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Commercialization of Solar Thermal Power Generation: Policy Issues

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INTRODUCTION

Energy from the sun is a concept which has fascinated people ever since someone first concentrated the sun's rays to produce an intense spot of heat. The sun has always risen, and scientific evidence suggests that it will continue to do so in the foreseeable future. Given a state of technology which enables human beings to reach the moon, and to be maintained in space for long periods of time and to work there, it appears reasonable to expect that industrial nations should be able to harness the sun to provide ever-renewable low-cost energy for various human needs.

The increasing cost of locating fossil fuel resources, and the accompanying international economic problems of universal demand with concentration of supply only in certain nations, have engendered research into various ideas of using sun-power for generating electricity. What is needed to exploit this sun-power is both technical and economic feasibility, and this requires governmental assistance. To bring about economic feasibility for solar power, government must overcome a number of legal, policy, and financial obstacles. Solar energy technology must be adapted to current legal boundaries of society and, at the same time, some legal boundaries must be modified to accommodate the benefits of the technology. National policy concerning energy needs to be reviewed and restated. Some existing statutes, and federal regulations and policies, impede the development of commercial levels of solar thermal power generation. These can be modified if those who are responsible for writing and enacting statutes and issuing regulations are convinced of the necessity.

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Without the focused public attention which has been drawn to nuclear power, without the tremendous outpouring of financial assistance from the federal government which was applied to nuclear development, without even the more moderate financial support devoted to synthetic fuel production, the utilization of sun-power to generate electricity has come to technical feasibility. Not only has it been demonstrated, but it has been made operational. Solar One, described in an accompanying article, is a technical success.[1] What is additionally needed is the dimension of economic success. This article will focus on those aspects of economic feasibility which delineate the legal, financial, and policy obstacles, and the possible means of overcoming those obstacles for solar energy technology in the field of electric power generation. Included are the following:

(1) A brief review of incentives which have been offered over the past years by the federal government to encourage the development of energy resources, including fossil fuels, nuclear energy, synthetic fuels, and renewable resources, and a statement of the monetary value of those incentives;

(2) Examination of the statements of national goals for energy in the United States as they have been espoused by different presidential administrations and expressed concerning solar energy; and

(3) A recommendation for policy, legal, and financial actions to be taken to produce a climate favorable for the rapid commercialization of solar thermal power generation.

Background

In September 1973, the United States and other industrialized nations of the world were brought sharply to the realization that they depended on a smooth supply of oil from a relatively few middle eastern countries for the continued operation of a twentieth-century industrial civilization. Dramatic price increases affected not only the western industrialized nations, but the developing nations as well. The past twelve years have been a time of re-examination of and reduction of standards of living, re-ordering of national priorities, and shouldering large burdens of international debt, in rich and poor countries alike.[2]

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1. Vant-Hull, *Solar Generation: The Solar Tower, Progress Toward Commercialization*, 25 NAT. RES. J. 1099 (1985).

2. The antecedents of the problems of fossil fuel resource supply and the current prospects for identifying and estimating future supplies of oil and gas, the most utilized fossil fuels, are very complex mixtures of the status of geology, geophysics, and politics. For an account of the politics of oil, *see* LACEY, THE KINGDOM, PART IV, OIL, 225-394 (1981). A concise, yet very readable summary appears in Browning, *Oil and the Gulf: A Survey*, THE ECONOMIST 1-50 (Jul. 28, 1984). Recent estimates of oil and gas potential in offshore fields around the United States are found in a

Between 1973-1979, Americans learned to conserve energy. Industrial firms began a major effort which has paid off in reduced consumption of fossil fuels for industrial purposes. Automobile manufacturers have increased the fuel efficiency of passenger cars in various ways. The crisis appeared to be easing when, in 1979, another major petroleum price increase shocked consumers by its impact on utility rates.[3] Since that time, there has been an additional shift in the allocation of money resources by individuals, and a great deal of attention focused on the size of utility bills. Because the U.S.population is over eighty-five percent urban, large numbers of people in cities have become entirely dependent upon centrally-generated electric power for lighting, heating and cooling, food refrigeration, maintenance of water pressure, and waste disposal. Industries, encouraged by the passage of the Public Utilities Regulatory Policies Act of 1978 (PURPA)[4] have successfully constructed generating devices in conjunction with the production of industrial process steam, and have been able to reduce their electric bills materially by selling excess power back to the utilities. However, the policies that have benefitted industrial companies have affected utility organizations adversely.[5] The law requires public utilities to buy whatever power is offered to them at prices which reflect "the full avoided cost" that they would incur if they generated the power themselves. Disputes concerning what those full avoided costs are, and what happens to extra expenses incurred by the utility companies, appear to be increasing the price of power sold to residential consumers.[6]

report of the U.S. DEPARTMENT OF ENERGY, OIL AND GAS TECHNOLOGIES FOR THE ARCTIC AND DEEPWATERS (May 1985). For a brief report providing 1981 Department of the Interior figures compared with the new 1985 estimates, *see Interior Slashes Offshore Oil Estimates*, 228 SCIENCE 974 (May 24, 1985). Based upon the data *id.*, the Department of Energy (DOE) has forecast that imports of petroleum will climb from the current level of about five million barrels per day to about seven million barrels per day in the 1990s. The Office of Technology Assessment of the U.S. Congress is even more pessimistic, suggesting that imports may rise to the previous record 9.3 million barrels of oil per day that was reached in 1977.

3. Daly, *The Crisis That Drones On*, 2 ENERGY LAB. NEWSLETTER 3 (1980).

4. PURPA, which is still in effect but open to amendment by Congress in 1985 or 1986, has required that public utilities buy electric power from industrial companies which have established facilities for generating electric power along with industrial process heat, and which from time to time have excess electric power over their own needs. Utilities must also buy from "small" generating facilities, and may not have significant ownership of such power generators. This has caused some real problems. *See* Nowak, *Contract Negotiations under PURPA and the Impact of Recent Developments on Transactions between Electric Utilities and Cogeneration and Small Power Production Facilities*, 3 ENERGY L.J. 273 (1982).

5. A recent report indicates that the largest customer in the United States for cogenerated power is the Houston Lighting & Power Company (HL&P) which faces major uncertainties in long-range planning because it must buy all power offered to it. Thus, HL&P may find that its planned fossil fuel and nuclear generating plants presently under construction are not needed when they are ready to produce power. Apparently residential customers will have to pay for this unwanted power in their electric utility bills. Houston Post, Apr. 29, 1985, § 6, at 1, col. 5.

6. Nowak, *supra* note 4, at 277.

The Nuclear Experiment

For many years there has been the vision of a completely new source of power for the generation of electricity. Nuclear energy was thought to be a safe and inexpensive source of power even while the nuclear weapon of World War II was under development. Immediately after the war, the various executive branch leaders and the Congress teamed up to spend large sums for research and development to produce nuclear reactors, and to encourage commercial companies to manufacture them for sale to public utilities. Since 1953 when the Shippingsport, Pennsylvania, nuclear generator was put into operation, the industry has grown until about thirteen percent of electric power distributed to communities throughout the United States is produced by nuclear resources.[7] Each year the Department of Energy (DOE) seeks large appropriations to further the development of various forms of nuclear power generation, particularly to enhance the safety of the commercial nuclear fission technology and to demonstrate the feasibility of nuclear fusion. Controlled nuclear fusion is currently proposed as a safe, non-polluting source of power but, as yet, that proposition has not been demonstrated. Additional billions of federal dollars for research and development may be expended before nuclear fusion can be proven safe in practice, and some think it will not be feasible for routine, everyday use at any time in the foreseeable future.

Public disillusionment with nuclear energy has set in and grown as our attention has been drawn successively to several major problems. The Three Mile Island accident of 1979 still looms up as a major financial disaster, with the fallout yet to be determined.[8] Numerous examples of the problems with nuclear power generators which have been operating for some time are coming to light. In California, the Humboldt Bay Power Plant Unit Three, built more than twenty years ago, was hailed as a pioneer of the atomic age. The owner, Pacific Gas & Electric Company (PG&E), the second largest utility in the nation, said the nuclear plant was the first one in the United States to generate electricity as cheaply as could be done with other fuels. Despite several radiation leaks, this unit operated until 1976 when it had to be closed, seventeen years earlier than had been planned, because it was located by error over the San Andreas Fault. Since the 1976 closing, tons of hot isotopes left from the thirteen years of operation have slowly decayed inside the plant, which is about 280 miles north of San Francisco.[9]

Clearly, nuclear power has failed even as its sponsors have attempted to convince the public of its safety. Costs have swollen in the past ten

7. Houston Chronicle, Nov. 19, 1984, §2, at 10, col. 6.

8. UNITED STATES DEPARTMENT OF ENERGY, NUCLEAR PROLIFERATION AND CIVILIAN NUCLEAR POWER: REPORT OF THE NON-PROLIFERATION ALTERNATIVE SYSTEMS ASSESSMENT PROGRAM (1980).

9. Houston Chronicle, Dec. 5, 1984, §4, at 14, col. 5.

years to ten times previous estimates. Since 1975, eighty-nine nuclear plants have been cancelled, some within a short time from completion. There are still predictions, however, that we will have an increase from the present thirteen percent[10] to as much as twenty percent of our electric power generated by nuclear reactors by the year 2000. In other countries, the figures are varied. France utilizes nuclear power for nearly fifty percent of its electricity generation, but the French government has a record of not taking policy decisions in the power arena to the public. A recent study of power generation in eastern European nations within the Soviet economic bloc indicates a wide variation. Bulgaria secures nearly one-third of its electricity with nuclear power; there is no nuclear reactor generated electricity in Poland or Rumania; and the USSR is estimated to generate about six percent of its electricity from nuclear sources.[11]

Coal and Synthetics

Since the enactment of strong environmental protection legislation in the United States, beginning in 1969 when Congress passed the National Environmental Policy Act,[12] the customary sources for the generation of electric power have fallen into disrepute. While the United States has what is estimated to be a three hundred years' supply of coal, the burning of coal has been decried as a source of severe atmospheric pollution, particularly in closed-in, urban areas. At the same time that there has been apprehension concerning the supply of oil and gas, and the safety of nuclear power, coal has become very expensive to burn in a raw form. Devices which can be installed to remove a large portion of the noxious gases and particulates thrown off by burning coal are expensive, and subject to malfunction.[13] Also, the low sulfur coal which burns with less pollution is mined in the western states, far from the eastern industrial sites where it might be burned, and both severance taxes and costs of transportation have, to all practical purposes, made coal non-competitive in delivered price.[14]

For a number of years it was thought that a long-term solution to the United States' problem of fossil fuel supply uncertainty might be secured through the transformation of oil shale, tar sands, or various grades of coal into synthetic petroleum. Indeed, during the Carter administration there was proposed to the Congress, investigated thoroughly by both the executive branch and the congressional research arms, and enacted into law, a major program of financial support for synthetic fuel in the form

10. *See* Houston Chronicle, *supra* note 7.
11. Franklin & Moreton, *COMECON Survey*, THE ECONOMIST 13 (Apr. 20, 1985).
12. National Environmental Policy Act of 1969, 42 U.S.C. § 4321, *et seq* (1970).
13. Schefter, *Solar Power Cheaper than Coal, Oil, Gas*, POPULAR SCI. 77 (Feb. 1985).
14. *Id.* at 78.

of the Synthetic Fuel Corporation.[15] Synthetic fuel, however, has not been able to fill petroleum's role. Ethanol can be blended into gasoline in only a very limited ratio for proper combustion in warm (summer) temperatures. Also, there is an economic problem. Synthetic fossil fuel profitability has behaved like a will-o-the-wisp; no matter how high the price of imported petroleum rose, the point of profitability for synthetic petroleum receded.

NATIONAL GOALS FOR ENERGY

In June, 1979, President Jimmy Carter told the Congress that, as a result of a domestic policy review, it had been determined that solar energy could produce as much as twenty percent of U.S. energy requirements by the year 2000, and that a program for development and energy funding of his administration would be focused on that goal. It was planned that the Department of Energy under the Carter regime would expend nearly a billion dollars for solar energy in 1982.[16]

In the 1979 Carter administration view of the future, the U.S. population, they said, is expected to rise from 234 million in 1983 to about 265 million by the year 2000.[17] In addition, in 1976 dollars, the Gross National Product (GNP) would be about $3.6 trillion in 2000, rising from $2.6 trillion in 1976, with an increase of about 2.1 percent per year. Energy demand was expected to rise from 79 quadrillion BTUs in 1980 to 95 quads in the year 2000. At present, in 1985, solar energy, by government definition including hydroelectric energy and energy generated by burning wood, amounts to about six percent of the total. It would need to be multiplied by a factor of four to generate the twenty percent share predicted by President Carter's staff in 1979.[18]

To accomplish the four-fold expansion of solar energy proposed by the Carter administration, it would have taken the $1 billion that the Carter group planned to spend if they had remained in office in 1982. Such a commitment would have entailed the utilization of a large number of federal programs, including the federal funding of research and development in private companies and universities, and transfer of technology

15. The Senate Budget Committee chaired by Edmund S. Muskie, through its Subcommittee on Synthetic Fuels with Gary Hart as its chairman, ordered a thorough analysis of the technological and economic feasibility of producing synthetic fossil fuels by a massive effort of private industry, funded by the Congress through the Department of Energy, using appropriated funds. Waiving any in-depth technical discussion, the Committee proceeded to an economic and managerial analysis provided by consultants. *See* SUBCOMM. ON SYNTHETIC FUELS OF THE SENATE COMM. ON THE BUDGET, 96th Cong., 1st Sess, REPORT ON SYNTHETIC FUELS (Sept. 27, 1979).

16. Bezdek, Wendling, Bennington & Chew, *National Goals for Solar Energy: Economic and Social Implications*, 22 NAT. RES. J. 337 (1982).

17. *Id.*

18. *Id.*

from the federal establishment to private enterprise. Also on the agenda would have been financial incentives underwritten by the federal government, such as the provision of risk capital at the front end of enterprise development, or federal subsidies for using solar modes of power generation and other modalities, to compensate for past subsidies to other power sources, particularly nuclear power.

In October, 1983, President Ronald Reagan took a quite different position with respect to federal energy development expenditures, having signalled his intention to do so quite early in his administration through statements of policymakers.[19] In presenting his National Energy Policy Plan for 1983 and 1984 to the Congress, President Reagan said that the hallmark of his policy is "to foster adequate supplies of energy at reasonable costs, minimize federal controls and involvement in energy markets, and promote a balanced and mixed energy resource system."[20]

The disparate views of the Carter and Reagan administrations on what was to be done were based on relatively common views of what the future will be like, economically and resources-wise. The second Reagan administration has focused on the costs of fossil fuels, assuming that supplies will be continuously available. The 1983 National Energy Policy Plan predicted that oil imports will continue to supply about twelve percent of the nation's energy needs through the year 2000, and that world oil prices would stabilize in the range of $23 to $30 per barrel, but might fall if Middle Eastern conflicts ended and the world economy slowed at the same time.[21] Oil prices in 1990 were forecast at between $26 and $40 in 1982 dollars, or about the same as the $34 price of 1982 in spending power. Synthetic fuels extracted from coal and shale were estimated at between $50 and $80 a barrel, compared with the $35 to $50 predicted in 1979 when Congress approved a $15 billion program to create a synthetic fuel industry.[22] The 1983 program makes no direct mention of solar energy, although the plan states that by the year 2000 the emergence of alternative energy sources, or technological changes that cannot be anticipated, renders current projections of doubtful value.[23] It is not certain what that statement meant when it was written. The plan did propose the completion of decontrol of the gas industry, which has now been accomplished, and decreased regulation of nuclear energy.

When the Reagan administration first entered office in 1981, they made

19. Johnson, *National Energy Policy—The Department of Energy's Perspective*, 3 ENERGY L.J. 331 (No. 2, 1982).

20. The 1983 National Energy Policy Plan, transmitted to the United States Congress on October 5, 1983, devoted major attention to conservation, finding substitutes for imported oil, and increasing the strategic petroleum reserves. Houston Post, Oct. 5, 1983, at Dl, col.

21. *Id.*

22. *See supra* note 15.

23. National Energy Policy Plan, *supra* note 20.

major changes in the use of federal incentives, in line with their different view of the role of the federal government. They also began to remove federal regulations which had surrounded the energy field, especially since the 1973 oil embargo. These approaches, very different from those of the Carter administration, were intended to leave the commercialization of energy alternatives, particularly that of solar thermal power generation, to the marketplace. As a result, capital investment to develop solar thermal power generation as a self-sustained, profit-making venture, has not been forthcoming.

A recent analysis by the Reagan administration's Department of Energy highlights that administration's intentions.[24] An analysis was made of amounts of money devoted to renewable energy research and development and also to the provision of incentives in the form of tax credits, in which the Reagan administration specifically compared its actions with those of the Carter administration. One may note by examination of Table I that substantial reductions from the Carter Research and Development (R&D) budget were made during the first Reagan administration. Support for solar research of all kinds, including central solar thermal power generation as well as other solar energy work, was reduced from a total of nearly $2 billion in the Carter administration to just over $1 billion in the Reagan administration. At the same time, the Reagan grants of tax credits for all types of renewable energy were increased over the tax credits granted during the last three years of the Carter administration, six-fold in the case of residential credits, and thirteen-fold in the case of business tax credits. The clear intention, as stated in the study from which these data are taken, is to transfer to the business community the responsibility for promoting the commercialization of solar energy actualization, with rewards to come only after the business investment, in the form of the tax credits.

The analysis document states that the $6 billion of incentives—$4 billion in research and development, and $2 billion in tax credits—have produced renewable energy worth $39 billion calculated at the 1984 world price of oil. The document also projects that the systems development generated by the investment, and fostered by the tax credits, will produce an additional $78 billion in additional energy (at current world oil prices) during their operational lives.[25]

If we take into account the economic uncertainties which have surrounded the community of applied technology in this country over the past four years, we may draw the conclusion that the projections of the Reagan administration's DOE are optimistic. If we take into account the

24. UNITED STATES DEPARTMENT OF ENERGY OFFICE OF RENEWABLE ENERGY, RENEWABLE ENERGY PROFILE 1975-1984 at 3 (Feb. 1985).

25. *Id.*

Table 1. Estimate of Renewable Energy R&D and Tax Credits*
$ in Millions

Research & Development Budget Authority	Solar	Geothermal	Hydro-electric	GRDF	Total
Carter Administration (1976–1980)	1,974.88	526.42	61.41	45.18	2,607.89
Reagan Administration (1981–1984)	1,123.62	295.51	8.95	– 16.30	1,411.78
Total R&D	3,098.50	821.93	70.36	28.88	4,019.67
Tax Credits		Residential	Business		Total
Carter Administration (1978–1980)		242	40		282
Reagan Administration (1981–1984)		1,235	526		1,761
TOTAL TAX CREDITS		1,477	566		2,043

*Adapted from: Renewable Energy Profile, 1975–1984, U.S. Department of Energy, February 1985, Office of Renewable Energy, Washington, D.C.

resource uncertainties of the supply of fossil fuels available for use in the United States over the foreseeable future, we may believe that renewable energy sources, particularly central solar thermal power generation, are deserving of the most stimulation that the federal government can provide, rather than a treatment which has not demonstrated much effectiveness up to this point. At the same time, it is instructive to review what the federal government has done to stimulate the development of all energy forms over an extended period. The availability of a long-term analysis enables us to review these matters.[26]

FEDERAL ENERGY INCENTIVES, 1918–1978

To enhance the development of various sources of energy, the federal government has provided, over the period from 1918-1978, enormous amounts of money which flowed to units within the government itself, and to private entrepreneurs as well.[27] Table II shows the estimated cost of energy incentives in billions of dollars; the varying sums carry easily discernable messages. Because the different energy sources became government recipients at different times, depending on their stage of development, it is not possible to make detailed comparisons. Over the past thirty years during which nuclear power activities were funded by the government, about $15 billion has been devoted to research, development engineering, and testing in this area. Over the same period, hydroelectric power received about $12 billion for the generation and sale of power to the government, and $5 billion for power transmission. The incentives provided for coal were an allowance amounting to about $3 billion for depletion, along with nearly $1.7 billion for research into better mining methods, development of advanced techniques for liquefying and gasifying coal, and fluidized bed combustion techniques, all designed to make coal a cleaner burning fuel. Oil received the largest single benefit, $40 billion in intangible drilling expense and depletion allowance, while natural gas received $11 billion for those two categories, or 8% of the incentive funds.

But in spite of the incentive programs of the government, fuel shortages have appeared from time to time in the United States, or extremely high spot prices for fuel have hampered industrial and personal economic development.

NEED FOR AN ASSURED SUPPLY OF ELECTRICITY

If one assumes that economic growth requires a bountiful supply of energy, one might also assume it would be an important national goal to

26. Battelle Pacific Northwest Laboratories, An Analysis of Federal Incentives Used to Stimulate Energy Production 268 (June 1978).
27. *Id.*

Table 2. Estimated Cost of Energy Incentives in Billions of Dollars**

	Nuclear	Hydro-electric	Coal	Oil	Gas	Total
Government purchases of grants				30.3	3.5	33.8
Requirements of government agencies	1.2	0.03	0.04	0.6	0.2	2.07
Traditional services paid by government			1.8	5.0	0.1	6.9
Non-traditional services such as research	14.2		1.6	0.8		16.6
Market activity assisting sales	1.7	17.5				19.2
Tax relief		1.7	3.0	40.5	11.3	56.5
Totals	17.1	19.23	6.44	77.2	15.1	$135.07 Billion
Percentages	13%	14%	5%	57%	11%	100%

**Adapted from: An Analysis of Federal Incentives Used to Stimulate Energy Production, Battelle Pacific Northwest Laboratories, Richland, Washington, June 1978.

reduce to a minimum the dependency of the United States on energy sources outside its boundaries. This goal has been subscribed to by various presidential administrations and Congresses, but only on a very intermittent basis.

At the same time that we have adopted cyclical and short-term points of view with respect to investments and returns, we have become, in the cities, utterly vulnerable, with a need for a continued, uninterrupted supply of electrical energy over the long-term. In the past ten years, sources of electrical power have become enormously expensive in many parts of the United States. But we have proceeded beyond the point of no return; we *must* have a guarantee of uninterruptible electric power. Because of the resource supply uncertainties of fossil fuel, it appears logical that, if a means of utilizing solar heat were practicable we ought to adopt it as one of our methods for providing electric power. Until 1982, one could be skeptical of claims made for central solar thermal power, as provided by the power tower. But since the installation of Solar One at Barstow, California, we no longer have the luxury of being doubters.[28] Assured, uninterrupted supplies of electricity, procured by combining centrally generated solar thermal power with other fuels, are only as far away as the final stages of cost reduction during the manufacturing process of building solar plants.

FEDERAL INCENTIVES FOR SOLAR POWER

Utilization of government-provided incentives has a long and respectable history in the United States, as the foregoing analysis has indicated.[29] There is no reason why the incentive system which has been used for oil, gas, coal, hydroelectric, and nuclear power cannot be extended to stimulate activity in solar thermal power generation.[30] The introduction of such incentives, designed specifically to increase the effectiveness of public utilities in their procurement and distribution of electricity at affordable rates, would be a very popular political move. Several private

28. Solomon, *SoCal Edison Puts Solar One on Line Fulltime, Abandons Plans for Solar 100 Project*, The Energy Daily, Aug. 29, 1984, at 1-2, col. 1-2.

29. Massachusetts Institute of Technology Energy Laboratory, Government Support for the Commercialization of New Energy Technologies (Nov. 1976).

30. SUBCOMM. ON SYNTHETIC FUELS OF THE SENATE COMM. ON THE BUDGET, 96th Cong., 1st Sess., ANALYSIS OF ECONOMIC INCENTIVES TO STIMULATE A SYNTHETIC FUELS INDUSTRY (Aug. 27, 1979). The report points out that:

> The aims of incentives are to improve economics, reduce project risks, and facilitate access to capital. Economic incentives can be applied to regulated or non-regulated industries, and may be front-end or production incentives.
>
> In non-regulated industries, tax measures, subsidies, grants, and various guarantees on price, project completion, and debt may be used. In regulated industries, convention incentives as permitted by law plus the payment for Construction Work in Progress (CWIP), all-events tariffs, and rolled-in pricing may be used.
>
> Front-end incentives encourage investment in plants by providing or guaranteeing capital, reducing investment requirements, or guaranteeing project completion. Production incentives focus on the

enterprises and consortia are prepared to take the necessary steps to develop commercial versions of the Solar One demonstration plant, once appropriate incentives are in place. Such incentives as investment credits for tax returns for plant capital investment, accelerated depreciation write-off periods for plants, and government plants leased to private operators would be of assistance. Such incentives have been utilized under a number of past economic and strategic circumstances, and frameworks exist for their utilization. From a legal point of view, incentives can be installed by statutory means, and left in place long enough to be effective, then removed after solar power generation takes its place with other commercial sources of energy.

If we are subject again to disruption of fuel supplies because of dependence upon foreign sources for fuel, it would be particularly important to have buttressed our electrical power grid with a strong network of solar thermal power generators, which are essentially uninterruptible power sources. This article has sought to make explicit the point that the decisions to be taken are not technological, but rather political. Examination of the statutory and regulatory environment does not reveal insuperable obstacles to the provision of federally guaranteed incentives, as indicated above.

viability of plant operations by improving the expected rate of return or reducing marketplace uncertainties.

Investment tax credits provide cash flow by offsetting a portion of capital requirements, but corporations must have sufficient other tax liability, that is, income, to utilize an investment tax credit.

Regulated utilities require that tax credits must be accompanied by tax normalization. State utility commissions may require that tax benefits flow through to the consumers or rate payers.

Expensing of construction costs increases after-tax income of investors prior to the operation of the facility. The deduction offsets a portion of the capital investment if the investors have sufficient other taxable income.

The project rate of return is enhanced substantially, and project risks reduced by shortening the period required to pay back the net capital investment accumulated at the time of plant start-up.

Accelerated depreciation is effective for high-risk investments.

The impact on federal tax revenues is, of course, with respect to timing, not to the actual dollar returns to the government during the life of the plant.

Construction grants provide directly to a developer a portion of capital costs, which otherwise might not be available. Grants may involve equity participation by the federal government, but this could involve the government in business decisionmaking, not viewed favorably by industry. Grants may be converted to loans, which would give the government a share in up-side benefits without giving it equity participation, which may be favored by industry.

Direct loans and loan gurantees make capital available where private sources are not interested, by means of lower interest rates, longer maturity terms, or higher fractions of debt compared with equity.

Completion guarantees are highly attractive to industry, which cites regulatory uncertainty as an important barrier to investment in commercialization projects.

The financial health of regulated utilities can be enhanced substantially by including CWIP in the ratebase. CWIP provides additional cash flow and reduced external financing requirements. However, ratepayers have learned to protest this type of incentive as it comes out of their pockets.