	N
COAL, NUCLEAR, ELECTRIC, ALTERNATE FUELS																			
Coal Information	1.1	1.1																Coal	N
Electric Power Information	2.3	0.0	0.0	0.0	0.0	0.4	0.1	1.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Current electric mix	N
Nuclear Information	1.5					1.5												Fission	N
Alternative Fuels Information	0.0																0.0	1/2 Renewables, 1/2 coal (synfuels)	N
Sub Total	18.0	1.1	11.2	2.0	0.0	1.9	0.1	1.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
ENERGY MARKETS/END USE	5.2	0.16	1.61	0.28	0.00	0.28	0.02	0.19	0.03	0.03	1.30	1.3	0.00	0.00	0.00	0.00	0.00	1/2 effic. (mkt studies); 1/2 spending mix	N
OTHER																			
Data Processing	6.7	0.4	4.2	0.7	0.0	0.7	0.0	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Above spending mix	N
Information Services	0.7	0.0	0.4	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Above spending mix	N
Statistical Standards	1.1	0.1	0.7	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Above spending mix	N
Program Direction	21.0	1.3	13.0	2.3	0.0	2.3	0.2	1.5	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Above spending mix	N
Total	52.7	3.1	31.0	5.4	0.0	5.4	0.4	3.6	0.6	0.6	1.3	1.3	0.0	0.0	0.0	0.0	0.0		
Relevant Allocation Bases																			
Electricity Mix	0.00%				0.00%	19.00%	5.68%	55.82%	9.59%	9.52%	0.00%	0.00%	0.04%	0.00%	0.00%	0.34%	0.00%	From ALLOCATION WK1	

Sources:
U.S. OMB, "Budget of the U.S. Government, FY1991."
U.S. DOE, "Budget Justifications," FY 1992.

DEPARTMENT OF ENERGY: POWER MARKETING ADMINISTRATIONS

The Power Marketing Administrations (PMAs) include the Alaska, Bonneville, Southeastern, Southwestern, and Western Area Power Administrations. Most of the power generated by federally owned facilities is marketed by these organizations. The power infrastructure was mostly constructed by the Army Corps of Engineers and the Bureau of Reclamation. (Cole et al, 138). PMAs are subsidized when power revenues are not sufficient to repay operating costs and construction costs assigned to power, and when money to fund construction is provided to the PMAs by the government at below-market rates. They are also subsidized through their tax-exempt status. Not having a requirement to earn a positive return on the billions of dollars of public funds invested in their infrastructure also reduces the cost of PMA-provided power.

The PMAs consist primarily of hydroelectric facilities and the associated transmission systems, although some of the larger ones, such as BPA, also purchase power from thermal generating units. The dams which comprise the PMAs were built with a number of purposes in mind, including flood control, irrigation, power generation, navigation, and recreation. Another area of expenditures, fish and wildlife, deals with the protection of these natural resources (many of which are adversely affected by the habitat modification created by the dams). The federal government allocates expenditures on dam construction among these various uses. The portions accruing to power must be paid back to the U.S. Treasury through power sales according to conditions explained in more detail below (see "Interest Rates Subsidies on Unrepaid Debt").

Irrigation portions must also be repaid, although numerous exceptions are made for users deemed unable to reimburse the irrigation cost. In some cases, a portion of the irrigation costs are assigned to power generation for repayment. Municipal and industrial water investment, and a portion of salinity control, must also be repaid. Non-reimbursable expenses include investments in fish and wildlife, recreation, and highway improvements, although expenditures to alleviate ecosystem impacts from flow modification from power generation are usually paid with power revenues. (GAO/RCED-90-2FS, 15). Due to existing statutory requirements, irrigation debt does not accrue interest even though power debt does.

Operations of all of the PMAs other than Bonneville are funded by Congress. Bonneville is the only one that retains the revenues from power sales to operate its power system rather than turning them over to the Treasury. (Kaufman et al, 6). PMAs, for the most part, sell to power wholesalers. Some customers buy power direct from the PMAs at a wholesale rate. Since part of the reason for constructing the power facilities was regional development, some industrial power users are eligible for discount power rates. (Kaufman et al, 29).

Although each PMA is required to submit an annual report to Congress, as well as to do a Power Repayment Study examining the repayment of the initial federal investments, each one approached these tasks in a different manner. As a result, the information that was available varied. The differences between the spreadsheets for this section reflect this variation.

Sources of Subsidies in the Power Marketing Administrations

The PMAs are supported by the federal government in a number of ways. These are presented in more detail below.

Operating Subsidies. In some years (although not in 1989), PMAs do not earn enough revenue on power sales to cover the costs of providing the service, even before capital repayment. The impacts of these shortfalls are reflected in the size of total unrepaid debt to the government and are not examined separately.

Interest Rate Subsidies on Unrepaid Debt. Although the PMAs must repay government debt within a "reasonable" time period (generally 50-60 years), there is no scheduled repayment plan. Although early loans charged interest rates above the government's costs of borrowing, the rates charged were later fixed by statute. This led to significant loan activity at subsidized rates. Since there is no required loan amortization until the final payment is due, PMAs minimize the costs of funds by deferring repayment of all low cost debt until the end of the loan life. Due to statutory requirements, repayment of government debt is the lowest priority use of surplus funds[43] (Barringer, 4/10/92). Every year for which the outstanding loans remain confers additional interest rate subsidies on the PMAs. For the purpose of calculating this interest rate subsidy, we assume that all capital plus subsidized interest will be repaid.

The government bears a direct cost from these loans since it subsidizes the rate at which PMAs borrow from the Treasury. In addition, it must refinance the debt one or more times during the period which the PMA holds the funds,[44] exposing the federal government to significant inflation and interest rate risks. We estimate the subsidies using a number of assumptions:

- Low end estimates use the yield on the longest term Treasury bonds available at the time of debt issuance, refinanced at the expiration of the debt instrument until the available instrument would remain outstanding in 1989. We assume a 30 year refinancing period (see Chapter B6, *Background Information on Debt*, for the rationale behind this assumption). For example, debt issued in 1946 would be refinanced in 1976. That debt would remain outstanding today. Thus, the interest rate subsidy in 1989 for this loan would be equal to [30 year bond rate in 1976 minus the actual rate charged the borrower]. Through this induced refinancing, the inflation and interest rate risk borne by the government by offering such long-term loans is approximated.

- High end estimates use the weighted average long-term bond rate on new power, gas, and light bonds as calculated by Moody's bond rating service. The use of this data assumes that the length of the power bonds is the same as the Treasury bonds, and that both were refinanced in the same years.

- Where payment of specific principal is not apparent (i.e., for all PMA's other than Bonneville), marginal interest rate subsidies could not be calculated. Therefore, interest rate subsidies are calculated on the net increase in federal investment for a particular year. We conservatively assume that principal repayments of prior debt reduce the outstanding debt with the highest cost to the government first.

- This methodology ignores reverse yield curves, where a rational investor would issue shorter-term, lower cost debt in expectation of future refinancing at a lower rate. Also ignored is the potential for refinancing of high cost debt prior to maturity.

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[43] Surplus funds are power revenues in excess of operating and private market debt service needs.

[44] There is some controversy over the depth of long-term debt markets in the early part of this century. We assume 30 year borrowing. See Chapter B6, Background Information on Debt, for more information on this issue.

What is in the Unrepaid Debt? All data used in this section include federal investments for power only; non-power-related costs assigned to the power users for repayment have been excluded. This debt figure does include all generation and transmission assets.

The initial year of unrepaid debt occurs when the first plant came into service, and reflects all project-related capitalized costs up to that time, including capitalized interest. Facilities in construction are generally not held on the PMAs' books, but rather on the books of the constructing agency, the Army Corps of Engineers or the Bureau of Reclamation. Upon completion, the capitalized value of that asset will be transferred from the construction agency to the PMA.

Provision of Lines of Credit at No Charge. Private markets sell access to credit lines because the provision of that credit requires lenders to restrict other lending activity somewhat to ensure that the promised credit is available when needed by the customer. These charges, generally a fraction of a percent, are called "commitment fees." Bonneville has a line of credit with Treasury for $3.75 billion, but does not pay any holding fee to the federal government. While Congress has the authority to restrict BPAs use of Treasury funds if it desires, banks may also curb credit line provisions under certain circumstances. We therefore impute a commitment charge for BPA's credit line in our high estimate.

Value of Intermediation. PMA short-term debt from Treasury or the Federal Financing Bank carry lower interest rates than would be available to an equivalent private sector borrower. The value of this government intermediation is included in the high estimate where data were available to do so.

Cross-Subsidies. Large write-offs of capital assets, such as nuclear plants, are borne by the current power mix. We convert these into annualized charges over the estimated period of loss and charge them against the energy source in question (in this case fission) and rebate them to the current power mix. While one write-off for BPA's share of a failed nuclear project was expensed in 1988 (and is therefore excluded from our estimates), we do include financing costs on two other "deferred" nuclear projects. Similarly, repayment of the irrigation portion of dam construction debt by power customers is converted into an annualized charge and rebated to the current power mix.

Interest Gain from Tax Exempt Debt. Any use of tax-exempt bond issues by the PMA's provides an additional subsidy in the cost of funds. However, these subsidies would be incorporated as part of the aggregate estimate in the tax-exempt bond issues for public power line item in the chapter on tax subsidies, and are not addressed in this section.

Tax Exempt Status and No Required Rate of Return. Rates set by the PMAs cannot return any net return (profit) to the government, despite the large risks and tied up capital of the enterprise.[45] (Kaufman et al, 8). This, coupled with the tax-exempt status of any net revenues, significantly reduce the cost structure of federally owned power as compared to privately-owned power. The net result is that

[45] PMA's can earn a "surplus." For example, in 1989, BPA earned about a 2% net return on sales, and plans for more. This is generally to create a buffer for repayment of federal debt in bad years. (Barringer, 4/13/92). However, the rates of return remain significantly below required levels for private market provision of services.

customers may continue to purchase electricity from the PMAs for reason of their beneficial ownership structure rather than their underlying economics.[46]

Allocation of Subsidies to Energy Types

Subsidy estimates are allocated to the current installed power mix of each PMA. Where data were available, this power mix includes investments into energy efficiency, through estimates of "average megawatts of reduced demand." Negative values for hydroelectricity reflect large cross-subsidies for fission and irrigation.

Areas of Potential Subsidization

In addition to areas where clear benefits are conferred to the PMAs by the federal government, there are a number of additional areas where there may be subsidies, but for which additional research would be necessary in order to refute or support any claims. These areas include:

Unreimbursed Services from Other Federal Agencies. We assume that all of the historic construction work done on the hydroelectric facilities by the Army Corps of Engineers and the Bureau of Reclamation has either been repaid or included in the government unrepaid capital figures provided by the PMAs, and yields no additional subsidy.

Share of Construction Allocated to Power and Unreimbursable Fish and Wildlife Costs. We assume that the share of total construction costs allocated to power by the government are fair estimates of the relative beneficiaries of the hydro projects. Similarly, we assume that all fish and wildlife expenditures associated with power production (e.g., from flow modification) are included in the amounts repaid by power users rather than reported as unrelated to power and paid by Congressional appropriations.

Below-Market Sales of Power to Certain Customers. There is a wide range of prices charged for power delivered to various customers. There are many possible explanations for pricing differentials, including volume purchase discounts, contracted versus spot purchases (firm versus non-firm),[47] or wholesale versus retail sales. However, there still appears to be preferential pricing of power to certain customers.[48] While this confers subsidies to certain power users, we do not try to measure the effect of this differential pricing, although data are presented on this issue for SWPA and WAPA.

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[46]While we were unable to calculate the value of this benefit in 1989, one estimate done by the Energy Information Administration for 1990 illustrates the potential impact of these two special operating conditions. Using the pre-tax rate of return on undepreciated assets for investor-owned utilities that year (15.3%), EIA found that the PMAs would need to charge prices more than $1.9 billion higher per year than their current prices. Of this amount, BPA comprised $1.2 billion of the shortfall, WAPA $505 million, and SWPA $102 million. (EIA, 65).

[47]Some non-firm power, such as power generated from water that has to be spilled over the dam regardless of power sales, can be purchased very cheaply. Investor-owned utilities are large purchasers of this power. (Barringer, 4/13/92).

[48]For example, BPA has a variable charge for aluminum producers which pegs the price of electricity to the price of aluminum.

Alaska Power Administration

APA has two main power systems, the Snettisham and the Eklutna. All financing for new construction is done at statutorily-assigned interest rates. Financing for replacements is done at the Treasury's cost of funds. APA did not carry any debt on replacement expenditures during 1989; therefore, data on replacements are not included on APA spreadsheet which follows this text.

Bonneville Power Administration

History. BPA was created in 1937 to market power from the Bonneville and Grand Coulee Dams on the Columbia River. In 1974 BPA gained the right to issue its own bonds to construct, operate, and maintain its own transmission system, independent of congressional appropriations. (Cole et al, 147).

During the World War II period, the Federal Government built plants for steel and aluminum production in the Bonneville service area. These industries were large consumers of electricity, and took advantage of BPA's cheap power. After the war needs were over, the plants were sold to private companies. (Cole et al, p. 128). This industrial concentration has remained. BPA now services more than 1/3 of the domestic primary aluminum smelting, and 11 percent of world capacity. They have recently introduced power rates which are tied to the price of aluminum. This seems to protect industries from having to upgrade their capital stock. According to one researcher, "[w]ith a couple of exceptions, northwest smelters are older and less energy efficient than the majority of the world's smelters." (Spies, 162, 163).

Interest Rate Subsidies on Unrepaid Debt. Since October 1973, BPA's interest costs for new borrowing have reflected the Treasury's cost of borrowing for similar investments. Prior to that date, interest rates were less than the market rate. (Kaufman et al, 8). Since Bonneville is not required to repay its federal debt on any annual time frame, DOE policy to minimize interest expenses is to defer payments on low interest debt until the end of the available repayment period. This is why BPA's weighted average interest rate remains so far below market rates.

Prior to 1965, BPA made a fixed annual repayment on outstanding debt.[49] (GAO/RCED-84-25, 2). In 1972, Bonneville began repaying debts on the basis of highest interest first, rather than in the order in which they were incurred. (GAO/RCED-84-25, i). Their debt repayment plan delays the bulk of repayment until far into the future.

Lines of Credit. BPA is the only PMA with debt-issuance authority, and may issue up to $3.75 billion in debt to the Treasury at "terms and conditions comparable to debt issued by U.S. Government corporations." (BPA Annual Report, 31). As mentioned in the introductory portion of the PMA section, private banks charge a commitment fee for making such credit available. While Congress has the authority to restrict BPAs use of Treasury funds if it desires, banks may also curb credit line provisions under certain circumstances. We therefore impute a commitment charge for BPA's credit line in our high estimate.

Government Intermediation on Borrowing Rates. BPA does have significant borrowings from the U.S. Treasury. We measure the value of federal intermediation in our high estimate by calculating the

[49] This was a practice utilized by BPA but not required by law.

BPA interest rate subsidy in relation to the private cost of borrowing rather than the Treasury's cost of borrowing.

Cross Subsidies. BPA has realized enormous losses from its involvement with the Washington Public Power Supply System. Annualized losses from this involvement are assigned to fission power and rebated to the existing power mix. Repayment of irrigation-related costs by power users are also rebated to the existing power mix.

Existing Power Mix. The BPA power mix represents installed operating capacity. Plants in-process, but not yet generating power, are excluded. Were such plants included, the fission fraction would increase. The efficiency share of the power mix reflects cumulative investments into energy efficiency.

Southeastern Power Administration

The Southeastern Power Administration markets power from 22 hydroelectric projects located throughout the Southeastern United States. All costs are therefore allocated to hydroelectricity. SEPA is the one power administration that does not own its own transmission facilities. (Kaufman and Dulchinos, x).

Data from SEPA are based on individual hydroelectric projects. Interest rates for some of these projects were fixed by statute. Others have been computed using data on annual interest payments and unrepaid federal investments. The interest rate subsidy is calculated using the following assumptions:

- Any net increase in debt in a particular year is financed at the longest bond term available at the time, and refinanced according to the methodology presented at the beginning of the PMA section.

- Any net decrease in debt reduces the debt with the highest interest rate spread (government cost of funds minus the rate charged SEPA) first.

Southwestern Power Administration

The Southwestern Power Administration markets hydroelectric power from Federal hydroelectric facilities located in the Southwestern United States. Annual data on the marginal cost of capital were not available from SWPA. As a proxy, the overall weighted average interest rate on outstanding debt was used instead.

Write-off of Truman Hydroelectric Plant Power Generation Liability. Due to concerns over water turbulence, river bank erosion, and fish kills, generation of power from the Truman Plant has been limited to less than 50 percent of the original design capability. (SW '89 Annual Report, 7). As a result, the repayable capital was limited to 44 percent of the full cost allocation for the dam. This yielded a reduction in federal capital investment to be repaid by power of $78.5m in 1989. Should the facility ever be operable at the design capacity, repayment of this debt would once again be incorporated into power rates, although this scenario currently seems unlikely.

These losses are real losses, since the capital has already been invested. While they may be attributable to engineering mistakes, the losses nonetheless reflect the riskiness of some of these ventures.

A private industry would either pay off the invested capital with the current power generating ability or go bankrupt. We therefore consider the write-off to be a subsidy to hydroelectric power. The write-off is amortized over a 88-year period in the low estimate (reflecting the expected service life of generating plant) and over a 50-year period in the high estimate (reflecting the allowed repayment period of federal construction debt). (SW 1989 Ann. Rept., 25).

Potential Below-Market Pricing. Large pricing differentials could be yielding cross-subsidies to certain classes of users. This area is worthy of additional research.

Southwestern Power Administration: Pricing Differentials

Type of Customer	Energy Sales (1000 kWh)	Total Sales ($)	Ave. Cents/kWh
Municipalities	1,822,750	22,947,109	1.52
Cooperatives	3,538,880	53,141,098	1.02
Government Agencies	204,760	5,516,317	2.19
Utility Companies[50]	615	2,460	0.96

Source: Southwestern Power Administration, 1989 Annual Report, pp. 36,37.

Western Area Power Administration

Detailed data from WAPA were not available in usable form. As a proxy, the cost of long-term funds to the government in 1989 minus the weighted average interest rate on WAPA's outstanding power debt as of 1989 was used to estimate interest rate subsidies. This approach implicitly assumes that all debt was refinanced in 1989, rather than comparing marginal rates as was possible (at least to some degree) with other PMAs such as Bonneville.

Cross-Subsidies to Irrigation. Cross-subsidies to irrigation from power were rebated to the current power mix. Cumulative irrigation repayment assigned to the power sector was amortized over the repayment period and rebated to the power mix.

Potential Under-realization of Capital Depreciation. WAPA estimates for capital lives range from 64 to 93 years (WAPA '89 Ann. Rept., 34). This expected life exceeds estimates used by other PMAs, and, if it is too long, will force system users towards the end of the facility life to incur large operating losses. To the extent that current depreciation charges are too low, current losses will be understated.

Potential Below-Market Pricing. Large pricing differentials could be yielding cross-subsidies to certain classes of users. This area is worthy of additional research.

[50]Sales include excess energy only.

Western Area Power Administration: Pricing Differentials

Type of Customer	Energy Sales (1000 kWh)	Total Sales ($)	Ave. Cents/kWh
Municipalities	10,456,964	159,241,951	1.52
Cooperatives	8,087059	82,410,720	1.02
Federal Agencies	1,959,308	42,829,047	2.19
State Agencies	4,614,664	44,072,692	0.96
Public Utility Districts	3,318,697	70,492,613	2.12
Irrigation Districts	2,280,853	24,802,078	1.09
Investor-Owned	2,2423,184	50,963,391	0.23
Interdepartmental	540,247	8,570,878	1.59
Interproject Sales (within Western)	6,580,108	84,677,057	1.29
BurRec Projects and Facilities	1,715,744	9,594,739	0.56

Source: Western Power Administration, 1989 Annual Report, p. 23.

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Alaska Power Administration

Part 1: Interest Rate Subsidies and Subsidies through Deferred Repayment ($Thousands)

SNETTISHAM POWER PLANT

Year	Last Refinance Year	Gov't Long Term T-Bond Rate (At Refinancing)	Power, Light & Gas Util.	Cumul. Federal Invest	Initial Invest & Expansions: Amount Unpaid (000s)	Initial Invest & Expansions: Net Increase in Debt	Interest Rate	LOW: Int. Rate Subsidy	LOW ESTIMATE: Annual Int. Subs.	LOW: Maximum Spread	HIGH: Int. Rate Subsidy	HIGH ESTIMATE: Annual Int. Subs.	HIGH: Maximum Spread
			(5)	(1)	(1)	(1)				(2)			(2)
1954	1984	0.1241	0.1425										
1955	1985	0.1079	0.1183										
1956	1986	0.0778	0.0961										
1957	1987	0.0859	0.0974										
1958	1988	0.0896	0.1003										
1959	1959	0.0413	0.0492										
1960	1960	0.0406	0.0472										
1961	1961	0.0392	0.0472										
1962	1962	0.0399	0.0440										
1963	1963	0.0405	0.0440										
1964	1964	0.0419	0.0455										
1965	1965	0.0427	0.0461										
1966	1966	0.0477	0.0553										
1967	1967	0.0501	0.0607										
1968	1968	0.0545	0.0680										
1969	1969	0.0632	0.0798										
1970	1970	0.0687	0.0879										
1971	1971	0.0612	0.0770										
1972	1972	0.0601	0.0750										
1973	1973	0.0712	0.0791										
1974	1974	0.0806	0.0959										
1975	1975	0.0799	0.0997	74,470	74,470	74,470	0.0300	0.0499	3,716		0.0697	5,191	
1976	1976	0.0761	0.0892	77,763	77,686	3,216	0.0300	0.0461	148		0.0592	190	
1977	1977	0.0775	0.0843	78,909	78,676	990	0.0300	0.0475	47		0.0543	54	
1978	1978	0.0849	0.0930	79,357	78,889	213	0.0300	0.0549	12		0.0630	13	
1979	1979	0.0928	0.1085	79,427	78,643	(246)	0.0300	0.0628	(14)	0.0549	0.0785	(17)	0.0697
1980	1980	0.1127	0.1346	79,427	78,250	(393)	0.0300	0.0827	(22)	0.0549	0.1046	(27)	0.0697
1981	1981	0.1345	0.1631	79,415	77,768	(482)	0.0300	0.1045	(26)	0.0549	0.1331	(34)	0.0697
1982	1982	0.1276	0.1493	79,410	77,219	(549)	0.0300	0.0976	(30)	0.0549	0.1193	(38)	0.0697
1983	1983	0.1118	0.1270	79,372	76,562	(657)	0.0300	0.0818	(36)	0.0549	0.0970	(46)	0.0697
1984	1984	0.1241	0.1425	79,372	75,873	(689)	0.0300	0.0941	(38)	0.0549	0.1125	(48)	0.0697
1985	1985	0.1079	0.1183	98,646	94,389	18,516	0.0300	0.0779	1,442		0.0883	1,635	
1986	1986	0.0778	0.0961	98,646	93,551	(838)	0.0300	0.0478	(65)	0.0779	0.0661	(74)	0.0883
1987	1987	0.0859	0.0974	98,646	92,689	(862)	0.0300	0.0559	(67)	0.0779	0.0674	(76)	0.0883
1988	1988	0.0896	0.1003	98,646	91,801	(888)	0.0300	0.0596	(69)	0.0779	0.0703	(78)	0.0883
1989	1989	0.0845	0.0992	98,646	90,777	(1,024)	0.0300	0.0545	(80)	0.0779	0.0692	(90)	0.0883
Annual Value of Interest Subsidies on Outstanding Borrowings in FY89									4,918			6,554	

Notes:

(1) Cumulative federal investment is net of principal repayments and plant retirements. The amount unpaid is APA's outstanding debt to the goverment, with annual increases shown in the "Net Increases in Debt" column.

(2) Maximum spread is the largest difference between APA's cost of debt and the private market interest rate in any year that APA borrowed. This spread is calculated using T-bond rates in the low estimate and public power rates in the high estimate.

(3) Debt on equipment replacements made after 1972 were charged Treasury costs of borrowing. Only the high estimate shows any subsidy for debt on replacement after 1972. All Eklutna and virtually all Snettisham replacements were repaid in the year the investment was made. Replacements are immaterial to this analysis and are excluded.

(4) The methodology for calculating the last refinancing year is described in detail in Appendix B7.

(5) Low Estimates use the interest rate differential between the Treasury bond rate and the interest charged APA. High estimates use Moody's weighted average cost of new power, light, and gas bonds to estimate the value of federal intermediation.

(6) Lending rates to APA for new construction were set by statute.

(7) Estimates of annual interest rate subsidies conservatively apply repayments to the highest cost debt to the government.

Part 2: Summary Table and Allocation of Subsidies to Fuel Types (Millions of $)

	Low Est	High Est
Eklutna	1.1	1.4
Snettisham	4.9	6.6
Total	6.1	7.9

All APA plant is hydroelectric. There are no irrigation subsidies included here.

Sources:

Alaska Power Administration, "1989 Snettisham Repayment Study," 5/15/91

Alaska Power Administration, "1990 Eklutna Power Repayment Study," 1/16/92

Scott Willis, Alaska Power Administation, Personal communication, January 1992

Alaska Power Administration

Part 1: Interest Rate Subsidies and Subsidies through Deferred Repayment ($Thousands)

EKLUTNA POWER PLANT

Year	Cumul. Federal Invest	Initial Invest & Expansions Amt. Unpaid	Net Increase In Debt	Interest Rate	LOW Int Rate Subsidy	ESTIMATE Annual Int. Subs.	Maximum Spread	HIGH Int. Rate Subsidy	ESTIMATE Annual Int. Subs.	Maximum Spread
		(1)	(1)	(1)			(2)			(2)
1954	30,521	30,521	30,521	0.025	0.0991	3,025		0.1175	3,586	
1955	30,521	30,264	(257)	0.025	0.0829	(25)	0.0991	0.0933	(30)	0.1175
1956	30,527	30,181	(83)	0.025	0.0528	(8)	0.0991	0.0711	(10)	0.1175
1957	30,497	29,891	(290)	0.025	0.0609	(29)	0.0991	0.0724	(34)	0.1175
1958	30,526	29,489	(402)	0.025	0.0646	(40)	0.0991	0.0753	(47)	0.1175
1959	30,599	29,069	(420)	0.025	0.0163	(42)	0.0991	0.0242	(49)	0.1175
1960	30,610	28,545	(524)	0.025	0.0156	(52)	0.0991	0.0222	(62)	0.1175
1961	30,963	28,285	(260)	0.025	0.0142	(26)	0.0991	0.0222	(31)	0.1175
1962	30,925	27,432	(853)	0.025	0.0149	(85)	0.0991	0.0190	(100)	0.1175
1963	30,945	26,586	(846)	0.025	0.0155	(84)	0.0991	0.0190	(99)	0.1175
1964	30,680	26,237	(349)	0.025	0.0169	(35)	0.0991	0.0205	(41)	0.1175
1965	30,513	25,708	(529)	0.025	0.0177	(52)	0.0991	0.0211	(62)	0.1175
1966	30,502	26,306	598	0.025	0.0227	14		0.0303	18	
1967	30,542	24,850	(1,456)	0.025	0.0251	(144)	0.0991	0.0357	(171)	0.1175
1968	30,534	24,210	(640)	0.025	0.0295	(63)	0.0991	0.0430	(75)	0.1175
1969	30,549	23,518	(692)	0.025	0.0382	(69)	0.0991	0.0548	(81)	0.1175
1970	30,669	23,184	(334)	0.025	0.0437	(33)	0.0991	0.0629	(39)	0.1175
1971	30,723	23,028	(156)	0.025	0.0362	(15)	0.0991	0.0520	(18)	0.1175
1972	30,729	22,512	(516)	0.025	0.0351	(51)	0.0991	0.0500	(61)	0.1175
1973	30,751	22,170	(342)	0.025	0.0462	(34)	0.0991	0.0541	(40)	0.1175
1974	30,771	22,191	21	0.025	0.0556	1		0.0709	1	
1975	30,779	22,198	7	0.025	0.0549	0	0.0991	0.0747	1	0.1175
1976	30,231	21,284	(914)	0.025	0.0511	(91)	0.0991	0.0642	(107)	0.1175
1977	30,231	20,632	(652)	0.025	0.0525	(65)	0.0991	0.0593	(77)	0.1175
1978	30,231	19,899	(733)	0.025	0.0599	(73)	0.0991	0.0680	(86)	0.1175
1979	30,231	19,536	(363)	0.025	0.0678	(36)	0.0991	0.0835	(43)	0.1175
1980	30,208	18,606	(930)	0.025	0.0877	(92)	0.0991	0.1096	(109)	0.1175
1981	30,178	17,883	(723)	0.025	0.1095	(72)	0.0991	0.1381	(85)	0.1175
1982	30,178	17,518	(365)	0.025	0.1026	(36)	0.0991	0.1243	(43)	0.1175
1983	30,178	17,006	(512)	0.025	0.0868	(51)	0.0991	0.1020	(60)	0.1175
1984	30,178	16,978	(28)	0.025	0.0991	(3)	0.0991	0.1175	(3)	0.1175
1985	30,178	15,945	(1,033)	0.025	0.0829	(102)	0.0991	0.0933	(121)	0.1175
1986	30,178	14,932	(1,013)	0.025	0.0528	(100)	0.0991	0.0711	(119)	0.1175
1987	30,156	13,998	(934)	0.025	0.0609	(93)	0.0991	0.0724	(110)	0.1175
1988	30,156	13,579	(419)	0.025	0.0646	(42)	0.0991	0.0753	(49)	0.1175
1989	30,156	12,072	(1,507)	0.025	0.0595	(149)	0.0991	0.0742	(177)	0.1175
Annual Value of Interest Subsidies on Outstanding Borrowings in FY89						1,149			1,365	

Part 1: Interest Rate Subsidies and Subsidies through Deferred Repayment

Year	Original Principal ($000s)	Current Still Outstanding ($000s)	Wght. Ave Int. at Issuance	Wght. Ave. Interest on Amt. Outstd.	Last Refinance Year	LOW ESTIMATE: Gov't L-T Rate at Last Refin.	LOW ESTIMATE: Est. Int. Rate Subsidy (%)	LOW ESTIMATE: Interest Subsidy ($Mils)	HIGH ESTIMATE: Gas, Power, & Light Rate at Last Refin.	HIGH ESTIMATE: Est. Int. Rate Subsidy (%)	HIGH ESTIMATE: Interest Subsidy ($Mils)
	(1)	(2)	(3)	(4)	(5)	(6)	(6)-(4)	(6-4)*(2)/1000	(7)	(7)-(4)	(7-4)*(2)/1000
1909	1,080	0	0.03000	0.00000	1969	0.0632	0.0000	0.0	0.0798	0.0000	0.0
1910	2,160	0	0.03000	0.00000	1970	0.0687	0.0000	0.0	0.0879	0.0000	0.0
1911	2,160	0	0.03000	0.00000	1971	0.0612	0.0000	0.0	0.0770	0.0000	0.0
1912	1,534	0	0.03000	0.00000	1972	0.0601	0.0000	0.0	0.0750	0.0000	0.0
1913					1973	0.0712	0.0000	0.0	0.0791	0.0000	0.0
1914					1974	0.0806	0.0000	0.0	0.0959	0.0000	0.0
1915					1975	0.0799	0.0000	0.0	0.0997	0.0000	0.0
1916					1976	0.0761	0.0000	0.0	0.0892	0.0000	0.0
1917					1977	0.0775	0.0000	0.0	0.0843	0.0000	0.0
1918					1978	0.0849	0.0000	0.0	0.0930	0.0000	0.0
1919					1979	0.0928	0.0000	0.0	0.1085	0.0000	0.0
1920					1980	0.1127	0.0000	0.0	0.1346	0.0000	0.0
1921					1981	0.1345	0.0000	0.0	0.1631	0.0000	0.0
1922					1982	0.1276	0.0000	0.0	0.1493	0.0000	0.0
1923					1983	0.1118	0.0000	0.0	0.1270	0.0000	0.0
1924					1984	0.1241	0.0000	0.0	0.1425	0.0000	0.0
1925					1985	0.1079	0.0000	0.0	0.1183	0.0000	0.0
1926	1,022	0	0.03000	0.00000	1986	0.0778	0.0000	0.0	0.0961	0.0000	0.0
1927	1,080	0	0.03000	0.00000	1987	0.0859	0.0000	0.0	0.0974	0.0000	0.0
1928					1988	0.0896	0.0000	0.0	0.1003	0.0000	0.0
1929					1959	0.0413	0.0000	0.0	0.0492	0.0000	0.0
1930					1960	0.0406	0.0000	0.0	0.0472	0.0000	0.0
1931					1961	0.0392	0.0000	0.0	0.0472	0.0000	0.0
1932					1962	0.0399	0.0000	0.0	0.0440	0.0000	0.0
1933					1963	0.0405	0.0000	0.0	0.0440	0.0000	0.0
1934					1964	0.0419	0.0000	0.0	0.0455	0.0000	0.0
1935					1965	0.0427	0.0000	0.0	0.0461	0.0000	0.0
1936					1966	0.0477	0.0000	0.0	0.0553	0.0000	0.0
1937					1967	0.0501	0.0000	0.0	0.0607	0.0000	0.0
1938	11,856	0	0.02500	0.00000	1968	0.0545	0.0000	0.0	0.0680	0.0000	0.0
1939					1969	0.0632	0.0000	0.0	0.0798	0.0000	0.0
1940	6,812	0	0.02500	0.00000	1970	0.0687	0.0000	0.0	0.0879	0.0000	0.0
1941	46,740	0	0.02603	0.00000	1971	0.0612	0.0000	0.0	0.0770	0.0000	0.0
1942	35,682	1,408	0.02784	0.02500	1972	0.0601	0.0351	0.0	0.0750	0.0500	0.1
1943	47,994	17,785	0.02600	0.02500	1973	0.0712	0.0462	0.8	0.0791	0.0541	1.0
1944	25,936	5,928	0.02870	0.02500	1974	0.0806	0.0556	0.3	0.0959	0.0709	0.4
1945	4,755	83	0.02500	0.02500	1975	0.0799	0.0549	0.0	0.0997	0.0747	0.0
1946	3,302	82	0.02500	0.02500	1976	0.0761	0.0511	0.0	0.0892	0.0642	0.0
1947	3,186	83	0.02500	0.02500	1977	0.0775	0.0525	0.0	0.0843	0.0593	0.0
1948	38,603	82	0.02873	0.02500	1978	0.0849	0.0599	0.0	0.0930	0.0680	0.0
1949	38,374	83	0.02875	0.02500	1979	0.0928	0.0678	0.0	0.1085	0.0835	0.0
1950	50,004	82	0.02697	0.02500	1980	0.1127	0.0877	0.0	0.1346	0.1096	0.0
1951	61,041	10,709	0.02833	0.02996	1981	0.1345	0.1045	1.1	0.1631	0.1331	1.4
1952	28,042	439	0.02507	0.02905	1982	0.1276	0.0986	0.0	0.1493	0.1203	0.1
1953	141,378	62,471	0.02775	0.02670	1983	0.1118	0.0851	5.3	0.1270	0.1003	6.3
1954	164,415	120,060	0.02501	0.02502	1984	0.1241	0.0991	11.9	0.1425	0.1175	14.1
1955	205,408	164,830	0.02501	0.02501	1985	0.1079	0.0829	13.7	0.1183	0.0933	15.4
1956	134,007	132,853	0.02501	0.02501	1986	0.0778	0.0528	7.0	0.0961	0.0711	9.4
1957	144,426	125,266	0.02513	0.02502	1987	0.0859	0.0609	7.6	0.0974	0.0724	9.1
1958	149,812	136,310	0.02510	0.02505	1988	0.0896	0.0646	8.8	0.1003	0.0753	10.3
1959	88,016	87,866	0.02503	0.02502	1959	0.0413	0.0163	1.4	0.0492	0.0242	2.1
1960	76,147	75,996	0.02503	0.02502	1960	0.0406	0.0156	1.2	0.0472	0.0222	1.7
1961	40,094	39,943	0.02507	0.02505	1961	0.0392	0.0142	0.6	0.0472	0.0222	0.9
1962	147,918	131,098	0.02502	0.02501	1962	0.0399	0.0149	2.0	0.0440	0.0190	2.5
1963	18,465	18,314	0.02565	0.02561	1963	0.0405	0.0149	0.3	0.0440	0.0184	0.3

Bonneville Power Administration

Part 1: Interest Rate Subsidies and Subsidies through Deferred Repayment

						LOW ESTIMATE			HIGH ESTIMATE		
Year	Original Principal ($000s)	Current Still Outstanding ($000s)	Wght. Ave Int. at Issuance	Wght. Ave. Interest on Amt. Outstd.	Last Refinance Year	Gov't L-T Rate at Last Refin.	Est. Int. Rate Subsidy (%)	Interest Subsidy ($Mils)	Gas, Power, & Light Rate at Last Refin.	Est. Int. Rate Subsidy (%)	Interest Subsidy ($Mils)
	(1)	(2)	(3)	(4)	(5)	(6)	(6)-(4)	(6-4)*(2)/1000	(7)	(7)-(4)	(7-4)*(2)/1000
1964	34,694	33,172	0.02668	0.02673	1964	0.0419	0.0152	0.5	0.0455	0.0188	0.6
1965	42,205	42,054	0.02933	0.02932	1965	0.0427	0.0134	0.6	0.0461	0.0168	0.7
1966	37,969	37,840	0.03023	0.03023	1966	0.0477	0.0175	0.7	0.0553	0.0251	0.9
1967	92,548	91,627	0.02948	0.02952	1967	0.0501	0.0206	1.9	0.0607	0.0312	2.9
1968	199,063	193,481	0.02889	0.02900	1968	0.0545	0.0255	4.9	0.0680	0.0390	7.5
1969	358,906	357,054	0.02688	0.02689	1969	0.0632	0.0363	13.0	0.0798	0.0529	18.9
1970	367,846	367,073	0.02838	0.02838	1970	0.0687	0.0403	14.8	0.0879	0.0595	21.8
1971	255,829	255,573	0.03012	0.03010	1971	0.0612	0.0311	7.9	0.0770	0.0469	12.0
1972	102,058	102,044	0.04288	0.04288	1972	0.0601	0.0172	1.8	0.0750	0.0321	3.3
1973	453,346	423,440	0.03472	0.03357	1973	0.0712	0.0376	15.9	0.0791	0.0455	19.3
1974	97,656	97,642	0.05207	0.05207	1974	0.0806	0.0285	2.8	0.0959	0.0438	4.3
1975	562,002	551,366	0.03263	0.03267	1975	0.0799	0.0472	26.0	0.0997	0.0670	37.0
1976	510,592	510,578	0.03502	0.03502	1976	0.0761	0.0411	21.0	0.0892	0.0542	27.7
1977	318,856	318,817	0.04082	0.04082	1977	0.0775	0.0367	11.7	0.0843	0.0435	13.9
1978	409,966	409,952	0.04518	0.04518	1978	0.0849	0.0397	16.3	0.0930	0.0478	19.6
1979	492,243	396,028	0.05051	0.03926	1979	0.0928	0.0535	21.2	0.1085	0.0692	27.4
1980	122,716	7,694	0.12358	0.02788	1980	0.1127	0.0848	0.7	0.1346	0.1067	0.8
1981	262,641	87,632	0.12132	0.03209	1981	0.1345	0.1024	9.0	0.1631	0.1310	11.5
1982	642,395	407,394	0.07290	0.03241	1982	0.1276	0.0952	38.8	0.1493	0.1169	47.6
1983	444,889	174,704	0.08460	0.03522	1983	0.1118	0.0766	13.4	0.1270	0.0918	16.0
1984	328,337	67,207	0.10792	0.03076	1984	0.1241	0.0933	6.3	0.1425	0.1117	7.5
1985	366,445	356,821	0.07033	0.06888	1985	0.1079	0.0390	13.9	0.1183	0.0494	17.6
1986	619,018	617,687	0.07563	0.07555	1986	0.0778	0.0022	1.4	0.0961	0.0206	12.7
1987	597,903	592,583	0.08315	0.08310	1987	0.0859	0.0028	1.7	0.0974	0.0143	8.5
1988	412,901	411,985	0.08785	0.08786	1988	0.0896	0.0017	0.7	0.1003	0.0124	5.1
1989	319,823	319,823	0.08029	0.08029	1989	0.0845	0.0042	1.3	0.0992	0.0189	6.0
Total	10,174,296	8,363,042						310.1			426.2

Notes

(1) Original borrowings, in nominal dollars, for investment in transmission and generation infrastructure. Figures exclude irrigation repayment assigned to power.

(2) Amount of original prinicipal remaining outstanding in 1989, in nominal dollars. Reflects repayment for low interest loans. Figures have been derived from payments through FY90 by deducting repayments made in 1990.

(3) Weighted average interest rate charged on marginal borrowing.

(4) Weighted average interest on principal still outstanding.

(5) Borrowings are assumed to be 30 year debt (see the "Technical Description of Debt" chapter for details), and refinanced at long-term rates until the point at which debt is still outstanding.

(6) Long-term treasury bill rates are used as a conservative estimate of the government's cost of funds.

(7) Public power bond rates estimate the lowest cost financing available for a private entity, and are used to generate a conservative high estimate of the subsidies to the PMAs.

(8) Interest rate subsidy for debt less than 30 years old is the difference between government borrowing cost in the year of issue and the interest rate charged. Subsidies for debt older than 30 years equals the current government cost of funds minus the interest rate on debt still outstanding.

Source: Bonneville Power Administration, "Power Repayment Study for 1991 Rate Filing," August 20, 1991.

Part 2: Lines of Credit (Note 1)

		Low Est.	High Est.	
Available debt	3,750.0			
Restricted to conserv. & ren. resource expen.	1,250.0	1.6	9.4	Allocated to efficiency
Net available for power	2,500.0	3.1	18.8	Allocated to power mix other than efficiency
Amount in use at end of 1989	1,232.0			
Private market committment fee for provision of credit		0.13%	0.75%	See RATES2.WK1 for details.
Estimated Value of Unused Credit Line (Note 2)		0.0	28.1	

Source: BPA 1989 Annual Report, p. 31; RATES2.WK1.

Notes to Part 2:

(1) Committment fees are levied on private borrowers to cover the provision of a credit line, whether or not that line is used.

(2) Low estimate treated as zero since item is not a monetary cost to the government. High estimate is treated as shown. Although Congress retains oversight to the borrowing, and may cut off the credit if desired (Barringer, 4/13/92), a bank may also do so.

Part 3: Cross Subsidies

These reflect expenditures for non-productive asset write-off or storage (primarily nuclear) or irrigation assistance, both of which are paid by the general customer base.

1. Holding costs for WNP No. 1 and No. 3 in FY89 — 378.2
(Nuclear units are "delayed indefinitely")
Includes interest, principal, and other costs

Total Nuclear Subsidies — 378.2

Cross-subsidies are allocated entirely from fission, and removed from the current power mix in proportion to installed capacity.

Source: BPA 1989 Annual Report, p. 33, 35.

2. Irrigation Assistance Charged to Power Users ($Millions)

	Low Est.	High Est.	
Cumulative Irrigation Assistance through FY89	757.0	757.0	(DOE, 1988-89 Ann. Rept., p. 220)
Years of Subsidy to Irrigation	60	60	(BPA 1989 Ann. Rept., pp. 24)
Estimated Annual Subsidy	12.6	12.6	

Notes:

(1) Estimated annual subsidy has no interest rate since federal investments in irrigation are not charged interest.

(2) According to the BPA annual report, this time frame is applicable to the repayment of most irrigation assistance.

Part 4: Bonneville Power Administration Power Mix (As of July 1991)

	MW	% of Total
Hydro	22,000	92.7%
Fission	1,439	6.1%
Efficiency	298	1.3%
Total	23,737	100.00%

Notes:

(1) Efficiency reflects average annual MW of savings/year resulting from historic investments.

(2) Fission component is from the Trojan and WNP #2 plants, and does not include plants not yet on line.

Source:

David Barringer, Bonneville Power Administration, personal communication, 1/16/91.

Part 5: BPA Subsidies Summary Table

	Low Est.	High Est.
Interest Rate Subsidies	310.1	426.2
Loan Defaults	0	0
Defaults on Federally-Guar. Debt	0	0
Free Lines of Credit	0.0	28.1
Interest Gain from Tax-Exempt Debt	In tax section under tax-exempt bond issues for public power.	
Tax-Exempt Operating Status	In tax section under tax-exemption for publicly-owned power facilities.	
Lack of a Required Rate of Return	Not Quantified	
Total Direct Subsidies	310.1	**454.3**

Allocation	Low Estimate: Total Low	Hydro	Fission	Efficiency	High Estimate: Total High	Hydro	Fission	Efficiency
Interest Rate Subsidies (See Note 1 below)	310.1	310.1			426.2	395.0	25.8	5.4
Free Credit Line (Note 2)	0				28.1	17.6	1.2	9.4
BPA Installed Capacity		92.7%	6.1%	1.3%		92.7%	6.1%	1.3%
Nuclear Cross-Subsidy								
Additions	378.2		378.2		378.2		378.2	
Subtractions	(378.2)	(350.5)	(22.9)	(4.7)	(378.2)	(350.5)	(22.9)	(4.7)
Irrigation Cross-Subsidy	(12.6)	(11.7)	(0.8)	(0.2)	(12.6)	(11.7)	(0.8)	(0.2)
Net Subsidies	**297.5**	(52.1)	**354.5**	**(4.9)**	**441.7**	**50.4**	**381.5**	**9.8**

(1) The vast majority of government-subsidized debt went to build the hydro dams and connecting transmission facilities. As a result, all of the associated interest rate subsidy in the low estimate is allocated to hydropower. (Barringer, 4/13/92). However, while later BPA spending on fission and efficiency did pay interest at the government's cost of funds, such investments, nonetheless, benefitted from government intermediation in debt markets (as did hydropower). Therefore, a portion of the high estimate accrues to these energy sources as well. (Barringer, 8/198/92).

(2) Free line of credit in high estimate allocated to efficiency based on restrictions shown in Part 2.

(3) Negative net subsidies for hydropower in the low estimate reflect its bearing the brunt of irrigation and nuclear cross-subsidies.

Southeastern Power Administration

Part 1A: Interest Rate Subs. and Subsidies through Deferred Repayment ($000s)

				JIM WOODRUFF PROJECT				T-BOND ESTIMATE		UTILITY ESTIMATE	
Year	Last Refinance Year	Refinance Rate, L-T Treas. Bnds.	Refinance Rate, Pub. Power Bnds.	Cumulative Investment (000s)	Net Outstanding Debt	Net Increase in Debt	Project Interest Rate	Interest Rate Subsidy	Annual Interest Subsidy	Interest Rate Subsidy	Annual Interest Subsidy
	(1)	(2)	(3)				(4)	(2)-(4)	(5)	(3)-(4)	(5)
1949	1979	0.0928	0.1085								
1950	1980	0.1127	0.1346								
1951	1981	0.1345	0.1631								
1952	1982	0.1276	0.1493								
1953	1983	0.1118	0.1270								
1954	1984	0.1241	0.1425								
1955	1985	0.1079	0.1183								
1956	1986	0.0778	0.0961								
1957	1987	0.0859	0.0974	21,990	21,990	21,990	0.025	0.0609	1,339.2	0.0724	1,592.1
1958	1988	0.0896	0.1003	22,750	22,522	532	0.025	0.0646	34.4	0.0753	40.1
1959	1959	0.0413	0.0492	22,854	22,215	(307)	0.025	0.0163	0.0	0.0242	0.0
1960	1960	0.0406	0.0472	22,921	21,820	(395)	0.025	0.0156	0.0	0.0222	0.0
1961	1961	0.0392	0.0472	22,950	21,428	(392)	0.025	0.0142	0.0	0.0222	0.0
1962	1962	0.0399	0.0440	22,966	20,937	(491)	0.025	0.0149	0.0	0.0190	0.0
1963	1963	0.0405	0.0440	22,983	20,443	(494)	0.025	0.0155	0.0	0.0190	0.0
1964	1964	0.0419	0.0455	23,026	20,093	(350)	0.025	0.0169	0.0	0.0205	0.0
1965	1965	0.0427	0.0461	23,055	19,577	(516)	0.025	0.0177	0.0	0.0211	0.0
1966	1966	0.0477	0.0553	23,112	19,040	(537)	0.025	0.0227	0.0	0.0303	0.0
1967	1967	0.0501	0.0607	23,128	18,378	(662)	0.025	0.0251	0.0	0.0357	0.0
1968	1968	0.0545	0.0680	23,145	17,709	(669)	0.025	0.0295	0.0	0.0430	0.0
1969	1969	0.0632	0.0798	25,026	19,209	1,500	0.025	0.0382	57.3	0.0548	82.2
1970	1970	0.0687	0.0879	25,041	18,645	(564)	0.025	0.0437	0.0	0.0629	0.0
1971	1971	0.0612	0.0770	25,047	18,208	(437)	0.025	0.0362	0.0	0.0520	0.0
1972	1972	0.0601	0.0750	25,060	17,726	(482)	0.025	0.0351	0.0	0.0500	0.0
1973	1973	0.0712	0.0791	25,081	17,437	(289)	0.025	0.0462	0.0	0.0541	0.0
1974	1974	0.0806	0.0959	25,104	16,557	(880)	0.025	0.0556	0.0	0.0709	0.0
1975	1975	0.0799	0.0997	25,192	15,813	(744)	0.025	0.0549	0.0	0.0747	0.0
1976	1976	0.0761	0.0892	25,341	14,433	(1,380)	0.025	0.0511	0.0	0.0642	0.0
1977	1977	0.0775	0.0843	25,434	13,952	(481)	0.025	0.0525	0.0	0.0593	0.0
1978	1978	0.0849	0.0930	25,591	13,647	(305)	0.025	0.0599	0.0	0.0680	0.0
1979	1979	0.0928	0.1085	25,689	13,368	(279)	0.025	0.0676	0.0	0.0835	0.0
1980	1980	0.1127	0.1346	25,815	13,274	(94)	0.025	0.0877	0.0	0.1096	0.0
1981	1981	0.1345	0.1631	26,058	13,274	0	0.025	0.1095	0.0	0.1381	0.0
1982	1982	0.1276	0.1493	26,151	13,517	243	0.025	0.1026	24.9	0.1243	30.2
1983	1983	0.1118	0.1270	26,168	13,417	(100)	0.025	0.0868	0.0	0.1020	0.0
1984	1984	0.1241	0.1425	26,776	13,690	273	0.025	0.0991	27.1	0.1175	32.1
1985	1985	0.1079	0.1183	26,871	13,600	(90)	0.025	0.0829	0.0	0.0933	0.0
1986	1986	0.0778	0.0961	26,948	13,677	77	0.025	0.0528	4.1	0.0711	5.5
1987	1987	0.0859	0.0974	27,056	13,785	108	0.025	0.0609	6.6	0.0724	7.8
1988	1988	0.0896	0.1003	27,156	13,884	99	0.025	0.0646	6.4	0.0753	7.5
1989	1989	0.0845	0.0992	27,395	14,124	240	0.025	0.0595	14.3	0.0742	17.8
Tot. Before Netting Repayments									1,514.2		1,815.2

Part 1B: Netting Debt Repayments from Interest Subsidies

	Net Increase in Debt	T-Bond Interest Rate Subsidy	T-Bond Annual Interest Subsidy	Utility Interest Rate Subsidy	Utility Annual Interest Subsidy
Tot. Repayments	(10,936)				
At Assumed Rates (Note 8)	243	0.1026	(24.9)	0.1243	(30.2)
	273	0.0991	(27.1)	0.1175	(32.1)
	10,422	0.0609	(634.7)	0.0724	(754.6)
Net Interest Rate Subsidy	0		827.5		998.3

Part 1A, Continued

Year	Last Refinance Year (1)	Refinance Rate, L-T Treas. Bnds (2)	Refinance Rate, Pub. Power Bnds. (3)	KERR-PHILPOTT SYSTEM Cumulative Investment (000s)	Net Outstanding Debt	Net Increase in Debt	Project Interest Rate (4)	T-BOND Interest Rate Subsidy (2)-(4)	ESTIMATE Annual Interest Subsidy (5)	UTILITY Interest Rate Subsidy (3)-(4)	ESTIMATE Annual Interest Subsidy (5)
1949	1979	0.0928	0.1085								
1950	1980	0.1127	0.1346								
1951	1981	0.1345	0.1631								
1952	1982	0.1276	0.1493								
1953	1983	0.1118	0.1270	38,497	38,177	38,177	0.025	0.0868	3,313.8	0.1020	3,894.1
1954	1984	0.1241	0.1425	77,202	76,882	38,705	0.025	0.0991	3,835.7	0.1175	4,547.8
1955	1985	0.1079	0.1183	77,774	77,453	571	0.025	0.0829	47.3	0.0933	53.3
1956	1986	0.0778	0.0961	78,277	77,953	500	0.025	0.0528	26.4	0.0711	35.6
1957	1987	0.0859	0.0974	78,594	77,647	(306)	0.025	0.0609	0.0	0.0724	0.0
1958	1988	0.0896	0.1003	78,658	76,315	(1,332)	0.025	0.0646	0.0	0.0753	0.0
1959	1959	0.0413	0.0492	78,697	75,825	(490)	0.025	0.0163	0.0	0.0242	0.0
1960	1960	0.0406	0.0472	78,785	74,340	(1,485)	0.025	0.0156	0.0	0.0222	0.0
1961	1961	0.0392	0.0472	78,803	73,607	(733)	0.025	0.0142	0.0	0.0222	0.0
1962	1962	0.0399	0.0440	78,828	72,391	(1,216)	0.025	0.0149	0.0	0.0190	0.0
1963	1963	0.0405	0.0440	79,394	71,555	(836)	0.025	0.0155	0.0	0.0190	0.0
1964	1964	0.0419	0.0455	79,506	71,877	322	0.025	0.0169	5.4	0.0205	6.6
1965	1965	0.0427	0.0461	79,558	71,359	(518)	0.025	0.0177	0.0	0.0211	0.0
1966	1966	0.0477	0.0553	79,720	70,327	(1,032)	0.025	0.0227	0.0	0.0303	0.0
1967	1967	0.0501	0.0607	79,910	69,713	(614)	0.025	0.0251	0.0	0.0357	0.0
1968	1968	0.0545	0.0680	79,955	69,363	(350)	0.025	0.0295	0.0	0.0430	0.0
1969	1969	0.0632	0.0798	79,955	69,126	(237)	0.025	0.0382	0.0	0.0548	0.0
1970	1970	0.0687	0.0879	79,870	68,748	(378)	0.025	0.0437	0.0	0.0629	0.0
1971	1971	0.0612	0.0770	80,045	68,138	(610)	0.025	0.0362	0.0	0.0520	0.0
1972	1972	0.0601	0.0750	80,096	66,751	(1,387)	0.025	0.0351	0.0	0.0500	0.0
1973	1973	0.0712	0.0791	80,147	64,410	(2,341)	0.025	0.0462	0.0	0.0541	0.0
1974	1974	0.0806	0.0959	80,266	62,282	(2,128)	0.025	0.0556	0.0	0.0709	0.0
1975	1975	0.0799	0.0997	80,355	60,363	(1,919)	0.025	0.0549	0.0	0.0747	0.0
1976	1976	0.0761	0.0892	80,498	57,690	(2,673)	0.025	0.0511	0.0	0.0642	0.0
1977	1977	0.0775	0.0843	80,807	54,893	(2,797)	0.025	0.0525	0.0	0.0593	0.0
1978	1978	0.0849	0.0930	80,855	52,891	(2,002)	0.025	0.0599	0.0	0.0680	0.0
1979	1979	0.0928	0.1085	80,898	50,639	(2,252)	0.025	0.0678	0.0	0.0835	0.0
1980	1980	0.1127	0.1346	80,942	46,775	(3,864)	0.025	0.0877	0.0	0.1096	0.0
1981	1981	0.1345	0.1631	80,981	45,039	(1,736)	0.025	0.1095	0.0	0.1381	0.0
1982	1982	0.1276	0.1493	81,102	41,546	(3,493)	0.025	0.1026	0.0	0.1243	0.0
1983	1983	0.1118	0.1270	81,167	36,626	(4,920)	0.025	0.0868	0.0	0.1020	0.0
1984	1984	0.1241	0.1425	81,304	32,546	(4,080)	0.025	0.0991	0.0	0.1175	0.0
1985	1985	0.1079	0.1183	84,474	33,348	802	0.025	0.0829	66.5	0.0933	74.8
1986	1986	0.0778	0.0961	85,431	33,309	(39)	0.025	0.0528	0.0	0.0711	0.0
1987	1987	0.0859	0.0974	85,668	29,554	(3,755)	0.025	0.0609	0.0	0.0724	0.0
1988	1988	0.0896	0.1003	86,172	27,893	(1,661)	0.025	0.0646	0.0	0.0753	0.0
1989	1989	0.0845	0.0992	87,312	25,796	(2,097)	0.025	0.0595	0.0	0.0742	0.0
Tot. Before Netting Repayments									7,295.1		8,612.1
Part 1B: Netting Debt Repayments from Interest Subsidies											
Tot. Repayments						(53,281)					
At Assumed Rates (Note 8)						38,705		0.0991	(3,835.7)	0.1175	(4,547.8)
						14,576		0.0868	(1,265.2)	0.102	(1,486.8)
Net Interest Rate Subsidy						0			2,194.2		2,577.6

Part 1A, Continued

Year	Last Refinance Year	Refinance Rate, L-T Treas Bnds	Refinance Rate, Pub. Power Bnds.	CUMBERLAND BASIN SYSTEM Cumulative Investment (000s)	Net Outstanding Debt	Net Increase In Debt	Project Interest Rate	T-BOND Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy	UTILITY Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy
	(1)	(2)	(3)				(4)	(2)-(4)	(5)	(3)-(4)	(5)
1949	1979	0.0928	0.1085	14.983	14,940	14,940	0.025	0.0678	1,012.9	0.0835	1,247.5
1950	1980	0.1127	0.1346	15.121	14,810	(130)	0.025	0.0877	0.0	0.1096	0.0
1951	1981	0.1345	0.1631	42 693	41,765	26,955	0.025	0.1095	2,951.6	0.1381	3,722.5
1952	1982	0.1276	0.1493	80 989	77,967	36,202	0.025	0.1026	3,714.3	0.1243	4,499.9
1953	1983	0.1118	0.1270	99 664	96,642	18,675	0.025	0.0868	1,621.0	0.1020	1,904.9
1954	1984	0.1241	0.1425	101 931	98,909	2,267	0.025	0.0991	224.7	0.1175	266.4
1955	1985	0.1079	0.1183	202 055	99,033	124	0.025	0.0829	10.3	0.0933	11.6
1956	1986	0.0778	0.0961	102.382	98,986	(47)	0.025	0.0528	0.0	0.0711	0.0
1957	1987	0.0859	0.0974	110.644	105,304	6,318	0.025	0.0609	384.8	0.0724	457.4
1958	1988	0.0896	0.1003	134 310	125,706	20,402	0.025	0.0646	1,318.0	0.0753	1,536.3
1959	1959	0.0413	0.0492	134.682	125,616	(90)	0.025	0.0163	0.0	0.0242	0.0
1960	1960	0.0406	0.0472	147 371	137,193	11,577	0.025	0.0156	180.6	0.0222	257.0
1961	1961	0.0392	0.0472	153 588	141,080	3,887	0.025	0.0142	55.2	0.0222	86.3
1962	1962	0.0399	0.0440	153,732	136,961	(4,119)	0.025	0.0149	0.0	0.0190	0.0
1963	1963	0.0405	0.0440	153,779	136,364	(597)	0.025	0.0155	0.0	0.0190	0.0
1964	1964	0.0419	0.0455	153.852	135,987	(377)	0.025	0.0169	0.0	0.0205	0.0
1965	1965	0.0427	0.0461	153 687	135,258	(729)	0.025	0.0177	0.0	0.0211	0.0
1966	1966	0.0477	0.0553	196,522	177,377	42,119	0.025	0.0227	956.1	0.0303	1,276.2
1967	1967	0.0501	0.0607	196,802	175,081	(2,296)	0.025	0.0251	0.0	0.0357	0.0
1968	1968	0.0545	0.0680	197,212	170,988	(4,093)	0.025	0.0295	0.0	0.0430	0.0
1969	1969	0.0632	0.0798	197,527	170,844	(144)	0.025	0.0382	0.0	0.0548	0.0
1970	1970	0.0687	0.0879	207,456	179,712	8,868	0.025	0.0437	387.5	0.0629	557.8
1971	1971	0.0612	0.0770	207,347	178,041	(1,671)	0.025	0.0362	0.0	0.0520	0.0
1972	1972	0.0601	0.0750	208,146	176,043	(1,998)	0.025	0.0351	0.0	0.0500	0.0
1973	1973	0.0712	0.0791	211.049	174,580	(1,463)	0.025	0.0462	0.0	0.0541	0.0
1974	1974	0.0806	0.0959	258 532	215,445	40,865	0.025	0.0556	2,272.1	0.0709	2,897.3
1975	1975	0.0799	0.0997	260 645	211,032	(4,413)	0.025	0.0549	0.0	0.0747	0.0
1976	1976	0.0761	0.0892	268,751	215,870	4,838	0.025	0.0511	247.2	0.0642	310.6
1977	1977	0.0775	0.0843	315,640	261,864	45,994	0.025	0.0525	2,414.7	0.0593	2,727.4
1978	1978	0.0849	0.0930	332 877	273,309	11,445	0.025	0.0599	685.6	0.0680	778.3
1979	1979	0.0926	0.1085	343,973	274,988	1,679	0.025	0.0678	113.8	0.0835	140.2
1980	1980	0.1127	0.1346	346.159	270,233	(4,755)	0.025	0.0877	0.0	0.1096	0.0
1981	1981	0.1345	0.1631	346.928	269,548	(685)	0.025	0.1095	0.0	0.1381	0.0
1982	1982	0.1276	0.1493	347,768	265,626	(3,922)	0.025	0.1026	0.0	0.1243	0.0
1983	1983	0.1118	0.1270	348.214	260,597	(5,029)	0.025	0.0868	0.0	0.1020	0.0
1984	1984	0.1241	0.1425	348,645	253,218	(7,379)	0.025	0.0991	0.0	0.1175	0.0
1985	1985	0.1079	0.1183	348.919	248,622	(4,596)	0.025	0.0829	0.0	0.0933	0.0
1986	1986	0.0778	0.0961	348 919	246,605	(2,017)	0.025	0.0528	0.0	0.0711	0.0
1987	1987	0.0859	0.0974	349 775	243,624	(2,981)	0.025	0.0609	0.0	0.0724	0.0
1988	1988	0.0896	0.1003	347 460	239,361	(4,263)	0.025	0.0646	0.0	0.0753	0.0
1989	1989	0.0845	0.0992	348.171	233,611	(5,750)	0.025	0.0595	0.0	0.0742	0.0
Tot. Before Netting Repayments									18,550.3		22,677.5

Part 1B: Netting Debt Repayments from Interest Subsidies

	Net Increase In Debt	T-BOND Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy	UTILITY Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy
Tot. Repayments	(63,544)				
At Assumed Rates (Note 8)	29,955	0.1095	(3,280.1)	0.1381	(4,136.8)
	33,589	0.1026	(3,446.2)	0.1243	(4,175.1)
Net Interest Rate Subsidy	0		11,824.0		14,365.6

Part 1A, Continued

Year	Last Refinance Year	Refinance Rate, L-T Treas. Bnds	Refinance Rate, Pub Power Bnds	GEORGIA-ALABAMA POWER SYSTEM Cumulative Investment (000s)	Net Outstanding Debt	Net Increase In Debt	Interest Paid	Computed Wghtd. Ave. Interest Rt On Cum. Debt	T-BOND Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy	UTILITY Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy
	(1)	(2)	(3)					(6)	(2)-(6)	(5)	(3)-(6)	(5)
1949	1979	0.0928	0.1085									
1950	1980	0.1127	0.1346	23,977	23,936	23,936	136	0.0057	0.1070	2,561.6	0.1289	3,085.8
1951	1981	0.1345	0.1631	24,768	24,587	651	599	0.0244	0.1101	71.7	0.1387	90.3
1952	1982	0.1276	0.1493	24,883	24,328	(259)	604	0.0248	0.1028	0.0	0.1245	0.0
1953	1983	0.1118	0.1270	57,743	56,896	32,568	827	0.0145	0.0973	3,167.7	0.1125	3,662.8
1954	1984	0.1241	0.1425	90,222	88,385	31,489	1701	0.0192	0.1049	3,301.8	0.1233	3,881.2
1955	1985	0.1079	0.1183	100,125	97,851	9,466	2392	0.0244	0.0835	790.0	0.0939	888.4
1956	1986	0.0778	0.0961	100,457	98,067	216	2428	0.0248	0.0530	11.5	0.0713	15.4
1957	1987	0.0859	0.0974	100,455	97,747	(320)	2425	0.0248	0.0611	0.0	0.0726	0.0
1958	1988	0.0896	0.1003	138,172	134,620	36,873	2465	0.0183	0.0713	2,628.6	0.0820	3,023.2
1959	1959	0.0413	0.0492	140,533	137,351	2,731	3322	0.0242	0.0171	46.7	0.0250	68.3
1960	1960	0.0406	0.0472	142,115	137,266	(85)	3325	0.0242	0.0164	0.0	0.0230	0.0
1961	1961	0.0392	0.0472	142,258	135,403	(1,863)	3292	0.0243	0.0149	0.0	0.0229	0.0
1962	1962	0.0399	0.0440	162,783	152,781	17,378	3314	0.0217	0.0182	316.4	0.0223	387.7
1963	1963	0.0405	0.0440	251,123	223,876	71,095	4821	0.0215	0.0190	1,348.4	0.0225	1,597.2
1964	1964	0.0419	0.0455	277,814	256,486	32,610	6151	0.0240	0.0179	584.3	0.0215	701.7
1965	1965	0.0427	0.0461	278,513	251,241	(5,245)	6249	0.0249	0.0178	0.0	0.0212	0.0
1966	1966	0.0477	0.0553	279,904	247,495	(3,746)	6178	0.0250	0.0227	0.0	0.0303	0.0
1967	1967	0.0501	0.0607	279,820	243,674	(3,821)	6064	0.0249	0.0252	0.0	0.0358	0.0
1968	1968	0.0545	0.0680	280,961	239,507	(4,167)	5965	0.0249	0.0296	0.0	0.0431	0.0
1969	1969	0.0632	0.0798	281,772	235,451	(4,056)	5869	0.0249	0.0383	0.0	0.0549	0.0
1970	1970	0.0687	0.0879	319,355	269,494	34,043	5966	0.0221	0.0466	1,585.1	0.0658	2,238.7
1971	1971	0.0612	0.0770	320,316	265,492	(4,002)	6499	0.0245	0.0367	0.0	0.0525	0.0
1972	1972	0.0601	0.0750	321,091	260,902	(4,590)	6766	0.0259	0.0342	0.0	0.0491	0.0
1973	1973	0.0712	0.0791	321,929	254,406	(6,496)	6054	0.0238	0.0474	0.0	0.0553	0.0
1974	1974	0.0806	0.0959	322,893	248,290	(6,116)	6092	0.0245	0.0561	0.0	0.0714	0.0
1975	1975	0.0799	0.0997	364,807	284,134	35,844	6212	0.0219	0.0580	2,080.3	0.0778	2,790.0
1976	1976	0.0761	0.0892	469,550	379,220	95,086	11101	0.0293	0.0468	4,452.6	0.0599	5,698.2
1977	1977	0.0775	0.0843	525,362	427,987	48,767	9416	0.0220	0.0555	2,706.5	0.0623	3,038.2
1978	1978	0.0649	0.0930	532,316	432,647	4,660	11329	0.0262	0.0587	273.6	0.0668	311.4
1979	1979	0.0926	0.1065	533,851	430,873	(1,774)	10976	0.0255	0.0673	0.0	0.0830	0.0
1980	1980	0.1127	0.1346	541,966	431,855	982	11168	0.0259	0.0868	85.3	0.1087	106.8
1981	1981	0.1345	0.1631	543,797	428,339	(3,516)	10555	0.0246	0.1099	0.0	0.1385	0.0
1982	1982	0.1276	0.1493	546,426	426,131	(2,208)	10478	0.0246	0.1030	0.0	0.1247	0.0
1983	1983	0.1118	0.1270	548,499	424,309	(1,822)	9868	0.0233	0.0885	0.0	0.1037	0.0
1984	1984	0.1241	0.1425	572,787	437,896	13,587	10535	0.0241	0.1000	1,359.3	0.1184	1,609.3
1985	1985	0.1079	0.1183	833,522	694,769	256,873	19345	0.0278	0.0801	20,564.3	0.0905	23,235.8
1986	1986	0.0778	0.0961	925,985	783,242	88,473	30007	0.0383	0.0395	3,493.7	0.0578	5,112.7
1987	1987	0.0859	0.0974	927,982	779,711	(3,531)	33939	0.0435	0.0424	0.0	0.0539	0.0
1988	1988	0.0896	0.1003	929,641	776,823	(2,888)	35393	0.0456	0.0440	0.0	0.0547	0.0
1989	1989	0.0845	0.0992	931,911	775,207	(1,616)	37960	0.0490	0.0355	0.0	0.0502	0.0
Tot. Before Netting Repayments										51,429.3		61,542.9

Part 1B: Netting Debt Repayments from Interest Subsidies

	Net Increase In Debt	T-BOND Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy	UTILITY Interest Rate Subsidy	ESTIMATE Annual Interest Subsidy
Tot. Repayments	(65,637)				
At Assumed Rates (Note 8)	651	0.1101	(71.7)	0.1387	(90.3)
	23,936	0.107	(2,561.2)	0.1289	(3,085.4)
	31,489	0.1049	(3,303.2)	0.1233	(3,882.6)
	9,561	0.1	(956.1)	0.1184	(1,132.0)
Net Interest Rate Subsidy	0		44,537.2		53,352.7

Notes:

(1) Last refinance year calculated using longest term treasury bonds available at the date debt origination, successively refinanced until the present

(2) Treasury bond rates reflect the longest-term treasury bonds available in the last refinance year.

(3) Utility bond rates are the weighted average cost of capital for new power, gas, and light utilities, as compiled by Moody's bond rating service. These borrowing costs are used to estimate the intermediation value to SEPA of borrowing through the Treasury, rather than on the capital markets directly. These bonds are assumed to require refinancing at the same time as the Treasury bonds.

(4) Project interest rates are those used for initial power investment, not for replacements. They were often fixed by Congress.

(5) Annual interest subsidies are equal to the interest rate subsidy times the net increase in debt. Negative values reflect debt amortization, assuming that debt with the highest cost to the government (i.e., highest interest rate subsidy) is repaid first.

(6) Interest paid was used to back-out an estimate of the average interest rate, since there were no annual data available on project rates.

(7) Prior to FY64, interest on construction for the Cumberland Basin System was a 2.0%. This was changed to 2.5% in 1964, and applied retroactively to plant investments. (1990 Power Repayment Study).

(8) Rates represent the highest spread between cost of borrowing and the rate paid by SEPA. The quantity of funds is limited by the increase in debt shown for the year in which the interest rate applied on repayments was taken from.

Sources:

Southeastern Power Administration, "1989 Power Repayment Study," July 1990. Separate printout for each power system. Data on the Georgia-Alabama uses the revised study.

Part 2: Summary Table ($Millions)

	At Treasury Cost of Borrowing	At Utility Cost of Borrowing
Jim Woodruff	0.8	1.0
Kerr-Philpott	2.2	2.6
Cumberland Basin	11.8	14.4
Georgia-Alabama	44.5	53.4
Total	59.4	71.3

All facilities are hydroelectric. SEPA has not made any significant investments into energy efficiency.

Southwestern Power Administration

Part 1A: Interest Rate Subsidies and Subsidies through Deferred Repayment

Year	New Investment (000s) (1)	Net Outstanding Debt (2)	Net Increase In Debt (3)	Wght. Ave. Interest on Amt. Outstd. (4)	Last Refinance Year (5)	LOW ESTIMATE Gov't L-T Rate at Last Refin. (6)	Est. Int. Rate Subsidy (%) (6)-(4)	Interest Subsidy ($Mils) (6)*(2)/1000	HIGH ESTIMATE Public Pow. Rate at Last Refin. (7)	Est. Int. Rate Subsidy (%) (7)-(4)	Interest Subsidy ($Mils) (7)*(2)/1000
1944	361	361	361	0.02656	1974	0.0806	0.0540	0.0	0.0959	0.0693	0.0
1945	25,195	25,489	25,128	0.02656	1975	0.0799	0.0533	1.3	0.0997	0.0731	1.8
1946	104	25,319	(170)	0.02656	1976	0.0761	0.0495	0.0	0.0892	0.0626	0.0
1947	175	25,031	(288)	0.02656	1977	0.0775	0.0509	0.0	0.0843	0.0577	0.0
1948	679	25,406	375	0.02656	1978	0.0849	0.0583	0.0	0.0930	0.0664	0.0
1949	965	25,793	387	0.02656	1979	0.0928	0.0662	0.0	0.1085	0.0819	0.0
1950	4,223	29,398	3,605	0.02656	1980	0.1127	0.0861	0.3	0.1346	0.1080	0.4
1951	13,609	43,050	13,652	0.02656	1981	0.1345	0.1079	1.5	0.1631	0.1365	1.9
1952	2,684	46,124	3,074	0.02656	1982	0.1276	0.1010	0.3	0.1493	0.1227	0.4
1953	62,380	109,564	63,440	0.02656	1983	0.1118	0.0852	5.4	0.1270	0.1004	6.4
1954	25,402	136,300	26,736	0.02656	1984	0.1241	0.0975	2.6	0.1425	0.1159	3.1
1955	5,251	144,811	8,511	0.02656	1985	0.1079	0.0813	0.7	0.1183	0.0917	0.8
1956	27,565	176,173	31,362	0.02656	1986	0.0778	0.0512	1.6	0.0961	0.0695	2.2
1957	485	181,266	5,093	0.02656	1987	0.0859	0.0593	0.3	0.0974	0.0708	0.4
1958	5,139	188,611	7,345	0.02656	1988	0.0896	0.0630	0.5	0.1003	0.0737	0.5
1959	27,348	218,399	29,788	0.02656	1959	0.0413	0.0147	0.4	0.0492	0.0226	0.7
1960	1,344	222,501	4,102	0.02656	1960	0.0406	0.0140	0.1	0.0472	0.0206	0.1
1961	14,086	235,799	13,298	0.02656	1961	0.0392	0.0126	0.2	0.0472	0.0206	0.3
1962	19,640	264,988	29,189	0.02656	1962	0.0399	0.0133	0.4	0.0440	0.0174	0.5
1963	665	259,841	(5,147)	0.02656	1963	0.0405	0.0139	0.0	0.0440	0.0174	0.0
1964	41,091	312,867	53,026	0.02656	1964	0.0419	0.0153	0.8	0.0455	0.0189	1.0
1965	89,064	405,960	93,093	0.02656	1965	0.0427	0.0161	1.5	0.0461	0.0195	1.8
1966	43,656	449,616	43,656	0.02656	1966	0.0477	0.0211	0.9	0.0553	0.0287	1.3
1967	7,557	458,195	8,579	0.02656	1967	0.0501	0.0235	0.2	0.0607	0.0341	0.3
1968	36,129	492,160	33,965	0.02656	1968	0.0545	0.0279	0.9	0.0680	0.0414	1.4
1969	4,192	490,765	(1,395)	0.02656	1969	0.0632	0.0366	0.0	0.0798	0.0532	0.0
1970	17,982	506,021	15,256	0.02656	1970	0.0687	0.0421	0.6	0.0879	0.0613	0.9
1971	13,437	513,485	7,464	0.02656	1971	0.0612	0.0346	0.3	0.0770	0.0504	0.4
1972	69,924	578,688	65,203	0.02656	1972	0.0601	0.0335	2.2	0.0750	0.0484	3.2
1973	301,406	605,149	26,461	0.02656	1973	0.0712	0.0446	1.2	0.0791	0.0525	1.4
1974	67,949	657,291	52,142	0.02656	1974	0.0806	0.0540	2.8	0.0959	0.0693	3.6
1975	1,190	638,336	(18,955)	0.02656	1975	0.0799	0.0533	0.0	0.0997	0.0731	0.0
1976	3,508	622,475	(15,861)	0.02656	1976	0.0761	0.0495	0.0	0.0892	0.0626	0.0
1977	1,453	634,337	11,862	0.02656	1977	0.0775	0.0509	0.6	0.0843	0.0577	0.7
1978	668	631,410	(2,927)	0.02656	1978	0.0849	0.0583	0.0	0.0930	0.0664	0.0
1979	4,916	630,568	(842)	0.02656	1979	0.0928	0.0662	0.0	0.1085	0.0819	0.0
1980	6,932	628,983	(1,585)	0.02656	1980	0.1127	0.0861	0.0	0.1346	0.1080	0.0
1981	3,292	665,211	36,228	0.02656	1981	0.1345	0.1079	3.9	0.1631	0.1365	4.9
1982	24,210	673,809	8,598	0.02656	1982	0.1276	0.1010	0.9	0.1493	0.1227	1.1
1983	58,855	723,179	49,370	0.02656	1983	0.1118	0.0852	4.2	0.1270	0.1004	5.0
1984	3,285	704,418	(18,761)	0.02656	1984	0.1241	0.0975	0.0	0.1425	0.1159	0.0
1985	136,670	810,153	105,735	0.02656	1985	0.1079	0.0813	8.6	0.1183	0.0917	9.7
1986	18,593	798,786	(11,367)	0.02656	1986	0.0778	0.0512	0.0	0.0961	0.0695	0.0
1987	9,909	788,231	(10,555)	0.02656	1987	0.0859	0.0593	0.0	0.0974	0.0708	0.0
1988	9,683	777,684	(10,547)	0.02656	1988	0.0896	0.0630	0.0	0.1003	0.0737	0.0
1989	9,944	763,948	(13,736)	0.02656	1989	0.0845	0.0579	0.0	0.0992	0.0726	0.0
1990	10,011	749,346	(14,602)	0	1990	0.0861	0.0595	0.0	0.0000		0.0
											0.0
Totals Through FY1989, Before Netting Repayments								45.3			56.0

Part 1B: Netting Debt Repayments from Interest Subsidies

Total Repayments	(126,738)				
At Assumed Rates	36,228	0.1079	(3.9)	0.1365	(4.9)
	13,652	0.1079	(1.5)	0.1365	(1.9)
	3,074	0.1010	(0.3)	0.1227	(0.4)
	8,598	0.1010	(0.9)	0.1227	(1.1)
	26,736	0.0975	(2.6)	0.1159	(3.1)
	3,605	0.0861	(0.3)	0.1080	(0.4)
	34,645	0.0852	(3.0)	0.1004	(3.5)
Net Interest Rate Subsidy	0		32.9		40.8

Notes to Parts 1A and 1B:

(1) Data includes all SWPA facilities including the Sam Rayburn Dam

(2) Net outstanding debt equals the prior year's outstanding debt + new investment - amortization payments

(3) Negative values reflect amortizaton payments in excess of new investment. These repayments are assumed to reduce the debt with the highest cost to the federal government outstanding at the time of the payment (see Part 1B).

(4) Weighted Average Cost of Capital on Federal Debt is calculated below since no annual figures were available

	Amount (000s)	Pct. of Tot. Debt	Rate	Weight
	455,631	35.79%	2.5000%	0.8947%
	600,156	47.14%	2.6250%	1.2375%
	238	0.02%	2.8750%	0.0005%
	113,791	8.94%	3.0000%	0.2681%
	102,981	8.09%	3.1250%	0.2528%
	5	0.00%	8.0000%	0.0000%
	291	0.02%	8.5000%	0.0019%
Total	1,273,093	100.00%		2.6556%

Source: Billie Johannsen, Southwestern Power Administration, personal communication, 1/30/92.

(5) Borrowings are assumed to be as long as available from the Federal government at the time, and refinanced at long-term rates until the point at which debt is still outstanding.

(6) Long-term treasury bill rates are used as a conservative estimate of the government's cost of funds. 30-year rates are used whenever available. Otherwise, the longest available financing is used

(7) The weighted average cost of new power, light, and gas bond issues is used to estimate the cost of borrowing without Treasury intermediation in financial markets.

(8) The interest rate subsidy for debt less than 30 years old is the difference between government borrowing cost in the year of issue and the interest rate charged. Subsidies for debt older than 30 years equals the current government cost of funds minus the interest rate on debt still outstanding.

Sources:

Southwestern Power Administration, "1990 Power Repayment Study. Integrated System and Sam Rayburn Dam" September 1991.
Billie Johannsen, SWPA, personal communication, 1/30/92.

Part 2: Write-off of Investment in the Harry S. Truman Dam ($Millions)

1989 Write-off due to performance problems	78.5	78.5	
Estimated Depreciation Period	88	50	(50 yr. repayment period, 88 yr. est. plant service life)
Straight-Line Amortization of Loss	0.9	1.6	

Source: Southwestern Power Administration, "1989 Annual Report," pp. 5,7,25,34.

Part 3: Summary Table and Allocation of Subsidies to Fuel Types

	Low Est.	High Est.
Interest Subsidies	32.9	40.8
Truman Write-off	0.9	1.6
Total	33.7	42.4

All SWPA plant is hydroelectric.

Western Area Power Administration

Part 1a: Cumulative Power Investment

Project	Cumul Power Invest. (1)	Unpaid (2)	Cum. Aid to Non-Power (3)
Boulder Canyon	207	32.8	25
Central Valley	435	220.2	62
Collbran	11	8.8	5
Central Arizona	0	0	65
Colorado R. Storage	799	247.6	709
Falcon-Amistad	44	38	0
Fryingpan-Arkansas	190	189.6	0
PNW-PSW Intertie	53	52.9	0
Parker-Davis	208	35.9	27
Pick-Sloan MO Basin	1592	697.2	516
Provo	1	0	2
Rio Grande	9	1.1	5
Washoe	9	8.7	0
Total	3,558.0	1,532.8	1,416.0

Notes to 1a:

(1) Excludes non-power repayments assigned to power. (WAPA 1989 Annual Report Stat. App., p. 12)
(2) WAPA "Status of Repayment," printout of 12/5/90.
(3) Non-power related costs, primarily irrigation, which are assigned to be repaid through power revenues. This is a subsidy to irrigation and a tax on power.

	Low	High
Total Unpaid Power Investment	1,532.8	1,532.8
Wght. Ave. Int. Rate on Debt	4.92%	4.92%
Cost of Funds in 1989*	8.45%	9.92%
Net Estimated Interest Rate Subsidy	3.53%	5.00%
Est. Int. Subsidy to Power	54.2	76.7

* Assumes debt must be refinanced in 1989. This is a crude approximator. Low estimate uses long-term treasury bond rate, high estimate uses the average public power bond rate.

Part 2: Summary Table and Allocation to Fuel Type

	Low Estimate	High Estimate
Energy Mix		
Hydroelectric	100.00%	100.00%
Annual Interest Rate Subsidy	54.2	76.7
Less: Cross Subsidy to Irrigation		
Cumul. Subsidy to Irrig.	1,416.0	1,416.0
Est. Life of Facil. (yrs)*	60.0	60.0
Est. Annual Cross-Subsidy**	23.6	23.6
Net Estimated Subsidy to Hydro	30.6	53.1

*Based on the 60-year repayment period for irrigation assistance discussed in BPA, p. 24
** Annual subsidies have no discount factor since irrigation repayment does not accrue interest.

Sources:

Bonneville Power Administration, "1989 Annual Report." For irrigation assistance repayment period only.
Western Area Power Administration, "Final 1990 Power Repayment Study," 12/5/90.
WAPA, "Interest Rates (Through FY1982) and Authority," 12/17/84.
WAPA, "1989 Annual Report," and "Statistical Appendix to the 1989 Annual Report."

Part 1b: Derivation of Weighted Average Interest Rate on Outstanding Debt

(Debt Mix as of Sept. 30, 1989)

Interest Rate	Unpaid Balance ($Mil)	Wghtd. Ave. Int. Rate	Pct. of Debt at This Rate
0.1236	56.3	0.0044	3.57%
0.1138	8.1	0.0006	0.51%
0.1107	0.1	0.0000	0.01%
0.1090	5.2	0.0004	0.33%
0.1076	73.8	0.0050	4.68%
0.1069	9.3	0.0006	0.59%
0.1040	8.0	0.0005	0.51%
0.1037	0.4	0.0000	0.03%
0.1025	22.0	0.0014	1.40%
0.1005	13.0	0.0008	0.82%
0.0950	25.6	0.0015	1.62%
0.0935	54.4	0.0032	3.45%
0.0925	41.3	0.0024	2.62%
0.0900	23.0	0.0013	1.46%
0.0888	20.6	0.0012	1.31%
0.0860	88.1	0.0048	5.59%
0.0800	2.6	0.0001	0.16%
0.0750	0.0	0.0000	0.00%
0.0721	0.7	0.0000	0.04%
0.0700	33.5	0.0015	2.12%
0.0663	0.1	0.0000	0.01%
0.0613	0.6	0.0000	0.04%
0.0606	0.2	0.0000	0.01%
0.0588	0.0	0.0000	0.00%
0.0563	1.6	0.0001	0.10%
0.0550	0.6	0.0000	0.04%
0.0538	0.8	0.0000	0.05%
0.0400	0.0	0.0000	0.00%
0.0322	91.8	0.0019	5.82%
0.0305	189.5	0.0037	12.02%
0.0300	188.5	0.0036	11.96%
0.0288	0.9	0.0000	0.06%
0.0263	141.7	0.0024	8.99%
0.0263	3.6	0.0001	0.23%
0.0269	8.7	0.0001	0.55%
0.0250	462.1	0.0073	29.31%
Total	1,576.7	4.92%	100.00%

Notes to Part 1b:

(1) Calculations exclude $702 million in interest-free irrigation debt
(2) As data may include some non-power investment other than irrigation, the unpaid power balance calculated in Part 1a is used for subsidy calculations

Source: WAPA Cumulative Investment Data as of 9/30/89.

DEPARTMENT OF ENERGY: FEDERAL ENERGY REGULATORY COMMISSION

The Federal Energy Regulatory Commission regulates natural gas and oil pipeline companies, electric utilities, and licenses and inspects hydroelectric facilities. Since the Omnibus Budget Reconciliation Act of 1986, FERC user fees charged to licensees are supposed to yield net taxpayer outlays of zero. Data for 1989 shows that fees actually slightly exceeded FERC's operating costs, yielding a *de facto* licensing tax. Expenditures have been allocated to the various fuel types based on data contained in FERC's annual report. License fee collections were credited to the particular fuels in direct proportion to the percent of spending that that fuel comprised.

Annual Charges and Fees. These are levied on the regulated entities in return for government licensing and oversight services. They are deducted from FERC's expenditures to yield net outlays. Revenues are assumed to occur in the same proportions as expenditures; thus if 10% of the costs are associated with hydroelectric regulation, than 10% of the licensee revenues are assumed to come from hydro facilities. Payments to states (see below) reduce net collections that FERC retains to offset operating expenses.

Payments to States Under the Federal Power Act. States are paid 37.5% of the receipts from licenses for occupancy and use of national forests and public lands within their boundaries issued by FERC. (OMB '91, A-676). These payments reduce FERC's retained collections from licensees which are available to offset operating expenses. Although we do not deduct these payments from FERC's offsetting collections, they are essentially payments in lieu of taxes. These payments amounted to $1.8 million in 1989.

Department of Energy
Federal Energy Regulatory Commission (FERC)

	Total Program	Total Energy	Fee Allocation	Net Subsidy	Beneficiary Fuel	Spending Type	Carbon Increasing?
EXPENDITURES							
Natural Gas Regulation		54.7	63.7	(9.0)	Gas	Admin./Reg	N
Hydropower Licensing and Regulation		26.1	30.4	(4.3)	Hydroelectric	Admin./Reg	N
Oil Pipeline Regulation		2.6	3.0	(0.4)	Petroleum	Admin./Reg	N
Electric Power Regulation		24.5	28.5	(4.0)	Non-hydro Electric Power	Admin./Reg	N
Total Expenditures		107.9	125.7	(17.8)			
REVENUES							
Annual Charges and Fees		125.7					
Net Subsidy		(17.8)					

Sources:

OMB, "Budget of the United States Government, FY 1991," A-676.
FERC, "1989 Annual Report," p. 2.

Federal Energy Subsidies:

Energy, Environmental, and Fiscal Impacts

Technical Appendix
(Appendix B)

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April 1993

The Alliance to Save Energy
Energy Price and Tax Program
Mary Beth Zimmerman, Program Manager