AN ANALYSIS OF CALIFORNIA'S TAX CREDIT FOR SOLAR-POWERED IRRIGATION PUMPING SYSTEMS

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PREFACE

Chapter 906, Statutes of 1980 (SB 1687), established a special state tax credit to encourage the installation of solar-powered irrigation pumping systems. This act also requires the Legislative Analyst's office to report to the Legislature on the economic and energy effects of the credit. Specifically, the office is directed to evaluate:

- The effects of the credit in encouraging the installation of solar pumps;
- The economic and fiscal consequences of the credit; and
- The energy savings attributable to the credit and the costs of this energy had it been produced by alternative sources.

This report has been prepared in response to the requirement set forth in Chapter 906. The report (1) describes solar-powered irrigation pumps; (2) summarizes existing state and federal tax provisions aimed at encouraging their installation; (3) analyzes the basic economics and cost-effectiveness of these systems, and (4) discusses both the costs to the state and the statewide benefits resulting from the tax credit. Our analysis is based on information from state tax returns supplied by California's Franchise Tax Board, interviews with individuals who are involved in the development and marketing of solar irrigation systems, and various other data used by the California Energy Commission and other energy analysts and economists.

Chapter I of this report describes the characteristics of solar-powered irrigation systems and lists their advantages and disadvantages. Chapter II provides an overview of the tax credit for solar-powered irrigation systems covering both its history and specific provisions. Chapter III provides our analysis of the economic, fiscal, and energy effects of the tax credit. Finally, Chapter IV discusses options available to the Legislature for encouraging the use of solar energy for agricultural irrigation, and provides our recommendations.

This report was prepared by Titus S. Toyama under the supervision of Peter Schaafsma. We acknowledge the assistance of the Franchise Tax Board in providing the tax data in which this report is based.

EXECUTIVE SUMMARY

Background and Purpose

A "solar-powered irrigation pump" is an agricultural irrigation pumping system which uses solar energy as its main power supply. These systems qualify for federal tax credits of 25 percent, as well as for special federal depreciation allowances. Pursuant to Ch 906/80 (SB 1687), California taxpayers were allowed to claim a state tax credit for systems installed between 1981 and 1983. This credit was equal to 50 percent of the system's cost, up to a maximum credit of $75,000 per system.

The state tax credit for solar-powered irrigation systems expired on December 31, 1983. During the 1983-84 Regular Session, the Legislature enacted two measures to extend the credit--AB 1272 and SB 1484. Both were vetoed by the Governor. Therefore, at the present time, no state tax credit is available specifically for solar pumps.

This report provides an analysis of the state credit. In particular, it considers the credit's effect on tax revenues, the state's economy, and energy usage.

Effects of the Credit On Use of Solar Irrigation Systems

The state tax credit was intended to provide a strong financial incentive for taxpayers to install solar irrigation pumping systems. The credit, however, has been claimed by very few taxpayers, and has not been particularly effective in promoting the installation of these systems. Based on information supplied by the Franchise Tax Board (FTB), we conclude that between 1981 and 1983, only about 50 claims for solar irrigation credits were filed. These claims added up to $120,000. In fact, FTB was able to positively verify only five tax credit claims for the 1982 tax year.

The failure of more taxpayers to install solar irrigation systems, despite the credit, is probably due to the fact that even with the state and federal tax credits, these systems are only marginally cost-effective relative to conventionally-powered systems. This is primarily because the photovoltaic power cells used in the most-common solar pumping systems are still quite expensive--about $12 per peak watt of electrical generating capacity. This results in a cost of approximately 27 cents per kilowatt hour (kwh) over the expected life of a typical system (20 years), over three times what agricultural customers must pay to utility companies for electricity. Thus, as a practical matter, solar-powered systems are cost effective only in those locations where conventional electric power either is not available or is extremely expensive.

Economic and Fiscal Consequences of the Credit

Because relatively few state tax credits for solar-powered irrigation pumps have been claimed, we conclude that the economic and fiscal consequences of the credit have not been significant.

The most direct, identifiable effect of the credit has been on state revenues. Based on information provided by the FTB, we estimate that the state's total, cumulative revenue loss resulting from the credit has been about $120,000--an average of $40,000 per year.

To the extent that the credit was the determining factor in the decisions of taxpayers to purchase solar-powered irrigation pumps, it has stimulated economic activity and generated new tax revenues in such forms as state sales taxes on the purchase of solar pumps. However, our analysis indicates that any added tax revenues resulting from the credit amount to only a small fraction of the $120,000 revenue loss. We estimate that these added revenues could not exceed $24,000, and probably are considerably less. This is because in the absence of the credit for solar irrigation pumps, the funds used to purchase these pumps probably would have been used for other purposes, thereby generating additional income and tax revenues for the state. When these "opportunity" costs are taken into account, we estimate that the total net cost of the credit to the state is likely to be approximately $116,000.

Energy Savings Attributable to the Credit

Since such a small number of solar systems were installed while the tax credit was available, the amount of energy savings that can be attributed to the credit is negligible. Specifically, we estimate that the maximum energy savings resulting from the credit is about 25,000 kilowatt hours per year, or the equivalent of about 40 barrels of oil. This amount of electricity, if purchased from utilities at current rates, would cost "end-users" about $2,500 per year.

Recommendations

Because the tax credit for solar irrigation pumps has had a *de minimis* effect on the state's economy and energy consumption, we recommend that the Legislature not reinstate the credit.

CHAPTER I

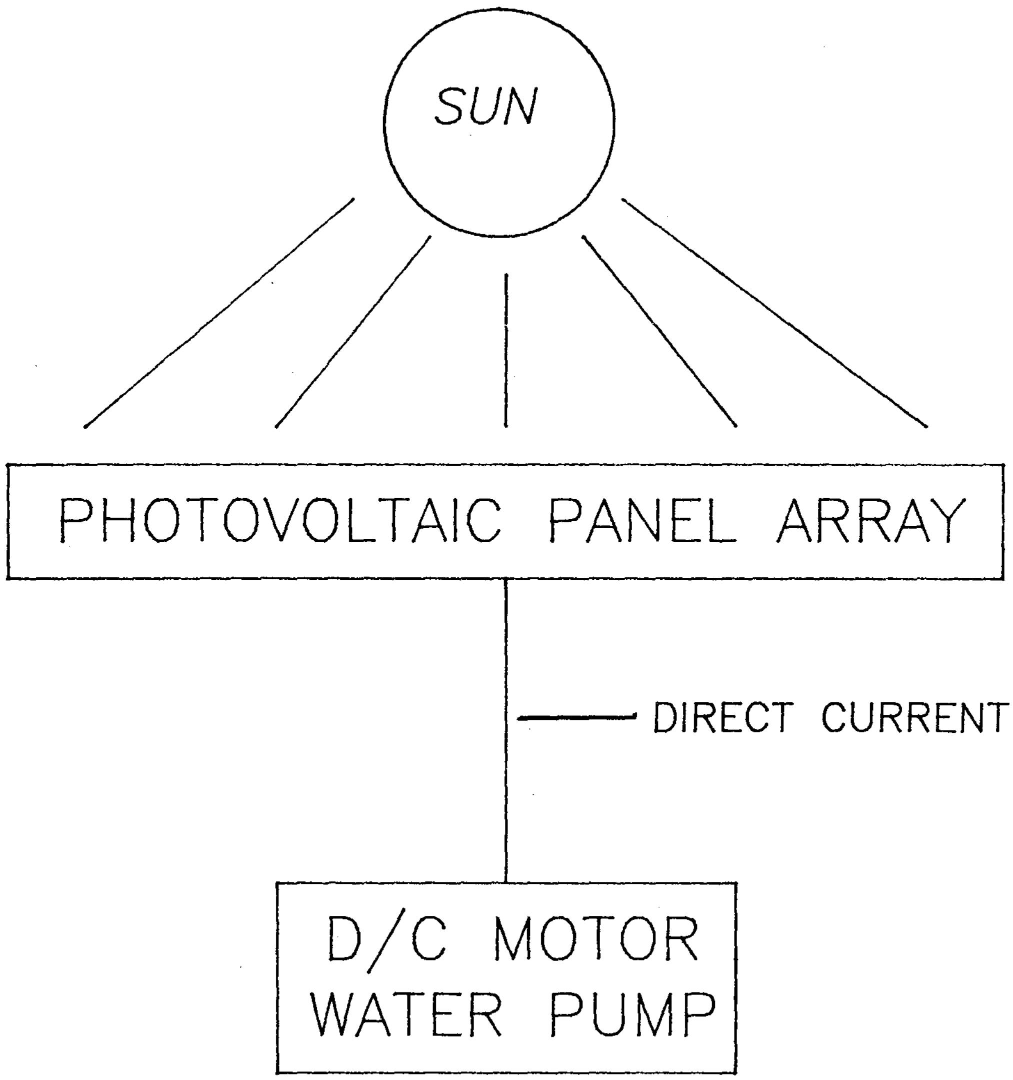
WHAT IS A SOLAR-POWERED IRRIGATION PUMP?

A "solar-powered irrigation pump" is simply an agricultural irrigation pumping system which uses solar energy for its main power supply.

The use of solar energy to power irrigation systems is not a new idea. In fact, windmills--which use solar power in the form of wind energy--had been used for centuries to pump water. Beginning in more recent times, other applications of solar energy for irrigation purposes have been tried. Nearly 80 years ago, an American engineer demonstrated that a 65-horsepower solar steam engine could pump 6,000 gallons of water per hour from the Nile River for irrigation purposes. This system converted solar energy into mechanical energy through the use of mirrors focused on boiler pipes, which produced steam to drive an irrigation pump. Since then, others have tested variations of this basic design to provide power for irrigation pump engines. The use of wind turbines to produce electrical energy also is a technologically feasible method of providing power for irrigation systems.

The most common type of solar-powered irrigation system in use today relies on photovoltaic cells to convert sunlight into electricity which, in turn, runs an irrigation pump. These systems consist of two primary components--a solar electrical assembly and a water pump assembly (please see Figures A and B). The former consists of individual solar cells, usually arrayed in groups which generate direct current (DC) power. The DC

FIGURE A


SUN
PHOTOVOLTAIC PANEL ARRAY
DIRECT CURRENT
D/C MOTOR
WATER PUMP

power is used to operate the water pump assembly, which consists of a DC electrical motor connected to a water pump. Water then is pumped directly through irrigation pipes to the field, or to a storage tank or reservoir for later use.

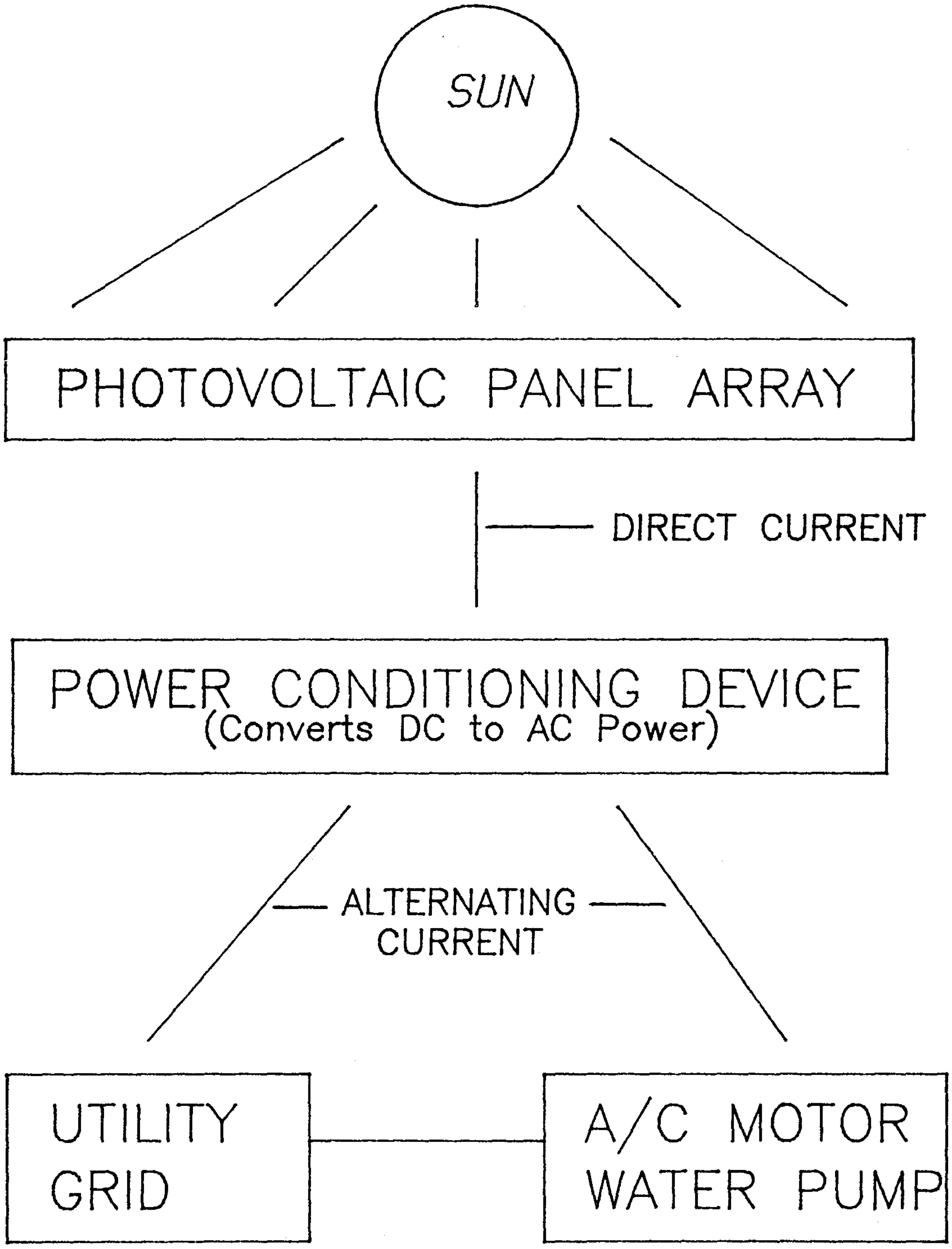
In some applications (please see Figure B), the DC power is connected to a "power conditioning device," which converts DC electricity to alternating current (AC). This permits the use of AC motors, which require less maintenance and can be "grid-connected," or operated using conventional AC electrical power from a utility. The conversion of DC to AC power, with the use of a power conditioning device, also means that excess power from the photovoltaic system can be sold to a utility. The utility must pay for this power at a rate that reflects its "avoided cost" (that is, what the utility would have to pay for additional power from other sources). The revenue from the sale of excess electricity adds to the financial feasibility and cost effectiveness of solar pump systems.

Advantages and Disadvantages of Solar Pump Systems

The main advantage of solar-powered irrigation pump systems is that the availability of solar power is greatest when irrigated water is needed the most. These systems are especially well-suited for irrigating land in remote areas, where utility power is either unavailable or too costly to hook up.

Solar irrigation systems, however, have certain disadvantages which limit their attractiveness. Despite recent technological advancements, solar systems using photovoltaic cells are still expensive, costing about $12 per peak watt of capacity. This corresponds to a cost of about 27

FIGURE B


SUN
PHOTOVOLTAIC PANEL ARRAY
DIRECT CURRENT
POWER CONDITIONING DEVICE
(Converts DC to AC Power)
ALTERNATING
CURRENT
UTILITY
GRID
A/C MOTOR
WATER PUMP

cents per kilowatt hour (kwh) over the expected life of the system (20 years). This is over three times the price that agricultural customers currently pay utility companies for electricity. Thus, in most areas, irrigation systems powered by conventional electric power are far more cost-effective than solar-powered systems. In addition, solar-powered systems obviously can operate only when a sufficient amount of sunlight is available. This makes them unsuitable for applications which require 24-hour power availability, or it may require users to arrange for backup power supplies or reservoirs to store the water that is pumped when sunlight is available.

The potential for using solar power for irrigation purposes also are limited by size constraints. Because solar power cells convert less than 15 percent of the solar energy striking the cells into electrical energy, they are relatively inefficient. As a result, the photovoltaic installations tend to require a significant amount of space that otherwise could be used for crops, storage, or maneuvering equipment.

Because of these disadvantages, solar pumps are suitable mainly for small farming operations with light irrigation needs. It appears that many of the systems marketed thus far have ranged in size from one to two kilowatts, and are capable of irrigating about five acres. Systems of this size can cost $10,000 to $30,000.

Examples of Applications

Currently, the state has several projects underway that are intended to demonstrate the potential for using solar power to irrigate agricultural lands. In Davis, the California Energy Commission and the University of

California operate a three-kilowatt grid-connected system. The system, which cost $45,000 in 1983, is being tested in furrow and sprinkler irrigation applications. In Fresno, the Center for Irrigation Technology at California State University has developed a two kilowatt system for irrigating a seven-acre vineyard. In Willits (Mendocino County), the California Department of Food and Agriculture has provided funds for a one-kilowatt system, which supplies power during summer months for pumping and aerating at a fish hatchery. Finally, in Rio Vista (Solano County), the Energy Commission and University of California, Davis, are testing a 40-kilowatt wind-turbine system which drives a 75-horsepower pump used to irrigate an alfalfa field.

The federal government also has funded demonstration projects for solar-powered irrigation systems. For example, the MIT-Lincoln laboratory operates a federally funded, 10 kilowatt photovoltaic system in Mead, Nebraska, which provides power to irrigate 80 acres of corn.

CHAPTER II

TAX CREDIT FOR SOLAR IRRIGATION PUMPS

In 1980, the Legislature made available a special tax credit to those installing solar-powered irrigation pumps (SB 1687--Chapter 906, Statutes of 1980). This credit, which was equal to 50 percent of system installation costs, was one of several tax provisions established by the Legislature in order to reduce the consumption of fossil fuel energy and encourage the development and application of alternative energy sources. Since 1976, the state has provided tax credits for solar energy equipment (as well as various credits for energy conservation measures, such as insulation and weatherstripping) and allowed accelerated depreciation for the cost of cogeneration, geothermal, and other types of alternative and renewable energy equipment. The Legislature also looked upon the solar irrigation pump tax credit as a means for reducing the cost of providing power for irrigation in remote locations where power from conventional sources is not available.

Provisions

Under the terms of SB 1687, the tax credit for solar-powered irrigation systems expired on December 31, 1983, thus making the credit available only for systems installed during 1981, 1982, and 1983. During this period, taxpayers were allowed to claim a credit equal to 50 percent of the costs of acquiring and installing a solar-powered irrigation pump. The maximum credit that could be claimed was $75,000 for each pumping system, and taxpayers could carry-over any unused portion of the allowable credit to subsequent tax years. The credit was available both to individuals and businesses under the personal income tax, and to corporations under the bank and corporation tax.

The types of solar irrigation pumps for which the credit could be claimed include active thermal systems, photovoltaic systems, and any other system which converts solar energy into electrical or mechanical energy for purposes of driving an irrigation pump. The credit also could be claimed for one-half the cost of installation and auxiliary components needed to operate the systems. Irrigation equipment, such as pipes and sprinklers, did not qualify for the credit, even if installed with the solar pumping system. The Franchise Tax Board (FTB), in consultation with the California Energy Commission (CEC), was given the authority to determine the eligibility of solar pumping systems for the credit.

Extension of Credit Vetoed by the Governor

During its 1984 session, the Legislature approved SB 1484, which would have extended the tax credit on solar irrigation pumps until January 1, 1989.[1] This measure also would have (1) reduced the amount of the credit from 50 percent to 40 percent of system costs, (2) made water-conserving irrigation equipment installed with the system eligible for the credit, and (3) allowed taxpayers to claim an accelerated depreciation deduction in lieu of the credit or for the costs in excess of the amount of the credit claimed by the taxpayer.

1. In 1983, the Legislature also approved AB 1272 (Hayden), which would have extended the credit to December 31, 1986, or until the federal tax credit for energy property was repealed. This measure also was vetoed by the Governor.

The Governor vetoed SB 1484 on the grounds that the credit's effectiveness was uncertain. In his veto message, the Governor stated that "(the) tax credit was originally intended to help develop a formative industry, and before it is extended, its continued efficacy should be thoroughly studied." The Governor also indicated that solar tax credits and exemptions were among the tax provisions that his Tax Reform Advisory Commission would be examining in order to determine whether changes in tax laws are warranted.

Federal Tax Provisions

Taxpayers purchasing solar-powered irrigation pumps also are eligible for special federal tax incentives. In particular, taxpayers may claim both a 10 percent investment tax credit and a 15 percent energy credit for the cost of these systems. In addition, under federal law taxpayers may "write-off" the costs of investment property (reduced by one-half of any federal credit claimed by the taxpayer), including solar irrigation systems, using the Accelerated Cost Recovery System.

Taken together the federal tax credits and the state credit make it possible for taxpayers to offset a substantial portion--approaching 75 percent--of what they spend on solar irrigation pumps. Taxpayers could not offset the costs by the full 75 percent (the sum of the state and federal credits) because claiming the state credit increases their federal tax liabilities. This is because state income tax payments can be deducted from income on federal income tax returns. For example, an investor in the 40-percent tax bracket who received a $5,000 solar pump credit would end up with tax benefits totaling only $3,000 since his federal tax liability would increase by $2,000 due to the state tax credit. Consequently, a large share of the benefit from the state's tax credit "leaks out" of the state to the federal government through higher federal income tax payments.

CHAPTER III

ECONOMIC, FISCAL, AND ENERGY EFFECTS OF THE CREDIT

By claiming both the state and the federal tax credits, taxpayers could reduce substantially the costs of installing solar-powered irrigation pumps. The state tax credit, however, has been claimed for very few systems. This suggests that the credit has not been effective in promoting the installation of solar irrigation systems.

Few Taxpayers Claim Tax Credit

Information collected by the Franchise Tax Board indicates that approximately 500 tax credits totaling $219,000 were claimed for solar irrigation systems installed between 1981 and 1983--the period when the credit was available to taxpayers. The actual number of bonafide claims for these credits, however, is likely to be lower. This is because a review of returns claiming the credit indicates that a substantial number of the claims are invalid. For example, although the FTB originally reported that approximately 300 credits totaling $146,000 were claimed for solar irrigation systems installed during the 1982 tax year, a subsequent examination of the returns revealed that nearly all of these "claims" were faulty, reflecting errors made by either keypunch operators at FTB or taxpayers themselves. In fact, the FTB has been able to identify and positively document only five of the credits claimed on the 1982 returns. These credits, all of which were claimed by individuals and partnerships, total $16,000. Of these systems, two were photovoltaic, two were of an unspecified type, and one was a wind generator adapted for irrigation purposes.

Because of the problems with the FTB's tax data, we found it necessary to develop our own estimates of the number and amount of credits claimed. In doing so, we adjusted FTB's data, based on the average cost of solar irrigation systems and the percentage of credits claimed that are likely to be invalid.

Our estimates are shown in Table 1. As the table indicates, we estimate that fewer than 50 claims for solar irrigation pump tax credits were filed between 1981 and 1983. We estimate that the amounts claimed in these years total $120,000. This implies that the total cost of those systems in these years for which tax credits were claimed amounted to $240,000. As discussed in the next section, the limited use of the credit should not be surprising. It is easily explained by the economics of solar energy, particularly solar photovoltaics, which at present deters farmers from using this energy source for agricultural irrigation.

Table 1

Estimated Usage of Solar-Irrigation Pump Tax Credit[a]

Year	Number of Claims	Total Amount of Credits Claimed	Total System Costs
1981	11	$29,000	$48,000
1982	15	41,000	82,000
1983[b]	20	50,000	100,000
Total	46	$120,000	$240,000

a. Legislative Analyst's estimates, based on tax return data from Franchise Tax Board.
b. Preliminary estimate.

Cost Effectiveness

Given the sizeable tax credits provided under both federal and state tax laws, taxpayers are provided with a strong financial incentive to install solar-powered irrigation systems. Nevertheless, very few systems actually have been installed. This suggests that even with these significant financial incentives, solar-power is not cost-effective relative to other, more conventional sources of energy for powering agricultural irrigation systems.

A major difference between solar and conventional power systems is the time pattern within which the costs and benefits associated with the different systems occur. Conventional irrigation systems require a small initial investment in equipment for generating electricity (or no investment at all, if electricity is supplied from a utility power grid) but involves ongoing expenditures for fuel and maintenance. On the other hand, a typical solar system may require a substantial front-end capital investment in order to obtain the electric generating equipment, such as photovoltaic arrays and other electrical components, but involves minimal future operating costs. Thus, the farmer, in deciding whether to invest in a solar irrigation system must take into account both the initial investment costs and the ongoing energy cost savings.[1]

Given current capital and energy costs, most farmers probably do not find solar irrigation systems an economically attractive investment. This is because it takes nearly 20 years for a system costing $12,000 to "pay

1. Martin Katzman and Ronald Maitland, "The Economics of Adopting Solar Energy Systems for Crop Irrigation", American Journal of Agricultural Economics, Vol. 60, No. 4 (November 1978), pp. 648-654.

for itself," even after the subsidies provided through the state and federal tax incentives are taken into account. This "payback" period is much longer than that for most other assets in which businesses invest.

The relatively small financial benefits to be gained from installing solar-powered irrigation pumps become even more apparent when we consider the annual "rate of return" on the farmer's investment in these devices. In fact, in many cases, we find that an investment in these devices will yield negative returns to the farmer. Put another way, the initial costs of solar-powered irrigation pumps are greater than the current value of the total benefits that the farmer can expect to receive over the system's economic life-span.

Consider, for example, the case of a one kilowatt system that costs $12,000. Taking into account the state credit (50 percent), the federal credit (25 percent), the federal tax on the state credit and various other taxes, the investor's initial net cost for the system amount to approximately $5,600. Our analysis indicates that these costs, together with on-going costs for operating expenses and taxes, would be offset by $5,800 in benefits from energy savings, sales, and tax deductions, leaving a net benefit to the investor of $200 over a 20-year period. However, when the benefits are "discounted," to account for the fact that they would be realized over the life of the system rather than immediately, we find that the current value of the benefits actually is likely to be much smaller or could even be negative. If we assume a discount rate of 10 percent (which implies that $1 received, say, five years from now is worth 62 cents today) the current value of the benefits in this example turns out to be -$1,600.

Consequently, in most circumstances these systems "make no sense" from an economic perspective. The main reason for this is the high initial cost of the equipment which supplies power for the solar-powered pump. For example, the cost of a photovoltaic system approximates $12 per peak watt of capacity. Thus, solar-powered systems generally are not competitive with conventional energy sources except in remote areas where power from conventional sources is not available except at an inordinately high cost.

As a result, the use of solar energy for agricultural irrigation will not become cost effective until the price of solar photovoltaic systems drops or--electric rates rise--significantly. The latter is not likely to happen in the foreseeable future. According to projections by the California Energy Commission, electricity prices (adjusted for inflation) are likely to rise only modestly over the next ten years. Therefore, in the near future, solar irrigation systems will not become cost-effective unless the cost of solar equipment, particularly photovoltaic cells, drops significantly. In fact, our analysis indicates that, even if the state and federal credits are continued, the cost of the equipment would need to fall by at least 50 percent in order for a farmer to realize a 10 percent annual rate of return on his investment in this equipment. In the absence of a state tax credit, the costs would need to fall by 75 percent to make these systems cost-competitive. If no federal credit were available, the price reduction would have to be 80 percent.[1]

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1. The high cost of solar generating equipment also has kept solar photovoltaic energy in general from penetrating other commercial and residential energy markets. Energy analysts have concluded that photovoltaic energy systems will not be cost-effective until the late 1980s or early 1990s.

Economic and Fiscal Consequences

Since the tax credit for solar irrigation pumps has been claimed by very few taxpayers, we conclude that the economic and fiscal effects of the credit have been negligible to date.

The most direct impact of the credit has been on state revenues. As noted above, we estimate that the General Fund has foregone approximately $120,000 since 1981-82 because of the credit.

The tax credit also has had indirect economic and fiscal effects, to the extent that it has stimulated economic activity that would not have occurred otherwise. These effects, however, cannot be measured, because it is impossible to determine exactly what the indirect effects of the solar pump credit have been on state revenues. Instead, we can only make assumptions about such factors as the impact of the credit on taxpayers' behavior, the industries which supply components used for solar power, and how the funds invested in solar pumps would otherwise have been used, and then draw conclusions based on these assumptions.

On balance, we conclude that the indirect effects of the tax credit have been negligible. There is no evidence to suggest that the credit has significantly increased investment in solar pumping systems. Moreover, it is likely that the indirect benefits to the state's economy from what little investment in solar-powered irrigation pumps has occurred is relatively insignificant. Thus, the additional tax revenues associated with this investment probably has offset only a small portion of the revenue loss attributable to the credit.

Despite the difficulty of measuring the effects of the solar pump credit on overall state revenues, it is possible to estimate the order of magnitude of these effects. This can be done using an approach that is frequently employed by the California Energy Commission[1] and other energy analysts and economists. This approach takes into account:

- The amount of investment attributable to the credit and the various economic inputs used for such investments;
- The indirect and induced effects of the investments on employment and income in the state;
- The tax revenues from various sources generated by the sale, installation, and use of the equipment; and
- The tax revenues that would have resulted if the state and private resources had been for other purposes.

Investment Attributable to Credit: As noted above, we estimated that total private and public sector spending for solar irrigation equipment on which the credit was claimed while it was available amounted to approximately $240,000. This level of investment, however, cannot be attributed entirely to the credit because a portion of it would have occurred in any case.

For purposes of this analysis, we have assumed that 70 percent of the investment ($168,000) can be attributed to the credit. This percentage is consistent with that used by the California Energy Commission in

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1. Our methodology is essentially the same as that used by the Energy Commission to evaluate the effects of the state's solar and energy tax credits. Their analysis is described in CEC Report No. P103-83-001, California's Solar Wind and Energy Conservation Tax Credits (December 1983).

measuring the impact of tax incentives on photovoltaic investments in general. It also reflects our view that relatively little investments in solar-powered irrigation pumps would be made in the absence of the credit, given their general lack of cost-effectiveness.

It is conceivable that the portion of total investment prompted by the credit--that is, the attribution rate--could be higher than 70 percent, since agricultural applications of photovoltaic energy may involve greater costs for support equipment than other applications. For example, many solar irrigation systems may not be economical unless farmer-installed water storage or conservation equipment is used in order to permit more efficient utilization of the system's water pumping capacity. The additional equipment, which would not qualify for the credit, would nevertheless add to the overall cost of the system. These additional costs would make solar pump investments even less cost-effective, making it likely that a smaller percentage of systems would have been installed without the credit. There is, however, no analytical basis for adjusting the overall attribution rate to account for these effects.

Composition of Economic Inputs. After determining the amount of investments in solar pumps that can be attributed to the tax credit, we examined the various inputs needed to produce each dollar of equipment. In this way, we were able to take account of the purchases from the other sectors of the economy such as electric equipment and plastic construction materials, stimulated by expenditures on solar irrigation pumps.

Indirect and Induced Economic Effects. In theory, the additional purchases induced by the investment in solar-powered pumps generate income and employment throughout the economy. In reality, the amount invested in solar pumps has been so insignificant that these secondary effects are too small to determine with any reliability.

Nonetheless, there are tools available which allow us to illustrate the potential magnitude of these effects. For this analysis, we used an input-output model of the California economy, developed at Lawrence Berkeley Laboratory, to estimate the specific values by which spending on irrigation systems is "multiplied" through the state's economy. Although this model has a number of limitations, it is a useful tool for conducting many types of cost-benefit analysis.[1]

Tax Revenues. We developed estimates of the tax credits net effect on tax revenues using a multi-step procedure, in order to take into account both the direct and indirect economic effects attributable to investment in solar irrigation pumps. These various economic effects can be divided into the following five categories:

- Increased Sales Tax Revenues, which can be estimated by applying the state sales tax rate to the estimated taxable portion of the total system costs.

1. However, in using the model to estimate the revenue effects of this tax credit, a special problem is encountered--namely, the 85 industry sectors contained in the LBL model do not include specific industries and related multipliers for either the solar or agricultural irrigation equipment industries themselves. Thus, for this analysis, we were required to develop separate multipliers, using a weighted average of those industry multipliers which were available, in order to account for the contributions of various industries to the productions of solar irrigation systems. We developed the specific multiplier values based on CEC's analysis of the types of materials needed to manufacture solar energy equipment and discussions with solar irrigation pump manufacturers regarding the various components of these systems.

- Increased Property Tax Revenues from Assessments on the Pumps, which can be determined by applying 1 percent of the property tax rate to the assessed value (the total system costs) of the solar pumps. The total amount of revenues collected during the life of the systems can be estimated assuming that the value of the property increases by the maximum allowable rate of 2 percent per year. (The state indirectly shares in the increased property tax revenues because these increases reduce state subventions to local school districts.)
- Increased Tax Revenues Resulting from the Income Multiplier Tax Revenues. We determined these revenues which are generated by the increase in economic activity and income resulting from the investment in solar irrigation pumps, by multiplying the amount of investment by the multiplier value we assumed (.86) for expenditures on solar pumps. The resulting estimate of tax revenues was based on the average amount of taxes paid per dollar of personal income.
- The Change in Tax Revenue Resulting from the Solar Pump Income Effect, which reflects the financial impact of the solar irrigation pumps on those farmers who install them. The total net impact is represented by the difference between energy-related savings and the net cost (including taxes paid) on the pumps. The impact of these factors on tax revenues can be determined by estimating the total direct and indirect changes in income and then applying an average tax rate to that change.

- Reduced Revenue From Utility Income Effect, which is the tax revenue from electric utilities that is forgone due to sales to farmers who use solar power instead of electricity to power irrigation pumps.

Table 2 displays our estimates of the fiscal effects resulting from the state tax credit for solar irrigation pumps. To simplify the analysis, we have treated the total increase in expenditures as if it occurred during a single year. In reality, these expenditures were spread-out over the three-year life of the credit. These estimates, therefore, do not correspond to any specific tax year or fiscal year.

Table 2

Estimated Effect on State Revenues of the Solar Irrigation Pump Tax Credit[a]

	First-Year	Total (20-year period)[b]
A. Level of Investment	$240,000	$240,000
B. Tax Expenditure	120,000	120,000
C. Tax Revenues		
Sales	6,400	6,400
Property[c]	500	12,200
Income Multiplier	12,900	12,900
Solar Pump Income Effect	(6,300)	(5,500)
Utility Income Effect	(100)	(1,700)
Subtotal	$13,400	$24,300
D. Fiscal Impact on State Budget	($106,700)	($95,700)
E. Tax Revenues from Alternative Expenditures		
Alternative State Expenditures	6,300	6,300
Alternative Private Investments	9,000	14,500
Total	$15,200	$20,800
F. Net Cost to State	($121,900)	($116,400)

a. Details may not add to totals due to rounding.
b. Values shown in table are not discounted.
c. This figure represents the state benefit from the increase in total property tax revenues, which is realized as a reduction in state aid to local school districts.

As the table shows, we estimate that investment in solar irrigation pump systems induced by the state tax credit increased direct and indirect state tax revenues by approximately $24,300 over a 20-year period. This amount represents the net effect of:

- a **$6,400 increase** in state sales tax revenues;
- a **$12,200 increase** in the indirect state share property tax revenues collected by local school districts (which reduced state General Fund expenditures by a corresponding amount);
- a **$12,900 increase** in income tax revenues, due to the additional income generated by the expenditures on solar pumps;
- a **$5,500 decrease** in income tax revenues, collected from farmers whose energy costs savings do not fully offset the cost of the pumps, and
- a **$1,700 decrease** in income tax revenues collected from utilities, due to lower electricity sales to solar pump users.

These net additional revenues offset only a small portion of the tax revenue foregone as a result of the state tax credit for solar irrigation pumps. Thus, we estimate that the net impact of the tax credit is negative, "costing" the state budget about $96,000 over this period.

As Table 2 also shows, the initial impact of the tax credits on the state budget is larger than the impact for the entire 20-year period. This is mainly because cumulative increase in property tax revenues continues long after the tax credit is taken. Since property taxes are assessed annually, additional revenues become available each year to compensate partially the state for its costs for the credit. Over a 20-year period, the state would receive a cumulative benefit of $12,200 from the increase in property tax revenues, compared to an initial benefit of less than $1,000.

Tax Revenues from Alternative Expenditures. A final factor to consider in estimating the fiscal effect of the tax credit is the tax revenues associated with the economic activity that would have occurred if the state and private funds spent for irrigation pumps had instead been used for other purposes. We estimated these tax revenues using the same basic assumptions we used for our analysis of the effects attributable to the solar pump credit. In addition, our estimate is based on one other important assumption. We assumed that the amount of private funds that would have been spent in the California economy for other purposes had there been no tax credit is equal to the net private outlays for solar irrigation pumps. To the extent, however, that the expenditures for solar pumps came from funds that otherwise (1) would be saved; or (2) would be expended outside of California, our estimate of the foregone tax revenues is too high.

Based on these assumptions, we believe that if the total amount of resources expended for solar irrigation systems had been used for other public and private purposes, about $21,000 in state tax revenues would have been generated. As shown in Table 2, when these "lost" revenues are taken into account, the total net cost to the state from the credit is $116,000.

Effects on Energy Costs and Usage

The use of solar power to drive irrigation systems helps to reduce the consumption of electrical energy from conventional sources. However, since the credit has been claimed for such a small number of solar irrigation systems, the effects of the credit on the costs and usage of conventional energy almost certainly have been negligible.

Based on our analysis of the investment in solar irrigation pumps that can be attributed to the credit, we conclude that the credit has resulted in solar investments with the capacity to generate approximately 25,000 kilowatt hours of electricity per year. The cost of this amount of electricity produced from conventional sources can be estimated by using the "avoided cost rate," or the marginal cost to utilities for additional power from other energy sources. Using current projections for avoided cost rates, we estimate that the total investment in solar irrigation pumps would reduce the costs to utilities in producing energy by about $1,500 in 1984 and $2,000 by 2001. An individual farmer who actually uses, say, a one kilowatt system is likely to see a reduction of $160 to $190 in his energy bill over the same period.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

The special state tax credit for solar-powered irrigation systems has not had any significant effect on the installation and use of such systems in California. The economics of solar power systems for agricultural irrigation are such that the high cost of these systems relative to conventional power systems greatly outweighs the benefits represented by energy savings and the federal and state tax credits, thus making these systems a relatively unattractive investment for most farmers. This conclusion is borne out by the fact that a very small number of taxpayers actually claimed the tax credit between 1981 and 1983. Since so few taxpayers have responded to the availability of the credit, the credit's effects on state revenues, the economy in general, and energy usage have been minor. Because the tax credit has not proven to be an efficient or cost-effective means for encouraging the use of solar power for agricultural irrigation, we recommend the Legislature not reinstate the credit.

Other Programs for Solar Irrigation Development

This report has described the state's use of the "tax expenditure" mechanism to encourage the development of solar energy for agricultural irrigation. By reducing the costs to farmers through tax incentives, this program has attempted--apparently with little success--to increase the sale of solar irrigation systems, and thereby allow suppliers to lower their unit production costs while learning more about the manufacture and marketing of such systems. At the same time, the government has also encouraged the development of solar power for irrigation uses in a more direct fashion, by funding basic research and development activities. As noted in Chapter I, the government has ongoing programs to test and demonstrate solar pumping systems in different applications.

Many economists and public finance analysts often contend that policies aimed at research and development (R & D) are more effective than tax subsidy programs at promoting new investment in alternative energy. This conclusion is based, in part, on the view that the proper role of government is to provide resources for basic research that benefits the public in general. It also reflects, however, the lack of clear evidence that tax incentives (particularly state tax incentives) actually have had a positive impact on new energy investments.[1] Indeed, in the case of solar irrigation systems, the credit has not had any significant impact, as shown in Chapter III. Thus, R & D programs, as well as other non-tax subsidy programs, such as providing information through extension services, would appear to be more deserving of public support than specific tax incentives.

1. See Leonard Rodberry and Meg Schachter, State Conservation and Solar Energy Tax Programs: Incentives or Windfalls? (Washington, D.C. Council of State Planning Agencies 1980).