Section II

EXCERPTS FROM OTA REPORTS COMPLETED IN 1977

The assessments carried out by OTA cover a wide spectrum of major national issues and examine a broad range of policy options and their possible consequent impacts on numerous and diverse interests: To provide some examples of this range, depth, and breadth, excerpts from several reports produced by the Office in 1977 are presented in this section.

The reader is cautioned that these excerpts are samplings from those reports. These paragraphs were selected merely to illustrate their diversity. Thus it should not be inferred that these excerpts represent either the full range of options considered or the major findings presented in any individual OTA report.

The projects themselves are discussed in the descriptions of OTA program activities in sections III and IV. (A list of OTA reports published to date, and the sources from which they may be obtained, may be found in the appendix.)


Enhanced Oil Recovery Potential in the United States
POLICY IMPLICATIONS OF MEDICAL INFORMATION SYSTEMS
A Preliminary Analysis of the
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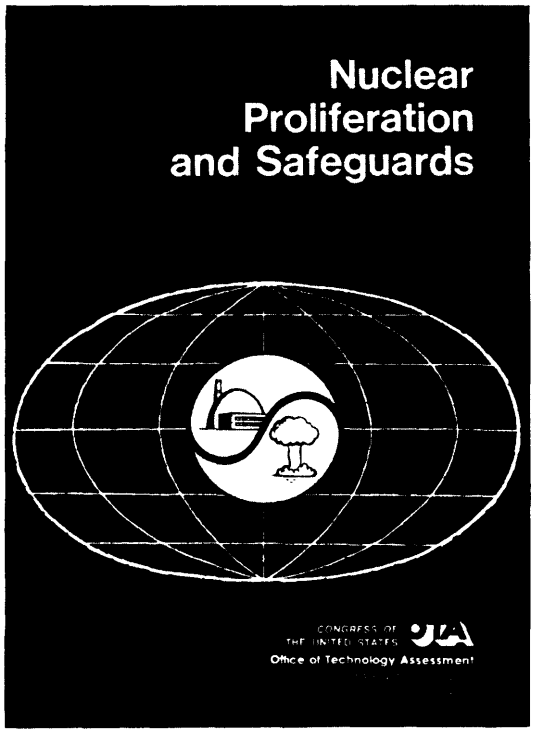
Section II
EXCERPTS FROM OTA REPORTS COMPLETED IN 1977



Nuclear Proliferation and Safeguards

At the root of the concern over proliferation is the fear that the spread of nuclear weaponry poses a grave and mounting threat to global stability. This threat could materialize in at least four ways. First is the obvious danger that nuclear weapons might actually be used. As is frequently pointed out, the statistical probability of use increases with the spread of weapons, other things being equal. Second, newly established nuclear powers could enter a nuclear arms race which might be politically destabilizing and, in itself, increase the likelihood of an outbreak of war. Third, the expanding quantity and distribution of weapons will increase the opportunities for theft, illicit sale, and sabotage. Finally, proliferation could undermine the present structure of the international political system as the acquisition of weapons alters the distribution of power. . . .

Reprocessing provides the strongest link between commercial nuclear power and proliferation. Possession of such a facility gives a nation access to weapons material (plutonium) by slow covert diversion which would be difficult for safeguards to detect. An overt seizure of the plant or associated plutonium stockpiles following abrogation of safeguards commitments could, if preceded by a clandestine weapons development program, result in the fabrication of nuclear explosives within days. Furthermore, such a plant reduces a nation's susceptibility to international restraints (sanctions) by enhancing fuel cycle independence. Finally, plutonium recycle is the most likely source for both black market fissile material and direct theft by terrorists. . . .

Given the weapons material and a fraction of a million dollars, a small group of people, none of whom have ever had access to the classified literature, could possibly design and build a crude nuclear explosive device. The group would have to include, at a minimum, a person capable of searching and understanding the technical literature in several fields, and a jack-of-all-trades technician. They would probably not be able to develop an accurate prediction of the yield of their device, and it could be a total failure because of either faulty design or faulty construction. If a member of the group is careless or incompetent, he might suffer serious or fatal injury. However, there is a clear possibility that a clever and competent group could design and construct a device which would produce a significant nuclear yield. . . .

Components of a nonproliferation policy would include: (a) steps designed to tip the balance of political incentives and disincentives regarding the acquisition of weapons in favor of disincentives; (b) a comprehensive safeguards regime to prevent the diversion of nuclear mater-

ial from civilian energy programs to weapons use; (c) controls over exports, particularly with regard to enrichment and reprocessing capabilities, in conjunction with arrangements for the return of spent fuel to the supplier or any international repository; (d) a broad range of domestic and foreign policy supporting actions, including steps to upgrade physical security measures to prevent theft of nuclear materials, expansion of reactor grade uranium production to obviate the need for reprocessing, and arms control negotiations; and (e) steps to assure that other countries can meet their energy requirements without resorting to enrichment and/or reprocessing national facilities. . . .

If the incentive for other nations to acquire national reprocessing plants is to be reduced, the United States will have to establish itself as a "reliable supplier" of low-enriched uranium. Other suppliers could be encouraged to take similar steps. Reliable supplier status presupposes a willingness to enter into binding agreements both to provide uranium enrichment services and to construct any additional enrichment capacity required. The more attractive the terms under which enrichment services are offered, the more likely their success in forestalling national facilities. . . .

The historical record provides no evidence that any criminal or terrorist group has ever made any attempt to acquire fissile nuclear material or radioactive waste material for use in an explosive or dispersal device.

One ought to take little comfort from this fact, however. The lack of intelligence or visible evidence does not mean that the option has not been discussed; that some group might move in this direction without providing clues or warning. It is disquieting to realize that, in the past, most new terrorist groups have not been detected before their terrorist act.

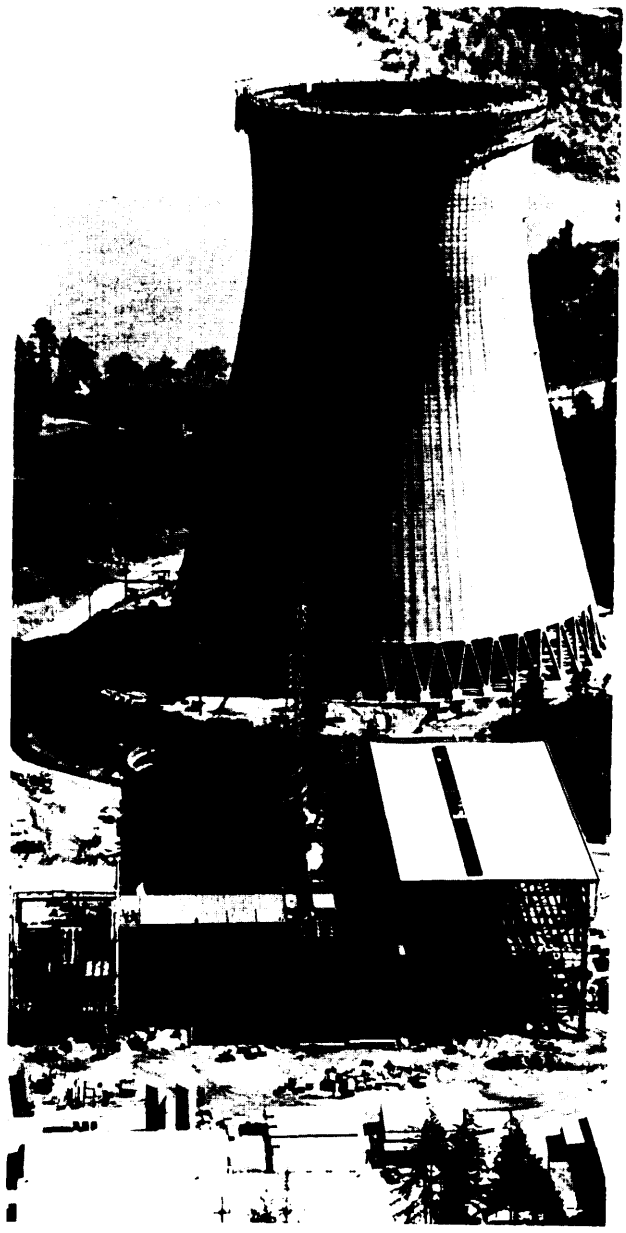
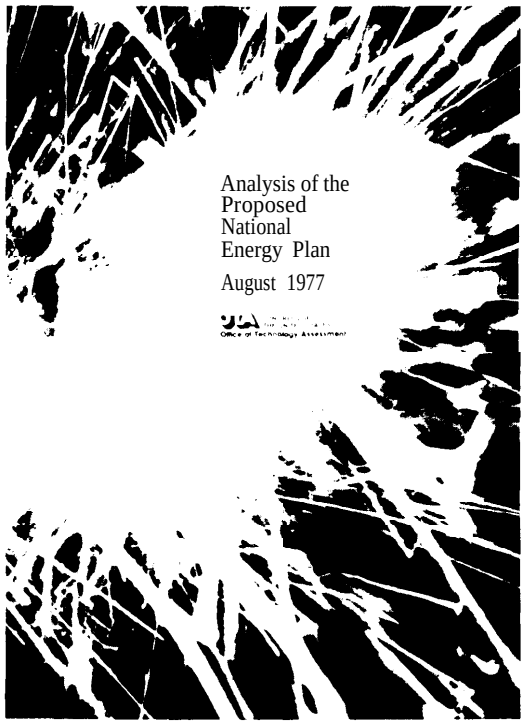


Photo Courtesy Jan Fardell for Portland General Elecfric Company

Trojan Nuclear Plant of the Portland General Electric Company is shown under construction near Prescott, Oreg., 42 miles northwest of Portland on the shores of the Columbia River



Analysis of the Proposed National Energy Plan

The National Energy Plan's assessment of the world energy crisis is accurate. The problems are complex and serious, and there is little time for fashioning new policies to respond to them. If the United States acts now, it may be able to reassert control over its energy future and prevent serious economic, social, and environmental impacts. To postpone decisions to raise energy prices and reduce waste is to risk losing that control, which would mean severe hardships for all Americans within the next 10 years.

The level of U.S. oil imports is the pressure gauge that will measure how well American policies are succeeding. If imports can be held close to the goals of the Plan, the United States and the rest of the world may well manage a relatively smooth and peaceful transition to sustainable energy resources. If not, the transition may be neither smooth nor peaceful. . . .

The levels of domestic supply projected by the Plan represent the upper limits of capacity, and supplies of all fuels are likely to fall below the Plan's production targets. . . If delays do occur, oil production could fall short of the Plan's objectives by as much as 1 million to 1.5 million barrels per day. Coal production could miss the Plan's target by up to 200 million tons per year. Nuclear power generation could fall short by as much as 15 percent. . . .

The indicated effects of the Plan on the overall economy and employment are likely to be minor but adverse: however, these costs appear small compared to the cost of increasing reliance on foreign energy sources. The basic energy choice to be made is between a series of immediate actions that may result in an economic slowdown which the Nation can endure, and a failure to act at all, which would lead to a major economic disruption in the future. . .

The cost of converting boilers and powerplants from oil or natural gas to coal will be high. Large industrial boilers, for example, would probably need pollution-control equipment averaging $4 million per installation. One major utility has estimated that it will cost about $4 billion to convert its 6,000 megawatts of generating capacity to coal. The question of whether these costs are lower than the penalty costs of continuing to burn oil or natural gas that would be imposed by the Plan must be decided case-by-case. . . .

There could be a further sizable incentive to U.S. solar equipment manufacturers in foreign sales. Current prices for fossil fuels, particularly in many developing nations, are considerably higher than in the United States, and in many of these nations solar heating systems are already economically competitive. Availability of U.S. -built solar power systems could also help defuse overseas resentment over U.S. moves to re-emphasize plutonium as a nuclear fuel. .

The market for coal that would be created by industrial users switching from oil and gas consists of a large number of widely dispersed installations, each of which can consume only relatively small amounts of coal. Therefore, the market would be incompatible with the present system of distributing coal. The disparity is important. For example, unit-train and other volume shipments of coal become justifiable at about

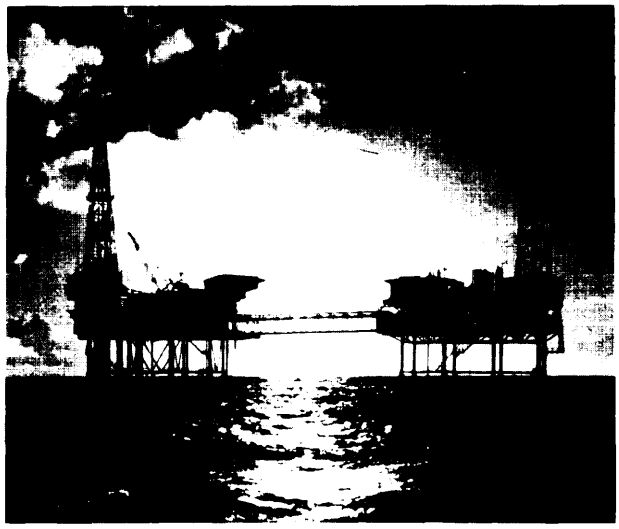


Photo Courtesy of EXXON Corporation

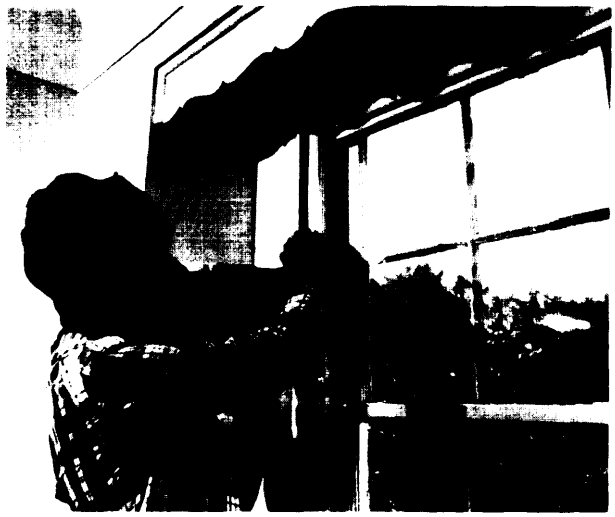
Production platform, Gulf of Mexico, 75 miles off the Louisiana coast

600,000 tons per year and become economically attractive at about 1 million tons per year, but a typical large-scale industrial facility can consume only about 80,000 tons per year; a very large industrial boiler plant may be able to consume as much as 130,000 tons a year. . . .

While the 1985 goal of weatherproofing 90 percent of all homes and new buildings is overly optimistic, the emphasis of the Plan on improving the thermal efficiency of buildings should accelerate an important energy-saving trend. It may be necessary to require either that information on thermal efficiency of housing be made available to potential buyers or that housing meet specified thermal efficiency standards at the time of sale if the goals are to be realized. The Plan's emphasis on single-family dwellings and duplexes could mean that large potential savings from conservation measures in commercial structures will not be achieved. Further, the Plan's lack of strong incentives for conservation in rental housing may result in a negative impact on the poor, because most low-income families are renters. . . .

The poor, and particularly the rural poor who probably comprise most of the half of the lower income group who own cars, will be hit most heavily by the increases in gasoline prices the Plan proposes. Not only do they spend a relatively larger proportion of their income on gasoline, they suffer from two other handicaps that would make it difficult to adjust to higher transportation costs. First, mass transit is not available for all essential travel, such as to work. Secondly, the poor generally cannot afford new, gas-economizing cars. They will be the purchasers in the secondhand market of "gas guzzlers" whose relative prices will fall as gas prices rise, bringing them within reach of lower income groups. Thus, those who can afford new, fuel-efficient cars will be saving money on gasoline while the poor will be spending more on gasoline. No element in the plan recognizes or offsets these possible inequities. . . .

But the possibility of sacrifice has already been raised for natural amenities—redwood forests, pristine valleys, and vulnerable species of plants and animals in danger of extinction. Can the Nation—should the Nation—protect these treasures against demands for more energy? Should workmen tear up a beautiful valley to get coal? Should a forest be demolished to get building materials? . . .



Enhanced Oil Recovery Potential in the United States

CONGRESS OF THE UNITED STATES
Office of Technology Assessment

Enhanced Oil Recovery

Between the years of 1946 and 1970, discoveries of new oil exceeded production from known domestic reserves. As a result, proved oil reserves (the amount of oil that can be recovered with current technology under existing economic conditions) increased from 20 billion barrels to 39 billion barrels, representing an average annual compound growth rate of 2.8 percent. Since 1970, however, production has outstripped new discoveries, and proved reserves have decreased at an average rate of 3.8 percent to about 31 billion barrels at the end of 1976. . .

There are two approaches to increasing domestic production of natural crude oil: locate additional oil through increased exploration; and develop more efficient methods for recovering oil from known reservoirs. This report assesses the potential for increasing domestic production by applying developing technologies, known collectively as enhanced oil recovery techniques, to known reservoirs. . . .

The 298 billion barrels that would remain in the ground after production of these primary and secondary reserves are the target for "tertiary" or enhanced oil recovery techniques that use heat or chemical fluid injections to drive out oil that has been left trapped in the pore spaces of sandstone and limestone reservoirs. . .

At the current world oil price of $13.75, the likely range of enhanced oil recovery production is from 11 billion to 29 billion barrels, representing a 31-percent to 83-percent increase in proved and indicated reserves from primary and secondary production. Increasing the price to the alternative fuels price of $22/bbl yields a range of from 25 billion to 42 billion barrels, an increase of from 71 percent to 120 percent in proved and indicated reserves. . . .

Enhanced oil recovery methods represent a developing and relatively unproven technology. For example, the two processes which represent over half of the total enhanced oil recovery potential—carbon dioxide miscible flooding and surfactant/polymer flooding–have received only limited field testing. Consequently, there are many uncertainties that must be considered when interpreting the results of assessments of the potential of enhanced oil recovery. . . .

Enhanced oil recovery processes in general require significant quantities of fresh or relatively fresh water, whereas secondary water flooding can use saline water. This consumption of fresh water not only will compete directly with domestic, agricultural, and other industrial uses, but also could result in a drawdown of surface water, which could, in turn, severely affect aquatic flora and fauna in the area of the drawdown. However, this impact usually would be localized and of short duration. The consumption of fresh water by enhanced oil recovery processes has been the greatest potential impact in California, Texas, and western Louisiana, where water supplies are limited. Development of enhanced oil recovery technologies to allow use of saline water could reduce this potential problem. . . .

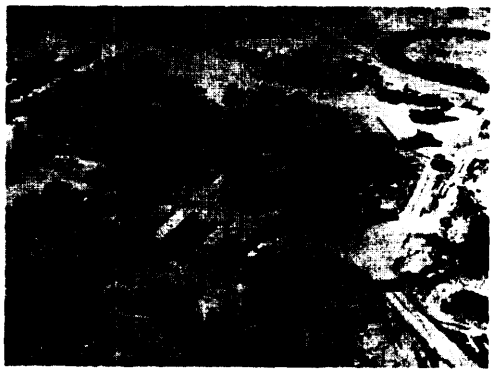
Oil does not occur in underground lakes, but rather is held within open spaces between the grains of rock that constitute the formation. The oil is retained in this open space in much the same way as water is held within a sponge. Almost invariably, water co-exists with oil in this open space between the grains; frequently gas is also present as a separate entity. . . .

Uncertainty concerning the physical and chemical nature of an oil reservoir is one of the most severe technological barriers to enhanced oil recovery processes. Not only are the reservoirs significantly different among themselves even within the same geological class (e. g., sandstones or limestones), but the place-to-place variations in thickness, porosity, permeability, fluid saturations, and chemical nature can be discouragingly large. The present capability to describe, measure, and predict such variability is extremely limited. Knowledge to measure and predict this variability within a reservoir is vitally important to forecast fluid movement and oil recovery efficiency. . . .

The law affects enhanced recovery of oil operations in many ways. Based upon the responses to questionnaires, price controls on crude oil constitute the most significant legal constraint to enhanced recovery operations. Approximately 65 percent of all producers responding to the questionnaire indicated that removal of price controls would make more projects economically feasibile or more attractive. . . .

Status Report on the

Gas Potential From Devonian Shales of the Appalachian Basin



November 1977

CONGRESS OF THE UNITED STATES
Office OS Technology Assessment
WASHINGTON, D.C.

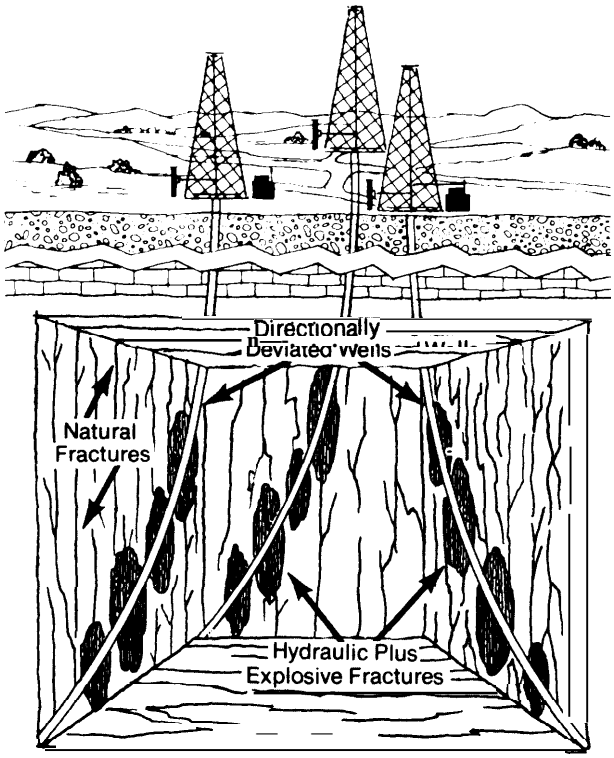
Gas Potential From Devonian Shales of the Appalachian Basin

The Devonian Brown shales of the Appalachian Basin, so-called because they accumulated during the Devonian age, have the potential of contributing significantly to the U.S. natural gas supply. It can reasonably be assumed that these shales contain as much as 15 to 25 trillion cubic feet of readily recoverable reserves that could be produced economically over a 20-year period at prices of $2.00 to $3.00 per thousand cubic feet. These reserves could ultimately support a production rate of about 1 trillion cubic feet of natural gas per year, which is about 5 percent of the current level of domestic gas production. Such a production rate is likely to require extensive drilling (on the order of 69,000 wells), a considerable expansion of the gas pipeline collecting network and, therefore, up to 20 years to achieve. . . .

Shale gas production has a slow flow rate over a long period of time, so ultimate recoverable reserves over the 30- to 50-year expected life of production could be 40 to 50 percent greater than the 15 to 25 Tcf estimate. . . .

The recoverable gas potential of the Brown shale depends on the (1) wellhead price and pro-

Figure 10. Deviated Wells and Earth Fracture Systems Process



Source Department of Energy

Deviated wells and earth frac ture systems process

duction costs, (2) extent of the Brown shale resource, and (3) the relat ive amounts of high-, medium-, and low-grade gas-producing Brown shales. .

The location of individual wells relative to potential pipeline connections (in addition to geologic promise) will continue to be an important determinant of the economic quality of Brown shale drilling prospects. Since Brown shale gas production is likely to be scattered over an extensive area, it is prudent to presume that Brown shale gas development will proceed at a gradual pace, probably requiring at least 20 years to reach a 1.0 Tcf production level (about 69,000 wells in the Brown shale will be needed to produce 1.0 Tcf per year). If improvements in drilling or stimulation technology are achieved and economic incentives provided, the time necessary for the development of the gas potential of the Brown shale might be reduced. . . .

If Congress takes no action on prices, existing prices would be the only incentive to encourage gas production from the Brown shale. Current maximum interstate gas prices encourage gas production with existing technology from only the high-quality Brown shale areas. Therefore, continuation of present gas-pricing policy could result in foregoing substantial additions to the U.S. natural gas supply which may be available from the Brown shale of the Appalachian Basin. . . .

Because of the importance of well stimulation in the production of gas from the Brown shale, improvement in the effectiveness and reductions in costs of stimulation techniques could make gas production from Brown shale more economically attractive. Price incentives can be expected to induce some private activity in these research and development areas. However, because much drilling, well stimulation, and production will be done by operators who do not control large shares of Brown shale resources, it is unlikely that these operators will invest large amounts in aggressive research and development programs. Therefore, it may be prudent to commit public funds for research and development activity directed specifically toward improvements in shale drilling and stimulation technology. . .

It should be noted that the Brown shale is not "oil shale" like that of Colorado and Wyoming. The organic matter is not the type of kerogen that characterizes such oil shales: rather, as noted above, the Brown shale are coal-like. . . .

The reservoir characteristics of Brown shale are vastly different from those of typical oil- and gas-producing formations. Porosity indicates how much space exists in a particular formation where oil, gas, and/or water may be trapped. A commercially oil- or gas-productive sandstone or limestone reservoir has porosities in the range of 8 to 30 percent. By contrast, gas-producing Brown shales have porosities of 4 percent or less. . . .

Policy options available to encourage production of gas from the Brown shale fall into four

generic categories: price incentives, tax policies, research and development funding, and information collection and dissemination. . . . There are three basic price strategies with respect to shale gas which could be pursued: exempt shale gas from FPC price control or establish higher prices for gas from the Brown shale, deregulate the wellhead price of all new natural gas supplies, or take no action. . . .

The tax policies available to Congress to encourage Brown shale gas production include: restoration of the general 22-percent depletion allowance, definition of Brown shale gas production as enhanced recovery so as to maintain the depletion allowance for small producers, retention of expensing of intangible drilling costs as a tax option, and creation of a 10-percent investment tax credit for gas production from the Brown shale. . . .

There are several areas in which research and development with special relevance to the Brown shale of the Appalachian Basin might be fruitfully pursued. These include: defining resource characteristics, development of drilling techniques and equipment, and improvement of logging and stimulation techniques. . . .

If the gas potential of the Brown shale is exploited, a large number of independent operators are likely to be drilling a large number of wells in many different locations on the Appalachian Plateaus. Under these conditions, particularly in the early years of the development effort, it might be desirable to fund publicly the collection, coordination, and dissemination of information and analyses detailing the results of actual operation experiences. . . .

Summary

PREPUBLICATION DRAFT
This copy is subject to editing before final publication.

Application of

Solar Technology

to

Today's Energy Needs

June 1977

CONGRESS of THE UNITED STATES
Office of Technology Assessment
WASHINGTON, D.C.

Application of Solar Technology to Today's Energy Needs

Small solar energy units that supply individual houses, apartment buildings, and commercial and industrial facilities (i. e., "onsite" solar energy systems) must be considered as a serious addition to the limited number of options available for meeting the world's demand for energy. Solar equipment is technically capable of providing almost any kind of energy: it can be used to heat and cool buildings, provide heat for industrial processes, provide mechanical power for pumps and other equipment, and generate electricity. Moreover, it can meet these demands with minimal adverse effect on society or the natural environment. In fact, onsite solar energy systems may have a favorable impact on employment by creating attractive new jobs, on international stability by easing the competition for conventional energy resources, and on the environment by replacing polluting energy sources. . . .

It is clear, however, that there is a market for some types of onsite solar equipment at today's prices and this market could expand rapidly if

Photo Courtesy of Bob Homan Photography

Solar collector installed on the Homan home. Indian Hills, NJ.

relatively modest increases occur in the cost of conventional energy. Solar equipment can produce hot water for domestic use at costs which are competitive with the cost of water heated by conventional electric water heaters. If the price of electricity increases by about 40 percent (in constant dollars) by the year 2000, it should be possible by 1980 to build solar systems which supply 100 percent of the heating and hot water needs of large buildings in three of the four cities examined in this report (Albuquerque, Fort Worth, Omaha, and Boston), at prices which are competitive with electric heating and hot water in all of the cities examined. .

The onsite solar systems examined in this work differ sharply from the equipment now used to provide most of the world's energy. Onsite devices are, by definition, intended to be located at the point of energy use, and would be designed, manufactured, installed, and operated much like today's conventional air-conditioners, heating systems, and process heat systems. In contrast, conventional nonsolar energy systems have become increasingly large, more complex, and centralized at locations remote from the point of end use. . .

The technology of energy storage is critical to the development of low-cost solar energy system. Storing energy directly in thermal form is by far the lowest cost method when the energy will ultimately be used to heat buildings or industrial processes. It should be possible in many parts of the country to install economically competitive solar heating systems using storage equipment of this type to provide 100 percent of the heating

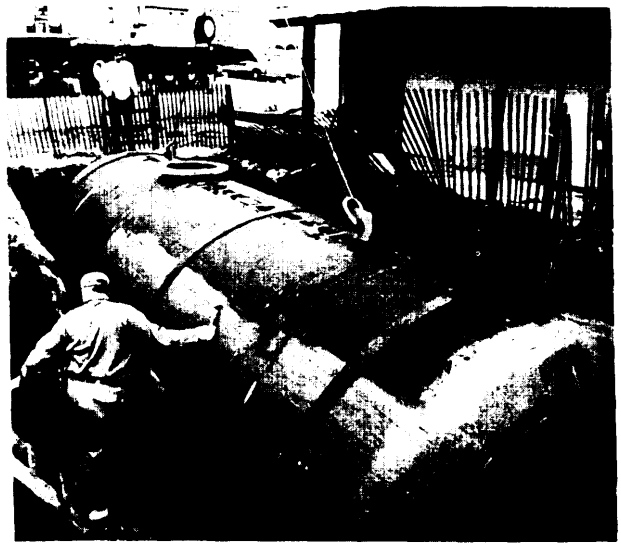


Photo Courtesy of Burger **Krig** *Corpora f/on*

Installation of Insulated, underground, storage tank at solar heated and air-conditioned Burger King, Camden, NJ.

needs of large buildings. A number of devices are being investigated which may greatly reduce the cost of storing electricity in onsite systems. . . .

Regional differences in the attractiveness of solar energy are often due more to differences in the price of conventional energy than to differences in the amount of sunlight available. . . .

One of the attractive features of onsite solar energy is that it can be developed and marketed with little special assistance from Federal or State governments. A small solar industry already exists and the analysis of this paper suggests that there may be a much larger market for unsubsidized equipment during the next decade. The technology, moreover, will fit easily into the framework of existing institutions: it can be produced by any of a large number of existing industries; financed in conventional ways; built and operated with existing labor skills. Moreover, it will not have a major negative environmental impact. As a result, its introduction will not need to be controlled by an elaborate set of new regulations, legislation, or regulatory agencies—modest adjustments of existing regulations governing conventional heating and cooling equipment should suffice in most cases. . . .

The Federal Government owns or leases approximately 446,000 buildings in the United States, with a combined floor area of nearly 3 billion square feet, and spends almost $1.7 billion annually to heat and cool them. (That figure is expected to reach $1.9 billion by the end of the year, and about $3.5 billion by 1985.) If 10 percent of the present heating/cooling costs were capitalized–-used for debt payments for the purchase of solar equipment—the Government could purchase nearly 100 million square feet of solar collectors annually. . . .

There is little doubt, however, that Federal legislation can accelerate the rate at which solar equipment enters the market if this is judged to be a desirable objective. The following types of policies can be effective:

- Direct incentives to potential customers (chiefly tax incentives, allowances for accelerated depreciation).
- Assistance to manufacturers (which include incentives for purchasing equipment to produce onsite devices, research and development grants, and Federal purchases) and assistance for testing laboratories certifying the performance of onsite equipment.
- Support of basic research and development programs in fields related to onsite solar energy.
- Legislation which might eliminate some barriers to usage of onsite solar systems (this would include freeing onsite equipment from regulation as a public policy and assisting States in designing local procedures for protecting the “sun rights” of owners of solar equipment).
- Encouragement of the use of solar energy in other countries through foreign assistance grants, joint research programs, and other techniques.
- Programs to support education and training in fields related to solar energy.

Perspectives on Federal Retail Food Grading

Perspectives on Federal Retail Food Grading

Present Federal food grades impart little information to the consumer. Federal grade criteria for sorting products are based on sensory characteristics—such as taste, flavor, color. or exterior appearance — and evolved as a mechanism to facilitate wholesale transactions in industry. To benefit consumers, simple, uniform terminology, increased nutritional information, and standardized systems for grading might be established. The question now arises as to whom grades should serve: consumers, industry, or both? . . .

Retail grade criteria should not be changed to reflect some combination of sensory and nutritional facts, as it is not meaningful to grade processed foods on both. Problems include an inverse relationship between sensory and nutritional characteristics and the timelag necessary to establish nutritional content and grade and label the products. For processed foods, analysis by OTA indicates that the most appropriate vehicle for conveying nutritional information to consumers is the nutritional labeling program already in operation. , . .

The first official Federal food grade standards were established for potatoes in 1917 . . . . The Government hoped the grading system would encourage farmers to grow higher quality produce, reasoning that since high-quality food would sell at higher prices, the farmer would receive more for what he produced and therefore would be persuaded to grow better quality food.

The primary reason for grades was to make wholesale transactions simple and more efficient, thereby cutting food costs to consumers in the long run. Because a common language would be used nationally at wholesale, transactions would be simplified and the time would be saved by wholesalers. Some of the cost reduction would be transferred to the consumer, and thus the consumer would benefit from wholesale grades by paying lower prices for food.

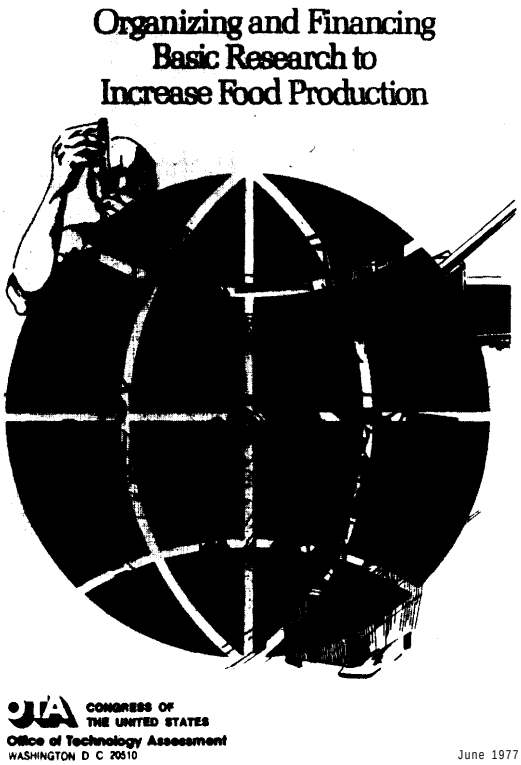
There are problems with the current Federal food-grading program, among them confusing nomenclature for grades and a general lack of

Photo Courtesy of U.S. Department of Agriculture

useful information conveyed by them to consumers.

The present confusion is a result of over 50 years of USDA allowing industry considerable latitude in deciding the grade nomenclature to be used so that there would be some degree of standardization. The reason for this latitude is that grading is optional: Industry has the option of not using the USDA grading system if it does not care for the USDA standards or grade designation for their products. Because different industries have differing concerns and requirements (or at least perceive them differently), the result is the present diversity of grades. . . .

While the cost of mandatory grade labeling is a legitimate concern of the food industry, a recent Grocery Manufacturers of America survey (March 6, 1975) concluded that $8.4 billion worth of food products would have nutritional labeling by the end of 1975. The survey indicated that for the $8.4 billion, the initial average cost of putting the information on labels per dollar of sales is .004 cents and that the average continuing cost of nutrition labeling is .00016 cents per dollar of sales. . . .



Organizing and Financing Basic Research to Increase Food Production

Studies of U.S. agricultural research productivity show annual rates of return of 30 to 40 percent. On the basis of past studies and the potential payoff from accelerated basic research to increase food production, it is highly probable that an investment of $300 million to $500 million over a 10-year period would yield returns of $1 billion to $2 billion over the next 20 years. . . .

Public support for research to increase food production has declined in the last two decades for a number of reasons. In the 1950's and 1960's, Congress was concerned more with the costs of storing surplus crops and maintaining farm income support programs than with food production research. . . .

There is substantial agreement among agricultural scientists that three high-priority basic research areas—photosynthesis, biological nitrogen fixation, and cell culture studies—offer unusual promise of high potential payoff over a moderate to long-term period. . . .

An increase in the efficiency of photosynthesis in a crop like soybeans could result in a 50-percent increase in yield per acre. The annual value of increased production, reduced acreage, and/or production costs would amount to no less than $1 billion, assuming this increase of only 50

percent in the yield of soybeans in the United States. . .

An even greater gain would be achieved with the development of symbiotic nitrogen fixation in corn, cereal grains, or any important crop other than legumes. Such a discovery could reduce the need for nitrogen fertilizer by millions of tons per year in the United States and throughout the world. A savings of half a billion dollars a year in the United States for nitrogen fertilizer is not an unrealistic expectation.

Cell-culture studies offer promise for developing new combinations of germ plasm and thus provide a means for genetic engineering which could lead to new strains of *Rhizobium* with much higher nitrogen-fixation capacity. They could also lead to new varieties of soybeans, cereals, potatoes, and other crops with substantially higher photosynthetic efficiency levels than occur in conventional plant-breeding methods.

CANCER TESTING TECHNOLOGY AND SACCHARIN

OCTOBER 1977

CONGRESS OF THE UNITED STATES
Office of Technology Assessment

Cancer Testing Technology and Saccharin

The "Delaney Clause" of the Food, Drug. and Cosmetic Act prohibits the use of any food additive that has been shown to cause cancer when ingested by humans or animals. Since saccharin has been shown to cause cancer in laboratory animals. the FDA must ban its use, .

Because saccharin is the only non-nutritive sweetener currently available to the American public, its ban has been widely criticized. The debate has prompted questions about the validity of the technology for testing whether a substance causes cancer, as well as the failure to consider the benefits as well as risks of a substance in determining whether it should be prohibited. . . .

Because carcinogenicity cannot be tested directly in humans, indirect methods are necessary. Current methods can predict that a particular substance is likely to cause cancer in humans. The technology for making quantitative extrapolations from animal experiments to human risk is progressing and has been verified in the few cases for which data are available, But this technology does not currently permit reliable estimates of the numbers or locations of cancers that might occur in humans. . . .

Animal tests are the best current methods for predicting the carcinogenic effect of substances in humans .-All substances demonstrated to be carcinogenic in animals are regarded as potential human carcinogens; no clear distinctions exist between those that cause cancer in laboratory anireals and those that cause it in humans. The empirical evidence overwhelmingly supports this hypothesis. . .

A general problem occurs when discussing experiments on dangerous substances. What conclusions are to be drawn when some experiments show the substance caused cancer in animals and other experiments do not? In the particular case of saccharin, all two-generation experiments have been positive. A number of other experiments have led some to conclude that saccharin is not a carcinogen. The Office of Technology Assessment reviewed those experiments and found none comparable in design to the three positive experiments. Furthermore, some others were too insensitive to have detected the carcinogenic effect of saccharin. This statement is no indictment of those experiments; cancer testing is rapidly evolving, and many older experiments are not now considered to be satisfactory. The postive two-generation studies come the closest of all that have been conducted to meeting the current testing standards. . . .

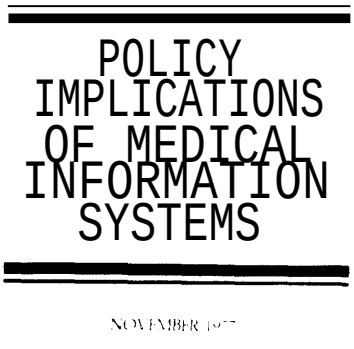
Saccharin was found to be among the weakest carcinogens ever detected in rats. Chemical carcinogens are very different in their carcinogenic potencies. For example, aflatoxin (AF-BI), a substance produced by certain fungi and found in moldy peanuts and certain grains, causes cancer in 50 percent of rats at a dose of more than one million times less than the dose of another carcinogen, trichloroethylene (TCE), a chemical that, until recently, was used to extract caffeine in the manufacture of instant coffee. . . . Where does saccharin fall on this millionfold scale? It actually extends the scale in the weak direction —it is slightly weaker than TCE. . . .

Standard procedure in animal tests is to feed substances at the "maximum tolerated dose. " In the case of saccharin, the "maximum tolerated dose" is 5 percent of the diet, even though humans are exposed to much lower doses. Contrary to popular opinion, all chemicals do not cause cancer at high dose levels. Many food additives and other chemicals have been tested in animals at this level without causing cancer. . . .

The rationale for feeding large doses of a substance in animal tests is as follows. As the dose of a substance that causes cancer is increased, the number of exposed animals that develop cancer also increases. To conduct a valid experiment at high dose levels, only a small number of animals (perhaps several hundred) is required. However, to conduct a valid experiment at low dose levels, a very large number of animals is required. . . .

After a test has been well validated, it can be reasonably assumed that if a previously untested substance is clearly positive in that test, it will probably be a carcinogen in animals. However, a negative result in a short-term test is more difficult to evaluate: such a result only suggests that the chemical is noncarcinogenic. Negative results are not necessarily definite because short-term tests do not detect promoting agents or cofactors in the carcinogenesis process, and such substances may be important in causing cancer. . . .

The best evidence to date for concluding that saccharin is a potential human carcinogen comes from the two-generation rat-feeding experiments. These tests demonstrated that, over a long period, diets high in saccharin produced bladder tumors in rats. Evidence for carcinogenicity by other routes of administration and in other species of laboratory animals, while not convincing by itself, supports the conclusions from the two-generation rat experiments. Recent results of short-term tests, including tests conducted as part of this study, also support the conclusion that it may be a carcinogen. These results do not rule out the possibility that the carcinogenic activity of commercial saccharin may reside in its impurities. Although further experiments are needed to identify the carcinogen(s), it is the manufactured product, not the isolated chemical, that is subject to regulation. . . .



Policy Implications of Medical Information Systems

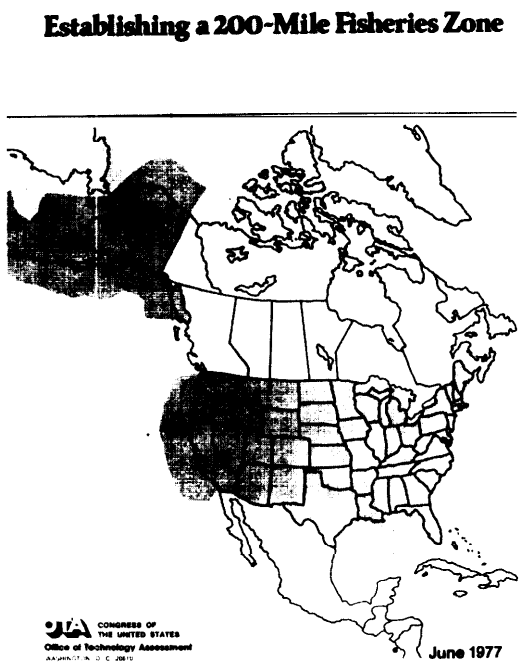
The complexity of medical care has greatly increased during the past 30 years. More technology. more professionals, and more support services are involved in the care of patients than ever before. Today's medical care institutions encounter problems coordinating and communicating massive quantities of data necessary for clinical care. Medical professionals must note and remember increasing amounts of data about each patient from an expanded number of diagnostic tests and therapeutic procedures. Physicians are also faced with the task of memorizing information about new diagnostic tests and treatments, knowledge that must be constantly updated. . . .

The application of computer technology offers a possible solution to these problems. Called medical information systems, this new application promises to change the medical record from a historical document to timely, accurate information that is instantly available to all those involved with patients. Medical information systems can be used to educate and assist medical professionals during clinical care, reducing the need to rely on memory. Potentially, they can increase efficiency and reduce or contain institutional costs. They can provide a way to monitor and evaluate the quality of medical services. They can eliminate data for evaluating and planning medical care services. Finally, they can be used to supply data that have been previously unavailable to researchers and policymakers. . . .

A medical information system is defined as a computer-based system that receives data normally recorded about patients, creates and maintains from these data a computerized medical record for every patient, and makes the data available for the following uses: patient care, administrative and business management, monitoring and evaluating medical care services, epidemiological and clinical research, and planning of medical care resources. .

If the role of computer systems in clinical decisionmaking increases in the future, medical education will change. Without the need to accumulate facts, students' education could emphasize the study of the processes involved in decisionmaking. as well as the social and psychological aspects of medical care. Such an educational experience would prepare students to take a new role as clinicians. . . .

The Federal Government could continue current policies and allow adoption of medical information systems to be determined in the open marketplace. However, this policy could result in medical information systems being marketed and adopted without additional investment in research to improve certain capabilities. Because capabilities to improve and monitor the quality of medical care and to facilitate research and planning are the least developed and require standardization, these potential benefits for patients and the medical care system might be lost. Computer systems limited to administrative and financial functions could continue to dominate the market. Medical information systems that might be used could also lack high standards of quality or provide inadequate protection for the confidentiality of patient data. . . .



Establishing a 200-Mile Fisheries Zone

Twenty years ago, the United States was the world's second largest fishing nation. But by 1974 American fishermen were fifth, catching only about 4 percent of the world's supply of fish. In that time, the U.S. catch had dropped only about 8 percent, but the catch of some foreign nations had increased by as much as 250 percent. In 1974, the world catch was nearly 70 million metric tons. Much of that was coming from waters off the United States where, within 200 miles of the coasts, about one-fifth of the world's fishery resources are located. . . .

Worldwide, the National Oceanic and Atmospheric Administration has projected that the oceans can sustain an annual catch of only 100 million metric tons, a catch figure they expect to be reached by 1980. Already, increased fishing has caused acute pressure on some stocks, depleting the supply and threatening their existence. For example, off the coast of the United States about **20** species of fish and shellfish are believed to be seriously depleted. . . .

.Technically sophisticated foreign fishing fleets have taken a heavy toll in traditional U.S. fisheries, particularly off the northeast and northwest coasts where there are several species of prime interest to U.S. commercial fishermen and consumers. The decline of the New England haddock fishery which was reduced from a major commercial enterprise in 1950 to a relatively small activity today, is a principal example of the effects of overfishing within 200 miles of the U.S. coasts. The U.S. haddock catch in 1950 was 20 times larger than it was in 1974. . . .

The task of husbanding the U.S. fishery resources is a major one. At stake is not only a major supply of animal protein, but also an American industry which provides employment for more than a quarter-of-a-million people and has a $6.5 billion impact on the U.S. economy. . . .

Management plans to be drawn up under provisions of the Act (Fishery Conservation and Management Act of 1976] will **lay** the groundwork for the types of regulations which will be required and which must be enforced. However, fish resources are already scarce enough and the demand for fish products high enough that it is logical to conclude that foreign nations can justify the risk of violating these regulations and the United States can justify the effort and expense of enforcing them. . . .

Current plans call for placing observers onboard 10 to 20 percent of the foreign vessels granted permits to fish in U.S. waters. These observers will be National Marine Fisheries Service (NMFS) personnel who will have no enforcement duties. They will be assigned randomly to vessels of foreign nations which in the past have been suspected of giving NMFS incomplete or inaccurate reports on their fishing activity. . . .

Foreign fishermen will realize that from their view the observer is primarily a policeman. The potential penalties for violations noted by the observer could be high, but the value of an illegal catch may be even higher. Therefore, foreign fishermen may attempt to bribe, harm, or deceive the observers, frustrating their scientific and enforcement functions. . . .

Use of new technology, particularly remote-sensing devices, may make it possible to improve enforcement of fisheries regulations in the future by better coverage, better performance, and a reduction of the need for expanding conventional ship and aircraft patrols. Although it may be possible for several agencies (such as the Coast Guard, the military, and NASA) to share the cost of new remote-sensing devices, these systems are extremely expensive and their use should be thoroughly evaluated before any one system is adopted. Any analysis of benefits and costs of remote-sensing systems should not ignore the argument that national security could be compromised by making some of these systems available for other than military missions. . .

In most cases, imposition of new fisheries regulations is likely to represent a loss of income to fishermen. This means that the costs of management (in terms of decreased catches) will be borne by the men currently in the fishery. The benefits will be gained by future generations of fishermen. . .

Fishermen can respond to the new economic opportunities presented by extended jurisdiction by adopting new boats and sophisticated fishing equipment or by using existing equipment coupled with new fishing and marketing strategies. If large numbers of people are willing and able to change existing practices or to invest in new boats and processing equipment embodying new technology, then the effects throughout the social and economic structure of the coastal communities will be enormous. If fishermen cannot or will not respond, offshore fishing may gradually be taken over by large corporations. . . .

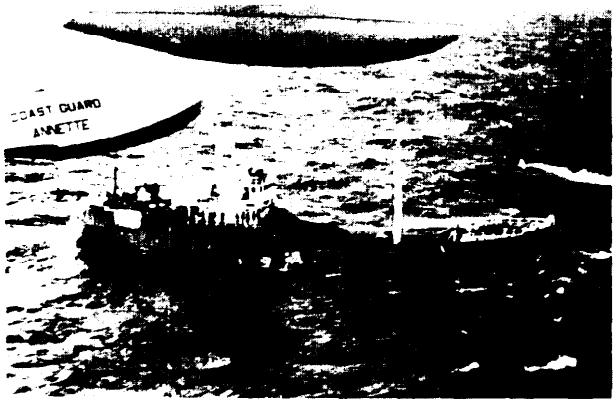


Photo Courtesy of National Marine Fisheries Service
U S Department of Commerce

U.S. Coast Guard "Albatross" keeping track of illegal fishing off the Alaskan coast

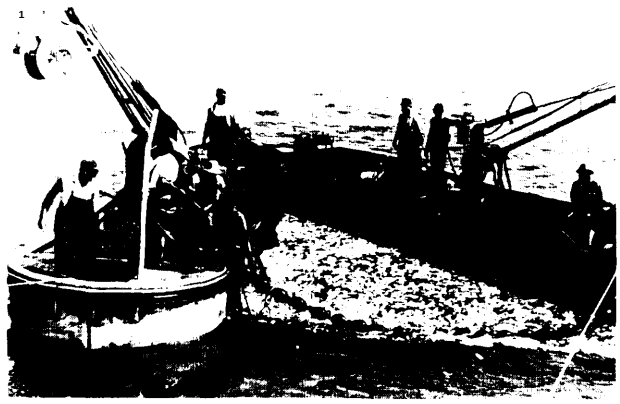
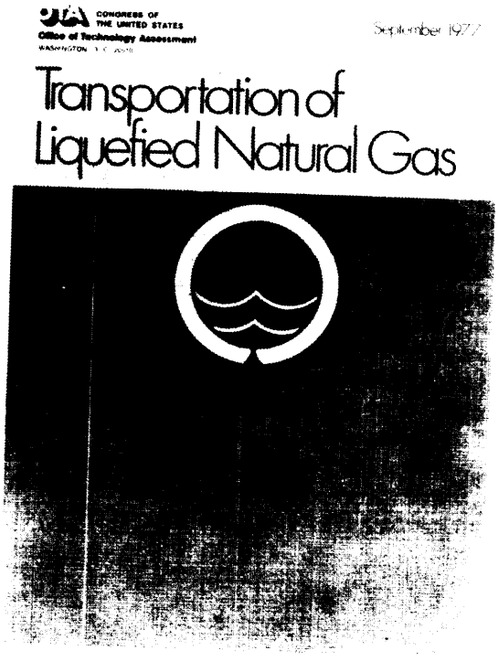


Photo Courtesy of NOAA

Menhaden being seined off the North Carolina coast



Transportation of Liquefied Natural Gas

It is possible that during the next two decades 5 to 15 percent of the U.S. natural gas consumption could be filled with liquefied natural gas (LNG) from Alaska or foreign countries. . . . To date, there have been few serious problems in the operation of small-scale LNG facilities existing in the United States. However, new ships and plants will be considerably larger than existing ones, and problems of scale and limited experience make it difficult to predict with any degree of certainty the safety of the LNG system. . . .

In order to import natural gas in a form practical for water transportation from Eastern Hemisphere nations, a system has been developed to convert the gas to liquid form at about l/600th the volume. The liquefied natural gas is then shipped in specially constructed tankers, introducing a marine link in the supply and demand of natural gas. This marine link is a large component, consisting of the liquefaction facility at the source of the gas, the LNG tanker, and the receiving terminal and regasification facility at a location near a gas distribution network. It is a very capital-intensive system which can cost more than $1 billion to construct. . . .

The United States is presently a net exporter of LNG. . . . Projects are now proposed which could bring as much as 3.5 trillion cubic feet of LNG per year to the United States from foreign sources within the next 10 to 15 years. , . ,

It is generally agreed that, if the vapor from a large LNG spill ignites, it would be beyond the capability of existing firefighting methods to extinguish it. Therefore, the key to reducing the hazard of an LNG fire is a strong prevention program. . . .

Only one major accident has marred the safety record of LNG plants. That accident occurred at the first LNG installation in 1944. At that time, a storage tank owned by East Ohio Gas Company in Cleveland ruptured, spilling 6,200 cubic meters of LNG into adjacent streets and sewers. The liquid evaporated, the gas ignited, and, where confined, exploded, The disaster remains the most serious LNG accident anywhere in the world. It resulted in 128 deaths, 300 injuries, and approximately $7 million in property damage. . . .

The location of a terminal can be **a** major factor in its safety. The magnitude and extent of any damage from an LNG spill can depend on the proximity of the terminal and storage sites to other industrial and residential areas. The site selection process is currently conducted by the company or consortium proposing the project. , . . There are, at present, no Federal siting criteria, and those projects which are now proposed have a variety of sites, ranging from remote coastal and riverine areas with 1,000-acre buffer zones to as little as a 90-acre site on Staten Island, . , .

The LNG industry has been particularly critical of the Federal Power Commission (FPC) in the realm of decisionmaking. One representative told OTA that the recurrent theme of industry's relationship with the FPC was "we can't follow the rules because we don't know what the rules are or will be. " One of the underlying problems

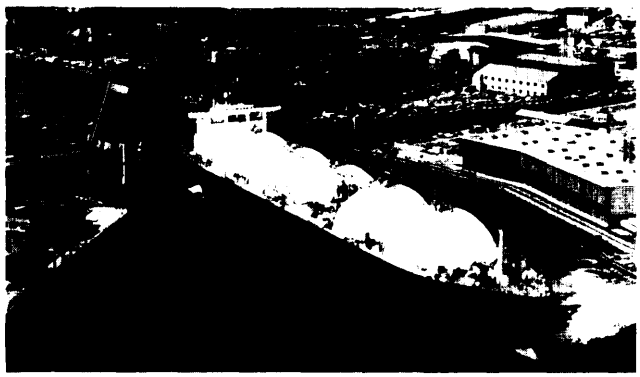


Photo Courtesy of Genera/ Dynamics

Photo by OTA

Two types of LNG tankers

which frustrates the FPC's decision making duties and processes is the fact that it is a regulatory agency, not a policymaking body. . . .

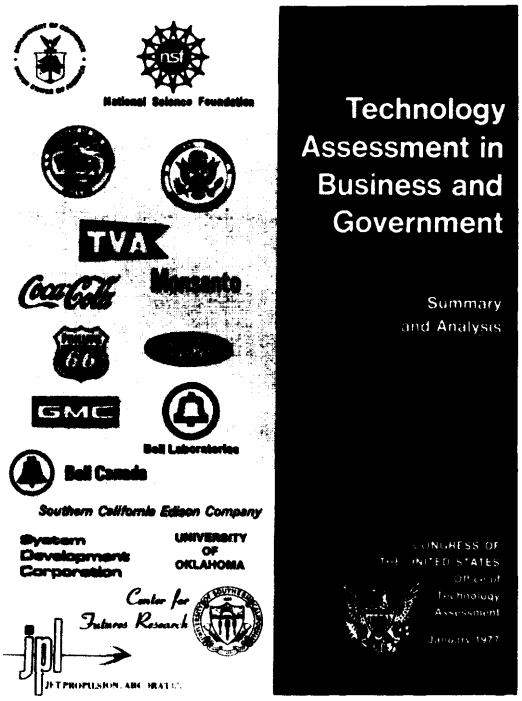
Before any LNG import or export project can begin operation, more than 130 permits must be obtained from Federal, State, and local agencies, and 12 different Federal agencies are involved in approvals and controls. . .

A ship collision could result in the rupture of one or more cargo tanks and spill a large amount of LNG onto the water. A water spill would spread much farther and evaporate much more quickly than a land spill. While it is most likely that a collision would produce some source of ignition which could fire the LNG vapor around the ship, a huge vapor cloud could be generated if no ignition occurred. . .

Imports of LNG to the United States currently come from Algeria, and there is some concern about the wisdom of becoming dependent upon any one country as the major source of supply. However, several other countries also control major portions of the world's natural gas reserves. . . .

A politically motivated disruption of LNG supplies is at least plausible and should not be dismissed quite as lightly as some LNG proponents have argued. . . .

Past research has produced conflicting results and predictions, and it is unlikely that the United States can afford the time and money to conduct enough research to resolve the differences and come to firm decisions about the safety and behavior of LNG. For this reason, decisions about LNG systems should be made on the basis of nonquantitative approaches which result in prudent siting criteria and strict design, construction, and operation standards. .



Technology Assessment in Business and Government

The study strategy of any particular technology assessment (TA) should be tailormade to fit the resources, timing, and needs of decision makers. A great premium is set on study strategies that are adaptable and flexible, yet stable, rather than routine or formalized. The TA process has been shown to be adaptable to a wide range of circumstances and needs. . . .

The private sector and the Government have substantially different orientations toward TA. The private sector is interested in TA as an aid in competing in the marketplace, for improving understanding of the future business environment, and for options for the decisionmaker. The Government sees TA as a better way to excercise its trusteeship, and to assist it in becoming more socially responsible. In the Government there also is a concern with understanding and trying to anticipate future events so that the introduction of new technologies does not cause, in terms of secondary impacts, too many positive and negative surprises for society. With an informed understanding through TA of what the impacts are, the policy makers and decision makers in the Government can better exercise their responsibilities to the general public. . . . They both see TA, however, as a fresh way to probe and explore mutual interests. . . .

Communication is essential for a TA's success. The effectiveness of an assessment depends on facilitating the creative free-flow of ideas among team members, as well as communicating with the ultimate users. There are two primary requisites for a TA to be useful: the first is the professional competence of the assessing team; and the second is the complete and open communication among all the concerned parties. . . .

A Preliminary Analysis of Demographic Trends Influencing the Elementary and Secondary School System

The present and past are decreasingly satisfactory models for the future, particularly for the future of the educational system which is undergoing major change. Planners and policy makers, therefore, need a substantive basis for understanding change. Demography is one such basis. It has the advantage of being quantitative and structural with regard to the organization of society, and quite reliable in its ability to forecast, from a policy point of view, over interesting intervals of time. . . .

For example, one can say with great certitude that the size of the high school population of 1990 will be about 25 percent smaller than in 1975. Judging from the "best guess" forecasts, recent declines in elementary school children are likely to continue through the mid-1980's. Thereafter, the number of school children will rise, leveling off about 1990 to present levels. . . .

Local mobility and internal migration are perhaps the two most important factors in producing State, regional, and local deviations from other large-scale national demographic trends. Movements between cities and suburbs, and between metropolitan and nonmetropolitan areas, as well as internal migration of subpopulations, such as blacks, Hispanics, and middle and working class families of all races, are major complicating demographic factors in elementary and secondary education planning. . . .

As a result of being in the labor force, fewer women will have time for voluntary service in the schools. At the same time that the availability of voluntary services may be declining, there may be an increase in demand for the kinds of services that volunteers can perform well. This decline of volunteers implies a decline in services offered or else greater demands on paid staff. . . .

The age of the onset of adolescence, which has been steadily declining at the rate of four months per decade since 1830, may now have leveled off. The junior high school has never adequately come to grips with the onset of puberty in terms of curricula, services, or goals. Especially critical is the increasing rate of early sexual activity among boys and girls of junior high school and high school age, creating both immediate and long-term social and educational problems and needs associated with adolescent childbearing. The only age group in the United States now undergoing significant expansion in birth rates are females under age 15. . . .

The importance of cultural shock among immigrants can be seen in the Chinese communities, particularly in New York City. The influx of large numbers of youths from Hong Kong results in all of the classic dislocations of foreign-language speaking, hard-to-acculturate students. The consequence is that what had been a model community, in terms of behavior, is experiencing an unfamiliar upswing in delinquency. One could anticipate the parallel and associated difficulties within the school system. Patterns of immigration, therefore, need to be better understood in terms of anticipating declining and growing needs of special services. Although the rate of immigration is low, because immigrants tend to collect in cities, one may anticipate continuing localized problems in already sorely troubled school systems. . . .

The highest payoff actions meeting the clearest needs are those involving the generation and distribution of knowledge about demographic trends to relevant State and local government planners. This generation and distribution could flow out of research, monitoring, surveys, data gathering, and to some extent from demonstration. . .

Familiarity with local circumstances can play a major part in whether a given forecast is policy useful or policy irrelevant. In general, there is not enough expertise now at the State and local levels to meet this need. . . .

The second major action area, therefore, is building capacity at the State and local level for more effective and timely planning in response to unfolding demographic trends. Building analytical capabilities and an information base focused on more fine-grain, detailed, and local analysis is needed. . . .

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A Preliminary Analysis of the

IRS TAX ADMINISTRATION SYSTEM

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A Preliminary Analysis of the IRS Tax Administration System

As it is intended to be operated and used to administer and enforce the revenue laws, the proposed "Tax Administrative System" (TAS) will determine or affect the collection, use, maintenance, and dissemination of large amounts of information about citizens. It will play a pivotal role in governmental and private data banks and information systems which contain the details of personal, organizational, and business lives of Americans at home and abroad. Since TAS is proposed at a time of intense public concern over the potential for abuses of the information resources of Government and the private sector, the system could be perceived as posing a threat to civil liberties, privacy, and due process rights of taxpayers. These effects might include a potential for surveillance, harassment, or political manipulation of files for which specific controls and safeguards are of concern to Congress. . . .

In its design concepts, TAS is on the leading edge of the state of computer art. The proposed procurement has been described in the 1976 Senate Appropriations Committee report as the "largest data processing project ever undertaken by the Federal Government. " The total cost of the system was then estimated to be between $750 million and $1 billion. Potential vendors of the computer equipment told congressional committees that to respond to the requests for proposals would cost around $2 million per proposal. . . .

Despite the importance of privacy in such a sensitive information system, there appears to be an element of secrecy about important aspects of the TAS which affect privacy. Nowhere in the testimony and materials given Congress did the IRS spell out the contents of the files to be consolidated in the new system; nor did it indicate how much of the specific information supplied by taxpayers on tax returns will be in an account in the new system. . . .

Another major management benefit planned under TAS is availability of a longer tax history through increased storage capacity. In light of what is known or perceived about the threats from other large computerized personal information systems containing financial data, and in light of recent public concerns about the IRS and other Government information practices, it is important to consider to what extent the longer retention time afforded by TAS might contribute to a public view of it as unfairly inhibiting people from starting new in society. There is a need to assure that, as programmed and operated, TAS will not stigmatize taxpayers long after their difficulties with IRS have been resolved in a satisfactory fashion. . . .

TAS will make large quantities of personal information about people available in the time it takes to snap two fingers. There may be a vastly increased potential afforded by TAS for speedier, more efficient invasion of privacy and breach of confidentiality of information, whether intentional or not, and whether authorized or not. This is true for inquiries and action in individual cases as well as for the initiation and pursuit of entire programs. Speed in obtaining access, retrieving and manipulating data may, without stringent rules, be a lure to repetition of past abuses affecting the privacy and due process of individuals and to pursuit of even more novel, wide-ranging programs for questionable or non-tax-related purposes. . .