FEDERAL INCENTIVES FOR SOLAR HOMES

AN ASSESSMENT OF PROGRAM OPTIONS

FINAL REPORT

Report to

U.S. DEPARTMENT OF
HOUSING AND URBAN DEVELOPMENT

July 1977

RUPI, Inc.
Cambridge, Massachusetts
with OR/MS Dialogue, Inc.
and Boston Urban Associates

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Prepared for:

Division of Energy, Building Technology and Standards
U.S. Department of Housing and Urban Development

By:

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AN ORGANIZATIONAL NOTE AND PREFACE

The research documented in this volume concentrated on solar incentives directed at single-family homeowners -- the segment of the residential market where solar technologies hold the most immediate promise of gaining widespread acceptance.

- Part I of the report sets the context for assessing the desirability, scope and purpose of a Federal incentive program (Chapter One) and provides "baseline" estimates of the prospects for residential solar energy use in the absence of such Federal support (Chapter Two).

- Part II presents our findings in respect to the likely effectiveness of the major incentive options under review: Chapter Three focuses on "front-end" subsidy payments (grants or tax benefits); Chapter Four assesses below-market rate loan options (including direct loan, interest reduction, and secondary purchase type programs); and Chapter Five explores the possibility of lender-oriented incentives (including special loan guarantees) that might improve the availability of market-rate financing from private sources.

- Part III explores cross-cutting issues of program design, with special attention to procedures for determining eligibility for incentives and other important issues of consumer protection (Chapter Six).

- Part IV analyzes two additional areas of concern: the special problems of devising incentives for the multi-family sector (Chapter Seven), and the possible use of utilities as intermediaries for delivering Federal subsidies to homeowners (Chapter Eight).

- Appendix A contains a brief descriptive review and compilation of residential solar incentive bills introduced into the 94th and 95th sessions of Congress (as of early May, 1977). Appendix B provides comparable information on recent state enactments and pending state legislation. Finally, Appendix C presents a note highlighting the methodologies employed in modeling the market impacts and public costs of incentives.

  Complete documentation of the methodologies employed in this study, as well as the consumer survey findings are available in supplementary volumes to this report.

Throughout this document, the reader will find the qualified results of our cost/impact analysis of different solar incentives set at varying levels of subsidy. We feel that these findings provide reliable measures of the likely <u>relative</u> magnitude of consumer response to the incentives tested and of their associated public costs. However, the estimates of the <u>absolute</u> number of solar units installed over time (whether in the "baseline", or with incentives), and of <u>absolute</u> budgetary impacts, should be used more cautiously. This is necessarily the case given the uncertainty attached to future fuel prices, the solar-state-of-the-art, regulatory policies for fossil fuels, and the inherent limitation of the forecaster's art.

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OVERVIEW

Possible Federal financial incentives to expand the residential market for solar energy systems were analyzed in a six-month cost-impact study that emphasized single-family homes and modeled market impacts on the basis of a field survey of 1,500 households in 8 cities. Major findings and recommendations are as follows:

- Federal incentives can work to increase the rate of growth of the residential solar market substantially, if provided at subsidy levels above the thresholds required to elicit significant consumer response. Estimated response to major incentive options at varying subsidy levels are compared in the body of the report.

- Front-end subsidies (tax credit or rebate/grant type programs) appear more desirable than loan programs. Front-end incentives should have a significantly greater market impact than loans on the market for solar domestic hot water systems, the solar application with the most immediate potential for residential use. Government loan programs, particularly at the small dollar amounts required for hot water systems, have transaction costs and administrative complexities that make a loan approach likely to be unworkable in practice.

- A grant approach, providing "rebates" upon application by solar purchasers, appears preferable to a tax credit, in light of its potentially greater market impact and the degree of administrative control desirable given the solar state-of-the-art today.

- Broad-based financial incentives might best be limited at the outset to solar hot water systems, which are at a more advanced stage of commercialization, easier to certify, and involve substantially less cost and risk for homeowners than space heating systems. Support for solar heating (and cooling) could be continued through demonstration programs, assuring greater geographic distribution.

- The design of system certification procedures to assure adequate standards for solar components, and possibly for installation, may prove as critical to the success of an incentive program as the specific type of financial support made available.

- Skewing benefits towards lower income households appears inappropriate at this time, given the risks still inherent in the use of solar technologies and the availability of more proven means to help relieve the hardship imposed on the poor by rising energy costs. Conversely, concern with extending subsidies to more affluent households may be out of place in the context of a program encouraging homeowners to "pioneer" a new technology.

- Steps might be taken to ensure that purchasers of new solar homes are not penalized by credit standards that exclude consideration of energy costs and savings, and that they are able to finance a normal portion of their solar investment as part of their mortgage loan.

- An incentive capable of inducing any significant degree of solar use in multi-family rental housing would require an unprecedented and, most likely, politically unacceptable level of subsidy.

EXECUTIVE SUMMARY

SCOPE AND METHODOLOGY

Both the Congress and the Administration have made evident their commitment to encouraging residential solar energy use. Over 45 bills proposing financial incentives have been introduced into the 95th Congress, including the individual tax credit contained in the President's National Energy Act that has been reported out of Committee in revised form. The present report documents the results of an intensive, six month research effort intended to provide information and analysis useful in making an informed choice among incentive options, and in translating any Congressional mandate into an effective program that finds a ready response within the housing market.

A distinctive feature of the study's methodology is the modeling of market impact based on a field survey of 1,500 homeowners and prospective homebuyers in eight metropolitan areas. The formal analysis of incentive costs and impacts was supplemented by an extensive program of interviews with knowledgable housing market participants (homebuilders, and sources of mortgage and home improvement financing), solar equipment dealers and manufacturers, and officials of State and Federal agencies. Throughout the study, the focus of attention has been single-family homes, the residential market segment where solar holds the most immediate potential, but a review of multi-family applications is provided as well.

BASIC FINDINGS AND RECOMMENDATIONS

The major findings and recommendations to emerge from this research are highlighted briefly below. The reader is cautioned that greater reliance should be placed upon the _relative_ rather than the _absolute_ estimates presented here of the likely costs and impacts of incentive options, given the uncertainties attached to future energy prices, utility rate structures, the evolving solar state-of-the art and numerous other variables.

1. _Over the near term, realistic aims for a Federal incentive are to help "kick over" the market for solar homes and to make visible the Federal government's commitment to developing the long-run contribution of solar use as a means of significantly reducing dependence on fossil fuel._

This will be accomplished to the extent that Federal support strengthens the credibility of the solar alternative and enhances demand for solar homes and the consequent growth of solar production, marketing, installation and servicing capabilities. However, even with a deep Federal subsidy, it is unlikely that the number of new or existing homes equipped with solar devices over the program's life will significantly alter the pattern of energy use in the residential sector. This study therefore uses the number of solar-equipped housing units induced by an incentive as its frame of reference, rather than resulting solar energy output from those units, its equivalent in "barrels of oil saved," or some more comprehensive measure that would include other environmental and economic benefits. The desirability of solar incentives, at least at the present time, rests upon essentially qualitative judgments reflecting a belief or hope that this fledgling industry, over time, can make a unique and valuable contribution to national energy program goals.

2. Federal incentives can work to substantially accelerate solar residential market development if provided at adequate subsidy levels.

Exhibit 1 illustrates this potential, using the example of a tax credit at various percentages of solar cost. The shaded "baseline" portions of the curve indicate our estimates of the cumulative number of solar units installed from 1975 through 1982 in the absence of any Federal market support. As can be seen, most of this usage will be solar domestic hot water systems, with first costs in the $1,000 to $2,000 range, and a majority in retrofit installations. By comparison, the number of combined solar heating/hot water systems (with costs varying from $3,000 to as much as $12,000 depending on local climate and other factors) is expected to be far more modest and to be limited primarily to newly built homes.

The desirability of an incentive cannot be discussed separately from the threshold level of subsidy required for it to induce an appreciable response in the market. As can be seen in Exhibit 1, a 40% tax credit (with a $2,000 limit) would approximately double the number of installations expected from 1978-1982; a 20% credit would increase expected installations by only one-fifth.

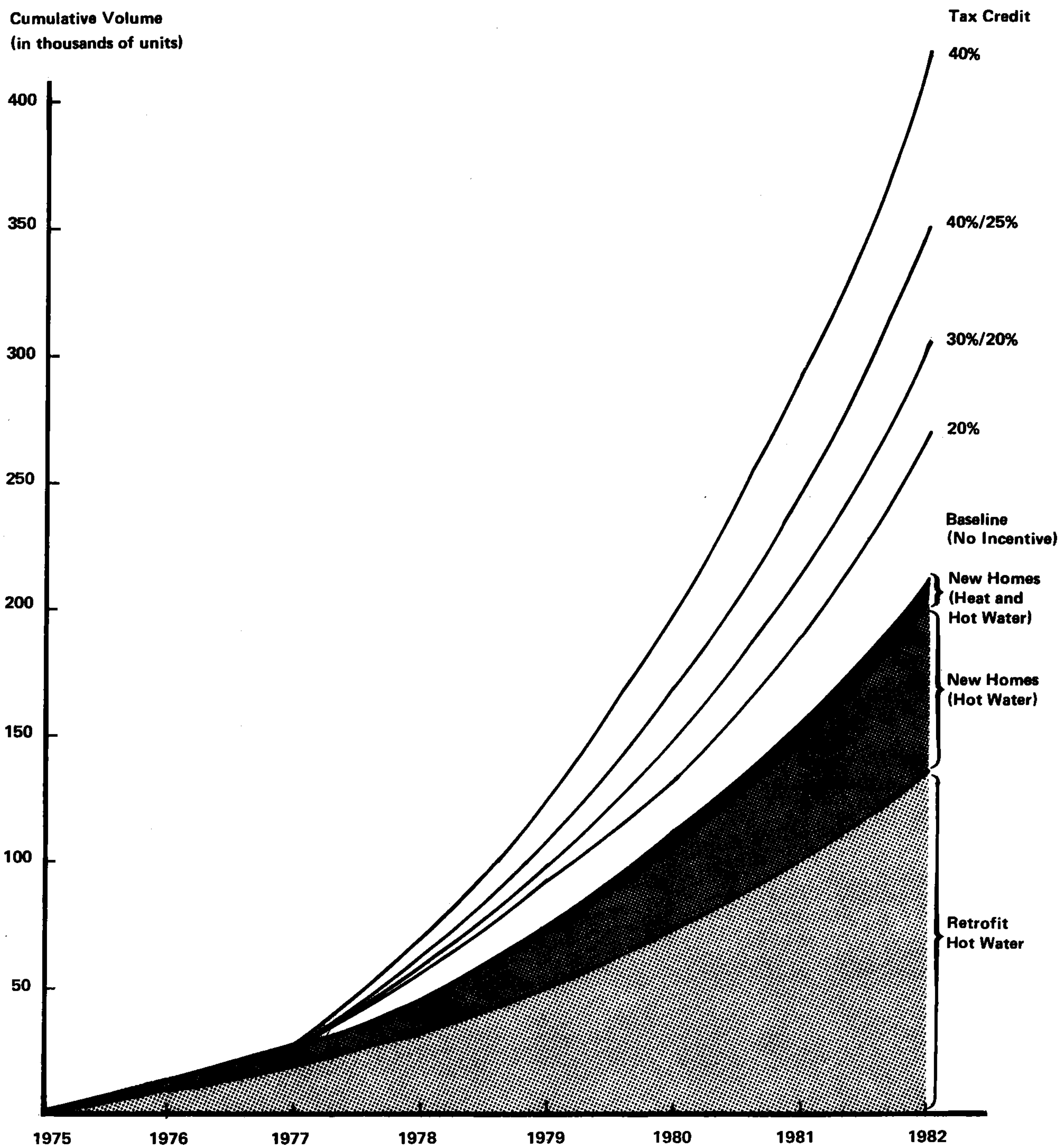
Any incentive program can be expected to have an accelerating effect on market development that will continue to yield benefits in the years after the program ends. The possible dimensions of this effect are suggested in Exhibit 2, which portrays estimated market growth for solar hot water heaters in the single-family home market under three assumptions: no incentive (the baseline estimate); a tax credit provided under a 40/25 formula and continuing in effect from 1978 through 1985; and the same credit, but with a 1982 termination date (showing both "high" and "low" estimates of the residual spill-over effect in 1983-85). Our estimates are that even if the credit were terminated in 1982, the continuing effect of this market stimulus could result in an additional 22,000 to 190,000 units during the 1983-85 period alone -- that is, possibly as many or more units than were directly induced during the life of the credit -- representing a further increase in the range of 4 to 39% over the baseline for the three year period after the credit had expired.

3. A "front-end" subsidy in the form of a tax credit or rebate/grant would be far more effective than a loan in the solar hot water market -- the major part of the solar market in the near term.

An incentive in the form of a front-end subsidy, such as a tax credit or rebate (grant), has the potential for a far more pronounced

Exhibit 1

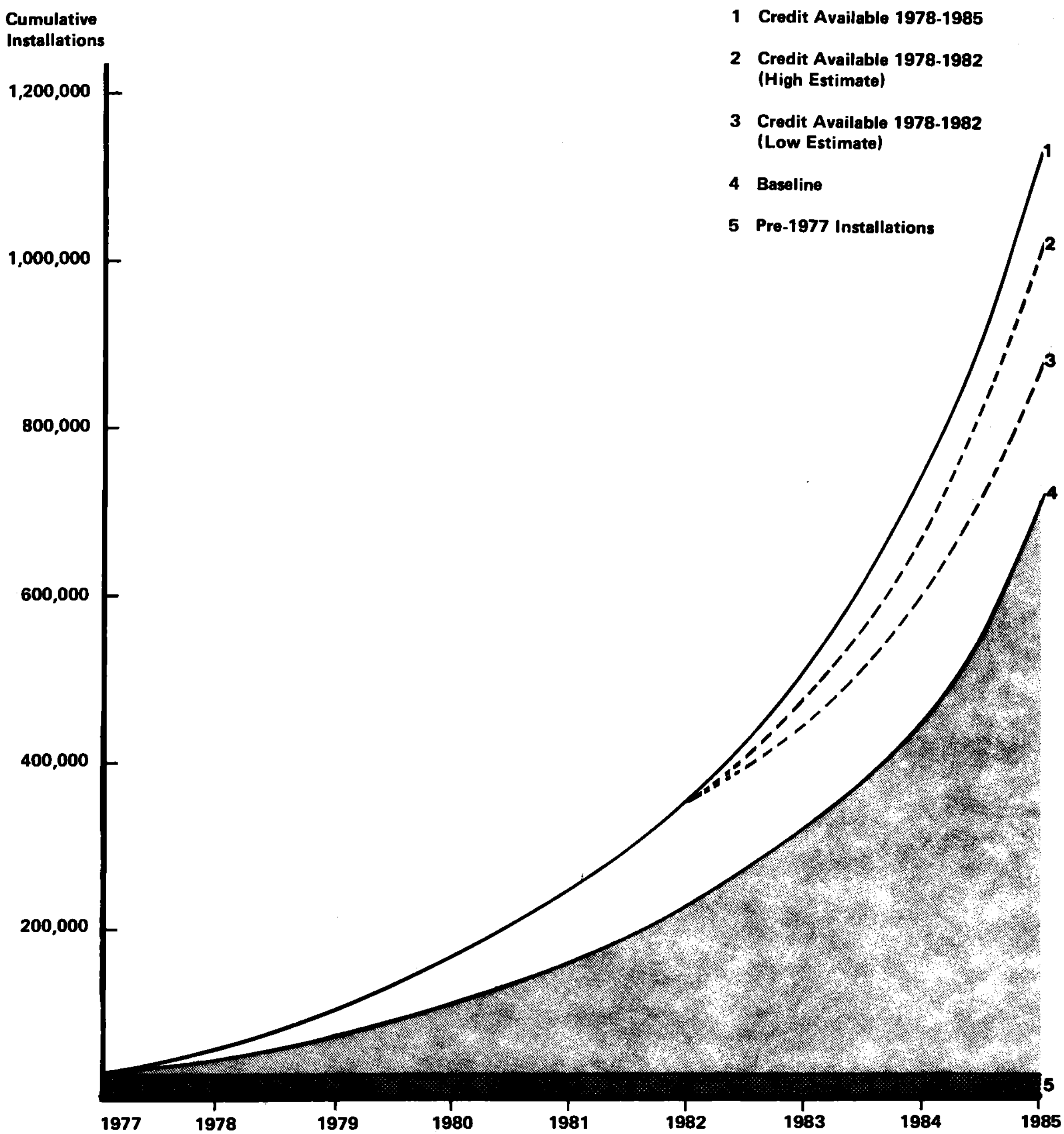
NUMBER OF SOLAR-EQUIPPED SINGLE FAMILY HOMES THROUGH 1982
"Baseline" Projections and Response to Tax Credit at Possible Subsidy Levels



Note: Market response to non-refundable tax credit provided as a percentage of total solar costs. Reading from top to bottom, terms of subsidy levels are: 40% up to $2000 maximum; 40% of first $1000, 25% of next $6400 ($2000 maximum); 30% of first $1500, 20% of next $8500 ($2150), and 20% (no maximum).

Exhibit 2

NUMBER OF SOLAR-EQUIPPED SINGLE FAMILY HOMES THROUGH 1985: Baseline Projection and Response to Tax Credit* Available 1978-1982 or 1978-1985



*Assuming non-refundable 40/25 tax credit (40/25 = 40% of first $1,000 of system cost, 25% of next $6,400; maximum credit = $2,000).

effect on the adoption of solar residential hot water systems than does the provision of assistance through loan programs, and appears substantially more cost effective. As can be seen in Exhibit 3, a tax credit offered under the formula proposed by the National Energy Act could increase anticipated solar hot water installations by approximately 67% during the period 1978-1982, and a rebate would induce a somewhat larger increase (approximately 80%) at a somewhat greater cost per induced unit. The loan program with comparable per-unit costs (a 7%, 10 year loan) would increase expected use only 14%; a deep-subsidy loan program (1%, 20 year loans) would increase usage approximately 56% at a substantially higher cost per unit.* Most of the financing bills introduced into Congress thus far would set interest rates at the government borrowing rate -- approximately 6.5% to 7.5%, depending on how that rate is defined -- plus half a point to cover administrative expenses; response to the 7% loan program noted here suggests that such a program will have a very limited ability to accelerate the adoption of residential solar hot water systems.

Exhibit 3

SOLAR DOMESTIC HOT WATER SYSTEMS: COMPARATIVE MARKET IMPACT AND PROGRAM COSTS[a] OF FRONT-END SUBSIDIES AND BMIR LOANS

Note: Estimates for Units Installed in Single Family Homes During Five Year Period, 1978-1982
Baseline: 1978-1982 Units Installed Without Incentive = 178,000

	Tax Credit			Rebate (Grant)		
Benefit as % of Cost	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit
20%	23%	$ 53	$1280	28%	$ 72	$1440
30/20[b]	46	90	1120	54	117	1220
30	50	96	1090	60	125	1170
40/25[c]	67	123	1040	80	158	1100
40	100	174	980	122	225	1030
50	176	305	970	214	392	1030

Separate Solar Loan (@ 100% of Solar Cost) — Direct Loan Program

Loan Terms	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit
7%—10 yr.	14%	$ 26	$1090
5%—10 yr.	22	49	1250
3%—15 yr.	36	89	1410
1%—20 yr.	56	154	1560

[a]All program costs given in present value terms using 7.5% discount rate, and include both subsidy costs and administrative expense.
[b]30/20 = 30% of the first $1,500 of system cost, and 20% of the next $8,500 (maximum credit of $2,150).
[c]40/25 = 40% of the first $1,000 of system cost, and 25% of the next $6,400 (maximum credit of $2,000).

Possible explanations for limited consumer responsiveness to the loan alternatives in the solar hot water market include:

- the fact that relatively few homeowners seek loans to pay for improvements to their property in this range of costs (less than 20% of all home improvements are financed with bank loans);

- the reluctance of new home purchasers to apply for a loan subsidy if it involves a loan instrument or processing track distinct from those involved in securing a first mortgage loan on their home;

- the lack of reduction in the total solar cost for which the buyer assumes responsibility (particularly compared to front-end incentive options); and

- the perceived effort in securing a subsidized loan compared to the relatively automatic nature of the tax credit or rebate.

4. A grant approach, providing "rebates" upon application by solar purchasers, appears preferable to a tax credit, in view of the considerable degree of administrative control desirable in a solar incentive program today, and in light of its somewhat greater potential market impact (and competitive cost-impact profile) when compared with tax approaches.

A front-end incentive can be provided either through a tax credit (or other tax expenditure approach) or through a separately administered "rebate" program that would respond to applications submitted directly by solar purchasers. Subsidy levels to users can be established on the same basis and at the same levels in either case, as a fixed dollar benefit or under a percentage-of-cost formula. The rebate approach appears preferable for a number of reasons:

- The availability of Federal incentives is likely to be seen by the public as a signal from the government that available solar systems are appropriate for the average homeowner today. This imposes special responsibilities that must be met in the design of an incentive program, given the wide range of quality and rapidly evolving technology in the solar industry, and in light of problems of consumer fraud. At the very least, it suggests that there may be a need for stringent controls -- in certification of eligible systems, in monitoring of manufacturer and dealer advertising and sales techniques, in familiarizing consumers with the risks as well as the promise of solar use today -- with the possible sacrifice of some market impact that such bureaucratic oversight would involve. These controls are more consistent with an actively administered grant-type program, and may be more difficult to impose successfully in the context of a tax benefit where no advance application is required.

- Consumer survey results suggest a somewhat greater response to a rebate than to a tax credit (see Exhibit 3), probably because of the direct receipt of funds closer to the time of purchase, and possibly because of the certainty that the full amount of the benefit can be claimed by the user (since it is not dependent on offsetting tax liability). In addition, if a rebate is made assignable, at least some solar retrofit companies may accept it as partial payment. This, however, should be an optional feature of a consumer-received benefit, as survey results show a strong preference for rebates directed to the consumer, rather than to the solar dealer.

- A rebate, direct-grant type program is more susceptible to on-going improvements in calibration of subsidy amount and manner of benefit delivery, to the tailoring of benefit levels to the often dramatic variations in the economics of solar use among regions, to the concentration of funds in prime market areas if desired, and even to full or partial administration through the states where that seems feasible and desirable.

- A rebate program would avoid the shortcomings seen by some as inherent in the "social" use of the tax code. This view has significant support within the Treasury Department and the Congress, and is reflected in continuing efforts to improve the tax equity and administrative simplicity of the tax collection system.

Notwithstanding these potential advantages, rebate approaches have received far less consideration than tax expenditures in legislative proposals to date. One reason for the disinclination of solar advocates and housing industry groups to propose grant-type programs is the spectre of administrative red-tape that might not only impose high per-unit administrative costs but also deter many individuals from participating in the program. Tax expenditure approaches are seen as likely to be easier to put in place, less costly to administer, more efficient in reaching consumers, and more appropriate for a short-lived program that might otherwise require substantial efforts to erect and then dismantle. Beyond these understandable concerns, however, there appears to be a more fundamental apprehension that political support cannot be mustered for substantial subsidy amounts that are provided in grant form. There is far greater precedent for higher benefit levels through tax expenditures, and a widely held belief that more can be provided through those channels than through a direct grant program. Given the intrinsically limited scale of any solar incentive program in the near term, the advantages offered by the rebate approach may provide an unusual opportunity for those opposed to "social" uses of the tax system to demonstrate that equal benefit levels can in fact be provided in this more direct manner.

5. Questions of consumer responsiveness aside, the study's findings argue against the feasibility and desirability of the loan approach on a number of other grounds.

- It is frequently assumed that existing Federal loan programs, such as the FHA/VA network could be easily adapted to deliver financing assistance to purchasers of solar equipment. However, Federal home mortgage loan and loan insurance programs are concentrated on a narrow segment of the new housing market and contain implicit and explicit eligibility limitations on borrower incomes that would severely constrain their reach into the potential market for solar.

Federal programs play an even smaller role in the market for improvements to existing homes, with less than 3% of all home improvements financed through FHA's Title I Property Improvement Loan Program. In practice, the market response to a loan program would be greatly limited by the absence of institutional arrangements for originating such loans that could be quickly activated and that would provide ready access for the vast majority of homeowners and home purchasers.

- Homebuilders and lenders in many cases associate Federal low-cost loans exclusively with programs directed at low-income families and the elaborate processing requirements such programs have invariably involved. A solar program would have to overcome these negative associations in order to enlist the participation of these professionals in "marketing" the program to consumers.

- Loans require the government to assume administrative responsibility for setting standards of borrower creditworthiness, long-term servicing of loans or subsidy payments, and dealing with defaults and delinquencies for years (several decades in the case of mortgage loans) after the program itself has expired.

Three basic alternatives for the delivery of interest subsidies were evaluated: (1) a direct Federal loan program; (2) interest subsidy payments for loans originated by private lenders; and (3) a Solar Tandem Plan utilizing GNMA/FNMA secondary market programs. All three of these approaches involve transaction costs and logistical complexities that would appear to be hard to justify in connection with the relatively small principal amounts and modest lending volumes that would be involved in solar loan subsidy programs.

This conclusion is reflected in the cost estimates shown in Exhibit 3. To achieve a 56% increase in solar units installed from 1978-1982 with a loan program would entail total program costs that are roughly a third more than the amount needed to get a comparable increase with the rebate and about 50% higher than with a credit. Over half the total program cost estimated for the loan at this subsidy level is accounted for by administrative expense, compared with an estimated 3% and 20% for the tax credit and rebate, respectively.

6. A strong argument can be made for limiting broad-based market incentives in the near term (one to three years) to solar domestic hot water systems -- which, in contrast to solar space heating, are simpler to certify, in a more advanced stage of commercialization, and involve less cost and risk to the homeowner. Moreover, at such time as market-type supports for solar space heating become more timely, a different incentive mix may be appropriate.* There appears to be a high potential

*In respect to a credit or rebate program, a fixed dollar amount subsidy (which precludes the need for cost certification) would be feasible for hot water systems, but far less practical for space heating. "Percentage of Cost" type subsidy formulas create difficulties in isolating solar related costs, particularly in newly built homes, unless eligible expenditures are limited to purchase of major systems components (collector, storage tank, controls) and exclude most on-site labor costs. Other suggested formulas are also more difficult to apply to space heating techniques.

market response to a loan program for space heating, although administrative considerations may still weigh heavily against such an approach.

The probable demand for solar space heating over the next five years seems more appropriate to the type and scale of support provided through demonstration programs than direct financial incentives. Our estimates envisage only 13,000 space heating units installed in single-family homes between 1978 and 1982 in the absence of Federal assistance, and program volumes in response to an incentive of from 5,000 to 53,000 units, depending on the depth of subsidy provided. In addition, demonstration support could allow greater control over the quality of individual space heating installations until adequate certification procedures for this more complex form of solar use can be brought on line.

Once sufficient market potential has matieralized to justify a solar space heating incentive, a below-market-rate loan program may merit some consideration as an alternative or supplement to a "front-end" subsidy. The results of the market impact analysis suggest that for combined solar space and water heating systems in new homes, which are far more expensive than hot water systems alone, a long-term, low-interest loan program could have an impact comparable to that of a rebate or credit, Such a program might be most attractive in the form of a subsidy that is rolled into the first mortgage on the entire property. As can be seen in Exhibit 4, 5%, 30-year financing for 75% of solar costs, integrated into the first-mortgage financing, would induce approximately the same increase in solar heating/hot water systems (109%) as a rebate based on the 40/25 formula proposed in the National Energy Act. (A program of direct separate loans for the full additional solar costs would need to be offered at deeper subsidies and would have less probable impact and substantially higher costs, as can be seen in Exhibit 4, assuming the shorter maturity typical of such second mortgage financing.)

The relatively strong market response to low-cost loans for heating systems, as compared to loans for hot water systems alone, may reflect the greater necessity for financing costs of this magnitude, as well as the substantial reductions in monthly expense achievable through long-term amortization structures. A homebuyer able to purchase an $8,000 solar heating system with a 3%, 30-year loan for 75% of the cost would increase his downpayment by $2,000 and his monthly mortgage payment by only $25.

As suggested in Exhibit 4, a Tandem Plan mechanism that made use of existing GNMA/FNMA secondary purchase arrangements for mortgage loans, could involve lower program costs and "cost-per-induced unit" than either a rebate or loan. However, this apparent potential for both market impact and cost effectiveness could only be realized if procedures for making such loans available to new home buyers could be quickly activated.* To accomplish this, many of the logistical problems

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*The use of secondary market mechanisms would be much less workable in the case of loans for hot water systems alone, where the loan size is too small to bear transaction costs involved, or for separate solar loans, given the absence of a secondary market for such debt.

previously discussed in connection with loan programs would still have to be overcome. Furthermore, if the solar loans remained in GNMA's portfolio, rather than being resold to FNMA or other institutional investors, the government would then be assuming long-term responsibility for loan servicing and foreclosure losses on entire mortgage loans, with concomitantly greater costs and administrative complexities.

Exhibit 4

SOLAR COMBINED HEATING/HOT WATER SYSTEMS: COMPARATIVE MARKET IMPACT AND PROGRAM COSTS[a] OF FRONT-END SUBSIDIES AND BMIR LOANS

Note: Estimates for Units Installed in New Single Family Home During Five Year Period, 1978-1982
Baseline: 1978-1982 Units Installed Without Incentive = 13,000

	Tax Credit			Rebate (Grant)		
Benefit as % of Cost	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit
20%	55%	20	$2750	65%	$23	$2710
30/20[b]	68	24	2710	73	28	2680
40/25[c]	90	33	2830	109	39	2740
30[d]	100	38	2930	117	44	2880
40[d]	178	55	2340	209	64	2350
50[d]	239	67	2140	263	76	2200

Separate Solar Loan (@ 100% of Solar Cost) — Direct Loan Program

Loan Terms	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit
7%—10 yr.	5%	$ 4	$5590
5%—10 yr.	13	9	5550
3%—15 yr.	79	33	3230
1%—20 yr.	222	104	3570

Solar Loan Combined with Mortgage (@ 75% of Solar Cost) — GNMA/FNMA Tandem Program

Loan Terms	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit
7%—30 yr.	43%	$ 7	$1200
5%—30 yr.	109	25	1770
3%—30 yr.	230	58	1920
1%—30 yr.	406	121	2270

[a]All program costs given in present value terms using 7.5% discount rate, and include both subsidy costs and administrative expense.
[b]30/20 = 30% of the first $1,500 of system cost, and 20% of the next $8,500 (maximum credit of $2,150).
[c]40/25 = 40% of the first $1,000 of system cost, and 25% of the next $6,400 (maximum credit of $2,000).
[d]Maximum credit of $2,000.

7. The design of procedures to certify the eligibility of solar systems for Federal support may prove as critical to the effectiveness of a solar subsidy program as the choice of the specific type of incentive provided. The solar industry today includes many new, small firms and offers an unfamiliar product for which there is no recognized standard of quality. These characteristics suggest that performance of installed units will vary widely, and that the market is particularly vulnerable to the types of abuses (shoddy equipment and workmanship, inflated performance claims, overbilling) that have long plagued the home improvements industry and were widely publicized incidents of the FHA's Title I home improvement program in the early nineteen-fifties.

To the extent that a solar incentive program results in a conspicuous number of defective installations it will defeat its aim of establishing the credibility of solar systems as a practical means of supplying home energy needs. But the resulting need for consumer protection measures presents the government with a difficult set of trade-offs. Elaborate precautionary procedures that require long lead times might discourage the participation of homeowners, lenders, homebuilders, and legitimate solar suppliers and installers. And standards that lack suppleness can prematurely freeze technology and inhibit innovation.

In designing eligibility requirements it is important to distinguish between procedures appropriate for components and those for total systems, and also between space heating vs. domestic hot water, and passive vs. active applications.

- Certification of major components (collectors, storage tanks, and so forth) may be relatively straightforward once a network of accredited testing facilities is in place. However, the various ad hoc procedures that might be used until such a network is fully operational all have serious limitations.

- Component certification is only a partial surrogate for advance certification of the quality or performance of systems as installed. The latter would be more responsive to consumer needs but poses even greater difficulties, particularly in regard to solar space heating. Here the most practical approach may be to secure a guarantee from the responsible actor (homebuilder, solar dealer) rather than attempting to certify the performance of systems whose design and performance will vary from site to site. Guarantees might be strengthened by requiring that installers be bonded contractors and expanding SBA's existing bond reinsurance program. Use of "white lists" of approved installers and FHA's home improvement contractors "precautionary measures of disbarment lists" might be a useful, albeit limited, supplement to this approach.

- Even if a "component" certification approach is taken, rather than one based on whole systems or systems as installed, there is a difficult choice to be made in determining the starting date for an incentive program. The program must either rely on presently available, but deficient, means for certifying component eligibility, or forestall the starting date until a reliable certification procedure has been developed -- with a depressive effect on the immediate market for solar, as prospective buyers defer purchases in order to assure their eligibility for the incentive.

- A consumer education program will be a necessary adjunct to any Federal incentive program, and should be buttressed by disclosure and information requirements integrated into the solar merchandising system itself, as a prerequisite for system eligibility.

- Requirements, as suggested in a number of Congressional bills, that solar systems supply or exceed a high minimum percentage of a home's thermal load may exclude the most cost-effective scale of system design for many homes and locations.

- Homes incorporating passive solar designs may make a significant contribution to energy savings in some locations. However, the review of passive systems raises difficult administrative and analytic problems -- for example in respect to performance standards, and the identification of those costs uniquely attributable to the solar feature -- that suggest deferring inclusion of passive systems in a Federal incentive program. The only currently used procedure for reviewing passive solar homes -- devised by officials in New Mexico, where passive applications can qualify for that state's solar income tax credit -- would be costly and cumbersome to apply to a large volume, nationwide program. However, within the context of delegated authority to an appropriate agency, a continued effort should be made to overcome the administrative barriers that make it difficult to include passive homes within a Federal incentive program.

8. <u>Efforts to assure the progressivity of benefits appear inappropriate for a solar residential incentive at the present time, given the risks inherent in the use of solar energy systems in the near term and the availability of more certain and more cost-effective means for helping poorer families to cope with rising utility bills.</u>

Solar incentive proposals in the present and past sessions of Congress have evidenced concern over the possibility that the benefits of such a program would be distributed in a regressive manner. Proposed measures to avoid this result have included restrictions on eligibility based on family income, benefits calculated inversely with income, and benefits subject to the inherently progressive effect of the Federal income tax.

The argument for income-skewing is based largely on the premise that Federal programs should be progressive in distribution of benefits, but also reflects concern that upper-income families are most likely to proceed in the absence of incentives and thus would receive substantial "windfall" benefits. The further argument for concentrating benefits on lower income families is that rising energy costs impose the greatest hardships on these families, who also lack the resources necessary to make energy saving investments, particularly in solar with its high first costs and long-term payoffs.

However, the limitation that income-related program structures would place on the ability to attain the primary goals of an incentive program -- and the unproven, expensive and rapidly changing nature of systems commercially available -- strongly suggest that progressive skewing of benefits through such devices is inappropriate for a near-term residential solar incentive program:

- There are more effective and more desirable means of reducing the energy cost burdens of lower-income families than incentives aimed at inducing them to install solar energy systems. Other home energy conservation measures which such families typically lack (greater insulation, weatherstripping, etc.) are more cost-effective from the individual homeowner's point of view and are comparatively free of the risks of performance failure or financial loss inherent in solar energy systems today.

- Income certification procedures would add significantly to program costs and complexity and restrict the impact of programs by reducing their use. Means tests have proved to be a troublesome aspect of Federal benefit programs in many fields, and are necessary and justifiable primarily where the basic program goal is a redistributive one. And both home builders and mortgage and consumer loan lenders interviewed in this study made clear their reluctance to participate in any program that would involve them in the process of income certification in any way.

- Concern over income-level of program participants may be out of place in a program aimed at inducing adoption of this energy production system. The benefits of Federal incentives for energy production in other areas are not restricted on the basis of recipient income, and concern over the extensions of benefits to upper income households may be uncalled for in view of the risks being assumed by all early users of these systems and the equal contribution such households would make to the goal of accelerating solar commercialization. Unless an incentive program is designed to assure purchasers of a desirable return on their investment, and hold them harmless against system failure or losses on resale, it would appear desirable that the risks involved be assumed by those families and individuals best able to bear such problems as may be involved.*

*It is this element of risk that makes the issue of "windfalls" less pertinent to the merits of a solar incentive than to those of incentives, such as the proposed tax credit for home insulation, which encourages individuals to make investments whose cost-effectiveness, in many cases, has already been demonstrated.

- Efforts to increase progressivity of incentives through the taxability of benefits would avoid income certification problems but may reduce the reach of a solar incentive program among the most responsive and most appropriate early solar users. This likelihood is illustrated in Exhibit 5, using the example of a 50% credit for solar hot water systems in three possible forms: a tax credit (available to the extent it can be offset against other tax liability); a "refundable" tax credit (under which a payment would be made for any excess of credit over tax liability, assuring full receipt of the benefit); and a "taxable refundable" tax credit (a refundable credit included in income subject to tax in the following year). As can be seen, making the credit refundable would slightly increase the response to the incentive over a five-year period; however, attempting to improve progressivity by subjecting the benefit to taxation would substantially reduce the impact of the program. It should also be noted that in the case of a maximum $2,000 credit, only homeowners with taxable income of over $18,000 -- less than 35% of all homeowners -- would have sufficient tax liability to take full advantage of the credit.

Exhibit 5

MARKET IMPACT OF INCREASING THE PROGRESSIVITY OF TAX CREDIT FOR THE PURCHASE OF SOLAR DOMESTIC HOT WATER SYSTEMS

Note: Estimates for Units Installed Over 5-Yr. Period — 1978-1982 Assuming, for Illustrative Purposes, a Tax Credit of 40% of the first $1,000 of System Cost, and 25% of the next $6,400 ($2,000 maximum).

Effect	Program	Cum. Units	Percent Increase Over Baseline
Somewhat Regressive	Credit	296,000	67%
Neutral	Refundable Credit	299,000	68%
Progressive	Taxable Refundable Credit	233,000	31%

9. As a complement to more direct forms of subsidy, Congress might consider measures to help ensure that purchasers of new solar homes are able to secure mortgage financing from private lenders on normal terms.

Homeowners who wish to retrofit solar systems to an existing residence and are able to satisfy routine credit standards should encounter no difficulty securing home improvement loans on normal terms and are already able to use Title I loans for this purpose. No need exists for special Federal loan guarantees or other lender-oriented types of incentives to increase the availability of financing in this segment of the solar market.

By contrast, Federal action may be called for to improve the availability of mortgage financing for newly-built solar homes. The size of mortgage loans is based on an appraisal of the property's market value. In the short run, many mortgage lenders will discount solar costs in their appraisals. As a result, a borrower will have to pay for a substantially higher than average portion of solar costs in the downpayment on a new home. Possible measures for encouraging loans that are closer to "normal" financing ratios include:

(1) a lender tax credit for foreclosure losses on solar homes (limited to some portion of system cost);

(2) a form of special insurance or guarantee to lenders against losses attributable to including solar costs in mortgage loans;

(3) liberalized loan ceilings and appraisal policies for solar homes under FHA, VA, and FmHA programs.

Claim costs to the government under any of these options would be fairly small since lenders would incur losses only if it should prove necessary to foreclose on a solar home, and only if the property were then disposed of for less than the outstanding balance of the mortgage. However, before implementing any such program, careful consideration should be given to the important role that lenders may play in helping to screen out less effective or overpriced solar systems, and to the risks -- to borrowers, lenders, and government insurance programs -- of either encouraging or mandating appraisals that may exceed actual market values. This concern is most important in the case of Federal credit programs that assist low and moderate income borrowers.

Congress should also consider action to ensure that borrowers contemplating purchase of solar-equipped homes are not penalized by credit appraisal procedures currently in widespread use which make no allowance for projected energy savings.

10. At the present time, an incentive capable of inducing any significant number of multi-family investors to install solar energy systems would probably require an unprecedented level of public subsidy.

In the short run, the types of incentives and subsidy levels which have received serious legislative consideration cannot be expected to have a substantial impact on demand for solar energy in the multi-family rental market. However, for the same reason, establishing such incentives in a form that has low program administrative requirements (e.g., an investment tax credit) would have little downside financial risk from a public cost perspective, and may be desirable simply to indicate the Federal government's recognition of the potential importance of solar in this segment of the housing market.

Our analysis of the requirements for motivating investors to include solar energy systems in larger multi-family projects indicates that there would be significant response only if a package of incentives were provided which essentially eliminated exposure to risk and required little or no capital investment. Such an incentive program for developers and investors has no precedents in the field of housing and would appear to lack political acceptability. Specific objectives for increased use of solar in multi-family projects may be better met in the near term through continuation of "demonstration" programs funding all or a large part of solar costs, particularly if one of the goals is broad geographic distribution of examples of multi-family solar installations.

As experience with operating solar systems grows and the extent and reliability of cost savings become more demonstrable, investors should become willing to invest in solar energy without demanding the level of public assistance that currently appears necessary. At that time, which could be within the next few years, an incentive program oriented to large-scale multi-family housing may be attractive and might offer advantages in terms of administrative economies attendant on the larger size of individual transactions -- at least for the 10 million units of rental housing in structures of five or more units.

It should also be noted that although rental housing makes up a significant proportion of the total housing stock (25.7 million rental occupied units in 1975, 35% of total occupied units), much of this involves structures of relatively small size. Fully one-third of rental units are in one-family attached and detached houses, and 26% are in units of 2-4 family structures. Except for those in 2-4 family owner-occupied buildings, these may well fall outside the reach of incentives designed for either larger multi-family rental housing or owner-occupied housing, and may be extremely difficult to attract through any practical incentive program.

I BACKGROUND

CHAPTER I

THE CONTEXT FOR FEDERAL ACTION

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CHAPTER ONE

THE CONTEXT FOR FEDERAL ACTION

A. THE FEDERAL COMMITMENT TO SOLAR

The incentives evaluated in this report are focused on residential applications of solar energy technologies. In the near term, these are solar thermal systems for providing part of residential hot water and space heating requirements; in the longer term, they include cooling systems as well. They are of obvious potential importance in light of national energy budgets which indicate that home space and water heating account for over 12% of national energy consumption and that space conditioning and domestic hot water requirements of all buildings taken as a whole account for 24% of the nation's energy use.

Solar energy holds the promise of a resource to meet these needs that is non-polluting, inexhaustible, and supportive of national and individual freedom of action. These potential benefits underlie the public commitment to solar energy development that has already been made at the Federal level (in research, development and demonstration projects) and through state initiatives, as well as the numerous proposals for more broadly-based solar energy incentives that have been introduced in recent sessions of Congress.* The latter include the provisions of Title II of the National Energy Act announced by President Carter on April 29 of this year, proposing a program of tax credits for purchasers of residential solar energy equipment that closely parallels incentives that received positive action by both Houses of Congress last year. The President's solar proposal has been reported out of Committee in the House in modified form, suggesting the extent of current political support for a residential solar energy incentive program.

The need for a Federal commitment in this form has in part already been made a matter of national purpose through the enactment of the Energy Conservation in Existing Buildings Act of 1976, which found that:

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*See Appendix A for a comparative analysis of recent and pending legislation in Congress, and see Appendix B to this report for an overview of present and proposed state incentive programs.

> [M]ajor programs of financial incentives and assistance for energy conservation measures and renewable-resource energy measures in dwelling units, non-residential buildings and industrial plants would:
>
> (A) significantly reduce the nation's demand for energy and the need for petroleum imports;
> (B) cushion the adverse impact of the high price of energy supplies on consumers, particularly elderly and handicapped low-income persons who cannot afford to make the modifications necessary to reduce their residential energy use; and
> (C) increase, directly and indirectly, job opportunities and national economic ouput.*

And the particular need for such Federal action was suggested in the Administration's National Energy Plan statement which accompanied its legislative proposals last April:

> Traditional forecasts of energy use assume that nonconventional resources, such as solar and geothermal energy, will play only a minor role in the United States' energy future. Unless positive and creative actions are taken by Government and the private sector, these forecasts will become self-fulfilling prophecies.**

With this national commitment in view, the present report documents the results of an intensive, six-month evaluation of alternative Federal financial incentives that might accelerate solar energy use within the residential sector. Its purpose is to assist in the choice among basic incentive approaches, to provide information and analysis related to the design of a program if one is to be implemented, and to supply information related to the underlying policy judgment regarding the desirability of broad-based market supports for solar at this particular juncture in time. The balance of this introductory chapter briefly

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*42 USC 6851, Title IV of the Energy Conservation and Production Act of 1976 (PL 94-385, 94th Congress, 2nd Session). Part C, Section 441 authorized $200,000,000 for a National Energy Conservation and Renewable-Resource Demonstration Program for Existing Dwelling Units (new Section 509 of Title V of the Housing and Urban Development Act of 1970) in which various types of incentive programs would be tried and assessed, but no action has yet been taken along those lines.

**Executive Office of the President, The National Energy Plan, p. XIII (April 29, 1977).

reviews three issues that help to set the context for these decisions:

- how government support for solar energy use fits within the context of past and present Federal intervention in the housing market;
- what criteria are pertinent in assessing the appropriateness and likely effectiveness of a Federal residential solar incentive; and
- in what way the income levels of recipient homeowners should be taken into account in the design of an incentive program.

B. DESIGNING SOLAR INCENTIVES FOR THE HOUSING MARKET

The underlying objectives of a Federal residential solar incentive, as discussed below, relate to goals for moderating national energy use. The means to that end will clearly involve a Federal program aimed at participants in the housing market. Previous subsidy and incentive programs aimed at inducing energy production and technological innovation may have some relevance in this regard. But many of the most useful guidelines for program design will come from consideration of past successes and failures of Federal intervention in the housing area.

Even a cursory review of such past Federal efforts makes clear the need for a program that does not fail from design excesses at the extremes:

- inadequate inducements that do not meet the real needs of actors in housing and development, and thus never pass from statute into effective programs (such as the Title X program of land development loan insurance);
- wasteful expenditures with little real benefit to the nation (such as the new homes tax credit, which may have had a windfall factor of 90% or more*, with costs to the nation of an estimated $750 million** distributed in a clearly regressive fashion;***) or

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*Office of Economic Research, Federal Home Loan Bank Board, Economics Briefs, (October 14, 1975).

**Office of Management and Budget, Special Analyses, Budget of the United States Government, 1978, Table F-1, p. 130 (January, 1977)

***See Department of the Treasury, Internal Revenue Service, Statistics of Income 1975 -- Preliminary Individual Income Tax Returns, Table C (Publication 198 (2-77), 1977).

- inadequacies in design or administration that allow abuse and fraud at great cost to individuals participating in the program, the Treasury, or both (such as the Section 235 low-income family homeownership program and early abuses of the Title I Home Improvement Program).

These problems are hardly unique to housing programs, but they have been a particularly visible issue in this setting. With this in mind, the present study sought insights through direct interaction with homeowners and homebuyers, who are the potential market for solar, and with those involved in the housing industry whose responses to this new technology will largely determine its rate of acceptance -- particularly homebuilders and commercial sources of home mortgage and home improvement financing. These fieldwork efforts - which included a survey of approximately 1,500 housing consumers in 8 cities -- were intended to evaluate not only the comparative merits of incentive approaches, but also to determine the threshold levels at which incentives would need to be offered in order to achieve a substantial market response, and to identify possible areas of difficulty in actual delivery of incentives. This in-depth testing at the market level allows for a more direct assessment of the likely impact of incentives than would be possible with a purely economic decision model that based estimates on a hypothesized consumer response to changes in solar economics over time.

The insights gained from exploring the parallels between the possible solar incentives and past Federal housing programs are incorporated throughout the body of this report, and are essential to the design of a successful program. However, it is also important to recognize that any solar residential incentive will also differ in significant respects from previous Federal housing initiatives. Such a program will be intended to induce homeowners to invest in a particular technology, and to make a relatively substantial front-end investment that will make economic sense (if at all) only over a considerable number of years.

There is little real precedent for a broad-based housing program with such aims. Most technologically-oriented efforts have been limited to demonstration programs, and even in those cases the goal was more often to lower initial housing costs (as in Operation Breakthrough).* And the unproven nature and high first costs of many of the solar energy systems now on the market clearly distinguish the issues at hand from those that pertain to the design of a home energy conservation program -- an area in which (it is widely believed) cost-effectiveness from the homeowners' perspective has already been demonstrated for many low-risk approaches (improved insulation, weatherstripping, etc.).

These unprecedented aspects of a solar energy incentive program, taken together with certain types of problems that have recurred in past Federal housing programs, suggest that a special effort will have to be made to balance the national interests in accelerating residential solar energy development with the responsibility of providing adequate information and protection to homeowners and homebuyers who respond to the Federal government's encouragement and implied approval of solar systems and become solar purchasers. It is appropriate to consider the dimensions of those interests in somewhat more detail before turning to the results of the present study.

C. REALISTIC EXPECTATIONS AND MEASURES OF SUCCESS

Although technical assessments of the costs, performance, reliability and related aspects of presently available solar energy systems were sought and used at various junctures of this study, this report does not directly review the current stage of development of residential solar energy systems. Such questions were in large part beyond the purview of this study. Nevertheless, any effort to judge the appropriateness of Federal incentives for solar energy must take into account the present state of transition within the solar industry. It is the unproven technical and economic characteristics of most systems today that make government support necessary; but these characteristics also raise important questions about the proper purpose of a broad-based incentive program.

*Efforts to focus attention on lifecycle costing in other fields have primarily taken the form of consumer education programs and product labeling requirements (as in EER ratings for appliances and fuel economy ratings for automobiles). FHA's little utilized Section 233 program (which provides mortgage insurance for homes of experimental design that do not satisfy FHA's Minimum Property Standards) is the only open-ended program of Federal market support for new housing technologies that is currently on the books.

The essential problem is that solar is still in the midst of change from an experimental technology to a fully reliable and economic home energy system. The principles of active solar heating systems have been established in practice for many years. Working systems installed in the 1930's are still providing hot water in some homes in Florida today, and solar water heating is widely used in other parts of the world where the costs or scarcity of alternative fuels make them economically competitive (for example, in parts of Israel). But the present solar "industry" in this country is relatively new and changing rapidly.

According to the most recent Federal Energy Administration production survey of solar collector manufacturers, the total number of such companies has grown from 39 in 1974 to 177 in the second half of 1976. An average of 35 companies have entered the market every half-year since the survey began in 1974. Thirty-four percent of companies actually manufacturing collectors during the last six months of 1976 had no record of production before that period, while eighteen percent of companies active in the previous half-year had stopped production.* While there are some signs of stabilization, the outlook for the next few years remains one of continued modification in system design and a shake-out among manufacturers as the great variety of solar components and installation configurations are tried in practice.

These conditions in the industry bear directly on two important questions: whether a broad-based, market support incentive program is appropriate at the present time; and what frame of reference should be employed in judging the costs and benefits of a solar incentive.

1. The Timing of a Broad-Based Incentive

The incentives currently under consideration are designed to broaden the market for residential solar energy systems by subsidizing and otherwise improving the economics of solar for homeowners and home buyers. Although requirements for screening programs to certify "eligible" systems have been included in most proposals, the vision

*Federal Energy Administration, Solar Collector Manufacturing Activity, July through December 1976 (April 1977).

of an effective incentive program is substantially different from that of the research and demonstration projects now underway.

The Residential Solar Demonstration Program administered by HUD provides for substantial review of each individual grant application: the selection of projects is based on the objective of testing a wide range of collector systems under different climatic conditions through intensive instrumentation, monitoring and follow-up; and the government assumes almost the full cost of systems chosen for the demonstration. This program is still in progress, and it will be several years before the field results of system evaluations are in hand. There is still no established and reliable procedure for testing or "certifying" individual systems yet in place, nor is one likely to be fully operational by the year's end.* Yet a broad-based incentive -- particularly if it is organized in an effective form, with relatively little need for advance qualification or other "red tape" -- is likely to be seen by the public as a signal from the Federal government that solar is ready now and appropriate for the average homeowner today. It will accelerate a testing of systems in the marketplace that is less formal but no less risky than the more circumscribed and controlled experiments currently being funded through the Demonstration Program -- but with the risks to a large extent borne by the individual purchasers.

This is not to say that individuals do not have a right to experiment with solar energy systems, and to take the risks involved. It does mean that the implicit endorsement of solar energy systems on the market today that may be inherent in the availability of a Federal incentive imposes special responsibilities that must be met in the design of the incentive program. At the very least, this suggests that there may be a need for stringent controls -- in certification of eligible systems, in monitoring of manufacturer and dealer advertising and sales techniques, in assurance of adequate knowledge by consumers of the uncertainties inherent in solar use today -- at the possible sacrifice of some market impact that such bureaucratic oversight would involve.

*See Chapter Six for a more detailed review of the efforts underway to establish adequate certification procedures and the logistical problems involved in achieving this end.

2. Weighing Costs and Benefits

The extent of flux in the evolution both of system designs and the structure of the solar industry also bears on a different but perhaps more fundamental issue: the choice of an appropriate framework for assessing the overall desirability of the Federal investment that would be required for an effective residential solar incentive program. Since there are relatively straightforward (though by no means precise) means for estimating the costs of most possible incentive designs, this question, in practice, is one of defining the appropriate measures to be used in assessing the beneficial impacts of such a program.

This study has used the number of solar equipped housing units as the frame of reference for assessing the impacts of available incentive systems. A brief review of the reasons underlying this choice of a measure of impact appears appropriate.

One possible frame of reference is provided by the long-term energy goals that underlie any incentive program: the energy production that would be attributable to solar energy systems put in place in response to an incentive. This is an approach that has been used in a number of recent evaluations of solar incentive programs, with the value of the solar "savings" that would result generally expressed in terms of the energy equivalent in barrels of oil. But there are several problems with such an approach.

- First, there is considerable uncertainty inherent in any estimate of the likely response to an incentive, and considerable disagreement over the "savings" that would result, even in the near-term. For example, estimates of the energy savings likely in 1982 from response to the individual tax credit contained in the President's proposed National Energy Act vary in a range exceeding twenty to one.*

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*Cf. Bezdek, Roger, et al., Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems, Table II-8-4, p. 122, Program of Policy Studies in Science and Technology, The George Washington University (April,1977) (1982 savings estimated at 10,950,000 bbl/year); Congressional Budget Office, President Carter's Energy Proposals: A Perspective, Table VII-2, p. 90, Staff Working Paper, (June,1977) (1982 savings estimated at 460,000 bbl/year).

- Second, these analyses generally assume that the value of such energy savings is established by the market price of oil and the estimated oil equivalent "saved" -- which may well be an overly narrow definition of the benefits of solar energy development. Energy prices in the market today do not necessarily reflect the full costs that need to be accounted for, omitting such considerations as the environmental impacts of extraction, refinement and use, and the costs of public incentives and subsidies for conventional energy exploration, development and transportation and distribution systems.* And there are other benefits that can be attributed to the development of the solar resource -- for example, the economic contributions to be made by the emerging solar industry.

- Third, few observers, including the most buoyant of solar enthusiasts, anticipate that solar energy systems, with or without Federal support, will visibly influence the pattern of energy use in the residential sector over the period immediately ahead. The targeted program volume of a five-year solar incentive program under even the most optimistic of assumptions, is a fairly modest one, at least in relation to the annual number of new residential units completed and the total stock of existing homes. The justification for incentives, if there is one, is to be found in the contribution that accelerated development of the technology can make in the decades ahead on a broad range of social and economic fronts.

Limitations of quantitative "cost-benefit analysis"

These shortcomings of the "energy equivalent saved" approach suggest a shift to an appropriately wider definition of costs and benefits. Yet such a shift raises even more difficult problems for a cost and benefit analysis. It is considerably easier to suggest the range of costs and

*A recent review of Federal energy production incentives, based on ERDA-sponsored research, estimated the cost of those incentives during the period 1918-1976 to be $144 billion in current dollars -- with the bulk of those costs attributable to the period 1950-1976. Bezdek et al., op. cit., Table II-2-1, p. 16.

benefits that might be involved than to reach agreement on the quantitative values and methods to be used in developing such a comparison. But those decisions (on which benefits to recognize, and on how to value them) will to a large extent determine the outcome of that analysis -- if such an analysis is indeed possible.*

Utility of "number of solar-equipped housing units"

The long-term objectives of any solar incentive program necessarily relate to national energy goals and energy-saving benefits. But the inherent limitations of the available approaches to quantifying benefits -- taken together with the formative stage of the solar industry's development and the considerable uncertainty as to the future costs of alternative

*A recent FEA study suggests that national involvement in solar energy research, development and demonstration efforts should be determined through a "social cost-benefit analysis" which will allow comparison with other possible energy technology investments. The report suggests that in this analysis

> "the social costs to be considered include: 1. The private market price (i.e., the private sector costs of production; 2. Existing or proposed government subsidies; and 3. Any other external social costs (external to the private sector price mechanism)....The social benefits...can also be divided into three parts including: 1. The value of the energy produced to the private sector; 2. Any subsidies on existing energy sources that are displaced; and 3. Any other social benefits...[including] the value of pollution abatement, health and safety, conservation of energy resources, insurance against foreign energy curtailments, exports, transferrable knowledge, and improvements in economic conditions."

To undertake this comparison, "an appropriate time frame must be chosen ...[and] the benefits and costs must be expressed in common units," assumedly dollars. The future flows of costs and benefits expressed in these units should then be converted to present values by application of a "social discount rate" that "should reflect the value that society places on time;" this might even be a negative discount rate if it were agreed "that resources for future generations should be valued higher than the present generation." This part of the report does not undertake the quantitative social cost-benefit analysis that it suggests in outline form, but does continue on to provide a survey of just one of the items on the list, past and present subsidies of other energy technologies, that by itself suggests the complexity and likely impossibility of an agreed-upon quantitative analysis of this inclusive a scope. Federal Energy Administration, Task Force on Solar Energy Commercialization, and Midwest Research Institute, Solar Heating and Cooling of Buildings (SHACOB) Commercialization Report, Volume III, Appendix E, Comparison with Other Energy Investments (Draft Final Report, June 9, 1977).

energy sources -- argues for a more immediate measure of the desirability of an incentive: its impact on the solar market. That is, the extent to which it contributes to the near-term objective of accelerating the development of the solar industry and its delivery and service networks, as expressed directly in the near-term market outlook for residential solar energy systems.*

In weighing the cost-effectiveness of alternative means to "kick-over" the solar market, the most useful measure of comparison is the additional number of solar-equipped homes that result from the availability of any given Federal incentive. This is the measure of impact employed throughout this report. Housing units provide a tangible indicator of whether or not the result of Federal support will be a sufficient number of solar installations (at least within prime market areas) to establish the credibility of the solar alternative and to support the emergence of locally based installation and maintenance services.

Such a measure is certainly an incomplete expression of the benefits that are sought through an incentive program. In fact, it assumes those benefits, rather than assessing them directly. But given the circumstances enumerated above, this may be the most appropriate course of action. Quantitative indicators of other aspects of the issue are also useful points of reference, and assessments of long-term energy savings

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*The President's National Energy Plan appears to focus on this aspect of solar development, suggesting that the program of incentives and supporting activities it proposes is meant to "launch the solar heating industry." Executive Office of the President, The National Energy Plan, p. 75 (April 29, 1977)

One traditional rationale for a Federal market support system appears to have limited applicability to the solar industry: namely that larger volume sales will enable manufacturers to achieve significant economies in production. Interviews with solar manufacturers indicated modest expectations at best for reducing the price of residential solar systems in the near term. Some savings should be achievable, particularly through more automated production of collectors. However, this would affect only a small portion of total installed cost, a substantial part of which consists of materials (copper, aluminum) and on-site labor -- both of which may well increase in cost faster than the general rate of inflation. Thus cost savings of more than 20 to 30% will probably depend upon some presently unforeseen breakthrough in the solar state-of-the-art.

and other benefits of solar may be among them. However, in the final analysis, the desirability of solar incentives, at least at the present time, remains essentially a social, political, and qualitative issue -- reflecting a belief, or hope, that this fledgling industry can make a unique and valuable contribution in the decades ahead to national energy conservation goals.

D. SOLAR INCENTIVES AND USER INCOMES

A final issue that needs special attention is how, if at all, the design of a residential solar energy incentive should accommodate differences in income among potential solar users and incentive recipients. When user income is considered, questions arise at both ends of the spectrum: whether upper-income families should be excluded from eligibility, or offered reduced benefit levels; and whether benefits should be skewed further to assure lower-income families access to solar energy systems. Both concerns were evidenced in several of the solar incentive bills introduced in the 94th and 95th Congress, which proposed such measures as restrictions on eligibility based on family income, benefits calculated inversely with incomes, and benefits subject to the inherently progressive effect of the Federal income tax.*

The argument for income-skewing is based largely on the premise that Federal programs should be progressive in distribution of benefits, but also reflects concern that upper-income families are most likely to proceed in the absence of incentives, and thus would receive the bulk of the "windfall" effect of an incentive program. The further argument is that poor families have been hit hardest by the financial burdens of increasing energy costs, and therefore should be accorded priority in any Federal program aimed at reducing family energy expenditures.

These arguments raise policy considerations of intrinsic merit. However, these desirable objectives must be balanced against the limits that income-related program structures would impose on the ability of an incentive program to attain its immediate goal of increased solar market penetration. They must also be considered in the context of

*Most of these proposals would authorize low-cost loans for households below a specified income level. See Appendix A.

the expensive, unproven and rapidly changing nature of many of the solar energy systems currently available. These comparisons strongly suggest that income skewing of benefits is inappropriate for near-term residential solar incentive programs:

- Income certification procedures, which are likely to be administratively complex, costly and ineffective, would restrict the impact of the program by reducing its use. Means tests have proved to be one of the most troublesome aspects of Federal benefit programs in housing and other fields, and are primarily justifiable where the basic program goal is a redistribution one. Calculating income or assets is a complicated process, requiring resolution of issues such as the definition of items to be included or excluded, receipt, review and verification of documentation of income, calculations of entitlement where there is a variable formula based on income, and audit and quality control both of submitted information and the review process itself. In addition to being costly to administer, income-based benefit programs often have high rates of inaccurate payments resulting from administrative error as well as from fraud. The likely impact of a solar incentive program would be reduced to the potentially substantial degree that such income review procedures -- either in principle, or in the extent they increased the transaction cost in time and effort -- deterred interested solar purchasers from participating in the program. Both home builders and mortgage and consumer loan lenders interviewed in this study also made clear their reluctance to participate in any program that would involve them in the process of income certification in any way.

- Income skewing through the taxability of benefits may reduce the reach of a solar incentive program among the most responsive and most appropriate early solar users. Income-skewing of benefits can be achieved without certification procedures by making benefit distributions subject to the inherent progressivity of the Federal income tax. In view of the benefit levels at which incentives are likely to be offered, this will result in incentive amounts considerably less likely to induce solar purchases by upper-income homeowners.* Moreover, it appears particularly desirable that families with above-average means play the role of innovative users of residential solar systems. At the present time, and for the next few years, most of the available solar energy systems will have limited track records in respect to either performance or durability. They will be further subject to the risks of economic obsolescence from rapid evolution in the quality of system production and the nature of system design.

These are the very reasons that an incentive program is necessary. But unless a fail-safe program is designed to assure purchasers of a desirable return on their own investment, and hold them harmless against system failures or losses on resale, it would appear preferable that the risks involved be assumed by those families and individuals best able to bear such problems as may be involved.

- There are more effective and more desirable means of reducing the energy cost burdens of lower income families than incentives aimed at inducing them to install solar energy systems. In addition to the potential problems and losses associated with solar energy installations, it is widely recognized that many other approaches to reduced home energy costs are more reliable and economically attractive than solar energy installations. The structure of the proposed National Energy Act reflects both the greater cost-effectiveness of residential energy conservation measures (insulation, weatherstripping, etc.) from the individual homeowner's point of view, and the disproportionate lack of many of these features in the homes owned by moderate

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*See Chapter Three. This may in fact increase the windfall effect among these households, with relatively few additional families induced to adopt solar, while all those proceeding even without the incentive would obtain its benefits (though the individual amount of the benefit would be smaller in each such case).

and lower income households. If reduced energy costs for lower-income households are an important national goal, expanded programs in the conservation area are far more appropriate than residential solar energy incentives, both from the perspective of the homeowners involved and from that of national program costs.

- Skewing of benefits to lower-income households might reduce the impact of a solar incentive program at any total level of program costs. One argument made for progressively-skewed incentives is that lower-income households are less able to make discretionary purchases, particularly investments such as solar energy systems which have relatively long term payoffs. It can hardly be doubted that, on the average, a higher incentive will be required to enable and induce such households to purchase solar energy systems than will be needed for those of higher income. Conversely, however, a far greater impact in terms of market response is likely to result from a smaller per-unit subsidy available to higher income households as well as moderate and low-income families than from higher per-unit subsidies restricted to those of lower income. Within any total level of program funding, scaling benefits down for middle and upper income groups is thus likely to substantially diminish the program's total impact.*

- Concern over receipt of Federal benefits by upper-income families may be out of place in a program aimed at inducing adoption of this energy "production" system. It should be recognized that a residential solar incentive for homeowners is more analogous to other Federal programs directed at energy producers than to traditional Federal housing programs, which are often inextricably involved with the redistribution of income. As a rule, the benefits of Federal incentives for energy production (such as the tax code provisions for the expensing of exploration and development costs, and the excess of percentage over cost depletion allowances) are not restricted on the basis of recipient income. Concern over the extension

*See Chapter Three, section "F" for a quantitative analysis of this issue in respect to a tax credit incentive.

of benefits and possible "windfalls" to upper income households may be particularly inappropriate in the context of a solar incentive program. Here, in contrast to the proposed tax credit for residential insulation, homeowners are being encouraged to make sizeable investments in a new technology that is just emerging from the experimental stage and to assume a variety of risks for the benefit of the nation as a whole.

These considerations appear to weigh against pursuing income redistribution goals in a residential solar energy incentive program today. Such conditions are liable to constrain the program from achieving its primary goal of hastening the development and use of residential solar energy systems, and might induce lower-income families to undertake inappropriate levels of personal risk. If progressivity in benefits _is_ considered necessary, it is better achieved through taxability of program distributions than through the use of eligibility and income certification procedures. And if homeowners of modest means are to be offered special incentives to adopt solar energy systems at this time, such incentives should be accompanied by appropriate long-term protection against any substantial risks that may be involved.

CHAPTER II

"BASELINE" ESTIMATES: THE PROSPECTS FOR RESIDENTIAL SOLAR ENERGY USE IN THE ABSENCE OF FEDERAL SUPPORT

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CHAPTER TWO

"BASELINE" ESTIMATES: THE PROSPECTS FOR RESIDENTIAL SOLAR ENERGY USE IN THE ABSENCE OF FEDERAL SUPPORT

This chapter presents estimates of the number of solar homes likely to appear between now and 1985, in the absence of broad-based Federal market support. These estimates provide a "baseline" for gauging the relative market impact of the various financial incentives under review. "Solar home" is used here as shorthand to denote single-family residences equipped with solar domestic hot water and/or solar space heating devices.

For the purposes of the present study, the formal modeling of baseline demand (and incentive impacts) has been confined to solar domestic hot water applications in both existing and newly-built homes and to combined space heating and hot water in new homes only. Retrofit space heating has been excluded on the grounds that the structural problems of converting most homes to solar energy for spaceheating purposes, and the consequently higher first costs incurred, will preclude sufficient enough retrofit activity to warrant systematic market analysis -- particularly within the short-term time frame of this study. Similarly, solar space cooling, with installed costs substantially higher than space heating, still appears to be a good number of years away from mass marketability.

Although this report presumes a general familiarity with solar energy systems, a brief review of present ranges of costs and savings for the types of systems under consideration here may help to set the context for presentation of baseline data and analysis. While residential solar systems have been commercially available for some time in many parts of the country, widespread home use of solar energy has been constrained by the substantial first costs involved -- both in absolute dollar amounts (when compared with conventional alternatives) and relative to the anticipated savings. Hot water systems require approximately 40 to 80 square feet of solar collector, and generally cost from $1,000 to $2,000 installed.* The optimal solar collector arrays for space heating in a typical 1500 square foot house can vary from as little as 100 square feet (in effect an incremental addition to a hot water system) in milder climates to over 500 square feet in regions with severe winters. Costs vary over an equally broad range (from $3,000 to upwards of $12,000). The associated dollar value of the savings delivered may range from only a few dollars to $175 annually for domestic hot water, and from $50 to $500 or more per year for space heating, depending on any number of variables including the home's thermal load (i.e. hot water consumption and/or heat requirements), the system's efficiency, local degree days and solar insolation, and local prices for energy from conventional sources.

A. ABSENCE OF DATA ON CURRENT SIZE OF RESIDENTIAL SOLAR MARKET

In the case of solar energy systems, the inherent difficulties of forecasting future demand for any new housing technology are compounded by the lack of any reliable data on the number of homes that have already been equipped with solar devices. The Federal Energy Administration's survey of solar collector manufacturing activity provides the only comprehensive and authoritative information available on current size of the solar market, but in a form that cannot be translated into actual numbers of solar homes.**

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*The cost of solar domestic hot water as expressed in dollars invested per BTU of yearly output, tends to be somewhat more favorable than for spaceheating plus hot water combined. On the savings side of the equation, solar hot water offers the advantage of year-round operation. However, this advantage is partially negated by higher costs, relative to collector size, for installation and other system components such as storage and controls. At the present time, it is generally conceded that residential solar devices have attained or are approaching true cost competitiveness with traditional hot water and space heating systems only in those localities where the major alternative energy source is high priced electric power. Conversely, where cheap natural gas is still readily available, the immediate savings that can be realized by conversion to solar use are virtually nil.

**Federal Energy Administration, Solar Collector Manufacturing Activity FEA/B-77-135), July 1977.

Residential space heating and hot water systems generally require solar collector panels capable of achieving operating temperatures of 140° and above. There are many system designs currently available in this range, which the FEA has classified as follows for its data gathering purposes:

- medium-temperature flat plate collectors, composed of a metal collector plate under glazing in a rigid frame, and generally capable of operating temperatures of 140-180° F;

- high performance medium temperature flat plate collectors, with heat traps, selective coatings or other features allowing temperatures up to 250° F (capable of use for absorption cooling systems); and

- "special" collector designs, including evacuated-tube and concentrating collectors that further reduce heat loss in operation and improve high-temperature operating performance.

The largest solar market share in collector square footage is accounted for by the FEA's fourth classification, low-temperature collectors, which are used almost exclusively in swimming pool heating systems, operate in the temperature range of 70° - 90° F, and increase water temperatures only 5° - 15° over ambient temperatures for larger volumes of more rapidly circulating water. The large market share of these systems is attributable to their considerable lower cost (they are typically of less expensive construction employing rubber or plastic), their acceptable performance despite the lack of a glazing cover (due to the low range of increase over ambient temperature), and the prohibitions on the use of conventional energy sources in some areas, most notably California (conventional swimming pool heaters are predominantly fueled by natural gas). Some medium temperature collectors are also used for pool heating applications.

According to the most recent FEA survey, total production of collectors from 1974 through December 1976 was as follows:*

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*Taking into account the average efficiency, seasonal use and other operating characteristics of each type of collector, and employing rough estimates of the actual distribution of use for each collector type, the FEA estimates that if all of this collector production were in use, swimming pool heating and other low-temperature applications would now provide energy "savings" equivalent to approximately 728 barrels of oil per day, and hot water, space heating and cooling savings would be about 560 barrels/day. (By comparison, total energy use for heat and hot water in the residential sector alone, currently consumes the equivalent of 4,000,000 barrels of oil daily.)

- low temperature collector: 8,040,000 square feet
- medium-temperature collector: 2,590,000 square feet
- special collector: 190,000 square feet

However, these square footage totals cannot be disaggregated by type of building sector (residential, commercial, industrial), foreign versus domestic sales, number of installations, housing type (single-family, multi-family) or type of solar application (domestic hot water, space heating, space cooling). This informational void precludes tying baseline projections for residential solar use -- which, for reasons explained in the previous chapter, are most usefully expressed in terms of "solar equipped housing units" -- to any documented starting point.

In the absence of any definitive numbers, the retrospective estimates of solar homes for 1975 up to the present (contained in Table II-1 and Figure II-1) were based on a sifting of expert opinion and the inventory of solar heated residences being compiled by the Franklin Institute as part of its Solar Information Dissemination Contract with HUD. The rate of growth shown for the 1975 to 1976 period conforms with the proportional increases in the volume of solar collectors manufactured in those years as reported in the FEA survey cited above.

B. BASELINE PROJECTIONS AND THEIR IMPLICATIONS

The point of departure for an incentive program is the estimate that 27,000 single-family homes are likely to be equipped with solar energy systems as of December 1977. Of this total, approximately three-fourths are assumed to have been retrofitted to existing structures and one-fourth to have been new homes incorporating the solar features at the time that they were built. Combined solar space heating/hot water installations account for roughly 1,600, or 6% of all solar homes estimated as being in place today. Figure II-1 graphically illustrates the changing rate of solar adoptions through 1985. As can be seen, a fairly modest increase in the estimated annual number of solar units installed occurs between 1977 and 1982. However, beginning in 1983, the forecast level of market demand accelerates noticeably. (The total number of solar systems installed jumps from 88,000 in 1983 to 144,000 in 1984, and to 256,000 in 1985, the last year for which estimates were made).

Table II-1

BASELINE ESTIMATES: LIKELY ADOPTION OF SOLAR ENERGY SYSTEMS IN SINGLE-FAMILY HOUSING MARKET THROUGH 1985 (WITHOUT FEDERAL INCENTIVE)

Year	Hot Water Only Retrofit	New Housing	Heat/Water New Housing	Total
Annual Volume				
1975	2,800	500	300	3,600
1976	5,800	1,500	500	7,800
1977	11,800	2,900	800	15,500
1978	15,100	4,900	1,200	21,100
1979	18,400	7,500	1,700	27,600
1980	22,000	10,900	2,400	35,300
1981	27,200	15,300	3,300	45,800
1982	35,600	20,900	4,400	60,900
1983	54,000	28,000	5,800	87,700
1984	100,800	36,600	7,500	144,900
1985	199,000	47,100	9,700	255,800
Cumulative Volume				
1975	2,800	500	300	3,600
1976	8,600	2,000	800	11,400
1977	20,400	4,900	1,600	26,900
1978	35,500	9,800	2,800	48,000
1979	53,800	17,200	4,500	75,600
1980	75,800	28,100	7,000	110,900
1981	103,100	43,400	10,200	156,700
1982	138,600	64,300	14,700	217,600
1983	192,600	92,300	20,500	305,400
1984	293,400	128,900	28,000	450,300
1985	492,400	176,000	37,700	706,100

The methodology used to simulate the market penetration for residential solar systems over time reflects a set of assumptions in respect to:

1) Probability of Purchase by household income and region based on an eight-city survey of 1,500 consumers.

2) Economics of Solar Use - the relative changes in solar system price and the cost of energy from conventional sources over time.

are subject to a great deal of uncertainty: another oil embargo, an unanticipated reduction in solar system costs, or a government decision to deregulate natural gas and oil could precipitate a surge in market demand well beyond the levels envisaged here. Conversely, a rash of unfavorable publicity -- such as has attended the New England Electric (NEE) demonstration* -- could undermine the credibility of the nascent solar industry and retard the growth of its sales.

To the extent that the baseline estimates presented here provide a reliable indication of the prospects for residential solar energy use in the absence of Federal financial support, at least in rough-order-of-magnitude terms, they have several implications that bear upon the design of any solar incentive program:

1) In absolute terms, by far the largest number of solar installations (with or without incentives) are likely to be for domestic hot water use in existing homes. This is a reflection of both the more manageable costs of solar hot water equipment (spaceheating can add 20% to the total price of a new home) and the sheer size of the existing housing stock. (There are presently 45 million owner-occupied single-family homes -- while little more than 1 million new single-family units are likely to be constructed in a typical year.)

2) In terms of receptivity, prospective new home purchasers are far more likely to adopt solar than are existing homeowners. This is illustrated by the market penetration estimates shown in Table II-2 for 1977, 1982, and 1985. For example, by 1982, only .3% of all single-family homes will have been retrofitted with solar domestic hot water systems. By contrast, in the single year of 1982 alone, an estimated 2% of all newly constructed single-family dwellings will utilize solar energy for their hot water needs. The following considerations account for the greater responsiveness to the solar alternative within the new as opposed to the existing home market:

   - Higher First Cost - As a rule, installing a solar system in an existing home will require at least some modification of the existing structure, and, as a result, higher installed costs for a system of any given capacity.

*New England Electric has installed solar hot water systems in the homes of about 100 of their customers. According to the utility, installed costs have averaged about $2,000 and savings thus far have been well below the 40 to 60% figure predicted by manufacturers of the systems.

Table II-2

MARKET PENETRATION ESTIMATES FOR RESIDENTIAL SOLAR ENERGY SYSTEMS IN THE ABSENCE OF FEDERAL INCENTIVES, AS OF 1977, 1982 AND 1985

Market Segment	1977	1982	1985
Solar Hot Water Retrofit Market:			
Cumulative Installations	20,400	138,600	492,400
Existing Housing Stock[a]	47,390,100	50,027,300	51,782,700
Solar Units as a % of Existing Homes	.04%	.3%	1%
Solar Hot Water/New Home Market:			
Annual Installations	2,900	20,900	47,100
New Homes Built[a]	947,800	1,000,500	1,035,700
Solar Units as % of New Homes	.3%	2%	5%
Solar Combined Space Heating and Hot Water/New Home Market:			
Annual Installations	800	4,400	9,700
New Homes Built[b]	947,800	1,000,500	1,035,000
Solar Units as % of New Homes	.08%	.4%	.9%
Percent of All Homes Solar Equipped[c]	.06%	.4%	1%

[a] Estimated total single family housing units as of end of previous year.
[b] Annual number of new homes built computed as a % of total housing stock in preceding year.
[c] Base includes new construction and housing stock losses in year for which estimate is made.

- <u>Suitability</u> - It will be difficult, and, in some instances totally impractical to install solar systems in existing homes due to: (1) building orientations and roof slopes that do not allow suitable placement of solar collectors; and (2) obstructions such as overhanging trees and abutting structures that limit solar exposure during prime hours of the day. Aesthetic considerations may also pose a significant constraint on the retrofit market. In newly built homes, it is easier to integrate the solar feature into the overall architecture of the building.

- Inertia and Awareness - An existing homeowner appears less likely to make the investment of time required to educate himself about solar systems than the prospective owner of a new home, who is actively engaged in choosing (and, in some instances, designing*) the type of dwelling in which he plans to live.

  This is partially borne out by the response to a set of questions which were designed to measure consumer awareness of residential solar systems (included in the survey conducted as part of this study).** As can be seen in Table II-3, existing and prospective homeowners were about equally likely to have learned about solar in a casual way -- reading a newpaper article, noticing panels on a neighbor's roof. However, the percentage of prospective homeowners reporting that they have actively "looked into it myself" was about twice that of existing homeowners (17% vs. 8%). The response to this last question most closely connotes "awareness" in the critical sense of having sufficient familiarity with solar systems to understand the probable relationship between costs and savings involved and the implications of solar use for the physical appearance of one's home.

- Higher Incomes of New Home Purchasers - Consumers comprising the market for newly built homes are more affluent on the average than existing homeowners. Baseline projections by income group confirm that the probability of investing in a solar system is proportional to household income. Of those judged likely to become solar purchasers by 1985 without the inducement of a Federal incentive only 5% have incomes below $16,000, while about 40% of all homeowners have incomes below this amount.*** (See Table III-II in Chapter Three).

3) Solar penetration into the residential market is unlikely to significantly reduce conventional energy use within the residential market by 1985. The last line of Table II-2 suggests that midway through the next decade approximately one percent of all homes may be equipped with solar energy systems assuming no incentive. Since most of these solar installations will be for hot water purposes only, the resulting reduction in fossil fuel use in the residential section would be but a small fraction of a percent.

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*Nearly 22% of all new single-family homes are built by the owners themselves or with the owner acting as a general contractor. Another 20% are built by the owner on his own land using a general contractor. The remaining 57% are built by developers for sale. Source: U.S. Department of Commerce, Bureau of the Census, Characteristics of New Housing (C25-75-13) 1975.

**The phrasing of these questions contained sufficient ambiguity that the level of response may be overstated. These results, including the methodological limitations, will be treated more fully in a supplementary volume to this report.

***The percentages cited here are estimated averages for the 1978-1982 period.

Table II-3

HOMEOWNERS' AWARENESS OF THE RESIDENTIAL SOLAR ENERGY ALTERNATIVE	New Home Sample	Existing Home Sample
I've seen it mentioned but have never seen anything very specific	41%	40%
I've read some articles about it	58%	63%
I've seen a house with solar collectors on the roof or in the yeard	33%	34%
I've looked into it myself	17%	8%

Note: Percentages apply to the 94% of new homeowners and 91% of existing homeowners who responded affirmatively to the screening question: "Have you heard anything about the use of solar energy for home and hot water heating?" Due to some ambiguities, "Yes" responses to questions may be inflated.

Even if a Federal incentive program should double or triple these figures, the basic conclusion would remain the same. This underscores the argument made in the introductory chapter, that, in the near-term, a solar incentive program should be judged, not by the amount of conventional fuel it "saves," but by its success in crystalizing viable markets for solar devices. Viewed in these terms, an incentive program that resulted in over a million solar equipped homes by 1985 might well be judged a success. With one out of every fifty single-family rooftops equipped with solar panels, a visible demonstration of the potential for solar use would presumably be underway within virtually every neighborhood across the country where solar energy holds some reasonable promise of commercial feasibility.

C. RELATIVE IMPORTANCE OF ECONOMIC AND NON-ECONOMIC FACTORS IN THE SOLAR PURCHASE DECISION

Before proceeding to the detailed assessment of incentive options, it is worth briefly noting certain results from our consumer survey which shed light on how homeowners will evaluate the merits and liabilities of using solar energy to meet their home energy needs. Respondents were presented with a list of factors that might possibly influence one's decision to invest in solar hot water or space heating systems and were then asked to rank the four most important from their perspective, assuming that they were contemplating such an investment. Table II-4 summarizes the results obtained.

Not surprisingly, economic considerations appear to be uppermost in consumers' minds: 56% cited a reduction of utility bills (i.e. anticipated savings) and 55% listed the initial price of the system as among the two factors that would weigh most heavily in their purchase decision. Both of these factors were ranked first or second three times as frequently as any of the other 12 considerations presented to respondents. Thus Federal incentives that markedly improve the basic economic calculus from the homeowner's perspective may have a significant impact. This was confirmed by the responses to questions concerning likelihood of of purchasing solar at different types and levels of incentives, which are reported in Chapters Three and Four of this report.

Table II-4

HOMEOWNERS' RANKING OF THE IMPORTANCE OF FACTORS RELATING TO POSSIBLE PURCHASE OF SOLAR ENERGY SYSTEM

	% Ranking First or Second
1. Reduction of utility bills	56
2. Initial price of the system	55
3. Reduced dependence on utility companies	15
4. Repair and upkeep cost of the system	13
5. Amount of heat and hot water provided	11
6. Civic duty to help conserve energy	9
7. Number of years system will last	9
8. Desire for a cleaner environment	8
9. Increase in the resale value of the house	7
10. Manufacturer's reputation	5
11. Availability of financing for the system	4
12. Increase in mortgage payments*	3
13. Solar collector appearance on outside of house	3
14. Increase in downpayment for house (new only)	2
15. Other	1

*Asked of new home sample.

Nevertheless, it is important to note that the investment decision for at least a substantial minority of consumers may not be a purely or even a primarily economic one. The third most frequently cited factor was "reduced dependence on utility companies," suggesting that perhaps a fear of future shortages in fuel supplies and possibly an active resentment of utility companies and higher energy prices, may be motivating factors. Nearly ten percent of those interviewed gave high precedence to public-minded considerations -- a "civic duty to conserve energy" and "desire for a cleaner environment." Interviews with solar manufacturers and dealers suggest that at present the residential solar market consists in large part of individuals whose purchase decisions are prompted as much by a self-perceived "ecological consciousness" and civic-mindedness or a special type of status seeking, as they are by the dollars and cents of costs and savings. This suggests that for a financial incentive to elicit some market response, it may not need to reduce solar first costs to the point where a solar purchase would meet stringent investment criteria.*

Finally, it should be noted that homeowners may consciously or unconsciously tend to discount the savings promised by solar use in order to allow for uncertainties concerning system performance. However, as indicated by Table II-5, existing and prospective homeowners interviewed appear much more skeptical of the basic economic attractiveness of solar systems available today than of their overall reliability. The financial incentives evaluated in the following three chapters of this report would, in varying ways, seek to relax this skepticism by lowering either the capital or the financing costs associated with solar use and contracting the elapsed time before the homeowner would realize an acceptable return on his investment.

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*By contrast, as detailed in Chapter Eight, the more rigorous investment perspective from which multi-family developers view the solar energy alternative poses a formidable constraint on solar use at this time -- even assuming some potentially plausible level of Federal subsidy were available.

TABLE II-5

CONSUMER RESPONSE TO QUESTIONS CONCERNING THEIR CONFIDENCE IN RELIABILITY AND COST-EFFECTIVENESS OF SOLAR SYSTEMS

QUESTION: Please circle the number below which best describes how likely you think it is that you can currently obtain reliable and dependable residential solar (heating) (hot water) systems.

	Not At All Likely					Very Likely	Don't Know
	1	2	3	4	5	6	-
RESPONSE:	10%	12%	14%	16%	10%	11%	27%
		36%			37%		

QUESTION: Please circle the number below which best describes how likely you think it is that you can obtain solar (heating) (hot water) systems that make economic sense.

	Not At All Likely					Very Likely	Don't Know
	1	2	3	4	5	6	-
RESPONSE:	16%	17%	15%	13%	8%	8%	23%
		48%			29%		

II INCENTIVE OPTIONS

CHAPTER III

FRONT-END INCENTIVES: REBATE (GRANT) AND TAX BENEFIT APPROACHES

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CHAPTER THREE

FRONT-END INCENTIVES: REBATE (GRANT) AND TAX BENEFIT APPROACHES

A. OVERVIEW

Front-end financial incentive programs that subsidize a substantial part of solar costs -- through either rebates (grant payments) or tax benefits -- can work to accelerate the growth of the single-family home solar energy market to a substantial degree. They would be far more effective than loan programs for the solar hot water market (the most important market segment in the near term), and offer a more practical means of affecting the market for solar space heating in new construction and of reducing the risks assumed by purchasers of those homes.

In the case of front-end incentives, there is a threshold amount at which such incentives need to be set -- probably in the range of 30-40% of solar costs -- before any substantial market response is likely.

A rebate (grant) program appears preferable to a tax credit as a means to provide such a front-end financial incentive. Its market impact is likely to be greater, and it would allow more flexibility for continued improvements in program design for regional adjustment of benefit levels, and for coordination with state solar initiatives. Most importantly, the extent of administrative control available would fit best with the special responsibilities attendant on a Federal incentive program that encourages homeowners to invest in this relatively unproven and rapidly changing technology.

B. CONCEPT AND FUNCTION

1. Definitions: Rebate and Tax Benefit

A "rebate" is used here to describe a payment that is intended to reimburse the purchaser of a new solar-equipped home or of a solar energy system for an existing home for some part of the solar energy system's cost.

While other descriptive terms might be employed to describe such a payment -- for example, "grant", which has many more precedents in government programs -- "rebate" has been used in this study because it more fully expresses the function of the payment, and may be more appropriate for use if such a grant-type approach should be adopted. It is a widely used term in commercial and consumer transactions, describing a return to the purchaser of part of an original payment that results in a net reduction in the cost of the product or service involved. In consumer rebate offerings, the purchaser often obtains the payment by submission of proof of purchase to a party (such as the manufacturer) other than the retail dealer from whom the product was bought; this familiar rebate procedure is consistent with the structure probable for a Federal solar rebate program.*

"Tax benefit" is used here to describe a benefit that is provided through the individual income tax system and made available through normal procedures for filing income tax returns in the tax period following that in which the solar purchase has been made. Whether provided entirely through forbearance of other tax liabilities, or provided in part or whole as direct payments, the benefit amount would be treated as a tax expenditure for Federal budgetary purposes.**

Tax benefits in solar legislation to date have been proposed primarily

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*"Rebate" has an additional advantage over "grant" in the context of a Federal residential solar incentive program: its use would avoid possible confusion between such a program and the residential solar demonstration program administered by HUD, with its "grant" cycles.

**"The Congressional Budget Act of 1974 requires a listing of tax expenditures in the budget. Tax expenditures are defined by that act as 'revenue losses attributable to provisions of the Federal tax laws which allow a special exclusion, exemption, or deduction from gross income or which provide a special credit, a preferential rate of tax, or a deferral of tax liability.' Tax expenditures are one means by which the Federal Government pursues public policy objectives and, in most cases, can be viewed as alternatives to budget outlays, credit assistance, or other instruments of public policy." Budget of the United States Government, 1978, Special Analysis F, Tax Expenditures, p. 119 (Office of Management and Budget, January 1977).

in the form of tax credits, though tax deductions have been considered as well. Various modifications have been suggested to overcome the constraint presented by uneven distribution of tax liabilities, including "refundable" credits that would provide a direct payment for any excess of credit over available tax liability.

A further conceivable variation would be direct payment in full of the benefit amount on the basis of an application submitted after the solar purchase is made, with the transaction handled by the Treasury Department and accounted for as a tax expenditure, but otherwise essentially comparable to the rebate previously described. However, such a procedure would so depart from current norms as to be indistinguishable from a rebate except for its attributed budgetary characteristic and its mandatory administration by the Treasury Department -- a grant program in tax clothing.* In the context of this study it has been considered as an administrative delivery option for a rebate program rather than as a "tax benefit" program, though it is subject to some of the structural problems inherent in the use of the tax code discussed later in this chapter.

2. Framework for Comparison of Incentives

Rebate and tax benefit subsidy designs have many characteristics in common. In both approaches, the incentive is provided in the form of a lump-sum benefit near the "front end" of the period of ownership of a solar energy system. This reduces the purchaser's effective investment in that system, whatever the mix of cash payment and debt assumption that investment might take. The front-end approach has important distinctions from the procedures and subsidy effects of loan programs, the other major incentive approach under review. As a result, the choice of incentive design can be usefully considered to have two aspects:

- a choice between the front-end approaches on the one hand (which reduce the total effective investment through a lump-sum

*The elusive budgetary identity of such a payment might be even greater than that of the refundable portion of the earned income credit, which itself is still unresolved; the Office of Management and Budget treats this as a direct outlay, while the Congressional Budget Office and the Congressional Budget Committees include it in the tax expenditure budget.

benefit) and loan programs on the other (which may finance a high proportion of solar costs and reduce monthly carrying costs by providing longer payout terms and lower interest rates); and

- a choice between the rebate and the tax benefit as means of providing a front-end incentive approach, if such an incentive is preferred over loan programs.

This chapter first briefly explores the choice between front-end and loan approaches for an incentive program, and then considers various features of and comparisons between rebate and tax benefit approaches. The following chapter (Chapter Four) then examines loan programs in detail.

C. SUPERIORITY OF FRONT-END INCENTIVES COMPARED TO LOAN PROGRAMS

An incentive in the form of a front-end subsidy, whether as a rebate or as a tax benefit, appears to be a clearly preferable approach for a residential solar energy incentive program at the present time.

First, the results of the consumer survey suggest that front-end incentives have the potential for a far more pronounced impact on the adoption of solar residential hot water systems than does the provision of assistance through loan programs, and appear substantially more cost-effective in these situations. As can be seen in Table III-1, a tax credit offered under the formula proposed by the National Energy Act could increase anticipated solar hot water installations by approximately 67% during the period 1978-1982, and a rebate would induce a somewhat larger increase (approximately 80%) at a somewhat greater cost per induced unit. The loan program with comparable per-unit costs (a 7 per cent, 10-year loan) would increase expected use only 14%; a deep-subsidy loan program (1 per cent, 20-year loans) would increase usage approximately 56% at a substantially higher per-unit cost.

Second, while a loan program has a potential for greater impact in the market for combined heating and hot water systems in new construction, there are serious questions as to the practicality or desirability of such an approach. These issues, considered in detail in Chapters Four and Five, include the purchaser's full exposure to risk of financial loss from system failure or the inability to recoup costs on resale,

Table III-1

SOLAR DOMESTIC HOT WATER SYSTEMS: COMPARATIVE MARKET IMPACT AND PROGRAM COSTS[a] OF FRONT-END SUBSIDIES AND BMIR LOANS

Note: Estimates for Units Installed in Single Family Homes During Five Year Period, 1978-1982
Baseline: 1978-1982 Units Installed Without Incentive = 178,000

	Tax Credit			Rebate (Grant)		
Benefit as % of Cost	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit
20%	23%	$ 53	$1280	28%	$ 72	$1440
30/20[b]	46	90	1120	54	117	1220
30	50	96	1090	60	125	1170
40/25[c]	67	123	1040	80	158	1100
40	100	174	980	122	225	1030
50	176	305	970	214	392	1030

Separate Solar Loan (@ 100% of Solar Cost) — Direct Loan Program

Loan Terms	Percentage Increase over Baseline	Program Cost ($ million)	Cost/ Induced Unit
7%—10 yr.	14%	$ 26	$1090
5%—10 yr.	22	49	1250
3%—15 yr.	36	89	1410
1%—20 yr.	56	154	1560

[a]All program costs given in present value terms using 7.5% discount rate, and include both subsidy costs and administrative expense.
[b]30/20 = 30% of the first $1,500 of system cost, and 20% of the next $8,500 (maximum credit of $2,150).
[c]40/25 = 40% of the first $1,000 of system cost, and 25% of the next $6,400 (maximum credit of $2,000).

and the considerable problems of certification procedures for heating systems that may make it appropriate to consider deferring incentives in this area (discussed in Chapter Six).

Third, there are significant institutional and administrative obstacles to the development of a loan program that make it likely to be an expensive, inefficient and hard to administer incentive effort with the least potential for market impact in practice. These logistical difficulties are also analyzed at length in Chapter Four.

D. IMPACTS OF REBATES AND CREDITS

The results of the consumer survey and related analyses strongly suggest that front-end incentives can work to accelerate solar residential market development if provided at adequate subsidy levels. These results also indicate that rebates may have somewhat greater potential than tax benefits in this regard.

1. Front-End Incentives Can Work If Provided Above "Threshold" Levels

As can be seen in Table III-2, front-end incentives appear capable of evoking a substantial increase in solar hot water use in single-family homes over the next five years (1978-82). The potential increase in market size in response to incentives is even more pronounced in the case of combined heating and hot water systems, though a far smaller number of units is involved (see Table III-3).

However, these tables also suggest that the desirability of such incentives cannot be discussed separately from the question of subsidy levels. The extent of differential response to varied subsidy levels is illustrated by Figure III-1. As can be seen there, a tax credit for 40% of solar costs (up to a $2,000 limit) would approximately double the number of installations expected from 1978-82; a 20% credit would increase expected installations by only one-fifth.

Table III-2

SOLAR DOMESTIC HOT WATER SYSTEMS: COMPARATIVE MARKET IMPACT OF REBATES AND TAX CREDITS

Estimates for 5 Year Period, 1978-1982

Benefit as % of Cost[a]	Rebate Cum. Units	% Increase	Tax Credit Cum. Units	% Increase
No Incentive	178,000	–	178,000	–
20	228,000	28	219,000	23
30/20	273,000	54	259,000	46
30	285,000	60	266,000	50
40/25	321,000	81	296,000	67
40	395,000	122	356,000	100
50	558,000	214	491,000	176

[a] Benefit formulas: 30/20 = 30% of first $1,500 of system cost and 20% of the next $8,500 (maximum credit of $2,150).
40/25 = 40% of first $1,000 of system cost and 25% of the next $6,400 (maximum credit of $2,000).
20, 30, 40, 50% of system cost (maximum credit of $2,000).

Note: Cumulative unit numbers have been rounded to the nearest 1000; percentages are based on the original unrounded figures.

Figure III-1

NUMBER OF SOLAR-EQUIPPED SINGLE FAMILY HOMES THROUGH 1982
"Baseline" Projections and Response to Tax Credit at Possible Subsidy Levels

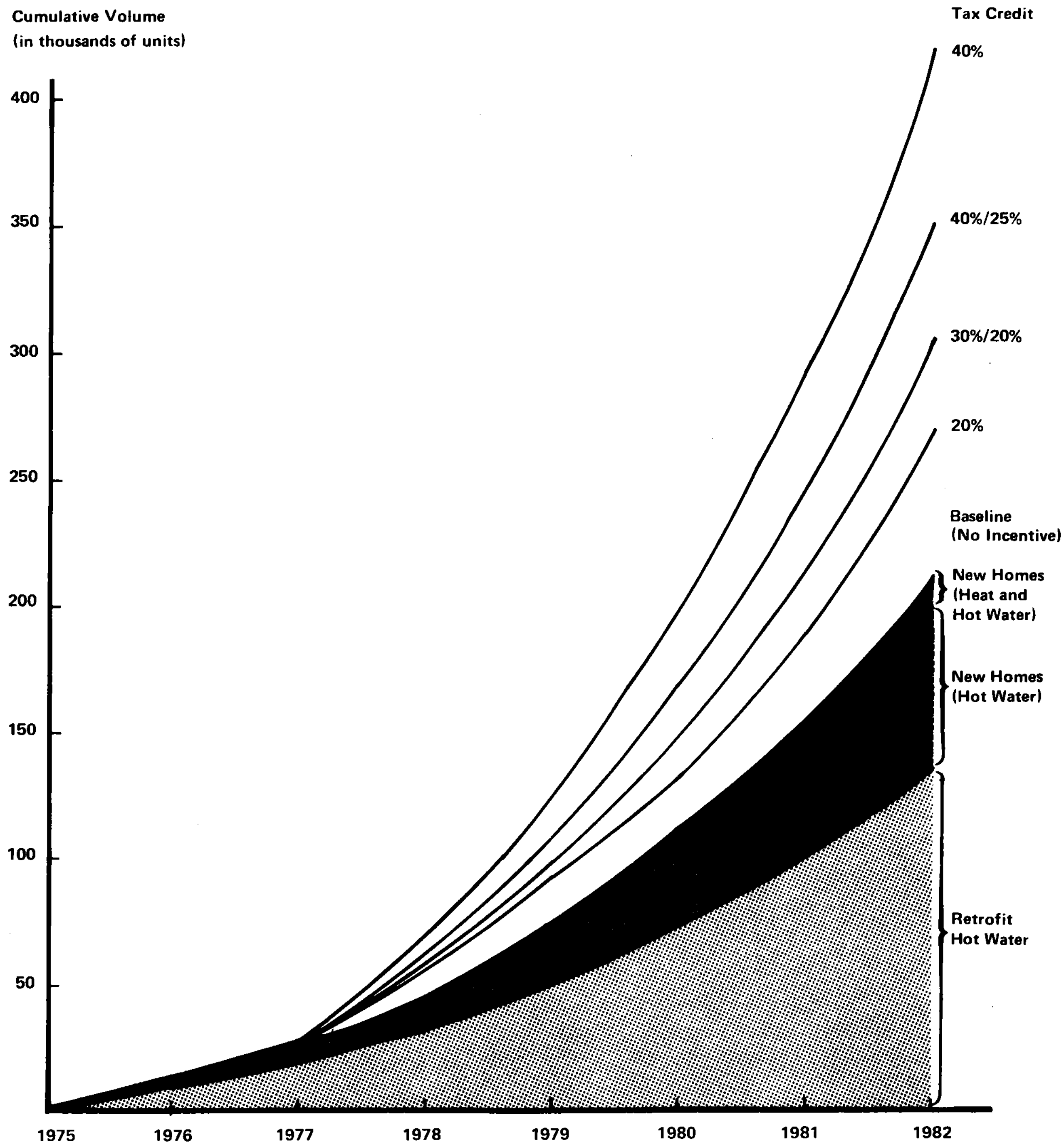


Table III-3

SOLAR COMBINED HEATING/HOT WATER SYSTEMS: COMPARATIVE MARKET IMPACT OF REBATES AND TAX CREDITS

Estimates for 5 Year Period, 1978-1982

Benefit as % of Cost[a]	Rebate Cum. Units	% Increase	Tax Credit Cum. Units	% Increase
No Incentive	13,000	–	13,000	–
20	22,000	65	20,000	55
30/20	23,000	79	22,000	68
30	28,000	117	26,000	100
40/25	27,000	109	25,000	90
40	40,000	207	36,000	178
50	47,000	263	44,000	239

[a]Benefit formulas: 30/20 = 30% of first $1,500 of system cost and 20% of the next $8,500 (maximum credit of $2,150).
40/25 = 40% of first $1,000 of system cost and 25% of the next $6,400 (maximum credit of $2,000).
20, 30, 40 and 50% of system cost (maximum credit of $2,000).

Note: Cumulative unit numbers have been rounded to the nearest 1000; percentages are based on the original unrounded figures.

Thus while the "optimum" calibration of subsidy level is an issue of program design with a number of analytic and political dimensions, it should be understood that there is a threshold size above which the benefit must be provided if any significant market impact is to be expected. For hot water systems -- the residential solar application in a most advanced stage of commercialization -- the analysis used in this study suggests that such a threshold may be in range of 30-40% of solar costs. If provided as a tax credit, this might increase the size of the market by 50-100% over the five-year period 1978-82; as a rebate, 60-120% (see Table III-2).*

The absolute increase achieved by a front-end incentive program will naturally depend on the length of time that an incentive is in force, as

*The issue of threshold size and market response may be in part understood as reflecting the way in which consumers will analyze a rebate or tax-benefit incentive. It appears that prospective solar purchasers may respond more through a perception of the gross size of the rebate or tax benefit -- either as a sum in itself, or in the proportion it provides of solar first costs -- rather than through any examination of its detailed impact on the "economic" relationship between the net first cost and projected savings (as expressed in payback or lifecycle cost analysis). Once 30-40% or more of the costs are provided by an incentive for solar hot water -- $450 to $600 for a "typical" $1,500 installation -- there will be a substantial impact on the market.

well as the depth of subsidy offered. However, the stimulus to solar industry and market development provided by any program of this type can be expected to have a continuing impact on the rate and extent of market growth even after the program is terminated. This longer-term effect of the incentive's market stimulus is the basic aim and justification for an incentive program at the present time. The possible dimensions of this effect are suggested in Table III-4 and Figure III-2, which show estimates of the growth of the single-family residential market for solar hot water heaters under three assumptions: no incentive (the baseline estimate); a tax credit provided under a 40/25 formula and continuing in effect from 1978 through 1985; and the same credit in effect only through 1982 (with both "high" and "low" estimates of the residual effect from 1982-85). Our estimates are that even if the credit were terminated in 1982, the continuing effect of this market stimulus could result in an additional 22,000 to 190,000 units during the 1983-85 period alone -- that is, possibly

Table III-4

NUMBER OF SOLAR-EQUIPPED SINGLE FAMILY HOMES THROUGH 1985: Baeline Projections and Response to Tax Credit* Available 1978-1982 or 1978-1985

	INDUCED UNITS					
	1978-1982 Number	%	1978-1985 Number	%	1983-1985 Number	%
Baseline	191,000	–	679,000	–	488,000	–
Induced Units 5 year program ends 1982 Low	130,000	68	152,000	22	22,000	4
High	130,000	68	321,000	47	190,000	39
7 year program	130,000	68	421,000	62	291,000	60

	CUMULATIVE UNITS				
	1977	1982	1983	1984	1985
No Incentive	27,000	218,000	305,000	450,000	706,000
40/25 Five Year* Tax Credit Low	–	348,000	444,000	596,000	858,000
High	–	348,000	473,000	675,000	1,027,000
40/25 Seven Year* Tax Credit	–	348,000	492,000	725,000	1,127,000

*Assuming non-refundable 40/25 tax credit (40/25 = 40% of first $1,000 of system cost and 25% of next $6,400; maximum credit = $2,000).

Note: Cumulative unit numbers have been rounded to the nearest 1,000; percentages are based on the original unrounded figures.

as many or more units than were directly induced during the life of the credit -- representing a further increase in the range of 4 to 39% over the baseline for the three-year period after the credit had expired.

2. Possible Greater Impact of A Rebate

Rebates appear to have a greater potential for inducing market response than do tax benefits. This is suggested by: (1) the somewhat greater market response to a rebate forecast from the results of the consumer survey; (2) a clear preference expressed by survey participants for rebates over tax benefits; and (3) the potential availability of this form of benefit closer in time to the solar purchase.

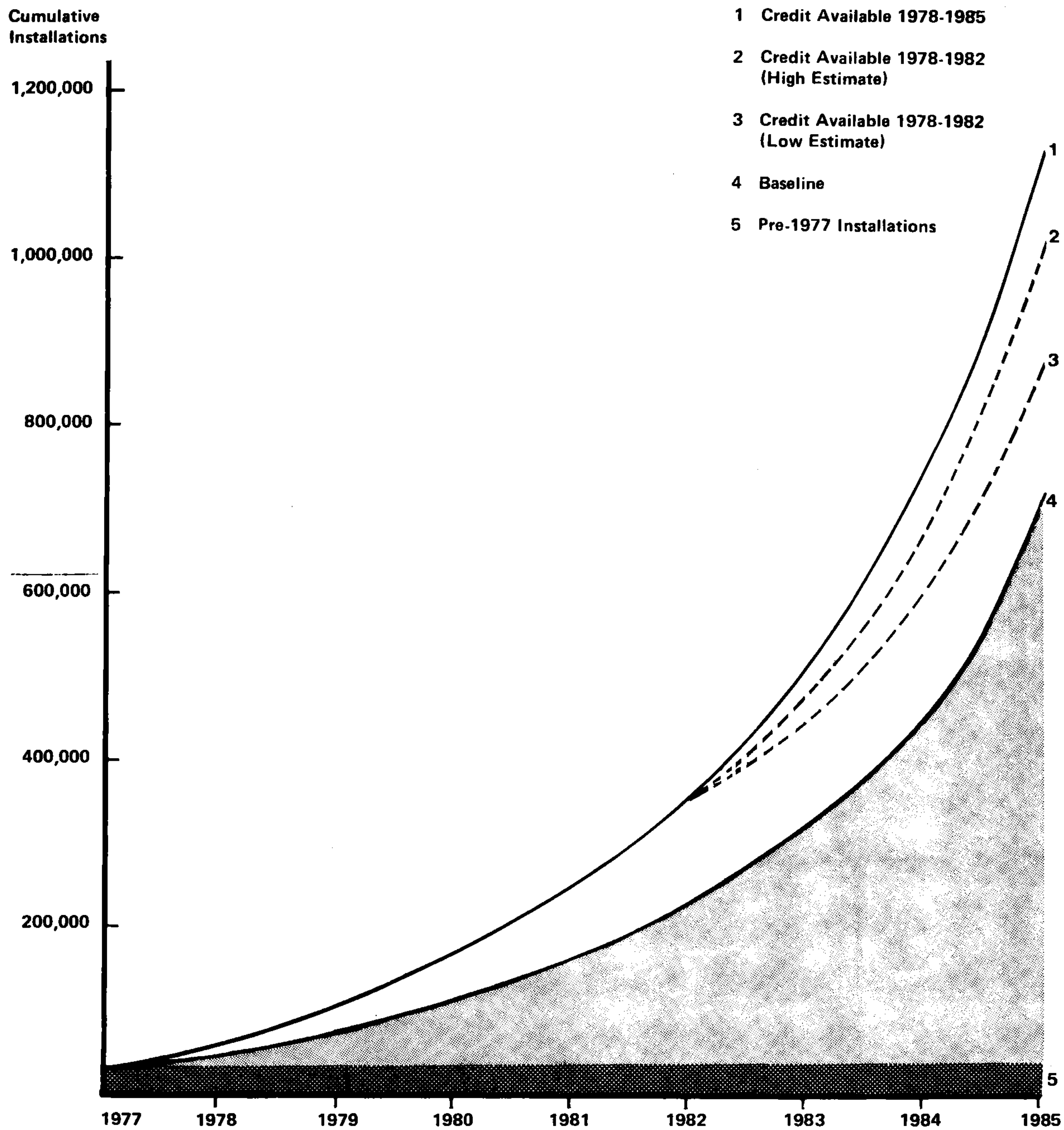
- Greater market impact. The market penetration estimates modeled from the consumer survey display a consistently greater response to the front-end benefit in rebate form than to a tax credit.* This is true at all levels of subsidy, and for both hot water systems alone and combined hot water/heating systems (see Tables III-2 and III-3). The extent of this advantage is not overly large in either percentage or absolute terms, but may be significant at higher benefit levels. For example, for hot water systems alone, a tax credit at the 40/25 level increased 1978-82 market size by approximately 67% (approximately 118,000 units); a rebate increased the market by 81% (143,000 units) -- an impact 21% greater than the increase estimated for a tax credit.

- Expressed consumer preference. These estimates of market impact were modeled from expressions of likelihood to purchase solar in response to each incentive, tested in a variety of ways (see Appendix C for explanation of methodology used). Another perspective on consumer preference was gained through the portion of the survey in which respondents were asked to make their own comparative rankings of incentive

*The market impacts discussed here and presented in Tables III-2 and III-3 reflect response to a standard form of "non-refundable" tax credit. As discussed later in this report, our survey results indicate only a very slight increase in response (in the range of a few per cent) if the increase is made "refundable." The differences between rebates and credits discussed in this chapter do reflect this differential as well as the varied response to the form of the incentive; however, this seems the more appropriate comparison, in view of the likelihood that any tax credit enacted will be non-refundable in form, and in view of the very slight difference in response between refundable and non-refundable tax credits.

Figure III-2

NUMBER OF SOLAR-EQUIPPED SINGLE FAMILY HOMES THROUGH 1985: Baseline Projection and Response to Tax Credit* Available 1978-1982 or 1978-1985



*Assuming non-refundable 40/25 tax credit (40/25 = 40% of first $1,000 of system cost, 25% of next $6,400; maximum credit = $2,000).

types after each type had been separately explored. As can be seen in Table III-5, a strong preference was expressed for rebates -- a preference that was most marked in the case of retrofit installations, generally agreed to be the market area of most importance in the near term. Loans ranked considerably below either form of front-end approach.

Table III-5

HOMEOWNERS RANKING* OF DIFFERENT INCENTIVE APPROACHES

	Prospective Homeowners	Present Homeowners
Grant or Rebate	3.8	4.1
Tax Reduction	2.4	2.6
Low Interest Loan	2.3	2.0
Private Leasing	1.5	1.3

*Constant Sum Rating: Homeowners were asked to divide 10 points up among the four alternatives, giving a higher number of points to program options that appealed to them more and fewer to those that appealed to them less.

- Timing of receipt and possible assignability of rebate. Many of those concerned with the design of solar incentive programs have emphasized the potential advantages of a rebate presented by its availability closer in time to the solar purchase. Interviews with home builders and members of the solar industry in this study generally supported this point of view. A solar purchaser applying for a rebate will confront a need to provide the full out-of-pocket cost until the rebate is received. The timing of this payment will depend on the manner in which such a program is designed and the skill with which it is administered. But there appears to be a significant difference between the effect of this administrative delay and that of the considerable deferral of benefits in most cases under the tax benefit approach -- with the benefit not available until tax filing in the following year (which may be as long as fifteen months after the purchase). Only a relatively few taxpayers would be able to enjoy the benefit sooner through adjustments in estimated income tax payments.*

*The difference in timing of receipt between rebates and tax benefits was felt by some builders to be particularly important. They suggested that the homebuyer market was effectively split into two segments: those who were "financing constrained," and could only enter into a purchase if they were able to finance a large proportion (80% or more) of the cost; and those who had sufficient resources to have a greater degree of choice as to the extent of downpayment they would make. While buyers

(footnote continues next page)

Rebates have the potential for even greater improvement in the timing of benefit receipt to the extent that solar dealers and home builders are willing to accept assignment of a rebate payment as part of a purchase price. In practice, our interviews suggest that at least some dealers and builders will be prepared to accept such an assignment of a rebate payment, if experience with program administration makes it appear likely that this payment will be forthcoming within a reasonably short period after the transaction, and assuming, of course, that the program allows such assignability.

Assignability should be considered if a rebate program is developed, but should be recognized as an issue distinct from the choice between structuring an incentive as a payment originally due to a homebuilder or installer, as compared to one receivable by the purchaser (and possibly assignable). As shown in Table III-6, participants in the consumer survey indicated a very strong preference for benefits provided directly to the solar purchaser.

Table III-6

RESPONSE OF PRESENT AND PROSPECTIVE HOMEOWNERS TO CHOICE BETWEEN A DEALER RECEIVED REBATE OR A REBATE GOING DIRECTLY TO THEMSELVES

Strongly prefer that dealer receives rebate	12%
Somewhat prefer that dealer receives rebate	11%
No preference	14%
Somewhat prefer that they receive rebate	9%
Strongly prefer that they receive rebate	54%

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in the latter class might be less affected by the difference in timing between a rebate and a tax reduction, the financing-constrained buyers, perceived as the considerable majority of those in the housing market, would be able to purchase a solar home (even one with only a solar hot water system) only if the incentive program provided the extra cash required at the time the transaction was completed. In this context, the rebate, particularly if assignable, would have a major advantage over the tax benefit. Attention is given elsewhere in this report to the question of whether it is appropriate to encourage "financing-constrained" homebuyers, or homebuyers with any other similar limitation on financial resources, to invest in solar energy systems at their present stage of development.

E. COST-IMPACT ANALYSIS OF REBATES AND TAX BENEFITS

Estimates of total program costs, and of comparative costs among incentive approaches, are of obvious importance in choosing among programs and in evaluating the overall desirability of a solar incentive. In the present study, three aspects of costs were separately calculated for each incentive option: direct subsidy costs (amounts paid out in benefits); administrative costs (including start-up costs, fixed costs and marginal per-unit processing costs); and potentially attributable tax expenditures related to the tax-deductibility of interest (resulting from the private borrowing attendant on investments induced by an incentive). The methodology employed in this cost analysis is briefly reviewed in Appendix C to this report.

The basic results of the cost analysis for rebates and tax credits are presented in Table III-7 (for hot water systems) and Table III-8 (for combined heating and hot water systems). As can be seen, these tables present anticipated program volumes and resulting costs for a range of possible subsidy levels, on an absolute basis and on a cost per induced unit* basis, including those subsidy levels proposed for a tax credit by the National Energy Act (40/25) and the revised formula adopted by the House (30/20). All costs shown are present values for expenditures over a five-year program life (1978-82), using a 7.5% discount rate.

Three major features of these cost and impact estimates stand out:

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*Cost per induced unit is an important basis of comparison among program options, and is also relevant in assessing the overall desirability of an incentive program. However, care should be taken in using the unit costs presented here for the latter purpose. The per unit cost reflects a distribution of program costs only among those units "induced" <u>during the program life</u>. It does <u>not</u> take into account the <u>additional</u> units above the baseline in the years after the expiration of the incentive program, which are attributable to the increased size, momentum and market acceptance achieved through that program. As has been noted (see Table III-4 and related discussion), such additional units for the years 1983-85 alone might equal or exceed the units induced during a five-year program from 1978-82.

- the relatively high per-unit cost for hot water systems;
- the relatively small differential in cost-per-unit between the rebate and tax benefit approaches, which shrinks further as benefit levels and program volumes increase;
- the relatively small costs related to the tax deductibility of interest.

1. Relatively High Cost Per Induced Unit for Hot Water Systems

As can be seen in Table III-7, our estimates of public cost per induced unit for hot water systems is relatively high, ranging from $1,000 to $1,400/unit -- within the range of direct costs of some systems available today. This high estimate of costs primarily reflects the inclusion in the cost base of 90% of the "baseline" units assumed to take advantage of the benefits of a rebate or tax benefit program. At the lowest subsidy level shown (20% of costs), this group of windfall beneficiaries accounts for 76% of total subsidy and administrative costs in the rebate program. Even at the 40/25 level, with approximately 144,000 units induced over a baseline of 178,000, these "windfall" benefits account for 53% of total subsidy and administrative costs, which range from $1,000 to $1,100 per induced unit for the tax and rebate approaches, respectively.

Such a high estimate of unit cost for a hot water incentive raises several issues. The first is the possibility of screening out "windfall" beneficiaries. This would of course reduce the per unit cost, but does not seem a desirable objective to pursue. No practical means for effecting such a culling-out process has been identified,* and it can be

*It can be argued that a grant approach might have an advantage in limiting the extent to which "windfall" benefits of the incentive would be claimed by baseline purchasers (i.e., those who would make the solar purchase even without the availability of the incentive). In this view, use of the tax system automatically extends possible benefit opportunities to buyers at the time they file their income tax returns in the subsequent year, including those who were unaware of the incentive at the time of their purchase, while time of filing restrictions could preclude such a result in a rebate program. However, it would appear that in practice the availability of an incentive -- whether as a rebate or as a tax credit -- will be well known to all sellers of solar homes and solar energy systems, and will be used by them as part of their sales effort. It is thus likely that most purchasers will be aware of the availability of the incentive, whichever form it takes, in time to take advantage of it.

objected to in principle on the grounds of "horizontal equity" -- that is, that all solar purchasers are taking the same risk, and contributing to the same degree to the national benefit, and therefore should be eligible for the same benefits.

The second possibility suggested by the high per unit costs is that of taking a different approach to increasing the market for solar hot water systems: instead of an "incentive" program, which provides a minority portion of solar costs for any solar purchaser, a "distribution" program would cover all (or a large proportion) of solar costs for a selected population of moderate income families unlikely to undertake a solar purchase on their own. This, it can be argued, would avoid the high windfall costs of an incentive program, and also provide a means for lower-income families to enjoy the benefits of solar energy systems.

There are, however, a number of problems inherent in this approach that weigh against such a "distribution" program:*

- the additional costs and difficulties related to operating a program with income eligibility limitations and participant selection procedures;
- the need for more intensive counseling and related back-up services;
- the continuing economic risks attendant upon installation of a solar energy hot water system -- including possible system failures and depressed home values -- that may be burdensome for families of limited means even if the system's initial costs are in large part subsidized;
- the possible public identification of solar energy systems as a technology especially identified with lower-income families;
- the possible distortions that would result in the structure and evolution of the sales, marketing and servicing network.

*Such a program would not require the purchase and distribution of solar energy systems by a public agency -- an approach that would in fact defeat the effort to encourage the development of normal marketing and distribution channels and the consequent competition of different systems in the marketplace. It could be modeled on a "rebate" program, but provide a large proportion (perhaps 75-90%) of solar costs for a defined number of low and moderate income families.

Table III-7

SOLAR DOMESTIC HOT WATER SYSTEMS: COMPARATIVE IMPACTS AND PUBLIC COSTS OF REBATES AND TAX CREDITS **Estimates for Units Installed in Single Family Homes During Five Year Period, 1978-1982**

Baseline: Units Installed Without Incentive, 1978-1982 = 178,000

Program and Benefit Levels[a]	Units in Program[b] (1978-1982)	Subsidy Cost ($ millions)	Administrative Cost ($ millions)	Total Program Cost ($ millions)	Units Induced	Cost/ Induced Unit	Cost of Interest Deduction ($ millions)
REBATE							
20%	210,000	$52	$20	$72	50,000	$1,400	$3
30/20	255,100	93	24	117	95,200	1,200	5
30	267,000	100	25	125	107,100	1,200	6
40/25	303,400	130	28	158	143,500	1,100	7
40	377,400	190	35	225	217,500	1,000	11
50	539,900	341	50	392	380,000	1,000	19
TAX CREDIT							
20	201,000	50	2	53	41,000	1,300	2
30/20	240,800	88	3	90	80,900	1,100	4
30	248,300	94	3	96	88,400	1,100	5
40/25	278,400	120	3	123	118,500	1,000	6
40	337,800	171	3	174	177,900	1,000	9
50	473,400	300	5	305	313,400	1,000	15

[a]Benefit formulas: 30/20 = 30% of first $1,500 of system cost and 20% of the next $8,500 (maximum credit of $2,150).
40/25 = 40% of first $1,000 of system cost and 25% of the next $6,400 (maximum credit of $2,000).
20, 30, 40 and 50% of system cost (maximum credit of $2,000).

[b]Assumes 90% of baseline units take advantage of incentive.

Table III-8

SOLAR COMBINED HEATING/HOT WATER SYSTEMS: COMPARATIVE IMPACTS AND PUBLIC COSTS OF REBATES AND TAX CREDITS **Estimates for Units Installed in Single Family Homes During Five Year Period, 1978-1982**

Baseline: Units Installed Without Incentive, 1978-1982 = 13,000

Program and Benefit Levels[a]	Units in Program[b] (1978-1982)	Subsidy Cost ($ millions)	Administative Cost ($ millions)	Total Program Cost ($ millions)	Units Induced	Cost/ Induced Unit	Cost of Interest Deduction ($ millions)
REBATE							
20%	20,300	$21	$2	$23	8,500	$2,700	$5
30/20	22,100	25	3	28	10,300	2,700	6
30	27,000	41	3	44	15,300	2,900	8
40/25	26,000	36	3	39	14,300	2,700	9
40	39,100	60	4	64	27,400	2,400	17
50	46,100	71	5	76	34,300	2,200	21
TAX CREDIT							
20	19,000	19	+	20	7,200	2,800	4
30/20	20,600	23	+	24	8,800	2,700	5
30	24,800	38	1	38	13,000	2,900	8
40/25	23,500	33	1	33	11,700	2,800	7
40	35,000	54	1	55	23,300	2,300	14
50	42,900	66	1	67	31,200	2,100	19

[a]Benefit formulas: 30/20 = 30% of first $1,500 of system cost and 20% of the next $8,500 (maximum credit of $2,150).
40/25 = 40% of first $1,000 of system cost and 25% of the next $6,400 (maximum credit of $2,000).
20, 30, 40 and 50% of system cost (maximum credit of $2,000).

[b]Assumes 90% of baseline units take advantage of incentive.
+Less than $500,000.

While such an approach is not inconceivable, it would appear to require a far more intensive administrative effort than an incentive approach of the types under consideration here, and would be less likely to provide the necessary degree of market stimulus.

The per induced unit cost estimates for heating systems, as noted in Table III-8, appear to fall within a moderate range in terms of the costs of the systems involved. This is accounted for by the proportionately greater response to the incentive, reducing the effect of the windfall units on total program costs, and by the limiting effect of the benefit ceilings on the effective proportion of total costs that can be recovered for these more expensive systems.

2. Relatively Small Differential Between Costs of Rebate and Tax Benefit

Although total program costs show considerable differences at each subsidy level, the cost per induced unit is remarkably similar in the rebate and tax credit cost impact estimates. Two offsetting effects account for this result. Costs of administration for a rebate program, derived from costs of the most analogous Federal grant programs identifiable, may be ten times as high as those of a tax credit; response to a rebate, however, is significantly greater than response to a tax credit at each subsidy level, with a consequently greater reduction in the per-unit cost of the windfall benefits involved.

In addition, the differential between the two approaches narrows further as the subsidy level is increased. This reflects both an increasing spread between the market responses estimated for the two incentives (from 9,000 units at the 20% subsidy level to 25,000 units at the 40/25 level) and the greater per-unit amortization of the start-up and fixed portions of rebate administrative costs (with only increases in the per-unit processing cost for the additional induced units).

A further note on the relative administrative costs of these two approaches is in order. It is possible that the estimates presented here understate the relative cost of the tax benefit approach.

- First, the administrative costs used here do not include expenditures on the system testing and certification procedures now being developed in large part under the pressure of the solar hot water initiative already operating in a limited number of states, and the expectation that a broader incentive program is imminent. If these costs are included, the differences between the two approaches are further reduced.

- Second, it is not clear that a significant difference in cost should be expected between a rebate and a tax benefit approach unless it reflects a necessary variation in the procedures that would be followed. Tax reduction approaches are viewed by many as offering the advantages of an existing, effective administrative structure through which solar incentives can be rapidly deployed, while a grant-type program would require the establishment of new structures and new channels of operation at substantially higher costs. But it would appear that costs are primarily related to what is done rather than which line agency performs the task, and a solar incentive program appears to require a substantial amount of administrative involvement beyond the simple act of recognizing a credit amount claimed on a tax return (as discussed later in this chapter). Conversely, it would appear possible to operate a rebate program in a manner close to that of the tax model in many respects. That is, the program could be structured to provide reasonably clear guidelines for eligibility (and methods to confirm eligibility); submission and documentation requirements of the same degree of simplicity or complexity as in a tax program (the forms used for the new home tax credit provide one model here); and relatively automatic payment on submission, with control through post-event auditing on a sampling basis.

- Third, in the case of solar incentives, the use of the tax system might bring its own special problems and costs. The income tax system is very large (82 million individual income tax returns processed in 1975*) in comparison to the probable solar program volumes (which might average 70,000 per year in response to a tax credit at the 40/25 level). Use of the tax system might require training a far larger number of personnel than would be involved in actual administration, and in other equivalent ways gearing up a far larger administrative machinery than required for the resulting work loads. Some of these possible disadvantages would be relieved if the home energy conservation tax credit survives through the end of the legislative process, assuming that there could then be a coordinated development of forms,

*Department of the Treasury, Internal Revenue Service, Statistics of Income 1975 - Preliminary, Individual Income Tax Returns, Publication 198(2-77) (1977).

employee training, and information dissemination programs, with the solar incentive piggybacked not so much on the existing tax system as on the effort to add these broader energy conservation credits to that system. Otherwise, the administrative costs that would be related to a solar energy tax credit may well approximate those of a grant-type program.

3. Relatively Small Costs Attributable to the Tax Deductibility of Interest

Specific attention was given to the task of estimating the attributable tax expenditure costs related to the tax deductibility of interest expense, since it was anticipated that these might be a substantial part of the overall cost of a solar incentive program. As can be seen in the last columns in Tables III-7 and III-8, the results of the study suggest that, to the contrary, it is liable to be a minor part of total program costs, amounting to 5 per cent or less of the total costs in all cases.

Two qualifications of this finding seem appropriate here. The costs shown in the table reflect the tax expenditure costs only of the units induced by the incentive, since the baseline units would have generated a tax expenditure cost in any case. Thus, this may be considered to understate the total public cost related to the development of the solar market (though unrelated to an incentive program). However, even if these costs are included, the tax deductibility of interest remains a relatively small part of public costs involved. For example, in the case of the rebate at the 40/25 level, the tax expenditure estimate for interest deductions would rise from 11 to 19 million dollars, still less than 5 per cent of total costs; for the tax credit at the 40/25 level, it would increase from 6 to 13 million dollars, or slightly less than 10% of total costs.

However, it remains unclear whether these interest deduction tax costs can legitimately be attributed to a solar incentive program in particular, or to the use of solar energy systems in general. First, there is a practical question of the extent to which the induced purchasers would have borrowed a similar amount of funds for some other discretionary purchase had the incentive not been made available, so that the public "cost" would have been incurred in any event. Second, there is an analytic, or theoretical, issue of the propriety of attributing the costs of this existing provision of the tax code -- meant to encourage and enhance consumer borrowing and home purchase and improvement in general -- to this particular use of it. Since the estimated attributable costs involved are relatively small, these issues do not require any fuller treatment here, but it is useful to recognize the problematical nature of associating such costs with an incentive program.

F. NEED FOR A BENEFIT STRUCTURE THAT IS NEUTRAL IN RELATION TO INCOME

As discussed in Chapter One of this report, it does not appear appropriate to seek income redistribution objectives in the design of a residential solar energy incentive program today. There are more reliable and more cost-effective means for reducing the energy cost burdens of lower income homeowners (particularly conservation measures), and the limited track records of most solar energy systems imply continuing economic risks that seem unwise for families of limited means.

In addition to these general considerations the results of our market survey analysis suggest that in any event it would be difficult to induce participation by families of even moderate income in a "front-end" type incentive program. As can be seen in Table III-9, the income distribution of "baseline" solar users projected for 1978-82 anticipates only 5 per cent of total installations among families with incomes under $16,000, and a slightly smaller representation (4 per cent) of those families among those responding to an incentive. The extent of commitment and resources necessary to induce substantial participation by these lower income families -- let alone to skew such a program towards their preponderant participation -- would be likely to seriously compromise chances of attaining the basic market stimulus objectives of an incentive program.

Income eligibility requirements would also present practical problems that would be likely to reduce the number of households

Table III-9

ESTIMATED DISTRIBUTION OF HOMEOWNERS INSTALLING SOLAR HOT WATER AND SPACE HEATING SYSTEMS BY INCOME, 1978-1982 (with and without Federal Tax Credit)

Income	Total U.S. Homeowners (Average 1978-1982) Number	%	Solar Hot Water Baseline Number	%	Solar Hot Water Units Induced 40/25 Credit* Number	%	Combined Space Heating/Hot Water Baseline Number	%	Combined Space Heating/Hot Water Units Induced 40/25 Credit* Number	%
$0–$16,000	19,131,100	39	8,800	5	4,800	4	500	4	300	3
$16,000–$32,000	18,305,400	37	63,400	36	48,400	41	3,900	30	4,100	35
$32,000–$48,000	8,664,300	17	69,900	39	43,400	37	6,400	49	5,200	44
$48,000+	3,431,500	7	35,600	20	22,000	19	2,300	18	2,200	18
Total	49,532,300		177,700		118,500		13,100		11,700	

*40/25 = 40% of first $1,000 and 25% of the next $6,400 (maximum credit of $2,000)

Note: Columns may not add due to rounding.

which could be attracted to the program, either because of objections to excessive red tape or because of resistance to a means test in principle. A simpler approach to a progressive benefit structure has been suggested by those concerned that benefits may be disproportionately gained by those of upper income: that front-end solar incentives (whether as rebates or tax benefits) be made taxable. This preference has been expressed by the Solar Energy Industries Association in its proposal for "taxable treasury rebates"* and attributed to the Treasury Department under the nomenclature "refundable taxable credits." A similar though somewhat more restricted debate has continued over whether or not incentives in the form of a tax credit should at least be made "refundable." This would allow payments to be made for any excess of credit over tax liability, thereby assuring a relatively neutral distribution of benefit amounts (not considering here the marginal utility of income) and full receipt of benefit entitlements by all solar users, irrespective of income.

The issue of progressivity in benefits is an important one, but it is necessary to consider it in light of the impact varying degrees of progressivity might have on the effectiveness of an incentive program.

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*See SEIA, Solar Energy Industries Association Proposed Solar Incentive Program (March 3, 1977).

It is useful in this regard to consider the hot water and heating markets separately, since the size of the benefit, and the consequent impact of progressivity, differ substantially between the two.

In the case of hot water systems, our analysis suggests that relative neutrality of benefits in relation to income (as in a rebate, or a refundable tax credit) would have little if any perceptible effect on response when compared to the theoretical regressivity inherent in a "non-refundable" tax credit; efforts to increase progressivity through taxation of benefits, however, would substantially decrease response to the incentive (see Table III-10). This reflects reduced response to the program among those middle and upper income families for whom the benefit is reduced to the greatest extent. These are precisely those households who may be the most appropriate early users of this technology, since they can best afford to deal with the performance problems and losses on resale that are continuing possibilities during the next few years.

Table III-10

MARKET IMPACT OF INCREASING THE PROGRESSIVITY OF TAX CREDIT FOR THE PURCHASE OF SOLAR DOMESTIC HOT WATER SYSTEMS

Note: Estimates for Units Installed Over 5-Yr. Period — 1978-1982 Assuming, for Illustrative Purposes, a Tax Credit of 40% of the first $1,000 of System Cost, and 25% of the next $6,400 ($2,000 maximum).

Effect	Program	Cum. Units	Percent Increase Over Baseline
Somewhat Regressive	Credit	296,000	67%
Neutral	Refundable Credit	299,000	68%
Progressive	Taxable Refundable Credit	233,000	31%

In the case of combined heating and hot water systems, where benefit amounts are necessarily much higher, the situation is somewhat different. While taxation of benefits is likely to have a similarly limiting effect on the reach of an incentive, an incentive is also likely to suffer if it has the regressive characteristics of a "non-refundable" tax credit. As can be seen in Table III-11, the full benefit of the maximum credit in the National Energy Act ($2,000) would be unavailable to 78% of taxpayers, and to 65% of present homeowners, because of insufficient

Table III-11

TAXPAYERS WITH INCOME TOO LOW TO REALIZE FULL NON-REFUNDABLE TAX BENEFITS

	Average Adjusted Gross Income			Percent of Returns with Income Less Than Average AGI		
Income Tax	All Tax Returns	Itemizers	Homeowners	All Tax Returns	Itemizers	Homeowners
$ 100	$ 3,700	$ 4,900	$ 4,300	22%	3%	13%
250	5,200	6,900	6,200	31	7	20
500	7,100	8,700	8,000	41	12	27
750	8,800	10,500	9,800	49	19	34
1,000	10,400	12,200	11,400	55	27	41
1,250	12,100	13,900	13,100	62	35	48
1,500	14,100	15,400	14,800	69	43	55
1,750	15,700	16,900	16,400	74	49	61
2,000	17,200	18,200	17,800	78	55	65
2,250	23,000	19,500	21,000	89	61	75
2,500	23,600	20,700	22,000	89	65	78
Median	9,108	17,175	13,648			

Source: Derived by RUPI from Dept. of the Treasury, *Preliminary Statistics of Income – 1975 Individual Income Tax Returns, 1977,* Tables 1, 2, 5; U.S. Dept. of Commerce, Bureau of The Census, *Annual Housing Survey 1975, Part C, Financial Characteristics of The Housing Inventory*, Table A-1.

tax liability to offset against the credit. The $2,150 ceiling in the formula as revised in the House would be fully usable by even fewer families.

This possible limitation on the reach of an incentive program aimed at solar heating systems should be of concern in the choice between a rebate and a tax benefit approach, since it now appears that the form of tax credit most likely to be enacted is a "non-refundable" one. More fundamentally, however, it should be recognized that taxation of either rebates or tax benefits is likely to restrict significantly the potential impact of a solar incentive program.

G. WHY REBATES MAY BE PREFERABLE TO TAX BENEFITS

While this report explores a number of aspects of solar incentives in considerable detail, there is a core of major findings set out in the Executive Summary which can be said to state the study's essential conclusions and recommendations. One of these findings is that a rebate program appears preferable to a tax benefit approach at the present time. Since the residential solar incentive reported out of committee in the House is in the form of a tax credit, it is particularly necessary that the reasons behind this conclusion be presented as clearly and completely as possible. That is the task of this section of the report.

The choice between a grant and a tax approach should, however, be considered in relation to a more basic finding of the study: that either of these front-end incentive designs is preferable to a loan program, which would have handicaps severely limiting its utility for the purposes at hand (as elaborated in Chapter Four). Tax credits can work as an incentive and can be expected to induce a significant response if provided at sufficient levels of subsidy. But rebates appear preferable to a tax approach, primarily because a grant-type program fits better with the substantial administrative obligations a solar incentive program must confront, and also because it may be more effective than a program offering benefits through the income tax system.

1. Possibility of Greater Impact

The market impact estimates prepared on the basis of our consumer survey show a somewhat greater market response to a rebate than to a tax credit. These findings, reviewed earlier in this chapter, suggest at the least that a rebate program offers the same potential to affect the market as a tax credit, at comparable costs, and that, contrary to some expectations, few if any solar purchasers will consider such a payment as any less acceptable a form of incentive than a tax credit, or as tainted by associations with government "handouts" in other areas. In addition, if a rebate is made assignable, at least some solar retrofit installation companies may accept it as a partial payment, increasing the utility of the incentive to the purchaser.

2. Better Context for Discharge of Special Federal Responsibilities

The potential for solar energy product failure and consumer fraud has been widely commented upon, and deserves attention even in the absence of an incentive program. The Federal Trade Commission has already made clear its own concern over the problems of consumer protection inherent in the evolution of the solar industry -- including those related to the setting of product standards, the nature of warranties and remedies, and product marketing and advertising claims.* But a Federal incentive program will bring with it special problems and obligations of its own. As was noted earlier in this report, the availability of Federal incentives is likely to be seen by the public as a signal from the government that available solar systems are appropriate for the average homeowner today. This will call for special efforts at oversight and control that are more consistent with an actively administered grant-type program, and may be more difficult to impose successfully in the context of a tax benefit where no advance application is required.

One example of such difficulties is suggested by the understandable effort to make the proposed incentive retroactive to the time of its initial public announcement, to avoid depressing the solar market in the interim. While the incentive may be technically retroactive, the requirements for certification of eligible systems and the lack of any existing mechanism for providing that approval at present would appear to leave the issue undecided for any individual purchaser today, with retroactivity in fact chancy at best and illusory at worst.

3. Better Fit with the Administrative Requirements of an Incentive Program

One of the greatest advantages of tax incentives is their relatively automatic operation, free of requirements for advance application and approval. Tax benefits provided to the average homeowner -- the tax deductibility of mortgage interest and local property tax -- partake of this unique ability to facilitate individual decision

*See letter and enclosed statement of Michael Pertschuk, Chairman, Federal Trade Commission, in Hearings on Tax Aspects of President Carter's Energy Program, Ways and Means Committee, House of Representatives, 95th Congress, 1st Session, Part 1, p. 386 ff., esp. at 386-87, 392-96 (1977). The FTC finds a broad mandate to act in its own interpretation of Section 5 of the Federal Trade Commission Act, but was also explicitly mandated responsibility in this area by sections 365(d) and (e) of the Energy Policy and Conservation Act, as amended by the Energy Conservation in Existing Buildings Act of 1976, Sec. 432(d). The Solar Energy Industries Association has made guidance available to solar dealers on some aspects of the FTC's concern in SEIA, Solar Advertising Guidelines (1977).

making. But it will be difficult to design a solar incentive program that will have that very characteristic of freedom from advance determination of eligibility that is the tax incentive's greatest strength.

One of the most troublesome issues that such a program must resolve is that of defining the eligibility of systems for the incentive (considered in greater detail in Chapter Six of this report). At least in the near term, any program will need to make prospective purchasers aware of the limitation of eligibility to a defined group of accepted systems, and of the consequent importance that a purchaser determine the eligibility of particular systems for the incentive if its benefit is to be assured. Purchaser inquiries will in fact have to be hoped for and encouraged, and a rapid and reliable means developed for providing determinations of system eligibility that purchasers can rely upon. At the same time, it would be possible to use such requests for information on eligibility as an opportunity to assure that prospective purchasers are provided with adequate solar consumer information -- that is, to integrate necessary consumer protection measures into the incentive program. This might include provision of a minimum guide to the operation of systems, to essential questions that should be asked in relation to the product being offered, its accompanying warranties, and to the dealer or installer's training and background and the minimum insulation and weatherproofing suggested as a prerequisite for solar (in the case of retrofit systems).

While such an information system could be operated in conjunction with a tax credit, it does not seem as logical or appropriate as it would be with a rebate program. The need for interaction among seller, purchaser, and the government would appear to substantially offset any advantage to be obtained by the automatic operation of a tax benefit, while the use of a tax credit might make it more difficult to assure that purchasers take the steps necessary to determine eligibility.*

*One of the few complaints of homebuilders about the new home tax credit -- aside from the fact that it had little apparent impact on the market -- was the extent of uncertainty and restrictions surrounding the question of eligibility, concerning such issues as when construction had "started" on a house, and whether its price could be changed, or had been changed.

4. Greater Opportunity to Improve the Program over Time

A rebate program would appear to be more susceptible to ongoing improvements in calibration of subsidy amount and manner of benefit delivery. Monitoring of the program's use and of changes in the volatile solar industry and in prices of alternative fuels could provide a basis for making periodic changes in benefit levels during the program's life, which is less likely to be possible with a tax-based incentive.

5. Possibility for Regional Variation of Benefit Level or Participation of the States in Administration

Adjustment of benefit levels to reflect local conditions is a familiar feature of grant programs in the housing field. A rebate program would allow for the possibility of tailoring benefit levels to the often dramatic variations in the economics of solar use among regions, or even to the concentration of funds in prime market areas, if experience over the near term suggested this as a desirable incentive strategy. A rebate program would also permit a greater degree of active coordination of a Federal benefit program with state and local solar initiatives, including the continuing possibility of delegating program responsibilities directly to state agencies where appropriate. A lead role for the states in implementation of energy conservation measures in general and solar energy incentives in particular was called for by the Congress in the Energy Conservation in Existing Buildings Act of 1976 to reflect the "diversity of conditions among the various States and regions of the Nation."* While state governments have shown varying degrees of interest and capacity in the implementation of solar energy programs, delegation of program authority might

*See findings and purposes as set out in the Energy Conservation in Existing Buildings Act of 1976, Sec. 402(4). That Title established weatherization programs (Part A) and state energy conservation plans (Part B) to be implemented by the states. Part C authorized a national energy conservation and renewable-resource demonstration program for existing dwelling units to be administered by HUD, provided for use of states and local instrumentalities in carrying out the demonstration, and mandated close coordination with state energy conservation plans. See Sections 509(c)(4) and 509(f) of Title V of the Housing and Urban Development Act of 1970, as amended by Sec. 441 of the Energy Conservation in Existing Buildings Act of 1976.

substantially increase program effectiveness in those states already demonstrating their own abilities and commitments, and provide a means of supporting the emergence of strong state programs elsewhere.

6. Possible Objections in Principle to Tax Benefits as Solar Incentives

Tax expenditures have been a favored approach in Congressional proposals for residential solar incentives to date. The only broad-based solar incentive to receive Congressional approval in the 94th Congress was a tax credit,* and the National Energy Act submitted to the current Congress by the President also proposed a tax credit, now reported out of committee in a modified form. This clear preference for a tax benefit approach reflects four major advantages it is perceived to have over grant (or loan) programs: speed of implementation and ease of administration through the existing, efficient operation of the Federal income tax system; freedom from authorization ceilings and annual appropriation cycles; automatic operation free from advance review requirements and misuses of administration discretion; and numerous and often successful precedents in the use of tax provisions to encourage private investment in activites deemed to be in the public interest.

These advantages are not unalloyed. Beyond the specific issues discussed thus far, considerable opposition has emerged in the past few years to the use of the tax code as a means to achieve national goals that are not intrinsically related to tax policy, and the recent solar energy and energy conservation tax incentive proposals have been objected to by those concerned with these issues.** In this view, the freedom from authorization ceilings and appropriation requirements is

*This credit, as passed in H.R. 6860, was dropped during conference in the final compromises that yielded the Tax Reform Act of 1976.

**See, e.g., Statement of Senator Kennedy (D. Mass.), Congressional Record - Senate, S5819-22 (April 7, 1977); Tax Reform Act of 1976: Compendium of Papers on Federal Tax Reform (S. Surrey, P. McDaniel and J. Pechman, eds.); Report on Proposed Residential Energy Conservation Credits in the Energy Conservation and Conversion Act of 1975, H.R. Rep. No. 221, 94th Cong., 1st Sess. (1975); Hyatt, Thermal Efficiency and Taxes: The Residential Energy Conservation Tax Credit, 14 Harvard Journal on Legislation 281 (February 1977).

at best a mixed blessing; it is seen as planting a fiscal "time bomb"* by eliminating the review and control that is necessary and appropriate for Federal expenditures, and as making the program far more difficult to terminate than a direct expenditure program even if enacted with a nominal expiration date. The ease of administration is acquired at the price of accepting features inherent in the tax code, such as the regressive effect of tax deductions or credits, that may be inappropriate for the program at hand. And, the argument continues, not only does use of the tax system distort the form of the incentive, but the provision of the incentive through the tax code degrades the tax equity and ease of administration that are essential features of a workable and socially accepted tax system, and is inconsistent with present tax reform efforts aimed at increasing progressivity in design, equity in result, and simplicity in administration.

Those supporting tax incentives reject these arguments on a number of grounds: that the tax code presently contains incentives for a wide range of public purposes, specifically including energy production incentives, that are not going to be eliminated, and that demonstrate how effective this approach can be; that a tax incentive is particularly appropriate for a solar incentive program that is intended to have a short life, avoiding the complications of erecting and dismantling a separate subsidy delivery system and entailing a far lower administrative overhead; that a solar tax incentive is particularly appropriate in the context of the national energy program proposed by the President and now being shaped by the Congress, which relies on tax penalties and tax incentives as a primary means to achieve a wide variety of ends.

The debate over the desirability of "social use of the tax code" clearly has dimensions that transcend the scope of this report. However, the issue is met in the context of the choice of a solar incentive, and will need to be resolved in this context -- particularly in light of the finding of this report that a rebate program is not only a possible alternative to a tax expenditure but one that appears to have

*Surrey et al., ibid., p. 169

specific advantages in balancing the public interests involved.

7. Practical Problems Posed by the Structure of the Tax Code

As noted above, an incentive provided through the tax code will have to accommodate itself to existing structural features of the tax system -- or vice-versa. If provided as a deduction, an incentive would be regressive in effect, with benefit levels inversely related to user income.* Increased resistance to this aspect of deductions is apparent; although tax deduction proposals have appeared in Congressional solar incentive bills in the 94th and 95th Congress, they have been outnumbered by tax credit proposals, and it is the tax credit that has emerged from the House committee as a solar incentive thus far.

Tax credits, however, are not completely neutral in relation to individual income. They can only be availed of to the extent that the user has tax liability to offset against the credit, unless the credit is made "refundable" (that is, made as a payment to the extent that it exceeds tax liability) or is available on a carryback or carryforward basis as a credit against tax liabilities of preceding or subsequent

*Taxability of interest subsidies: If loan programs are adopted for all or part of a solar incentive program, a tax question may arise if interest subsidies are provided through annual payments to the borrower, or to a lender on behalf of the borrower. A possible precedent for such an approach is the Section 235 loan program for low-income homebuyers. In that program, the subsidy payment is made to the lender in an amount determined as the difference between the debt service required for the face amount of interest on the loan, and the lower debt service actually paid by the homebuyer, which is calculated as if the loan had been written at the target below-market interest rate. An even deeper subsidy than the amount of that payment is actually provided where, as in the 235 program, the borrower is allowed to exclude the subsidy payment from his gross income for tax purposes, yet also allowed to deduct the interest amount reflected in the full debt service payment. Such an approach, which is regressive so far as the increased interest deduction is concerned, does not seem as appropriate for a solar energy deduction as in the case of loan programs aimed at enabling low-income households to achieve the benefits of home ownership. If other methods for providing lower-interest loans are adopted -- for example, the "tandem plan" approach, or direct loans -- this complication does not arise. In fact, in these cases, the lower interest rate paid by the borrower has a progressive effect when the tax-deductibility of mortgage interest is considered. The comparative merits of these approaches are considered in detail in Chapter Four of this report.

years (primarily a device to mediate business taxation, as in the 10 per cent investment tax credit for machinery and equipment and the analogous device of loss carryovers).

There are relatively few examples of refundable credits, and the recently adopted earned income credit provides the only real precedent for a "refund" that is not a return of monies actually overpaid to the government. Though the Congressional Budget Office has expressed concern over possibly regressive effects of credits in the absence of refundability,* recent Congressional actions suggest that a non-refundable credit is the form in which a credit is most likely to be adopted. The regressive implications of a non-refundable tax credit will depend on the maximum size of the credit available. As noted earlier, our analysis suggests a virtually imperceptible difference in response to the incentive for solar hot water heaters, and thus little or no regressivity in fact in this area, while the larger potential credit available for heating systems is likely to be reflected in a significant difference in use by income groups (see text at Table III-10 above). There are important reasons for exercising caution in the design of an incentive so that lower income families are not inappropriately induced to invest in relatively expensive and unproven solar energy systems, but a regressive benefit structure imposed by the nature of the tax code is neither the most effective nor most desirable means to that end.**

Concern over a need for progressivity in benefit structure has also led to proposals that solar incentives be made taxable, even if they are provided in the form of tax benefits. While it has been argued that taxation of a refundable credit is necessary in the case of programs aimed at business in order to avoid implicit regressivity

*Congressional Budget Office, President Carter's Energy Proposals: A Perspective, Staff Working Paper, pp. 92-94 (June 1977).

**One problem with a nonrefundable credit would be that the considerable and unavoidable "windfall" benefits involved in any of these incentive designs would be distributed on a regressive basis.

in benefit,* providing an incentive to individuals in the form of a "tax credit" that is not only "refundable" but also "taxable" would seem to bend the tax code so far out of shape as to be unrecognizable. A more basic problem with taxing incentive benefits, however -- one which applies to both tax-based approaches and direct payments in a rebate program -- is that it will substantially reduce the market impact of the program (see Table III-10, above) and make the basic objective of stimulating the solar market difficult or impossible to achieve.

8. Open Questions for the Rebate Approach: Program Structure and Political Support

One important question that will need to be answered in assessing the desirability of a rebate program is whether or not it appears likely that such a program can be administered effectively. While many questions of detailed program design are beyond the scope of this study, our initial assessment is that the nature of the tasks involved and the expected program volumes would make it feasible to develop an effective rebate program. Our estimates of program volumes for a rebate at the 40/25 level are for a total of 329,000 units in the program over a five-year period, including all "baseline" units claiming benefits; at the 30/20 level, the expected program volume is 277,000 units. These appear well within the capacity of an actively administered program, recognizing that there will be a relatively slow start and an increase in annual volume over time (at the 40/25 level, from 34,000 units in year one to 105,000 units in year five). Documentation and check issuance could be handled centrally, with field offices of the responsible agency as a resource for information programs.**

*See Congressional Budget Office, Real Estate Tax Shelters and Direct Subsidy Alternatives, p. 75 (May, 1977).

**It should be recognized that the solar industry itself is likely to serve as the most active and effective source of information on the availability of an incentive in any case, and might be utilized within the program structure to provide references to local, state, regional or central sources of information on program requirements and system eligibility.

Beyond the specific questions of how a rebate program might best be structured, and where (and whether) the administrative capacity to run such a program now exists, or can best be provided, is a more fundamental question as to whether there is sufficient political support for a rebate program of the type considered here.

The only direct precedents for grant-type payments for home improvements are the limited program of weatherization grants for low-income families and the Section 115 grant program, which provides up to $3,500 for specified improvements made by low-income homeowners living within defined code enforcement or renewal areas. These are not compelling precedents for the rebate approach, and far larger sums have been spent in the housing field through other means. Substantial benefits on an individual and on a total basis have been and are being provided to low and moderate income occupants of rental housing through a wide variety of devices, including the expanding Section 8 program. Considerable program subsidies were and are provided low-income homeowners through the interest subsidy payments of the Section 235 program. The only housing-related subsidies that have avoided income eligibility qualifications are the comparatively vast benefits (estimated at over 11 billion dollars for fiscal 1978) provided to homeowners through the tax-deductibility of mortgage loan interest and property taxes -- a form of subsidy that is now widely recognized to be regressive in effect.

The nature of these precedents in the housing field may help to explain why most of the solar proposals in Congress to date have been limited to either tax expenditure or loan approaches. <u>The emphasis on use of the tax code to provide subsidies is particularly understandable in view of the numerous and often successful precedents for using tax benefits to encourage private investment in activities deemed to be in the public interest, in housing and energy development among other fields</u>. Support for tax expenditures reflects their apparent ease of implementation, and the related concern that the extent of red tape inevitably associated with grant programs might impose high per-unit administrative costs and deter many individuals from participating in the program.

The evidence of the present study, however, is that a rebate program for residential solar energy incentives has perceptible advantages in potential impact when compared to tax expenditures and can be competitive in program costs. Perhaps more importantly, it provides greater opportunities for the design and administration of a program that will best meet the varied public interests to be considered in the process of accelerating acceptance of this evolving technology.

Notwithstanding these potential benefits, there appears to be a fundamental apprehension that political support cannot be mustered for substantial subsidy amounts that are provided in grant form. There are far greater precedents for higher benefit levels through tax expenditures where homeowners are concerned, and a widely held belief that more can be provided through these channels than through a direct grant program. Given the intrinsically limited scale of any solar incentive in the short term, the advantages offered by the rebate approach may provide an unusual opportunity for those concerned about "social" uses of the tax system to demonstrate that equivalent benefit levels can in fact be provided in this more direct -- and, in the present case, probably more effective -- manner.

CHAPTER IV

BELOW MARKET INTEREST RATE LOANS

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CHAPTER FOUR

BELOW-MARKET INTEREST RATE LOANS

A. OVERVIEW

After tax credits, direct loan programs represent the incentive approach towards encouraging solar energy use in the home that has appeared most frequently in Congressional legislation introduced to date.* However, the study's findings tend to argue against the desirability and feasibility of this approach:

- Results from the consumer survey indicate that subsidized loans, even under the most liberal of financing assumptions, have a limited ability to motivate the adoption of solar hot water systems -- the most commercially advanced residential use of solar energy.

- Proponents of solar loans generally assume that the existing FHA/VA network could be easily adapted to deliver financial assistance to purchasers of solar equipment. However, Federal credit programs are concentrated almost exclusively upon a narrow segment of the new housing market and play a very marginal role in the market for improvements to existing homes.

- The housing finance system is not an integrated one. Institutional participation differs depending on whether the financing is for new construction or improvements to existing homes, whether loans are Federally or privately insured or uninsured, and whether the property is in an urban or rural area. In practice, the market response to a loan program would be strongly constrained by the absence of institutional arrangements for originating such loans that could be quickly activated and that would provide ready access to the majority of homeowners and home purchasers.

- Homebuilders and lenders in many cases associate Federal low-cost loans exclusively with programs directed at low-income families and the elaborate processing requirements such programs have invariably involved. A solar program would have to overcome these negative associations in order to enlist the participation of these professionals in "marketing" the program to consumers.

*See legislative compilation in Appendix A.

- Loans require the government to assume administrative responsibility for setting standards of borrower creditworthiness, long-term servicing of loans or subsidy payments, and dealing with defaults and delinquencies for years (several decades in the case of mortgage loans) after the program itself has expired.

- Three basic alternatives for the delivery of interest subsidies were evaluated: (1) a direct Federal loan program; (2) interest subsidy payments for loans originated by private lenders; and (3) a Solar Tandem Plan utilizing GNMA/FNMA secondary market programs. All three of these approaches appear to involve transaction costs and logistical complexities that would be hard to justify in connection with the relatively small principal amounts and modest lending volumes that would be involved in a solar loan subsidy program.

A possible exception to these generally negative findings might be a Tandem-type program for new homes installing combined hot water/space heating, with the interest subsidy rolled into the first mortgage on the property itself. The market impact analysis suggests that long-term, low-interest loans might prove as attractive to prospective owners of newly-built solar homes as either tax credits or rebates. Use of a Tandem Plan arrangement would be the most cost-effective means of making such loans available, but would still be subject to many of the administrative problems listed above. In any event, the establishment of a special loan program for solar space heating might be premature at this time, given the very small number of space heating installations envisaged over the next few years, even with a Federal subsidy.

B. BASIC CONCEPT

Low cost loan incentives are intended to assure the availability of financing (thus reducing the up-front costs to purchasers of solar systems) and to reduce the monthly carrying costs on the repayment of loans taken out to finance solar installations. Reduction in carrying cost is achieved by subsidizing the interest rate, and in some instances, extending loan maturities; reduction of downpayment requirements is accomplished by providing higher loan-to-value ratios than those available from private lenders.

A separate solar loan to finance purchase of a solar hot water system would, because of the size of the loan, share the characteristics of a home improvement loans such as those insured under HUD's Title I property improvement loan program. The underwriting process for such loans focuses on the creditworthiness of the borrower with little, if any, attention to the collateral value of the improvement itself. In the dollar range associated with domestic hot water systems ($1000-$2000), such a loan would typically be unsecured. Because of their larger size, loans for solar space heating or combined space heating and hot water systems ($8000 and up in regions with colder climates) would in all likelihood be secured by a mortgage lien against the property (all Title I loans above $7500 require such security), which would make the loan in the case of new construction and most retrofit situations a second mortgage. With separate loans of large amounts, lenders are going to be concerned about the risks involved if the borrower's equity in his home is small or if the value of the property in the future in in doubt.

In the case of newly built homes, an alternative approach to issuing separate solar loans would be to calculate an interest subsidy on the solar related portion of the home's total cost and then apply this subsidy to the first mortgage payment on the entire property.

C. WEAK RESPONSE TO LOAN SUBSIDIES FOR SOLAR DOMESTIC HOT WATER

Below-market-interest-rate (BMIR) loans evidence only a marginal ability, at best, to influence the adoption of solar hot water systems, particularly in existing homes. Most of the bills authorizing low-cost financing for residential solar uses that have been introduced into Congress thus far, specify an interest rate set at the government borrowing rate (6.5% to 7.5% depending on how the rate is defined *) and a loan maturity of about eight years. The market estimates indicate an extremely weak response (only 14% above the 1978-1982 "baseline" to a special solar loan at 7% with maturities as long as 10 years) for solar hot water use in either new or existing homes. (See (Table IV-1). Even assuming the availability of much deeper subsidies (1% interest for 20 years) the analysis suggests only a 56% increase in the number of adopters over this

*One common definition is the average rate on all outstanding Federal debt (currently about 6.5%).

Table IV-1

SOLAR DOMESTIC HOT WATER SYSTEMS: MARKET IMPACT OF 100% SEPARATE SOLAR LOAN
Estimates for units installed over five year period, 1978-1982

	Market Impact – Cumulative Units					
Loan Terms	Retrofit	% Increase	New Homes	% Increase	Total	% Increase
No Incentive	118,000	–	59,000	–	178,000	–
7%, 10 years	135,000	14	67,000	12	202,000	14
5%, 10 years	145,000	23	72,000	21	217,000	22
3%, 15 years	159,000	34	82,000	38	241,000	36
1%, 20 years	177,000	50	99,000	67	277,000	56

five-year period. (The estimated responsiveness is somewhat higher among new home purchasers than among existing homeowners: a 67% increase above the baseline for the former group versus only 50% for the latter.) A 1%, 20-year loan for $1500 it should be emphasized, would involve monthly payments of less than eight dollars per month -- extremely advantageous financing terms when contrasted with the typical 12%, 4-year terms of conventional home improvement loans (with monthly payments of nearly forty dollars).

A possible explanation for the limited response to the loan alternative for solar hot water purchases may be found in a variety of factors; (1) the way in which loan subsidies effect the economic attractiveness of solar use from the consumer's perspective when contrasted with a front-end case subsidy; (2) the fact that existing homeowners typically prefer to pay for improvements to their property with cash rather than assuming additional debt; (3) the reluctance of new home purchasers to apply for a loan subsidy if it involves a loan instrument and processing track distinct from those involved in securing a first mortgage on their property; and (4) the perceived effort involved in securing a subsidized loan compared to the relatively automatic nature of a tax credit or rebate.

1. Impact of Loan on Economics of Solar Use

Unlike rebates, tax credits and other up-front incentives for which exact monetary value is apparent, incentives which offer favorable financing terms (e.g., below-market interest rates, extended loan maturities) may be evaluated differently by different consumers. Thus, some potential purchasers might be more sensitive to the size of the monthly payment, others to the effective interest rate, others to the maturity of the loan.

Table IV-2 compares a government rate loan with the typical conventional financing alternatives available to a new home purchaser and existing homeowner, respectively. An individual who purchased a new solar-equipped home and financed the solar cost in the permanent mortgage, would receive no immediate incentive from the

Table IV-2

COMPARISON OF MONTHLY PAYMENTS WITH GOVERNMENT RATE LOAN AND CONVENTIONAL FINANCING ALTERNATIVES

System Cost: $1,500.

Loan Type	Loan/ Cost Ratio	Extra Downpayment	Interest Rate	Maturity	Monthly Payment
Conventional Mortgage Loan	75%	$375	9.0%	25 years	$ 9.44
Government Rate Loan	75%	$375	7.0%*	10 years	$13.06
Net Savings with Government Loan					($3.62)
Conventional Home Improvement Loan	100%	0	12.0%	4 years	$39.50
Government Rate Loan	100%	0	7.0%*	10 years	$17.42
Net Savings with Government Loan					$22.08

* Average rate on all outstanding Federal debts, plus ½% fee.

government loan terms, even though the interest rate is lower. In the example given, the new homeowner would, in the short run, pay out more than three dollars extra per month on the ten-year government loan than on a twenty-five year mortgage. In contrast, such a loan would clearly benefit a homeowner installing a retrofit system, since home improvement financing generally carries a shorter term and higher interest rate. (The four-year maturity and 12% interest rate given in Table IV-1 are fairly typical.) Here, the borrower would pay twenty-two dollars less per month on the ten-year government loan than on the four-year home improvement loan.

Consumers with longer time horizons, or high financial liquidity, would presumably opt for a lower interest government loan, irrespective of the monthly payment comparison. In practice, however, most potential purchasers appear far more likely to juxtapose the additional monthly payment in the first year with the monthly savings expected from the solar investment. Moreover, in comparing a loan incentive with a simple "front-end" subsidy, consumers may be sensitive to the fact that the loan, no matter how attractive the interest rate, still leaves the borrower exposed for the full cost of the solar system.

Finally, it should also be kept in mind that an incentive already exists for solar use, or, for that matter, any investment that is financed with borrowed funds: the tax deductibility of interest for Federal income tax purposes. This means that the after-tax benefit of participating in a government low-interest loan or interest subsidy program will be less than the level of subsidy would suggest at first glance -- particularly for higher income consumers. Table IV-3 illustrates the extent to which after-tax considerations diminish the net benefit of an interest subsidy from the point of view of two homebuyers -- one in a 45% marginal tax bracket, the other in an 18% bracket -- who would otherwise have financed the $1,500 investment in a solar hot water system conventionally. For example, the higher income taxpayer would realize $46 in tax savings from his payments on a conventional mortgage. (In effect, this reduces his actual financing cost to somewhat less than 5%.) With the subsidized 4% loan, these tax

Table IV-3

EFFECT OF TAX DEDUCTIBILITY OF INTEREST ON NET BENEFIT IN FIRST YEAR OF 4% SOLAR LOAN TO A HIGHER INCOME AND LOWER INCOME CONSUMER

	Mortgage Loan		Home Improvement Loan	
	Higher Income	Lower Income	Higher Income	Lower Income
Marginal Tax Bracket	45%	18%	45%	18%
System Cost	$1,500	$1,500	$1,500	$1,500
Loan Amount*	1,125	1,125	1,500	1,500
First Year Interest**	101	101	180	180
Tax Savings	46	18	81	32
First Year Interest @ 4%	45	45	60	60
Tax Savings	20	8	27	11
Reduction in Interest Payment with subsidized loan	56	56	120	120
Reduction in Tax Savings with subsidized loan	26	10	54	21
Net Benefit to Consumer	30	46	66	99

*Loan-to-Cost Ratio is assumed to be 75% for mortgage and 100% for home improvement loan.
**Interest calculated at 9% for mortgage loan, and 12% for home improvement loan.

savings would be reduced by $26, thereby cancelling out much of his $56 savings on interest, and lowering the net benefit of the subsidized loan to $30 in the first year.* These figures would be magnified in the case of a retrofit system where the taxpayer's alternative financing is a 12% home improvement loan. Here, the 4% loan would reduce first-year interest payments by $120 before taxes, but by only $66 after taxes for the higher income purchaser, and $99 after taxes for the lower income purchaser.

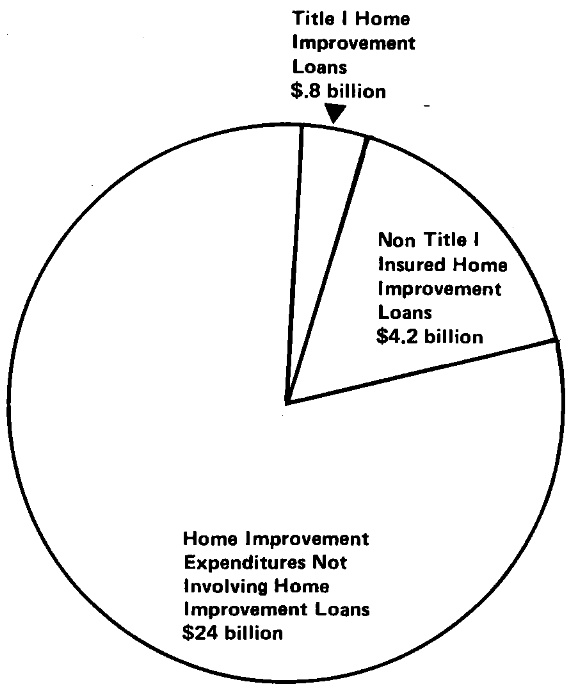
2. Homeowners Tend To Pay Cash for Home Improvements

The low response to the loan option among existing homeowners is consistent with the fact that less than 18% of home improvements of any kind are financed with borrowings from commercial lenders (see Figure IV-1). The remainder are paid for with cash, merchant credit (30 to 45

*This assumes, of course, that the allowable interest deduction is at the subsidized interest rate. In the Section 235 interest subsidy program, home borrowers were initially allowed to deduct interest computed at conventional rates rather than at the subsidized rate actually paid, thus greatly increasing the net financial benefit received.

Figure IV-1

DOLLAR VOLUME OF HOME IMPROVEMENT AND TITLE I LOANS IN RELATION TO HOME IMPROVEMENT EXPENDITURES 1976



Source: Federal Reserve Board, 1975 HUD Statistical Yearbook

day billing), revolving charge accounts and credit cards. This disinclination to borrow funds for the purpose of improving one's home appears to be in part a function of the relatively unattractive terms of home improvement financing (discussed above), in part of the relatively small dollar amounts involved (the average cost of the give most common types of home improvements is less than $500, while the average home improvement loan is in the $2500 to $3000 range), and in part of a widespread reluctance to incur debt unless absolutely necessary.*

3. Possible Inappropriateness of "Separate" Solar Financing for Newly Built Homes

In respect to new construction, a number of builders and lenders interviewed indicated that there might be reluctance on their part, or on the part of consumers, to financing the solar installation separately from the first mortgage on the home itself, particularly for the relatively small amounts involved for domestic solar hot water alone. (Most Congressional proposals for solar loans introduced to date appear to make no distinction between new and existing homes, or hot water versus heating systems, although such distinctions may prove critical to consumer responsiveness to a loan program should one be enacted.)

A solar loan program would, in most cases, involve the borrower in an entirely distinct processing track from that required to obtain permanent financing and would necessitate the negotiation of a separate debt instrument. This would obviously be the case should the subsidized loans be originated directly by a government agency such as HUD or the Farmers' Home Administration. However, it would also apply even if government subsidies were to be administered through private lenders. Most homeowners (over 50%) obtain their mortgage financing through savings and loan associations, mortgage bankers, and commercial banks,

*Several questions testing general attitudes toward debt financing were included in the consumer interviews. 60% of those interviewed "strongly disagreed" with the statement "When I can, I prefer to buy on credit." Nearly 40% agreed with the statement, "I'd be better off if I could pay my home mortgage off early." (31% disagreed.) Consumers were also asked to choose between two payment plans for retiring a $1,500 loan; one involving payments of $240/month for 8 years, the other $160/month for 15 years. These were set such that the present cost to the government of making the loans available would be identical. 52% of the respondents expressed a preference for the short-term, high-interest loan, while only 19% chose the long-term, low-interest option. (30% indicated "no preference".) While none of these results is unequivocable, they do suggest a strong concern on the part of consumers with minimizing financial exposure, and, in contrast to the professional real estate investor (as described in Chapter Seven), a relative disinterest in opportunities for leveraging their individual cash resources.

In interpreting these results, it should be noted that respondents were not educated to the extra effort that might be required to secure a separate solar loan -- locating a lender participating in the subsidy program, undergoing a second credit appraisal and technical review of the solar system, making a separate set of payments, etc. Moreover, a number of lenders interviewed appear skeptical of issuing a separate loan, particularly one with a second mortgage lien, at the same time as the first mortgage and before the homeowner has built up any equity in the property. Thus, there is still good reason to believe that a loan subsidy for solar uses in newly built homes (assuming it could be justified at all), would most appropriately be applied to the permanent first mortgage financing on the home in its entirety.

D. LOANS MAY BE MORE ATTRACTIVE FOR SPACE HEATING

The results of the market impact analysis suggest that for combined solar space and water heating systems in new homes, which are far more expensive than hot water systems alone, a long-term, low-interest loan program could have an impact comparable to that of a rebate or credit. Such a program might be most attractive in the form of a subsidy that is rolled into the first mortgage on the entire property. As can be seen in Table IV-6 , five per cent, 30-year financing for 75% of solar costs, integrated into the first-mortgage financing, would induce approximately the same increase in solar heating/hot water systems (109%) as a rebate based on the 40/25 formula proposed in the National Energy Act. A one per cent, 30-year loan elicited the largest response of any of the incentives tested through the survey -- producing a four-fold increase in the estimated number of space heating units installed over the next five years.

By contrast, a program of direct separate loans for the full additional solar costs would need to be offered at deeper subsidies and would have less probable impact (as can be seen in Table IV-6), assuming the shorter maturity typical of such second mortgage financing. Even here, however, the estimated response to the separate solar loans is markedly greater than that indicated for loans of identical interest rates and maturities in the solar hot water market. A comparison of

TABLE IV-6

SOLAR COMBINED HEATING/HOT WATER: COMPARATIVE MARKET IMPACT OF SEPARATE SOLAR LOAN AND LOAN COMBINED WITH MORTGAGE*

Separate Solar Loan (@100% of Solar Cost)

Loan Terms	Market Impact Cum. Units	% Increase
No Incentive	13,000	–
7%–10 yr.	14,000	5%
5%–10 yr.	15,000	13%
3%–10 yr.	23,000	79%
1%–20 yr.	42,000	222%

Solar Loan Combined with Mortgage (@ 75% of Solar Cost)

Loan Terms	Market Impact Cum. Units	% Increase
No Incentive	13,000	–
7%–30 yr.	19,000	43%
3%–30 yr.	43,000	230%
1%–30 yr.	66,000	406%

*Estimates for units installed over five year period

Tables IV-6 and IV-3 indicates a 79% increase above the baseline for a three per cent, 15-year solar space heating loan, versus only a 36% increase for a solar hot water loan.

The relatively strong market response to low-cost loans for heating systems, as compared to loans for hot water systems alone, may reflect the greater necessity for financing costs of this magnitude, as well as the substantial reduction in monthly expense achievable through long-term amortization structures. A homebuyer able to purchase an $8,000 solar heating system with a three per cent, 30-year loan for 75% of the cost would increase his downpayment by $2,000 and his monthly mortgage payment by only $25. Thus, the system would have to save him only $300 annually in his heating bills in order to be generating a positive cash flow the first year it is in operation.

Here, two caveats are in order: First, the impressive proportional increases in demand for solar space heating are measured against a very small base. Only 13,000 homes are estimated to utilize such systems in the absence of incentives between 1978 and 1982. Even the most potent loan terms tested (a one per cent, 30-year loan) would result in an estimated program volume of only 62,000 units over a five-year period, and of only 800 units and 8,000 units, in years one and two, respectively. (See Table IV-6.) Second, the potential market impact for the low-cost, long-term loans could only be realized if procedures for making such loans readily available to homeowners could quickly be established. As discussed in the following section of this Chapter, a number of administrative considerations weigh heavily against this being accomplished.

E. ABSENCE OF APPROPRIATE LOAN DELIVERY SYSTEM

Whatever the potential demand for BMIR solar loans, the ability of a special Federal program to reach its potential users will depend in large part on the adequacy of existing channels between the Federal government and various segments of the new housing market and the commercial lending community. Loan subsidies are in effect a special financial service that must be marketed and distributed to homeowners through conveniently located outlets; considerations of timing and expense preclude creating such a distribution network from scratch, particularly for a loan program of small volume and fixed duration.

Despite the substantial Federal involvement in housing finance through its diverse credit and regulatory activities, no existing loan program with access to the housing market as a whole can be identified on which one could easily "piggyback" an interest subsidy for residential solar use. As can be seen by referring back to Table IV-4 and Figure IV-1, the Federal government at the present time finances only a trivial percentage (less than three per cent) of all home improvement activity. A more substantial portion of newly built homes (24%) are financed through Federal mortgage credit agencies. However, this assistance is concentrated almost entirely in the low-to-moderate income segment of the market, where solar use at this time may be least appropriate and feasible.

The difficulty of quickly mobilizing a solar loan program becomes more apparent when examined in terms of the three basic administrative models for delivering interest subsidies that were selected for evaluation as part of this study:

(1) a direct Federal loan program;

(2) an interest subsidy program operated through private lenders; and

(3) a Solar Tandem Plan operated through Federally-supported secondary market entities.

The problem of implementing either of these models through existing Federal programs and lending networks is summarized in Figure IV-2 and discussed in detail immediately below.

Figure IV-2

POTENTIAL DELIVERY MECHANISMS FOR BMIR SOLAR LOANS

Administrative Model	Precedents	Possible In-Place Delivery Mechanisms	Access to Market
Direct Federal Solar Loan Loan Program	HUD Sec. 312 Rehab Loans;	HUD Field Offices	No existing capability for making direct loans
	Section 202 Elderly Housing	Local government community development and public housing agencies	Spotty and fragmented coverage, varying administrative capability
	Sec. 221 (a) 3 BMIR Rental Project Loans		
	FmHA Sec. 504 Home Repair Loans	FmHA County Offices	Good access to small towns and rural areas, but primarily lower income constituency.
	Sec. 502 Home Improvement Loans		
Subsidy Payment to Lender			
Separate Solar Loan	No Federal precedents; Some CDBG funded local programs	HUD/Title I Approved Lenders	Limited access to majority of homebuyers and homeowners, particularly in West.
Financed as part of Mortgage Loan	Sec. 235 Home Loans	FHA/VA Approved Lenders	Access limited to low/moderate income market. Many lenders do not participate in FHA/VA programs. Unless backed by secondary purchase program, excludes mortgage bankers who do not lend for their own portfolios.
	Sec. 236 Rental Project Loans		
Solar Tandem Plan			
Separate Solar Loan	None in Housing Field (Sallie Mae for Guaranteed Student Loans)	HUD Title I Approved Lenders GNMA/FNMA	Would have to create relationship between GNMA/FNMA and Title I approved lenders. Even if this in place, access would be limited.
Financed as part of Mortgage Loan	Tandem Plans for FHA/VA Loans	GNMA/FNMA/Mortgage Bankers	Good access to moderate income FHA/VA market.
	Emergency Home Purchase Acts of 1974 & 1975	GNMA/FHLMC/S&L's	Good access to mortgage market as a whole, but FHLMC and most S&L's not involved in Tandem Plans at present time.

Option #1: A direct loan program in which a government agency originates the loan, lends the principal at a below-market interest rate, services the loan until the debt is repaid, and bears the full risk of default.

In general, the Federal government has eschewed direct lending as a means of providing housing assistance to individual homeowners, choosing instead to convey its support in the form of loan insurance, interest subsidy payments, and purchase commitments.* A major exception can be found in the direct lending programs operated by the Farmer's Home Administration (FmHA), most relevantly its Section 504 program of home repair loans and grants for very low income families and its basic Section 502 program of single family mortgage loans, which also makes home improvement financing available on very attractive terms.** These programs are administered through FmHA's network of nearly 1800 county offices, which provides nationwide access in rural areas and small towns. In administrative terms, it would be a fairly simple matter to set up and operate a solar loan program through these county offices. However, the effectiveness of doing so is subject to several qualifications. FmHA's constituency consists for the most part of households towards the lower end of the income spectrum. (The average sales price of new homes financed through FmHA in 1975 was only $23,000; this was $10,000 less than the average FHA insured home and nearly $20,000 less than the

*These latter approaches share two major virtues from a Federal policy perspective: first, origination and servicing are performed by private lenders who, in many cases, share enough of the risk to retain an incentive to make judicious underwriting decisions; second, unlike a direct program, only the interest subsidy, not the loan principal, is chargeable as a Federal budgetary expense. In the case of HUD, the only example of a direct loan program for homeowners is the 312 loan program, but HUD has financed rental projects with direct loans. The Section 202 Elderly Housing Program and the 221(d)3 program have provided direct loans at below market interest rates to multi-family project sponsors.

**FmHA officials describe their basic 502 program as an "insured" rather than a "direct" loan program; loans are made through the Rural Housing Insurance Fund which is capitalized by securities placed with the Federal Financing Bank. However, in terms of risk and administrative costs, the program is still comparable to a direct loan program, since all underwriting, servicing and claims management are performed by FmHA staff.

national average for all homes sold in that year. (See Table IV-10.) FmHA officials have gone on record as refusing to finance any solar homes for the time being, on the grounds that the technology remains too experimental for use by the lower income homeowners assisted through their programs. Moreover, FmHA's lending programs are focused upon very small towns with populations of 10,000 or less (or 20,000 or less where conventional financing is not otherwise available). For FmHA to successfully market a solar loan program to rural homeowners having average incomes or above would require an effort to reach out to moderate sized towns and to moderately affluent borrowers who associate its programs exclusively with assistance to poorer families.

Turning to more urbanized communities, no established network exists that readily lends itself to the delivery of direct Federal loans. HUD's Section 312 program provides direct loans to lower income homeowners to rehabilitate their properties, with all loan origination and servicing handled through local public agencies. Use of the program has largely been confined to a limited number of larger cities and to designated target areas or urban renewal areas. In addition, a number of cities have set up programs to make home improvement loans using CDBG funds and/or state and local monies. However, nothing remotely resembling a nationwide network of local loan offices can be said to exist at this time. Conceivably, loans might be administered directly through HUD's 10 regional offices and 76 area/insuring offices (Table IV-7). However, such an arrangement would be highly inconvenient for most homeowners and would necessitate the creation of entirely new capabilities within these offices.

The consumers interviewed as part of this study were asked whether they would prefer applying for a subsidized loan through a public agency or a private lender. Nearly 40% indicated a strong preference for a privately originated loan, while less than 10% favored dealing directly with the government. (See Table IV-8.)

Table IV-7

SOLAR ENERGY DELIVERY SYSTEMS ALTERNATIVES

Type of Institution	Number of Field Offices/ Participating Institutions
1. Federal Agencies	
HUD	
Area/Insuring Offices	76
Regional Offices	10
FmHA	
County Offices	1,760
VA	
Regional Offices	49
2. State and Local Government Agencies	
States	
State Housing Agencies	39
Local Government Agencies	
CDBG Recipients	3,338
CDBG Recipients proposing housing/rehab type programs	1,470
Section 312 Agencies	200-250
3. Private Institutions (Categories overlap)	
Title I Lenders	
Approved	10,000
Active	4,600
FHA Mortgagees	
Approved	11,700
Active	7,500
FNMA Originators	
Approved	3,000
Active	1,500
Very Active	400-500
FHLMC Originators	
Federally Supervised Savings & Loans	2,048
Active	1,400
GNMA Originators	
Approved (all are FNMA approved originators)	1,000
VA Mortgagees	
No approval system	NA

Source: Interviews with respective agencies

Table IV-8

RELATIVE LIKELIHOOD OF USING SOLAR LOAN PROGRAM IF ADMINISTERED BY A PRIVATE LENDER (COMMERCIAL BANK/SAVINGS & LOAN) OR THROUGH A GOVERNMENTAL AGENCY	
Much more likely to use if bank	37%
Somewhat more likely to use if bank	11%
No preference for either	31%
Somewhat more likely to use if government agency	8%
Much more likely to use if government agency	12%

Option #2: An interest reduction program in which the government reimburses private lenders on a periodic basis for the interest differential between a market rate loan and a subsidized below-market rate interest loan.

To be effective, a program organized along these lines would have to enlist the widespread participation of those commercial lending institutions to whom borrowers normally turn for home improvement and second mortgage financing. As can be seen from Table IV-4, these consist primarily of commercial banks, savings and loans, and credit unions. The only identifiable group of such lenders having an established relationship with a Federal housing agency are those authorized to write loans under FHA's Title I insurance program. At the present time, the active participants in Title I number 4,500, and include roughly 20% of all commercial banks and savings and loan associations. At first glance, this might appear to provide an adequate network for marketing a solar loan program to homeowners and homebuyers. However, there is good reason for believing that this would not prove to be the case.

- Over the past twenty-five years, Title I's share of the home improvement market has declined from over 50% to less than 18%, as lenders have come to see home improvement loans as a safe investment not requiring insurance. The program's 12% interest ceiling and competition from private loan insurers have also been factors in the program's decline.

Many Title I lenders make only nominal use of this program; the average active lender made 53 Title I loans in 1975, while the largest 20 participants made over 20% of all Title I loans. Thus, the visibility and strength of program activity varies widely from lending area to lending area, and is particularly thin in Southern and Western states. (Table IV-9).

Table IV-9

REGIONAL DISTRIBUTION OF OWNER OCCUPANTS AND TITLE I LOAN ACTIVITY – 1975

Region	Number of Owner/ Occupants (in 000's)	Percent of Total	Number of Title I Loans	Percent of Total
Northeast	9,818	21.1	46,567	19.1
North Central	13,455	28.7	118,037	48.4
South	15,332	32.8	59,435	24.3
West	8,263	17.4	20,854	8.2
Total	46,867	100.0	244,893	100.0

Source: Annual Housing Survey 1975 Part A and Title I Property Improvement Loan Program June 1977.

- Even the more active Title I lenders may be resistant to participating in an interest subsidy program. Title I procedures require no special paperwork or consultation between the lender and FHA, except notification of loan activity, unless a claim is made under the insurance. A subsidy program, however, would inevitably involve a greater amount of special processing, record keeping, and reporting. Moreover, the average size loan insured through Title I is roughly $3,000, about double the cost of a typical solar hot water installation. Without some special inducement, solar loans (with the exception of the limited number that may be written for more costly space heating systems) may appear too small to justify the time and expense involved in dealing with a government program.

Although less likely, the interest subsidy program could be made available for conventional loans that met specified standards. Some non-Title I lenders might participate if paperwork were minimal, reviews expeditious, and servicing fees set fairly high in relation to the loan amount.

In respect to newly-built single family homes, a precedent for a mortgage subsidy program run through private lenders can be found in HUD's Section 235 program. Given the problems that have plagued the Section 235 existing housing programs, including widely-publicized revelations of fraud, the precedent is not an auspicious one. This raises a serious question in respect to the likelihood of developers and contractors using a Federal loan program to help market solar systems to their customers and of private lenders cooperating in such efforts. Presumably a solar loan program would be a far simpler proposition to administer smoothly than the traditional HUD subsidy programs aimed at lower income households: the clientele for the program will be homeowners of average or above average income, not a special high-risk population; the item being financed is a mechanical system, not an entire property. However, our interviews suggest that many, if not most, builders and lenders will automatically associate a Federal loan subsidy program with low and moderate income families and all the complexities of income certification, property inspection, high default rates, and claims processing procedures such programs have involved. This includes builders and lenders who deal exclusively with the conventionally financed segment of the market, as well as those that have participated in Federal programs in the past and, as a result, are extremely leery of doing so again in the future. Thus, no matter how free of red tape a solar loan program may be, and no matter how creditworthy its target population, it will still have to overcome these negative associations in order to attract any meaningful level of private sector involvement.

Option #3: A Solar Tandem Plan under which GNMA would issue commitments for the purchases of loans made at below-market rates (either mortgage loans on new homes or separate solar loans) and either warehouse the loans or resell them to FNMA at prices reflecting the latter's higher yield requirements.*

Applicability to newly built homes

In the case of first mortgage loans on new solar homes, interest subsidies could easily be provided by utilizing GNMA-FNMA Tandem Plan arrangements which are already in place.** Under these Tandem Plans, loan origination and, as a rule, loan servicing are performed through a network of approved private lenders, consisting for the most part of mortgage bankers.*** Mortgage bankers originate about 75% of all FHA/VA insured loans (Table IV-3) and close to 90% of all loans purchased by GNMA or FNMA. It should be emphasized, however, that this network affords market access primarily to purchasers of homes that sell below the median price and which are built by merchant homebuilders. (As Table IV-10 shows, the average FHA insured new home sold for nearly $15,000 less than the average conventional home, and the average VA home for nearly $12,000 less.)

In order for a Solar Tandem Plan to reach the majority of conventionally financed new homes, it would have to involve savings and loan associations, by far the most important source of mortgage funds for

*GNMA designates the Government National Mortgage Association, organized primarily to provide a secondary market for loans written under government subsidized interest programs; FNMA is the Federal National Mortgage Association, whose purchase programs feed mortgage funds into local housing markets where capital is in short supply. GNMA operates within the Department of Housing and Urban Development; FNMA (since it was spun off from HUD in 1968) is a privately owned, but Federally supported and regulated stock corporation. They are frequently referred to as Ginnie Mae and Fannie Mae, respectively.

**GNMA is not purchasing single-family mortgages at the present time; however, interviews with the officials of the Association suggest that there would be no serious difficulty in re-activating single-family purchase arrangements for the purposes of a Solar Tandem Plan.

***Mortgage bankers or mortgage companies are not deposit institutions and rarely maintain loan portfolios of their own; they are primarily in the business of originating loans on behalf of other investors and realize their profits from origination and servicing fees.

Table IV-10

MARKET SHARES AND SALES PRICE OF NEWLY BUILT, SINGLE FAMILY HOMES IN 1975 BY TYPE OF FINANCING

	No. Units (000's)	%	Average Sales Price
FHA	78	9	$32,900
VA	69	8	$35,700
FMHA	61	7	$23,100
Total Federal Market Share	208	24	$31,000
Conventional	502	58	$47,400
Cash	156	18	$42,200
Total US	866	100	$42,600

Source: HUD Office of Management Information

such properties. Only a few of the larger, more progressive S&L's (most conspicuously in capital short areas such as California and the Sunbelt) participate directly as sellers to GNMA/FNMA. However, the Federal Home Loan Mortgage Corporation (FHLMC) -- which serves as an in-house secondary market for the savings and loan industry -- offers a direct link to individual S&L's throughout the country. This relationship has been utilized on one occasion in the recent past to carry out a major Tandem Plan. Under the Emergency Home Purchase Acts of 1974 and 1975, Ginnie Mae, for the first and only time, was authorized to purchase conventional mortgages at the government borrowing rate. For the purposes of this program, FHLMC acted, in effect, as an agent conveying mortgages originated by individual S&L's to Ginnie Mae, which subsequently resold them to FNMA and other institutional investors at the prevailing market rate.

In sum, the machinery for reaching new homebuyers through the Tandem Plan type arrangement is already in place.* Whether this machinery should be activated for the purposes of a small volume, solar loan

*In respect to the potential access to the mortgage market achievable through a Tandem Plan, it is interesting to note that an increasing and substantial proportion of lenders who are not active participants in the secondary market at present, nevertheless have begun to underwrite their mortgage loans in compliance with FHLMC/FNMA guidelines and forms in order to ensure their eligibility for purchase should the need arise. This trend was accelerated by the "disintermediation" of several years ago, which made lenders more concerned with maintaining their mortgage portfolios on a liquid footing.

program is questionable, since over the next few years, the bulk of solar installation will be for solar hot water purposes only and will thus involve a relatively modest incremental cost in the context of a new home purchase. Perhaps several years from now, as the market for solar space heating begins to coalesce and solar space cooling systems enter the commercialization stage, a special Tandem Plan for new homes incorporating these larger and more costly types of solar technologies would be desirable.

Tandem Plan for separate solar loans less feasible

A "Tandem Plan" approach would be much harder to create for a program providing loans that are separate from the first mortgage and that cover solar costs only. An entirely new mechanism would have to be created and promoted, since no Federally-supported secondary market program presently exists for consumer loans (that is, unsecured personal loans) or even for property improvement loans that are secured by a subordinated mortgage. Institutions actively participating in Title I constitute the logical group of private lenders who would have to be recruited as sellers for a Tandem Plan involving separate solar loans. The problems of gaining access to the housing market as a whole through the Title I network, discussed above in connection with the periodic interest subsidy option, also applies here.*

There has been some discussion in recent years of creating a secondary market for home improvement loans in general, and Title I loans in particular. President Carter, as part of his overall Energy Plan, has proposed that FNMA be authorized to purchase home improvement loans for energy conservation purposes.** Needless to say, if such a secondary market program were fully operative, it could easily be utilized to provide a subsidy for solar loans.

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*At one time, mortgage bankers were more active in Title I lending, but primarily where relatively larger amounts were involved and loans were originated through dealers.

**Officials at FNMA interviewed as part of this study indicated their belief that they already have authority to purchase Title I loans, although this authority has never been used.

However, even in the event that this market were created, lenders might prove relatively disinterested. The public and private officials with whom we spoke indicated that, in respect to home improvement lending (whether for solar system purchases or any other purpose), there is neither a shortage of capital nor a problem of liquidity at the present time -- the two conditions that would argue most powerfully for the need to create a secondary purchase program. And, given the small dollar amounts and far shorter maturities associated with home improvement type loans when compared with mortgage loans, lenders will be less motivated to perform the paperwork involved and less attracted by the servicing fees (unless such fees are set at an extremely high level in relation to the face value of the loans).

4. The Administering Agency

Should a loan incentive be adopted, interviews with homebuilders and lenders conducted as part of the study confirmed our earlier finding that:

> Most [housing market participants] would prefer that any solar incentive program be administered through the Federal housing agencies with whom they have traditionally dealt, rather than through Federal energy agencies or any new entity [e.g., a special solar financing bank] that might be created for the purpose of promoting solar technology....Above all, lenders, in describing the desirable characteristics of whatever agency may administer an incentive program, stress the importance of professionalism (i.e., staff who "can speak the language of banking and mortgage finance"), and, of course, a minimum of red tape.*

Lenders in particular have a fairly high regard for the real estate and financing expertise of FNMA/FHLMC, and would appear to be most receptive to Tandem type arrangements involving the active participation of these secondary market entities. Nevertheless, it was recognized that the specialized nature of their function precludes their being the primary administrative instrument for orchestrating an incentive program.

Despite a lack of enthusiasm for HUD/FHA programs, particularly as

*Barrett, Epstein, and Haar, Financing the Solar Home: The Importance of Understanding and Improving Mortgage Market Receptivity to Housing Innovation, RUPI, Inc. (June, 1976) (Research supported by the National Science Foundation) they have operated since being re-oriented towards lower and moderate income families during the sixties, most of those interviewed acknowledged that HUD was the most logical agency to administer any incentive oriented towards the housing market.

F. COST EFFECTIVENESS OF LOAN OPTIONS

A major argument frequently advanced in support of loan programs as a preferred form of Federal financial support, is that they are in large part self-financing, with principal and interest being repaid over time.* However, as suggested by the market impact estimates presented above, extremely deep interest subsidies may be required to elicit any significant consumer response to a loan incentive. In addition, loan programs invariably involve substantial administrative costs.

The public costs associated with each of the three loan delivery options evaluated (direct government loans, subsidy payments to lender, and a "Solar Tandem Plan") can be understood more clearly when analyzed in terms of their respective (1) subsidy costs (defined here as including any loan losses incurred), (2) administrative costs, and (3) costs

*From a political perspective, another attraction is that budgetary impacts may be spread over a period of years, even though the total program costs in present value terms may be quite high. The extent to which this is true depends to a large degree on the specific delivery model adopted and the manner in which various costs are accounted for. Under a direct government loan program, the total principal loaned may appear as a budgetary expense in the early program years even though it will be repaid over time. For example, the 312 rehab loan program is funded as an annual budgetary expense, with appropriations added to the Rehabilitation Loan Fund. However, capital losses simply reduce the fund and are not recorded as budgetary charges. The Section 202 elderly housing loan program operates through a special revolving fund which is capitalized by direct borrowings from the Treasury rather than annual appropriations. Another variation was used in the Participation Sales Program for College Housing and Public Facility Loan program. Under this approach HUD held the loans but sold participations in them to investors. All transactions were treated as budgetary expenses (participation sales were recorded as income; loan amounts and default losses were entered as expenses).

attributable to the tax deductibility of interest. (Tables IV-11, IV-12, and IV-13 summarize these components of public costs for 100% separate hot water loans, 100% separate space heating loans, and 75% solar loans combined with mortgages, respectively.)

1. Direct Subsidy Costs

Under the direct loan approach, the subsidy amount reflects the cost of capital to the government for the principal loaned as well as the interest differential between the subsidized rate and the government borrowing rate. The figure shown here in Tables IV-11 and IV-12 also includes an allowance for bad debts, corresponding roughly to the default and claim loss experience with Title I and FNMA loans.

In the case of the subsidy payments to lender option, the subsidy simply consists of the periodic payments. However, these are calculated on the sizable differential between the subsidized rate offered the borrower and the 12% market rate assumed as a minimum for enlisting lender participation.*

Similarly, in the case of a Tandem Plan for separate solar hot water loans, it is assumed that GNMA originates the loans through private lenders at the below-market-interest rate, and subsequently disposes of them to FNMA at the 12% market rate. This interest differential explains why the subsidy cost component of total program cost is higher for both the Tandem and Subsidy Payment options than for the Direct Government Loan Program.

Table IV-13 shows the magnitude of these subsidy costs for a single one per cent, 20-year loan used to purchase a $1,500 solar hot water system. For example, under the "subsidy payment to lender" option, the

*This 12% figure might be lowered by providing a 100% federal loan guarantee. For example, under the student loan program, the students borrow funds at 7%, while the lender receives a quarterly allowance from the Federal government that brings his return to approximately 10%. (The precise rate is a fluctuating one, pegged at 3-1/2% above the average rate on 90-day Treasury notes for the previous quarter.) With the 100% guarantee, this 10% rate is sufficient to attract a reasonable level of private lender participation. However, the saving realized by the government under this arrangement in terms of reduced interest subsidy payments is more than balanced out by the increased costs it incurs in being fully liable for all loan losses.

Table IV-11

SOLAR DOMESTIC HOT WATER SYSTEMS: PUBLIC COSTS OF 100% SEPARATE LOANS
Estimates for Units Installed in Single Family Homes During Five Year Period, 1978-1982

Baseline: Units Installed without Incentive, 1978-1982 = 178,000

Loan Terms	Units in Program[a] (1978-1982)	Subsidy Cost ($ millions)	Administrative Cost ($ millions)	Total Program Cost[b] ($ millions)	Units Induced[c]	Cost/ Induced Unit[b]	Cost of Interest Deduction ($ millions)
DIRECT LOAN							
7%, 10 years	47,600	$ 2	$25	$26	24,300	$1100	3
5%, 10 years	75,500	11	39	49	39,200	1300	2
3%, 15 years	106,000	31	59	89	63,300	1400	2
1%, 20 years	146,600	67	87	154	98,800	1600	(1)
SUBSIDY PAYMENT TO LENDER							
7%, 10 years	47,600	11	11	23	24,300	900	3
5%, 10 years	75,500	25	18	42	39,200	1100	2
3%, 15 years	106,000	51	27	78	63,300	1200	2
1%, 20 years	146,600	94	40	135	98,800	1400	(1)
TANDEM PLAN							
7%, 10 years	47,600	11	3	14	24,300	600	3
5%, 10 years	75,500	23	4	27	39,200	700	2
3%, 15 years	106,000	47	6	53	63,300	800	2
1%, 20 years	146,600	87	8	95	98,800	1000	(1)

[a] Excludes portion of households in "baseline" who do not use incentive. Portion excluded declines with depth of subsidy. See Methodological Note, Appendix "C."
[b] Numbers may not add due to rounding.
[c] Induced units are those purchased **only** because of the incentive, excluding subsidy recipients counted in the baseline.

Table IV-12

SOLAR COMBINED HEATING/HOT WATER SYSTEMS: PUBLIC COSTS OF 100% SEPARATE LOANS
Estimates for Units Installed in New Single Family Homes During Five Year Period, 1978-1982

Baseline: Units Installed without Incentive, 1978-1982 = 13,000

Loan Terms	Units in Program[a] (1978-1982)	Subsidy Cost ($ millions)	Admin-istrative Cost ($ millions)	Total Program Cost[b] ($ millions)	Units Induced[c]	Cost/ Induced Unit[b]	Cost of Interest Deduction ($ millions)
DIRECT LOAN							
7%, 10 years	4,100	$ 1	$ 3	$ 4	700	$5,600	($1)
5%, 10 years	7,600	5	5	9	1,700	5,600	(2)
3%, 15 years	18,300	24	12	35	10,300	3,400	(2)
1%, 20 years	40,600	79	25	104	29,600	3,600	(4)
SUBSIDY PAYMENT TO LENDER							
7%, 10 years	4,100	4	2	6	700	8,600	(1)
5%, 10 years	7,600	10	2	13	1,700	7,600	(2)
3%, 15 years	18,300	39	5	45	10,300	4,300	(2)
1%, 20 years	40,600	11	12	123	29,600	4,200	(4)
TANDEM PLAN							
7%, 10 years	4,100	4	1	5	700	7,300	(1)
5%, 10 years	7,600	10	1	11	1,700	6,400	(2)
3%, 15 years	18,300	37	2	39	10,300	3,700	(2)
1%, 20 years	40,600	103	3	106	29,600	3,600	(4)

[a] Excludes portion of households in "baseline" who do not use incentive. Portion excluded declines with depth of subsidy. See Methodological Note, Appendix "C".
[b] Numbers do not add due to rounding.
[c] Induced units are those purchased **only** because of the incentive, excluding subsidy recipients counted in the baseline.

government would pay the private lender $118 yearly -- that is, the difference between the $201 payment that he would normally receive for a 12% conventional home improvement loan, and the $83 paid by the solar purchaser receiving the benefit of the subsidy. Assuming the loan is prepaid in nine years, the cost of the interest subsidy to the government in present value terms would be $751 or just 50% of the solar system's cost.

For combined solar heat/hot water systems in newly-built homes, the program options were also costed out on the assumption that an interest subsidy on the solar portion of the home's cost is applied to the mortgage loan on the entire property. (Table IV-14). Here, the cost calculations are done for only two administrative models (the Tandem Plan and interest subsidy) since creation of a direct government mortgage loan program for such purpose has no precedent and would clearly be inappropriate.* The subsidy cost shown in Table IV-14 for the Tandem Plan for 75% mortgage loans assumes that the loans are resold to FNMA at a price reflecting its minimum acceptable return on investment, currently about 8% (essentially FNMA's cost of capital and an allowance for administrative expense and profit).**

Under the type of Tandem arrangements for which cost estimates were made, the total amount of the subsidy would be borne by the government in one year, rather than spread over the life of the loan as would be the case in a direct loan or monthly subsidy payment plan. In the event that GNMA simply warehoused the loans itself rather than reselling them, the program would, in effect, take on the characteristics of a direct loan program, with comparable costs for loan losses and opportunity costs on the

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*This would involve the government in underwriting the entire property, loaning the full mortgage amount, and assuming substantial risks having nothing to do with the solar feature itself.

**At present, this minimum return is roughly 8%. In preliminary discussions, FNMA officials indicated that, if a solar tandem plan were mandated, they might negotiate the purchase of below-market-rate solar loans at this yield -- at least insofar as the program volume was relatively modest and had no adverse effect on the Association's borrowing rate.

TABLE IV-13

PRESENT VALUE COST TO GOVERNMENT OF INTEREST SUBSIDY FOR A SINGLE SOLAR HOT WATER LOAN

LOAN TERMS: 1% - 20 years on 100% of $1,500 system cost. Loan is assumed to be prepaid without penalty at end of ninth year.

DIRECT LOAN PROGRAM

End of Year	Cash Flow	Present Value @7.5%	Explanation
0	($1,500)	($1,500)	Loan funds disbursed to solar purchaser.
1-9	83	530	Annual payments on loan.
9	862	449	Balloon payment.
		($521)	Net Present Value

SUBSIDY PAYMENT TO LENDER

End of Year	Cash Flow	Present Value @7.5%	Explanation
1-9	($118)	($751)	Government pays difference between the $201 payment that lender would receive at conventional 12% rate, and the $83 paid by homeowner.
		($751)	Net Present Value

SOLAR TANDEM PLAN

End of Year	Cash Flow	Present Value @7.5%	Explanation
0	($1,500)	($1,500)	GNMA disburses loan funds.
0	754	754	FNMA purchases loan at discount, FNMA price of $754 is present value of 9 years of payments and 9th year balloon (See Direct Loan) discounted at 12%.
		($746)	Net Present Value

NOTE: To simplify the example, loan payment and present value calculations have been made on an annual basis. GNMA purchase and resale assumed to occur at same point in time.

amounts of principal outstanding.*

2. Administrative Costs

Any estimate of the administrative costs likely to be associated with various solar loan options involves a host of assumptions (re: start-up costs, the complexity of processing procedures, etc.) each of which is highly conjectural and introduces a substantial potential for error into the analysis.** However, under even the most optimistic of assumptions, a loan type program for solar hot water systems will necessitate fairly high transaction costs. Most private lenders regard loans in amounts of $1,000 to $1,500 as the absolute minimum required for profitable lending operations. Figures published by the Federal Reserve Board indicate that it requires from $35 to $55 for a commercial bank to place a consumer loan on the books and $2.50 to $3.00 per payment to service it.*** Using these averages, an eight year $1,500 solar loan would cost a total of from $275 to $343 to originate and service, or between 18% to 23% of the principal loaned.

A Federal solar loan program, even if as efficiently run as a private lending operation, would invariably involve some greater expense -- for start-up costs, public information services, congressional relations, solar system screening and consumer protection, and, most importantly,

*This option has been adopted by GNMA when the particular type of mortgage instrument is not a readily marketable security that can either be placed in a mortgage-backed security pool or sold at auction to other investors. For example, GNMA bought over $1.5 billion dollars of section 221(d)3 loans which were kept in its portfolio, with services provided by FNMA.

**To find a major precedent for Federal subsidy and secondary purchase of small consumer loans, one must turn from the housing field to the government's Guaranteed Student Loan Program and its associated secondary market entity, Sallie Mae. Here the government was undertaking a massive and open-ended commitment to provide financing for a large, high-risk borrower population, most of whom could not otherwise secure financing from conventional sources. This program currently writes nearly a billion dollars of loans annually; Sallie Mae, since it began purchasing loans in 1975, has accumulated a portfolio of over half a billion dollars. The program is highly complex, involved start-up costs of several million dollars and over two years to put in operation. Administrative costs and loan losses have been extremely high. (The program now has over 500 employees, more than 200 of whom work settling claims in defaulted loans.)

***Federal Reserve Bank of Boston, Functional Cost Analysis; 1975 Average Banks, pp. 12.2, a-c.

promoting and servicing loans that would be originated in modest volumes through outlets dispersed around the country, rather than through a single institution.

The accompanying tables provide rough order-of-magnitude estimates of administrative costs for delivery options, given the program volumes anticipated at various levels of subsidy. Of the three models, the direct government loan approach would necessitate by far the highest administrative expense. The start-up costs involved in setting up a network of loan offices, training field representatives, drafting regulations and underwriting guidelines, publicizing the program -- could prove substantial. This would be true even if the program were administered through HUD and FmHA, both of which have most of the in-house capabilities that would be required.

Moreover, the entire gamut of administrative functions (credit and technical appraisals, collection of payments, claims management*) would be performed by public staff. Processing of HUD 312 rehab loans or a Farmer's Home 504 repair loan requires as much as 20 man-hours or close to $300.** Both these programs involve an extensive amount of hand-holding with the individual borrower; in addition to certifying the applicant's eligibility (verifying data on income and personal assets), public agency staff are involved in reviewing blueprints, preparing plans and specifications, obtaining bids from contractors, and on-site property inspections. Presumably a solar loan program, with borrowers subject to normal credit standards, would be substantially cheaper to administer. On the other hand, procedures for certifying eligible costs and the compliance of solar systems with established performance standards could prove to be cumbersome and expensive to administer. And, it should be emphasized

*As a rule, Federal loan and loan insurance programs for home improvement type financing do not get involved in the expense of foreclosure proceedings and property disposition, even where a second mortgage is involved. In the case of defaults, field representatives will meet with the borrower as necessary to work out an orderly repayment schedule. Ultimately, the case may be referred to the U.S. Attorney General who may enforce a judgment lien against the property if and when it is resold.

**Based on cost of an average HUD man-year, weighted to include overhead expense. Source: HUD Budget Office, and FmHA.

again that the loan amounts for solar hot water, at least, would be relatively small; FmHA Section 504 loans average above $3,000, and the typical HUD 312 loan exceeds $10,000.

Under the "subsidy payment to lender" approach, the government's responsibility extends only to mailing subsidy payments and routine record-keeping, unless the loans are also backed by a guarantee. The burden of underwriting the loan and dealing with bad debts would reside entirely in the hands of the private lender.

Under the basic Tandem Plan arrangement, government involvement extends only from the time a purchase commitment is made by GNMA until the loan is acquired and transferred to another investor. Although Ginnie Mae is the holder of record during this interim period, the administrative tasks involved in issuing a commitment, administering the portfolio, etc., are performed by FNMA (and its approved sellers) on the basis of a negotiated fee. Should Ginnie Mae hold the solar loan indefinitely, FNMA -- and the mortgage banker or other private lender who originated the loan -- would continue to provide the basic servicing required on the loan until such time as the debt is repaid. Under this arrangement, total administrative costs incurred by GNMA would approximate those of the direct loan option -- the only difference being that origination and possibly servicing would still be performed by mortgage bankers and other private lenders on a fee basis rather than by public agency staff.

The establishment of a special Tandem Plan mechanism for separate solar loans might necessitate fairly substantial start-up costs. A standardized debt instrument and underwriting guidelines would have to be developed such as already exist for mortgage loans traded in the government-supported secondary market. And, as indicated earlier, sizable expenditure and effort might be required to recruit and structure the participation of private lenders. This type of investment could be better justified only within the context of a more comprehensive effort to create a secondary purchase program for energy conservation loans (as proposed in the President's Energy Plan), or for home improvement loans in general. Here again, however, the small cost of the average home improvement (particularly for home weatherization investments such as storm windows or insulation) and the general availability of funds for home improvement loans may weigh heavily against such an initiative.

3. Net Public Costs Attributable to Tax Deductibility of Interest

With any subsidized interest rate program, one can identify opposing effects on government revenues that result from the tax deductibility of interest for Federal income tax purposes. First, public costs are increased by those taxpayers (the "induced" purchasers) who are deducting on solar systems that they have installed only because of the Federal incentive. Second, with below-market financing options, the government recoups some revenue from those homeowners who would have purchased solar systems even in the absence of an incentive program (the "windfall recipients") but are now claiming tax deductions based on the subsidized rather than the market interest rate.

As can be seen from Table IV-11, in the case of a seven per cent, 10-year government rate loan for solar hot water purchases, taking the cost of interest deductions into account would add another $3 million, or 12% to the 5-year program costs. As the subsidy deepens, tax revenue "losses" decline, until, with a one per cent, 20-year loan, the government actually experiences a net revenue gain. In the case of a separate loan for 100% of solar space heating costs, the government records a revenue gain at all subsidy levels for which estimates were made.*

An implication of the analysis is that in the case of a loan program, the inclusion of costs attributable to tax deductions lessens the net cost to the government of benefits claimed by individuals who receive their subsidies as a windfall for an investment they had already been prepared to make.

4. Conclusion

Figure IV-3 summarizes the relative cost-effectiveness of the three loan delivery models as they apply to both solar hot water and homes

*The greater tax revenue gain from the separate (100%) loan for space heating compared with the 75% loan, reflects the fact that in the former case, the private financing utilized by "windfall" recipients in the absence of a government program is assumed to be 12% home improvement/second mortgage financing as opposed to a 9% mortgage loan.

Table IV-14

SOLAR COMBINED HEATING/HOT WATER SYSTEMS: PUBLIC COSTS OF 75% SOLAR LOAN COMBINED WITH MORTGAGE Estimates for Units Installed in New Single Family Homes During Five Year Period, 1978-1982

Baseline: Units Installed without Incentive, 1978-1982 = 13,000

Loan Terms	Units in Program[a] (1978-1982)	Subsidy Cost ($ millions)	Administrative Cost ($ millions)	Total Program Cost[b] ($ millions)	Units Induced[c]	Cost/ Induced Unit[b]	Cost of Interest Deduction ($ millions)
SUBSIDY PAYMENT TO LENDER							
7%, 30 years	13,000	$ 7	$ 5	$12	5,700	$2100	$2
5%, 30 years	25,000	26	9	35	14,200	2400	2
3%, 30 years	39,000	57	14	71	30,000	2400	2
1%, 30 years	63,200	118	22	139	53,000	2600	(2)
TANDEM PLAN							
7%, 30 years	13,000	6	1	7	5,700	1200	2
5%, 30 years	25,000	24	1	25	14,200	1800	2
3%, 30 years	39,000	56	2	58	30,000	1900	2
1%, 30 years	63,200	117	3	120	53,000	2300	(2)

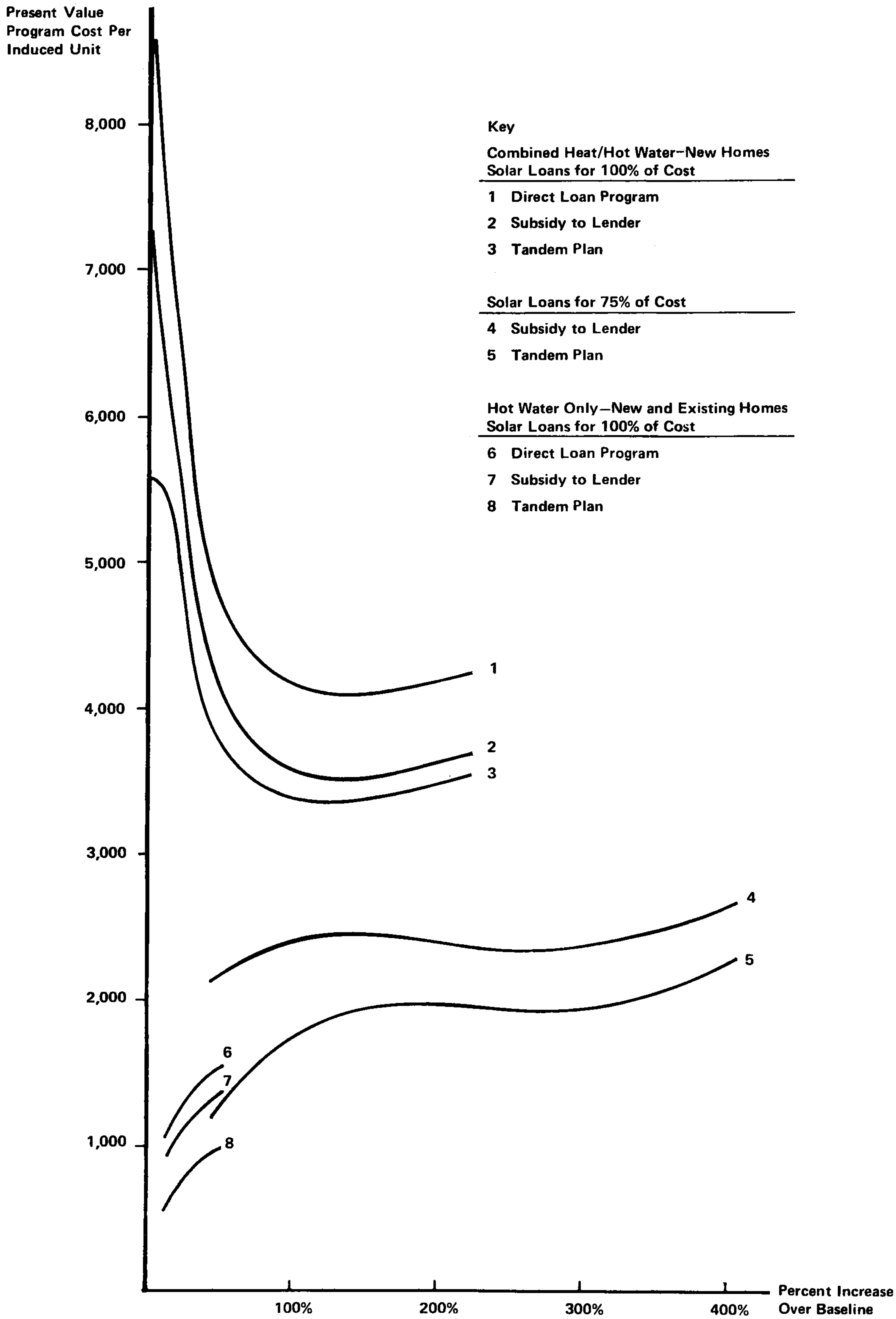
[a] Excludes portion of households in "baseline" who do not use incentive. Portion excluded declines with depth of subsidy. See Methodological Note, Appendix "C".
[b] Numbers may not add due to rounding.
[c] Induced units are those purchased **only** because of the incentive, excluding subsidy recipients counted in the baseline.

with combined solar space heating/hot water systems. As can be seen, the direct government loan involves measurably greater public expenditure for each household "induced" to purchase a solar hot water system because of the availability of below-market rate financing than either of the two alternative loan delivery models. In large part, this is due to administrative costs, which actually exceed subsidy expenses at the relatively low volume of response indicated for the hot water loan (See IV-12).

In the case of the separate loan program for combined space heating/hot water, the situation is reversed, with the direct loan actually appearing somewhat more favorable in terms of "cost per induced unit". This is due to the greater responsiveness to the loan option within the space heating segment of the market. As a result, the sizable fixed start-up costs for the loan program are amortized over a larger number of units, while both the Tandem arrangement and subsidy payment approach

Figure IV-3

COMPARATIVE PROGRAM COST PER INDUCED UNIT, LOAN INCENTIVE OPTIONS



involve substantially greater subsidy costs/unit.

By comparison, applying the interest subsidy to a mortgage loan (particularly through a Tandem Plan) appears much more efficient than a direct separate loan as a means of encouraging residential use of combined space heating/hot water systems in new homes. For example, a three per cent, 30-year financing for a solar system when combined with a 75% mortgage loan results in an additional 30,000 units being installed above the baseline, roughly the same increase in solar hot water usage (29,600 units or 222%) as a one per cent, 20-year direct government loan for 100% of system costs. However, the former option achieves this impact at a cost per induced unit under $2,000, or $1,700 less than the induced cost per unit for the direct government loan. (Tables IV-12 and IV-14). The suggestiveness of these results, however, at least for the near term, are mitigated by the small program volumes estimated for a space heating loan subsidy (less than $10 million in the first year and $20 million in the second, under the deepest subsidy plan tested) (Table IV-15). This hardly seems sufficient to justify reactivating the secondary market relationships (dormant since the Emergency Home Purchase Act was phased out) needed to re-establish a Tandem type operation for conventional mortgage loans.

Table IV-15

ESTIMATED ANNUAL BUDGETARY IMPACT OF TANDEM PLAN FOR 1%, 30-YEAR LOANS FOR COMBINED HEAT/HOT WATER SYSTEMS, 1978-1982 (All Program Costs in Nominal Dollars)

Year	Annual Program Volume	Subsidy Cost	Administrative Cost	Total Program Cost	Cost From Interest Deduction
1	800	$ 8,100,000	$ 936,000	$ 9,035,000	($ 36,000)
2	8,000	15,814,000	273,000	16,086,000	($ 106,000)
3	12,300	24,903,000	442,000	25,345,000	($ 217,000)
4	17,000	35,972,000	657,000	36,629,000	($ 380,000)
5	22,100	49,728,000	935,000	50,663,000	($ 606,000)
Total	62,000	$134,516,000	$3,243,000	$137,759,000	($1,345,000)

Note: Numbers may not add due to rounding.

In sum, low-cost financing approaches at the small dollar amounts required for solar hot water systems, have administrative costs and complexities that make a loan approach unworkable in practice. By contrast, once sufficient market potential has materialized to justify a space heating incentive, a "Solar Tandem Plan" for mortgages on newly-built solar homes may merit some consideration as an alternative or supplement to "front-end" subsidies on grounds of both cost and impact. At present, however, the probable demand for solar space heating seems more appropriate to the type and scale of support provided through demonstration programs than direct financial incentives.

CHAPTER V

SUPPLEMENTARY MEASURES TO IMPROVE THE AVAILABILITY OF FINANCING

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CHAPTER FIVE

SUPPLEMENTARY MEASURES TO IMPROVE THE AVAILABILITY OF FINANCING

A. OVERVIEW

The preceding chapter examined the feasibility of Federal direct loans or loan subsidies as a means of reducing the financing costs for homeowners installing solar energy devices. A separate issue relates to the need and options for improving the availability of financing at market rates from conventional sources such as savings and loan associations, mortgage bankers, and commercial banks.

Homeowners who wish to retrofit solar systems to an existing residence and are able to satisfy routine credit standards should encounter no difficulty securing home improvement loans on normal terms.* Given this ready availability of funds, no need exists within the existing home segment of the solar market for Federal loan guarantees or other lender-oriented types of incentives.

By contrast, Federal action may be needed to improve the availability of mortgage financing for newly-built solar homes. The size of mortgage loans is based on an appraisal of the property's market value. In the short run, many mortgage lenders will discount solar costs in their appraisals. As a result, a borrower will have to pay for a higher portion of solar costs in the downpayment on his new home than he would for some other conventional housing component. Possible measures for encouraging loans that are closer to "normal" financing ratios include:

(1) a tax credit for foreclosure losses on solar homes;

(2) some form of special insurance or guarantee to lenders against losses attributable to including solar costs in mortgage loans;

*However, there is a sizable portion of homeowners (over one third had incomes of less than $10,000 in 1975) who may not be able to secure financing because lenders do not consider them creditworthy or they cannot afford to repay borrowed money. As was suggested in Chapter 1, our analysis is predicated on the assumption that "creditworthiness" is an appropriate self-screening device -- that is, that those households so financially constrained that they are unable to self-finance the cost of a solar hot water retrofit installation should not be encouraged by Federal programs to undertake the substantial risks involved.

(3) liberalized loan ceilings and appraisal policies for solar homes under FHA, VA, and FmHA programs.

A program along these lines could be an important complement to the more direct form of financial incentives under review (tax credits, rebates, BMIR loans). Costs to the government would be fairly nominal, since losses would be incurred only if it should prove necessary to foreclose on a solar home, and only if the property were then disposed of for less than the outstanding balance of the mortgage. However, before implementing any such program, careful consideration should be given to the important role that lenders play in helping to screen out less effective or overpriced solar systems, and to the risks -- to borrowers, lenders, and government insurance programs -- of either encouraging or mandating appraisals that may exceed actual market values. This concern is most important in the case of Federal credit programs that assist low and moderate income borrowers.

Congress should also consider action to ensure that borrowers contemplating purchase of solar-equipped homes are not penalized by credit appraisal procedures (currently in widespread use) which make no allowance for projected energy savings.

B. THE LIKELIHOOD OF LARGER DOWNPAYMENT REQUIREMENTS FOR SOLAR HOMES

In a previous NSF-funded study, RUPI, Inc. investigated the likely response of mortgage lenders to loan requests for new homes using solar space heating and domestic hot water systems.* In addition, a series of lender-oriented incentive measures were developed and evaluated in detail. This research was largely based on interviews with officers of lending institutions in New England and Florida. Interviews with bankers in other areas of the country, conducted as part of the present study, largely confirmed the major conclusion of our earlier research, namely that:

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*See Barrett, Epstein, and Haar, Financing the Solar Home: Understanding and Improving Mortgage Market Receptivity to Energy Conservation and Housing Innovation (RUPI, Inc. June, 1976). A revised and condensed version of this report entitled Home Mortgage Lending and Solar Energy (March, 1977) was prepared under contract to HUD, and publication of an edited version of the original study by Lexington Books is anticipated for October, 1977.

> In many, if not most cases, lenders will make loans available for solar-equipped homes, where the borrower and property satisfy routine underwriting standards. But so long as the technology remains in the experimental stage, they will often be willing to make such loans only if their risk is reduced by limiting the loan amount to a smaller than normal portion of the total costs... The controlling factors here are that mortgage loans are made in relation to the value of the property offered as collateral, rather than its costs -- and that there is considerable uncertainty right now as to how much value a solar energy system adds to housing... Over time of course, the market will serve as the definitive arbiter of value, with the knowns, unknowns, and virtues and liabilities of solar systems reflected in the price consumers are willing to pay for new and used homes that incorporate solar energy devices. But right now, and for the next few years, this information will be lacking in most markets, and lenders will have to proceed in the absence of data on the role of "comparable" homes.

The stance taken by individual appraisers will vary widely from institution to institution. Some of those interviewed said that for the time being they would discount the entire cost of solar systems, while a few expressed a willingness to include the full cost of a solar system in the appraisal of property value. Indications are that in many cases a borrower will be able to locate a bank willing to include at least a substantial portion of these costs in the assessment of value.

Table V-1 depicts the implications of this variety of possible lender attitudes on the financial position of an individual contemplating the purchase of a new home with a solar space heating system that adds $8000 to the price of the house. As can be seen in that table, if 50% of this "solar cost" were recognized in the appraisal (a reasonable reference point under present conditions) and 80% financing provided, the purchaser would be able to borrow $3200 towards this portion of housing cost. Even if the purchaser could anticipate receiving the benefit of a rebate or a Federal tax credit based on the tax credit formula recently reported out of Committee in the House, an additional net cash investment of between $3050 and $3550 would still be required -- approximately 38% to 44% of the solar costs.*

*The formula presently proposed is 30% of the first $1500 and 20% of the next $8500. If <u>all</u> of the $8000 were recognized as the cost basis for the incentive calculation, the subsidy amount would be $1750, leaving a net of $3050 required from the buyer. If eligible costs for this purpose are limited to certain of the solar components, the benefit size would be reduced. In the above example, $5500 of the $8000 total cost -- somewhat over two-thirds -- is a likely estimate of allowable component costs, with a resulting subsidy amount of $1250. In either case, the purchaser would need to find an "interim" source of funds to complete the purchase, since the rebate or credit would not be available until some time afterward.

TABLE V-I

IMPACT OF BELOW COST APPRAISAL AND LOWER LOAN-TO-VALUE RATIOS ON DOWNPAYMENT FOR NEW HOME WITH AN $8,000 SOLAR ENERGY SYSTEM

		Loan/Value Ratio		
	% of Solar Cost in Appraised Value	Conventional Loan 70%	Conventional Loan 80%	FHA Insured Loan 93%
Net Addition to Downpayment for Solar Use	100%	$2400	$1600	$ 560
	75%	3800	3200	2420
	50%	5200	4800	4280
	25%	6600	6400	6140
	0 %	8000	8000	8000

SOURCE: Barrett, Epstein, and Haar, Home Mortgage Lending and Solar Energy, 1977.

Lenders, on the whole, should prove less concerned about including solar first costs in their appraisals of domestic hot water systems -- where the dollar amounts represent a much smaller net addition to the sales price of the home -- as opposed to full-scale space heating or cooling systems. They may also be more liberal in certain markets -- such as the rapid growth areas within the Sunbelt -- where there is strong confidence in the rapid appreciation of property values and somewhat greater familiarity with solar technologies.

It should be noted that a generally cautious stance on the appraisal of solar homes represents the policy of not only private lenders, but also FHA, VA, and the quasi-public secondary market entities, FHMA and

FHLMC.* The Farmer's Home Administration, as noted earlier, refuses to finance any solar homes whatsoever, except on a demonstration basis, until the technology has proven itself reliable enough for its largely low-income constituency.

C. MEASURES TO ACHIEVE HIGHER FINANCING RATIOS

1. Tax Credit for Foreclosure Losses

The simplest means of overcoming the problem of below-cost appraisals of solar systems in new homes, would be to offer lenders an income tax credit for some portion (80%-90%)** of any losses actually incurred in selling solar homes under foreclosure conditions. A ceiling on the total credit that could be claimed would be tied to the appraised value assigned the solar system. This approach would share the virtues associated with tax benefits as discussed earlier (Chapter Three) -- ease of administration, quick start-up etc., while also being subject to the same objections that have been voiced against further complicating the tax code in the midst of efforts to simplify and reform it.

The government's financial exposure would be minimal since the credit could be claimed only _if_ a participating bank had to foreclose on a solar home, and _if_ a financial loss resulted for the bank. Lenders doubt that foreclosures on a residence with solar equipment should be any higher than the rate for conventionally financed homes as a whole. Since any given bank would still be liable for some share of the loss, it will retain an incentive to perform a sound job of reviewing the

*VA has accepted full cost appraisal of solar hot water heaters in Florida, where some comparative resale experience is available.

**Under present tax law, lending institutions could deduct any such losses from their taxable income. The 80-90% figure assumes the credit is taken in lieu of deduction.

specific solar use proposed and underwriting the property as a whole.*

Even where foreclosure occurs, the risk of loss is relatively small, as illustrated in Table V-2. In this example, the borrower obtains a conventional 80% mortgage on the purchase of a solar home valued at $48,000 with the entire $8,000 cost of the solar heating system included in the appraisal. As can be seen, the mortgage loan amount is $37,400 or $1,600 less than the appraised market value of the basic home without the solar system. This means that even if a foreclosure should occur in the first year, before any principal had been repaid, the solar system would actually have to subtract more than $1,600 from the home's resale value in order for the bank to incur a loss and to claim a tax credit.** In other words, the 80% loan-to-value ratio appears to provide a hedge against any serious cost to the government under this approach, particularly in the light of the fact that few new homes of any kind are built in neighborhoods with declining property values. This is not to imply that private lenders would not view such a situation as providing a markedly narrower margin for error and higher risk than would a mortgage on the same home without solar.

2. Special Insurance Programs for Lenders

The reluctance of lenders to make high loan-to-cost ratio financing

*Some procedure may be required to guard against lenders overvaluing the solar system and undervaluing the basic home in order to increase the potential size of the credit. For example, the portion of appraised value covered might be limited to documented replacement costs for the solar equipment.

**This assumes that the value of the house without solar is accurately appraised. A foreclosure loss might also occur if the lender mistakenly appraised the house above the true property values prevailing in the given neighborhood.

available for solar homes could be addressed through some form of special insurance program as an alternative to the tax credit approach. Two such insurance concepts were detailed in our previous report cited above:

- Conversion Insurance

  Under this approach, the lender would be insured against the costs of repairing or replacing a solar energy system or converting to a conventional heating system, if, in the event of foreclosure, the solar system threatens to impede resale, at a price equivalent to the unpaid balance of the mortgage.

- "Top-Part-of-The-Risk" Mortgage Insurance

  This type of program would insure lenders against loss on mortgage loans up to some proportion of the incremental cost for the solar system. In form and operation, it would be analogous to the types of mortgage insurance offered by the Veterans Administration and Private Mortgage Insurers (PMI's).

3. Comparative Attractiveness of the Tax Credit and Insurance Concepts

On balance, the tax credit for foreclosure losses appears preferable to the specialized insurance approaches on three grounds:

- First, it would provide universal coverage and preclude the need of creating a special distribution network for promoting and administering the insurance program; only a small proportion of the mortgage lenders approached by borrowers interested in solar homes could reasonably be expected to undergo the application process and paperwork that an insurance program would involve.

- Second, since very few disbursements to satisfy claims would have to be made under the insurance option, it would seem superfluous to create a special program and administrative vehicle solely for this purpose.

- Third, the need for any government involvement in this aspect of solar financing will hopefully vanish within a few years, as a history of comparative sales data for solar homes begins to accumulate.

Nevertheless, should the tax credit be rejected, either the "Top-Part-Of-The-Risk" or "Conversion Insurance" approach might merit serious consideration. Lenders interviewed indicated a fairly high degree of receptivity to both these concepts. Since both approaches would rely on the lender himself for underwriting and appraisal, they should lend themselves to being administered in a way offering fast and responsive service. Both strictly limit the government's coverage of risk to those uncertainties uniquely associated with including solar costs in mortgageable value. Although administrative costs would be greater than those associated with the tax credit for foreclosure losses, government expenditures for satisfying claims should actually be lower since only those lenders taking the trouble to enroll in the insurance program would be eligible for reimbursement.

Of the two insurance concepts, the "Top-Part-of-The-Risk" approach has the virtue of being somewhat more straightforward. It also may be possible to operate such a program inexpensively, by contracting with Private Mortgage Insurers (PMI's) to provide the basic administrative services required. Moreover, the notion of "Conversion Insurance" is in some respects a negative one, calling attention, as it does, to a problem that may never materialize to any significant degree, i.e. the need to remove a solar system after it has been installed. Both concepts would require the creation of totally new programs; the effort involved in their initial implementation may not be justified by their prospective net impact on the market for solar systems.*

D. PRO'S AND CON'S OF ENCOURAGING APPRAISALS AT OR NEAR COST

The purpose of either the tax credit on foreclosure losses or the insurance type options just discussed would be to assure the availability of adequate financing for purchasers of solar homes. To accomplish this purpose, eligibility would have to be conditioned on the lender including some given proportion of solar cost in his property appraisal (e.g. 50% or more) and offering the borrower a normal loan-to-value ratio loan (e.g. 70-80%). A difficult issue of program design concerns how appropriate this condition is and how stringent it should be.

*Another potential problem is the difficulty of determining after the fact that a foreclosure loss is entirely attributable to the solar feature. For the tax credit or insurance options to be workable, it may be necessary to presume that any loss incurred through foreclosure, up to whatever limit is specified, has resulted from the fact that the home is solar equipped.

Efforts to have solar systems appraised at or near their full cost may prove to be a disservice to the homebuyer. The standard appraisal process provides an indirect form of consumer protection. Where the lender assigns a property a value substantially below its selling price, it signals the prospective purchaser that the home may not have a market value as great as its costs.

For at least some solar installations today, the lender's perception that the additional costs are greater than the value added will be correct. Should appraisals be done purely on the basis of cost -- either through the implicit effect on appraisal practice of the availability of Federal loan insurance and subsidies for the solar costs involved, or through some more dubious approach of "mandating" such an appraisal practice -- the consumer will be effectively encouraged to pay more for the property than it is worth (as judged by the immediate and practical measure of what he could hope to recapture on resale).

This overpayment may be partially or wholly concealed in practice by the appreciation in home values that is a major characteristic of home ownership today, if sufficient time passes before resale takes place. But unanticipated changes in personal circumstances -- a job transfer to anothercity, unemployment -- may necessitate resale within a short period of time, and the extent of loss (or, more precisely, the extent to which it is perceived) may be far greater in such cases.

The nature of this risk is illustrated in Table V-2. Here the homeowner has paid $48,000 for his new home including $8,000 for a solar heating system. With the modestly optimistic assumption that the property appreciates in value at a 5% annual rate, the "basic" home without the solar system would have been worth $44,000 after two years.

If at that time, the homeowner were obliged to resell the property and received $48,000 (his original purchase price) he might, at first glance, appear to have broken even. In fact, he will have recovered only $4,000 or (50%) of the initial solar investment. In order to realize the same 5% appreciation in value on the $8,000 solar system as he did on the $40,000 "basic home", the owner would have to receive $53,000 on the sale of his solar home.

TABLE V-2

RESALE VALUES REQUIRED TO BREAK EVEN
AND REALIZE 5% ANNUAL RETURN AFTER TWO YEARS

BASIC FINANCING ASSUMPTIONS

"Basic" Home Cost Without Solar	$40,000
Solar Heating System	8,000
Total Cost of Home	$48,000
Loan-to-Value Ratio	80%
Mortgage Amount	$38,400
Downpayment	$9,600

BORROWER'S SITUATION AFTER TWO YEARS

Value of Home Without Solar (assuming appreciation of 5%/year)	$44,000
Resale Price to Recover Cost of Solar System	$52,000
Resale Value Required to Realize 5% Appreciation in Solar System	$53,000

Notwithstanding these possible problems, a lender-oriented tax credit or special insurance program would need to specify that appraisals make some reasonable allowance for market value -- either by specifying that a minimum percentage of costs (50%) be included, or that a specific procedure (e.g. capitalization of expected savings) be employed. Since, if a solar system works at all and delivers some savings, it presumably has some tangible market value, a policy along these lines could be imposed without placing the borrower in an unusually exposed position. At the same time, it would ensure that the lender makes some larger amount of financing available to the solar homebuyer in exchange for the protection against foreclosure loss afforded by the credit or insurance.

E. MODIFICATIONS TO EXISTING FEDERAL MORTGAGE CREDIT PROGRAMS

Both FHA and VA have issued general guidelines on the appraisal of solar homes that permit solar costs to be recognized in appraisals to the extent that some market value can be justified. Although these Federal credit agencies could all be authorized or even mandated to value solar systems on the basis of replacement cost rather than market value for the purpose of their mortgage credit programs, FHA/VA officials interviewed question the wisdom of any such initiative.

FHA officials note that, while precedent for appraising housing improvements at costs that exceed their actual value can be found in certain housing rehabilitation programs, in practice, this has invariably resulted in high default rates with loan losses for FHA and for many borrowers, the loss of equity in their home.* In this connection, they underline the fact that their borrower populations consist of low and moderate income families who lack financial cushions. With the high loan to value ratio mortgages through Federal credit agencies (up to 97% for FHA, 100% for VA and FmHA), the home buyer will be placed in a questionable financial position if he is allowed to borrow more money than the clearly recognizable resale value of his home. The Veterans Administration's generally conservative position on appraisals reflects a viewpoint similar to FHA's as well as the fact that under a VA loan guarantee, the borrower is personally liable for any loss sustained by the agency in event of foreclosure.

As can be seen from Table V-3, in the case of a 93% loan to value FHA loan, the borrower's mortgage on the $48,000 solar home is $44,460. After two years, the outstanding balance of the mortgage would have been reduced to $43,925, but would still exceed the appraised value of the basic house by $3,925 or 49% of the $8,000 solar system.

Thus, should a need to prepay the mortgage within two years arise, the solar system would have to add at least $3,925 to the resale value of the home in order for the borrower to retire his loan. Using 100% VA or FmHA financing, the solar system would have to add even larger amounts to the home's resale value ($7,232 and $7,254 respectively) if the loan is

*Under HUD's Section 233 Program of mortgage insurance for experimental homes, FHA appraisers have discretion to base mortgageable value for replacement cost, but in practice have proved highly reluctant to do so.

to be fully prepaid at the end of two years.*

TABLE V-3

RESALE VALUE OF SOLAR SYSTEM TO RETIRE FHA, VA & FmHA LOAN AFTER TWO YEARS

Basic Financing Assumptions	FHA	VA	FmHA
Home Cost w/o Solar	$40,000	$40,000	$30,000
Solar System Cost	8,000	8,000	8,000
Total Cost of Home	48,000	48,000	38,000
Loan-to-Value Ratio	93%	100%	100%
Downpayment	3,360	0	0
Mortgage Amount	44,640	48,000	38,000
Interest Rate	8.5%	8.5%	8%
Situation After Two Years			
Mortgage Outstanding	43,925	47,232	37,354
Amount Mortgage Balance Exceeds Original Value of Home w/o Solar	3,925	7,232	7,354
Excess as % of Solar Cost	49%	90%	92%

F. TOWARDS "PITI" WITH "E"

In determining the maximum size mortgage loan that any given borrower can carry, lenders generally use some standard for comparing projected

*Questions of appraisal aside, some thought might be given to raising the loan limits for FHA/VA insured homes that are equipped with solar energy devices. The merit of increasing present loan limits has been a subject of discussion for several years among those concerned with the future of the FHA program; a provision to this effect has been included in the 1977 Housing Act currently before Congress. Several developers interviewed noted that in many locations it is nearly impossible to build a home that satisfies FHA Minimum Property Standards and can still be sold at a price falling within FHA mortgage limits. The single-family loan limit currently is $45,000. In legislation recently passed by the House, H.R.6655, the FHA mortgage limit has been raised to $60,000. Even if enacted, a special higher ceiling for solar homes might still be justified; otherwise the prospective FHA homebuyer, contemplating an $8,000 investment in a solar space heating system, would have to sacrifice a significant amount of usable space or some other more basic aspect of the home's overall quality and livability in order to finance the home with an FHA mortgage.

housing expense with personal income. The most commonly used rule-of-thumb for such purposes -- the so-called "PITI"* ratio -- does not take into account energy costs. Consequently, these procedures tend to shrink the potential market for any energy conserving features in new homes which involve additional first costs, including solar energy devices. The PITI calculation reflects the added cost in higher monthly payments, but makes no compensating allowance for the anticipated savings in operating expense.

In this setting, it appears appropriate for the Federal government to initiate actions leading to the increased use of a credit appraisal standard that systematically takes energy costs and savings into account (and can therefore be referred to as PITI+E). The result of such action would be to relate the threshold income required to obtain mortgage financing for a home directly to its energy efficiency: the lower the energy costs, the lower the income needed. This would have a generally beneficial effect, but be of greatest immediate importance in the case of solar space heating, where the most substantial first costs are involved.

Such initiatives must be based on a thorough and careful analysis of all aspects of the situation. The FHA already includes energy costs in its underwriting; some private lenders do as well, and others are considering such a change in light of rising energy costs of the past few years. But, for most lenders, this will require an important adjustment in lending procedures. Moreover, appropriate increases are required in the percentage of income used in the PITI test, or else the inclusion of energy costs will simply increase the threshold income level required.

Once the necessary analysis has been completed, however, there are significant avenues of influence over lending practices that could be

*PITI is an acronym designating four components of housing expense: Principal, Interest, Taxes, and Insurance. The maximum allowable ratio of housing expense to income is frequently set at 25%. Some lenders apply such rules more flexibly than others. However, in so far as energy costs are taken into account, it most often is to lower the available mortgage loan amount in electric homes or in other cases where utility bills are unusually high.

availed to bring about the desired changes -- in the context of a solar incentive program, or more broadly as an energy conservation related measure. Progress towards encouraging the use of PITI+E might be achieved by amendment of the underwriting guidelines and forms used by FNMA and The Mortgage Corporation of the FHLBB in their secondary purchase programs. (As noted earlier, FNMA/FHLMC procedures have an influence on private lending practice that far transcends actual participation in their secondary market programs.) Directives might also be issued through the agencies which regulate financial initiatives, the Federal Home Loan Bank Board and the Federal Savings and Loan Insurance Corporation (FSLIC), both of which oversee the activities of savings and loan associations; and through the Comptroller of the Currency, the Federal Reserve Board, and the Federal Deposit Insurance Corporation (FDIC), all of whom regulate the activities of commercial banks. As a rule, these regulatory agencies exercise very little control over credit judgments, preferring to leave such matters explicitly to the lender's discretion unless mandated by Congress to intervene. (For example, the Federal Reserve Board, at Congress's insistence, has issued regulations that a wife's income must be taken into account under equal credit legislation.)

It should also be noted that any Federal action in this regard should probably be taken in the context of a more comprehensive examination of the credit appraisal standards currently in use in the lending industry.*

G. THE READY AVAILABILITY OF RETROFIT FINANCING

In most instances, the experimental status of solar systems should have no negative effect upon the basic availability of financing for retrofit installations. Over the near term, most solar retrofits will be for domestic hot water purposes with costs of less than $2,000. As a rule, homeowners wishing to finance such systems would do so with unsecured

*Such an examination is already underway with the Department of Housing and Urban Development.

consumer loans -- in this case, described as home improvement loans.** In underwriting such loans, many lenders are relatively indifferent to the specific investment being made because their primary concern is the creditworthiness of the borrower -- the amount of additional indebtedness he or she can reasonably be expected to support.

Lenders are often eager to make home improvement loans regardless of the specific type of expenditure envisaged. The default rates on such loans are quite low (compared with other categories of personal loans); the interest rates high; and the borrowers have a history of orderly loan repayments on their mortgage, are less mobile than other types of consumers, and have built-up equity in their homes where some collateral is required.

Interviews with home improvement lenders suggest that, in many cases, they will conduct only a cursory technical review, if any, of the proposed solar system itself. To the extent that the lender does undertake a technical review, his intent will primarily be to ensure that the borrower purchases a reputable product from a reputable dealer or installer -- not to evaluate the economic attractiveness of the specific application (paybacks, life-cycle costs) on the impact of the property's market value. This concern with "reputability" will be most evident when the customer obtains a so-called "indirect" or "dealer" loan through the installer or merchandiser of the solar equipment, particularly in light of the recent (May, 1976) FTC "Holder-in-Due-Course Ruling" which determined that banks and other creditors are liable for defective goods and services financed in this way.

In sum, there appears to be no need for any major Federal incentive of a financial nature directed at the institutions who would normally provide loans to existing homeowners planning to purchase solar energy devices. How-

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*In the rarer instance of retrofit installation of solar space heating systems with costs as high as $8,000 to $12,000, the loan would typically be secured by a second mortgage. With loans of such a size, lenders will give some consideration to the size of the homeowner's equity and the value of the property. However, in such cases, banks still tend to focus more on the borrower than the property; and, in many instances, the homeowner will have already built up sufficient equity through his mortgage payments to provide adequate collateral for the loan.

ever, given the heightened lender sensitivity to product liability, a well-conceived program of system certification, coupled with an energetic effort to disseminate information on the performance and reliability of specific systems and components, would have a positive impact on the readiness with which existing homeowners can obtain conventional home improvement loans for solar energy purposes.*

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*Beyond this, there are several modest initiatives the Federal government might contemplate in respect to the financing of retrofit installations which would have the effect of encouraging lending for solar energy purposes.

Banks are the largest lenders for home improvement purposes, but savings and loan associations and credit unions also play important roles. Restrictions on lending by Federal credit unions have been recently liberalized; however, the involvement of savings and loan associations in home improvement lending is restricted by Federal regulation. Savings and loan associations can only invest 20% of their assets outside of first mortgages. Loans for solar energy equipment could be exempted from these regulations. The effect of such a waiver would be small but it might serve to improve the availability of financing to some degree.

In addition, greater usage of Title I insurance for the purposes of solar energy applications might be encouraged by insuring loans for 100% instead of 90%. Premium rates (currently set at one-half of one percent of the original loan balance) could be reduced for solar homes, thereby increasing the potential profit for the lender. However, it is questionable whether the market impact of such initiatives would be sufficient to justify an unprecedented departure from the self-financing nature of Title I as it has traditionally operated.

Another possibility might be to permit existing homeowners having FHA/VA mortgage loans to refinance their properties to cover the expense of a solar system, or, alternatively, to simply finance the investment through extended payments on their present mortgage without the need for the formalities and expense (closing costs, etc.) involved in refinancing. A balloon payment at the time the mortgage is retired might be used to recover the differential between the present FHA interest rate and the rate at the time the mortgage was originally written. (Rhode Island is currently exploring the possibility of having private lenders participate in such a plan on a voluntary basis.) Participation might be limited to FHA/VA homeowners who have already been in their homes a certain number of years and have therefore built up sufficient equity to provide a financial cushion.

This Chapter has discussed a number of measures that might improve the availability of financing of solar homes by encouraging lenders to give some recognition to the increased value of such homes and to the potential energy savings that solar systems promise to deliver. At the same time, these measures pose many complex administrative issues and raise the fundamental question about the extent to which lending judgments should evolve out of experience in the market place or should be influenced by governmental intervention.

III PROGRAM DESIGN

CHAPTER VI

CONSIDERATIONS IN THE DESIGN OF AN INCENTIVE PROGRAM

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CHAPTER SIX

CONSIDERATIONS IN THE DESIGN OF AN INCENTIVE PROGRAM

A. OVERVIEW

Irrespective of whether a solar subsidy takes the form of a rebate, a tax credit, or loan, there are a number of program design issues that must be resolved before any program can actually be implemented:

- How will solar components and systems be screened to ensure compliance with minimum standards of quality and performance? This is the most critical issue to be resolved in the workability of an incentive program. Certification of components may be relatively straightforward once a network of accredited testing facilities is in place. However, the various *ad hoc* procedures that might be used until such a network is fully operational all have serious limitations, and certification of systems--which implies predictions of their performance after installation--raises difficult problems, particularly in regard to space heating. The most practical approach may be to secure a guarantee from the responsible actor (homebuilder, solar dealer) rather than to attempt certification of systems whose design and performance will vary from site to site. Guarantees could be strengthened by expanding the SBA's existing bond reinsurance program and requiring that all installers of subsidized solar systems be bonded contractors.

  Requirements (as suggested in a number of Congressional bills) that solar systems meet or exceed a stated percentage of a home's thermal load are inappropriate and may exclude the most cost-effective scale of system design for many homes and locations.

- How should the individual benefit amount be determined? A flat sum benefit reduces the risk of fraud, and eliminates the need for cost certification. This may be the preferred approach for solar hot water, but is less useful for solar space heating systems where costs vary over a wide range. A more effective approach in the latter case is to provide a subsidy amount as a percentage of costs. The difficulties of certifying sales costs (particularly in new construction) could be reduced by basing the definition of eligible expenditures on the costs of major systems components (i.e., excluding on-site installation costs).

- Should "passive" solar systems be eligible for incentives? Homes incorporating passive solar designs may make a significant contribution to energy savings in some locations. However, the inclusion of passive systems in an incentive program raises difficult problems in respect to performance standards and the identification of those costs uniquely attributable to the solar feature. A workable procedure for reviewing passive solar homes has been devised by officials in New Mexico where passive applications can qualify for that state's solar income tax credit. However, any such procedure would be extremely costly and cumbersome to apply to a large volume, nationwide program.

- Is it desirable to involve the states in program administration? Some thought might be given to conditioning eligibility for benefits upon state action eliminating certain constraints on solar energy use (most notably the imposition of local property tax assessments on solar installations). Administering an incentive program through the states might offer some advantages in terms of equity and impact, but would probably involve higher administrative costs and substantially longer lead times.

- How should an incentive program be phased? Eligibility should be retroactive, to the extent that implementation of procedures for determining system acceptance permits. Program life should expire after a brief, finite period (five to seven years), at which time the appropriateness of continued or expanded incentives would be reassessed. Discretion to adjust subsidy levels on a periodic basis should be delegated to an appropriate executive official in order to accommodate any significant changes in fuel costs, the solar state-of-the-art, and the market response to the previously established incentive levels.

- Should eligibility be limited to specific types of solar applications? A variety of considerations suggest that in the near term (one to three years), broad based market incentives might best be limited to solar domestic hot water systems--which are simpler to certify, are in a more advanced stage of commercialization, and involve less cost and less risk for the homeowner than space heating. Incentives for space heating might be phased in once more adequate procedures for certifying components and qualifying solar installers are in place.

B. SYSTEM ELIGIBILITY: THE TRADE-OFFS BETWEEN CONSUMER PROTECTION AND ADMINISTRATIVE FLEXIBILITY

The design of procedures and standards to certify the eligibility of solar systems for Federal support may prove as critical to the effectiveness of a solar subsidy program as the choice of the specific type of incentive to be provided. These certification standards and procedures will affect the program's administrative complexity. They will greatly influence future technological developments in the solar industry, since any eligibility criteria are likely to become the industry's production standard (just as the FHA's Minimum Property Standards serve as maximums for home-builders selling to the mass market).

Eligibility requirements are also the most effective instrument at the government's disposal for ensuring that solar users are adequately protected from shoddy equipment, improper installations and inflated performance claims. Experience with previous Federal housing programs--most pertinently, with the Title I property improvements program during the nineteen-fifties--suggests that a solar subsidy program inevitably will bring in its wake abuses along these lines.* The solar energy industry has some of the same structural characteristics which facilitated Title I abuse--many small, independent firms and no recognized standard of quality. Moreover, solar systems consist of a number of components that must be custom-tailored to the individual home. Thus, unlike conventional household appliances, testing under the best of laboratory conditions can provide only limited information on the adequacy

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* More recently, shoddy workmanship under HUD's Section 235 program was so serious and extensive that the 1974 Housing and Community Development Act specifically authorized funds for HUD to correct such defects. (Sec. 306--"Compensation for Defects"). To the extent that low and moderate income families are encouraged to install solar energy systems, the government should probably be prepared to pick up the expense of any serious maintenance and repair work that may later be required. (See also Vincent DiPentima, "Abuses in Low Income Housing Programs--The Need for Consumer Protection: Response by FHA," 45 Temple Law Q461 - 1972.)

of a specific installation.

Balancing the need for administrative simplicity against the concern for consumer protection presents the government with a difficult set of trade-offs. Elaborate precautionary criteria and procedures are likely to deter homebuilders, installers, and potential solar users from becoming involved with the program's "red tape" and will require longer lead times to put in place. Standards that lack suppleness and are overly specific can prematurely freeze technology and inhibit innovation. And ideally, the procedures adopted should enable the seller of the solar equipment to assure his prospective purchaser of his product's eligibility for the incentive in unambiguous terms, without the need to wait for a determination of eligibility on a case-by-case basis, and through procedures that place as minimal a burden as possible on legitimate firms. However, to the extent that an incentive program fails to provide adequate consumer protection, it is likely to defeat its own aims, since news reports of $2,200 systems that "won't heat a teacup" (Wall Street Journal) are certain to unleash a market backlash.

1. Realistic Expectations and Consumer Education

Before discussing specific options for determining system eligibility, it is important to note that the most any such procedures can hope to accomplish is to reduce the risk of both inadvertent failures and deliberate abuses to an acceptable level. Even the most competent and reputable of plumbing or heating contractors may make mistakes in initial solar installations.* Experience to date suggests that most systems will require a fair amount of tinkering before they perform smoothly, and at least some portion will invariably break down or produce substantially less energy than originally envisaged. In addition, the newness of the technology itself underscores the importance of procedures to ensure that Federal subsidies are spent on reputable products:

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* The ideal solar installer is an eclectic tradesman: part roofing contractor, part plumber, and part heating technician.

the confusing variety of solar hardware on the market; the unproven output and durability of most systems; the absence, in many cases, of manufacturers with proven willingness and ability to stand behind their warranties; the homeowner's vulnerability, given his ignorance of the basic concepts and equipment involved.

A consumer education program, buttressed by disclosure requirements integrated into the solar merchandising system itself, will be a necessary adjunct to any Federal incentive program, and is probably an appropriate area for immediate Federal support even if no incentive program is put in place in the near future. The widespread acceptance and use of this approach--in fields ranging from truth in lending to energy performance ratings for cars and appliances and delimitations of permissible warranty language--provide sufficient models for the continued rapid design of solar education and disclosure requirements. A number of state and Federal agencies have already taken initiatives in this area, and monitoring of advertising and sales representations is already a visible issue, even in regards to the manner in which solar distributors should be allowed to make reference to possible eligibility for the proposed Federal incentive program. But along with these measures, the difficult problem of certifying systems as eligible for the incentive must be accorded a high priority if the Federal program is to achieve its goal of strengthening the market and avoid raising false expectations capable of undermining the credibility of the solar alternative in the next few years.

2. Alternatives for Qualifying Solar Installations

Components and systems pose very different eligibility certification problems. Collectors of a given model produced by a manufacturer may be relatively standardized, making it possible to assess materials, construction techniques and energy output by testing one or more sample collectors and checking periodically to ensure that those being manufactured are comparable to the product tested. Predicting or evaluating the performance or quality of solar systems as installed introduces another order of complexity; predictions of system performance are difficult even with on-site inspection and review of individual installations on a case-by-case basis. This applies particularly to space heating systems. Thus, for purposes of designing eligibility guidelines, it is important to distinguish between criteria and procedures appropriate for components and those appropriate for total systems, and also between space heating and domestic hot water applications.

3. Approaches for Components

A broad and coordinated effort at setting standards for all aspects of solar systems is presently underway.* One outcome of

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* A comprehensive listing of solar standard setting activities is found in Tables A1-C4 of the National Bureau of Standards' Plan for the Development and Implementation of Standards for Solar Heating and Cooling Applications. The following represents the highlights of this activity:

(1) The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) has just released standards (ASHRAE 93-77 and 94-77) for test procedures for evaluating the thermal performance of solar collectors and storage tanks.

(2) The American Society of Testing Materials' (ASTM) Subcommittee on Solar Heating and Cooling Applications has developed a number of draft standards for systems', subsystems', and materials' performance.

(3) The Council of American Building Officials' Board for Coordinating Model Codes, working jointly with the National Conference of States on Building Codes and Standards, has incorporated a version of ASHRAE's 90-75 energy conservation standards into all three model codes and plans a similar effort for solar standards. (Beaty)

(4) The Sheet Metal and Air Conditioning Contractors National Association (SMACNA), under contract with HUD, has prepared a manual describing recommended installation and system design practices.

(5) HUD and NBS have developed two sets of standards, the Intermediate Minimum Property Standards, primarily specification standards, "based on current state of the art technology and ...therefore somewhat restrictive in nature," and the Interim Performance Criteria, less restrictive standards geared to permit the development of further innovation. (NBS Plan)

The efforts of the above organizations and others important to the diffusion of solar technology are coordinated through the consensus standard-setting procedures of Solar Energy Steering Committee of the American National Standards Institute (ANSI).

this effort will be a network of laboratories, accredited either by the Federal government or a representative industry/professional organization, that will test and validate the operating characteristics of solar components. There seems to be general agreement that limiting eligibility to those components tested and certified by accredited laboratories, the standard approach to quality assurance in the HVAC industry, is the optimal approach for solar--as opposed, for example, to direct Federal certification. A few solar testing facilities have already emerged--the Florida Solar Center, Desert Sunshine in Arizona, and the Polytechnic Institute of New York (which is compiling a list of qualified manufacturers for ten of the eleven states participating in HUD's residential solar hot-water initiative). However, despite this encouraging development, and the recent work of the American Refrigeration Institute to accelerate the development of a certification network, no such nationwide system of testing laboratories, nor even Federal or industry solar laboratory accreditation procedures, presently exists, or is likely to be in operation should a solar incentive become effective by early 1978.

In the absence of accredited solar testing and certification laboratories, there are two interim approaches that might be adopted to ensure that solar equipment purchased with Federal monies satisfies some reasonable measure of quality:

- In order to be eligible for Federal subsidy components must be listed as "officially approved". Approval could be granted by either the Federal government or an industry association, and could be secured by manufacturers in one of two ways:

  (a) submitting test data to the approving organization which then reviews it for compliance with certain standards (i.e. the HUD Intermediate MPS); and/or

  (b) submitting proof of a specified number of successful installations to the approving organization.

  The first approach requires the organization in charge to have substantial technical expertise, and both options require a fairly large staff to review and verify the documentation provided by the manufacturer. However, a list of approved products would have several important advantages. It is an approach familiar to and easily used by consumers, builders, lenders, and local building officials. If an industry association administers the approval process, it provides the industry with the leverage to do an effective job of policing itself. (However, this approach may be vulnerable to conflicts-of-interest, particularly if manufacturers' representatives serve on the body that issues approvals and rejections.) In addition, there may be some risk of graft, since manufacturers failing to meet technical standards will have a substantial motive--eligibility for Federal subsidy--to attempt to buy or lobby their way onto the list.

- In order to be eligible, components must have specified quality or service guarantees, for example, warranties and service contracts which extend over a significant portion of the payback period. Consumers are familiar with these types of product guarantees; administrative logistics would be fairly simple--the issuance of regulations concerning the requisite warranty or service contract features and on-going review. For compliance, this review function might be performed by some non-governmental body such as an industry association. However, since there is nothing to preclude solar manufacturers and dealers from promising what they cannot or do not intend to deliver, this approach provides less than an optimal degree of consumer protection.

Neither of these approaches appears to be entirely satisfactory. In the short run, much may depend on the success of the eligibility procedures being developed for the HUD "solar hot water initiative" now underway, and the ease with which they can be expanded to apply on a national basis.

4. Approaches to System Eligibility

Unfortunately, high quality components are a necessary but not sufficient condition for a high quality system. Most solar manufacturers interviewed expressed reluctance to give performance guarantees, even within fairly wide ranges, precisely because of the overwhelming importance they attached to system design and installation. This is understandable because solar is a relatively unforgiving technology when compared to ordinary heating. Small deviations from the manufacturers' prescribed installation practices can have a substantial influence upon performance and reliability. If the user is to be provided with a reasonable level of protection, there must be procedures to ensure the quality of the completed system as installed.

While differences between hot water and space heating units are relatively unimportant in certifying component quality, it is important to distinguish between space and hot water when designing procedures to ensure the quality of installed solar systems. Increasingly, hot water heaters are packaged in three components: the collectors; the storage tank with integral heat exchanger, sensor and auxiliary; and a "black box" with controller, pumps, and valves packaged as a unit. Because there are relatively few ways in which such a solar hot water heater can interface with a house, field conditions and installation procedures can be covered adequately in a manual. With such a packaged system, most installation failures can be curtailed, and system or component failures attributed directly to the manufacturer. Thus, for solar domestic hot water, certification of the whole system and its performance, using procedures similar to those applicable to component certification, is both possible and desirable.

By contrast, even the simplest space heating system is specific to the house and such factors as its location, orientation, size, design, thermal load and heat loss. While some manufacturers are producing a packaged unit with few options, many more are leaving the system design to professionals or to the installer. Thus, certification of space heating systems--independently from the specific site--is virtually impossible due to the difficulties in determining what are "standard" conditions of design and installation. Recognizing this problem, the industry is moving toward a delivery and service infrastructure to allow one actor (manufacturer, dealer, or installer) to gain control over the whole process. Respecting this orientation, the appropriate failure-prevention measures for space heating should focus on a guarantee from the responsible actor. There are several approaches the Federal government could take to support manufacturers'/installers' guarantees of total system quality.

- Provide Federal reinsurance for warranty pools that back up manufacturer/installer guarantees, irrespective of whether the company continues to be in business. Warranty pools clearly lower risks to the solar user and participant cost-sharing, based on past claims experience, would penalize less competent installers. One solar manufacturer interviewed in Florida has attempted to establish such a pool on a state-wide basis. A Federal program to help create some kind of a pooling arrangement and support it through reinsurance might be set up either within the Small Business Administration or HUD's Federal Insurance Administration.* The major argument against this approach is that those manufacturers/installers most interested in sharing the costs of their system's failures are likely to be those with the poorest quality systems, and that, as a result, warranty pools may prolong the industry's shakedown period.**

- Establish regional "white lists" of firms experienced and successful in designing and installing solar systems and require that all Federally subsidized systems be installed by listed companies. This approach has the advantages and disadvantages of the components' list, discussed above. A list approach has two additional advantages. First, it should protect consumers from unscrupulous dealers without burdening legitimate firms and present an opportunity for providing the consumer with information about solar technology and potential abuses by dealers. Second, a list approach provides a useful means for obtaining feedback about systems' performance on an ongoing basis. To be effective, such an approach requires a responsive complaint system that enables consumers using a listed installer to register complaints with the monitoring agency. The "white list" of eligible installers is preferable to the FHA home improvement contractors "precautionary measures or debarment lists", since the latter approach functions as a "black list", which provides a safeguard only after any harm has been done and does nothing to hinder itinerant

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* The Federal Insurance Administration currently operates three basic programs: Flood Plan Insurance, Crime Insurance in high risk areas, and Riot Reinsurance Insurance.

** Another approach considered was to provide Federal support to existing homeowner's warranty programs (such as the HOW program operated through the National Association of Homebuilders). HOW warrants against defects in a home's plumbing, heating and cooling system for two years and has already settled a claim on one solar home in the Southwest. Unfortunately, homeowner warranty programs are in their infancy in the U.S. and cover only a small percentage of the new homes built each year. (HOW has insured 150,000 homes since its inception in 1974.) Nevertheless, the program is now operational within 40 states, with 340 local programs, and might be utilized within the context of a more comprehensive program of protection for solar consumers.

"suede shoe" operators who can disappear before being listed. However, FHA experience suggests that even the white list will not be a totally effective deterrent to abuse. Reasons for this include lags in the reporting and processing of complaints and difficulties in determining whether a given contractor's performance warrants removal.*

- Expand the existing SBA bond reinsurance** program to include solar installation and require that all Federally subsidized systems be installed by a bonded installer. Since a typical SBA-guaranteed payment and performance bond includes a one-year maintenance bond which makes the contractor liable for all system problems for a full year after installation, this approach provides a year's worth of cash-backed, total system warranty. A year should prove sufficient to work out any major problems--leaks, freeze-ups, control failures, etc. It has the further advantage of being a relatively

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* The effectiveness of any complaint program is limited by consumers' unfamiliarity with solar technology. Not only does this encourage abuse, but it also makes detection difficult. For example, a dealer could sell overpriced or oversized units without the homeowner finding out. This problem might be reduced to some degree by extending the infant FHA pre-purchase counseling program to cover solar. However, the counseling program presently has limited coverage and is perceived as a welfare-type service, which is likely to limit its acceptance and use by middle and upper income home buyers.

** The SBA Surety Bond Guarantee program was established in 1971 because smaller contractors and subcontractors were finding it increasingly difficult to secure bonding in the private market and consequently were seriously hampered in competing for construction contracts. The program reinsures, for 90% of the loss, bonds issued by certified insurance companies, many of whom are specialty insurance companies dealing exclusively in SBA guaranteed bonds. To be eligible, contractors must do less than a specified amount of business annually ($2,000,000 for generals and $5,000,000 for subs) and must pay a 1-1/2% premium (as compared to the private market's 1% premium) and a processing fee. Although the average job bonded in 1976 was $68,000, the range of jobs bonded, $5,000 - $200,000, seems wide enough to encompass installation of solar space heating systems.

The program seems to be successful--the demand for program funds is roughly twice the current appropriations level, and, according to the president of the specialty firm serving New England, the specialty insurance companies are interested in keeping the program going since their loss experience to date has been generally good. Although 90% of the bonds guaranteed are for construction contractors, other types of companies, each with different gross income limits, are also eligible.

The Federal Trade Commission, in Congressional testimony on the President's solar tax credit proposal, has noted that a case can be made in support of performance bonding requirement for solar installations, but also warns that this could raise serious barrier-to-entry questions. However, use of SBA (Surety Bond Guarantees), as proposed here, would provide a means of maintaining relative ease of entry for small firms. See Hearings before the House Committee on Ways and Means "Tax Aspects of President Carter's Energy Program, Part 1, (May 16-19, 1977)" - page 393.

simple add-on to an already established program, thereby minimizing the administrative costs and lead time required to deliver the program. A bond requirement would encourage high quality work and provide a major deterrent to unscrupulous itinerant operators.

While none of these approaches is without its limitations, the performance bonding concept, possibly supplemented by a list of approved installers, appears to offer the most practical solution.*

5. Thermal Load and Insulation Requirements

In addition to requiring that the Secretary promulgate guidelines for system eligibility, a number of solar incentive bills introduced in the 94th and 95th sessions of Congress also require that to be eligible for Federal subsidy, systems be designed to carry a certain proportion of a home's thermal load, typically 100% for hot water and 40% for space heating systems. Thermal load requirements are basically unsound policy for the following reasons:

- Such requirements are virtually impossible to enforce since they require data that is exceedingly costly and difficult to acquire. Determining whether or not a system has carried 40% of a home's thermal load requires instrumentation of each individual installation. Inferences about system performance cannot be reliably drawn from last year's bills because weather conditions and family behavior, critical determinants of solar efficiency and thermal load respectively, can vary considerably from year to year.**

- Designing a solar system to bear a very high percentage of either space or hot water load is often impossible, impractical, or inefficient. Where an individual home's annual thermal requirements are subject to considerable seasonal variation, as is true in most parts of the country, a system that supplies 100% of thermal needs will be oversized, excessively costly and generally inefficient. Thus stringent thermal requirements severely limit the flexibility of the system designer to create the most efficient total system to meet a particular home's needs.

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* Any of the alternatives discussed here could be complemented by a Federally supported training program. Given the pattern of licensing and union organization in the building trades, such an effort would be most appropriately channeled through state and local programs, as in the analogous EPA inspection/maintenance mechanic training effort.

** It would, of course, be possible to define minimum load requirements through simulation of prototypical installations.

- Stringent thermal requirements discourage an incremental approach to solar utilization. In some parts of the country, it may be technically feasible and economically prudent for solar consumers to adopt an incremental approach, purchasing a "starter system" that supplies a relatively small percentage of their home's thermal load, and adding to it if it works, thereby reducing their risks and financial exposure.

A more appropriate task for the Federal government may be to require that manufacturers supply to all customers data in a standardized format which gives the performance characteristics of their equipment under certain specified conditions, on the model of the EPA mileage ratings.* This would provide homeowners with a means of comparing systems' performance while allowing room for the user to choose the system size that makes most sense in light of his individual needs.

6. Home Insulation Requirements

A somewhat different issue is raised by the possible desirability of establishing home insulation and weatherization standards as prerequisites for eligibility for a solar incentive. Requirements of this type would be applicable primarily for retrofit installations, since energy conservation standards now in place and under development appear likely to achieve the necessary results in the case of new construction.

Such requirements would reflect the greater cost-effectiveness of most weatherization investments from the homeowner's perspective, and the concommitant Federal responsibility to shape a solar incentive that does not distort the consumer's energy investment context. However, any procedure that adds unduly to the process of establishing eligibility has its own shortcomings, and "adequate" weatherization prerequisites may be difficult to define in concept and enforce in practice. Given these competing interests, the best solution may be to ensure that adequate information on the relative desirability of weatherization measures is provided to consumers--not only through

* This could be done by establishing three or four prototypical houses as loads and simulating equipment efficiency using standard input parameters determined by either manufacturer or laboratory testing and one of the computer simulation procedures now used by the HUD/ERDA demonstration programs (notably SOLCOST).

the programs of public information now underway for conservation efforts, but in the specific context of a solar incentive program as well.

C. SUBSIDY FORMULAS, COST-CERTIFICATION AND THE RISK OF FRAUD

A basic program design issue in any Federal subsidy program for solar is how to determine the amount of allowable entitlement per person and/or per unit. There are a number of considerations that bear upon the choice of entitlement determination procedures. Ideally, such procedures should be:

- Easy to administer -- avoids complex cost-certification procedures.
- Readily understandable by consumers -- a simple formulation may greatly facilitate "marketing" an incentive program.
- Resistant to fraud -- past experience warns that cost certification procedures are vulnerable to fraudulent receipts and appraisals, as well as bonus and rebate schemes. (The 1954 FHA investigation into abuses in the Title I home improvement program found over 1,000 cases, without attempting a comprehensive search, where borrowers had been charged 100 to 150% over actual costs.)*
- Technically neutral -- does not unintentionally encourage large or small, cheaper or more expensive installations (since cost effectiveness varies widely among installations).
- Fair -- does not unintentionally favor a region or interest group.

There are two basic approaches to specifying the amount of solar subsidy: a rebate or credit which provides a fixed dollar amount; or a subsidy (whether a rebate, credit or loan) based on a proportion of the system's costs.

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* Senate Committee on Banking and Currency, FHA Investigation, 1954, Vol. 47, p. 1374.

1. Fixed Dollar Benefits

Where rebates or tax expenditures are involved, a fixed dollar amount is attractive on several grounds. First, no certification of costs is required, only proof of purchase. Second, there is no incentive for installers to fraudulently inflate system cost estimates, since the subsidy amount is the same in all cases.* Third, the fixed benefit provides some inducement for cost reduction.

However, this simple approach may only be applicable to solar hot water systems, which tend to carry price tags that fall within a relatively narrow range. As a rule, except for the southernmost reaches of the country where freezing weather is not a serious risk, solar hot water installations employ pumped-circulation type systems costing between $1,200 to $2,000.**

By contrast, a fixed benefit amount is inappropriate in the case of space heating systems. It would discriminate against potentially desirable, well-designed, high output systems, and a nationally uniform amount would provide a subsidy that is a larger proportion of costs precisely in those locations where the climate is mildest and the need less.*** This difficulty might be circumvented by using existing computer simulations, already in use in the demonstration program, to classify systems by their potential output and establish a "fixed" subsidy amount for each

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* The possibility of forged sales receipts or certificates-of-completion might still require some spot-checking for fraud.

** The simpler and far cheaper "thermo-syphoning systems", once widely used in Florida and recently regaining popularity, might either be ineligible for the subsidy or eligible only for a smaller amount.

*** For example, a system designed to provide 60% of the heating needs of a house in Pennsylvania might cost twice as much as a 60% system in California.

of several categories of energy output.*

2. Proportion of Cost Formulas

Most solar incentive legislation introduced in the Congress requires that subsidy levels be computed as a percentage of system cost--either a single percentage of the total cost, or a "stepped"

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* One procedure would be to pre-run typical systems, varying collector type, collector area, climate data and house size. Using the output from these prototype designs, each application would be computer sorted into an appropriate category, and assigned the output of the closest prototype. Errors less than the calculated errors supplied by manufacturers could easily be achieved. Special cases could be run separately.

The grant amount could then be a pre-set amount, based on a fixed proportion of the cost indicated by the simulation as required to achieve the given output. For example: An applicant from Chicago proposes a 400 square foot system using a single-glazed water-cooled collector with a selective surface. His house is 1200 square feet, and he has a family of four. With this data, the house might be assigned to the category of: 350-450 square feet systems, single-glazed, selective-surface, water collectors; Chicago airport weather data; small one-family house. The prototype run has established that systems in this category produce 40 million BTU per year on the average. A reasonable amount to allow for capital costs is $200/MBTU yearly output, which would yield a system cost of $8,000. The grant for all homes falling within this broad category would be some set portion of this figure.

The advantages of this approach are:

- Extending the simplicity of flat grants over the entire range of system costs and types.
- Providing strong incentive for cost-effective systems, i.e., those which would get the most out of the smallest investment.
- Supplying feedback to the consumer concerning the relative output and cost-effectiveness of his proposed system, and providing a tie-in with the procedures to determine system eligibility discussed earlier.

On the other hand, the procedure could prove cumbersome, insofar as the applicant must submit a number of system characteristics for sorting into categories. Nevertheless, inasmuch as the demonstration program has spawned reliable computer simulations, which could be pre-run to deal with almost every case, this modification of the flat grant should be considered further--particularly for space heating installations.

formula with a higher percentage of a base amount and a lower percentage of the remainder. A step formula which encourages price competition is the more desirable approach, particularly if a single formula is to apply to both hot water and heating systems. However, both formulations present the difficult administrative problem of determining which costs constitute the basis for computing the subsidy.

Basing the subsidy amount on total installed cost leaves considerable room for fraudulent claims, particularly in new construction, where it is next to impossible to separate distinctly solar from total construction expenditures.* It is even difficult to distinguish expenditures for equipment and materials; for example, plumbing and heating contractors are unlikely to maintain accounts that carefully separate pipes used exclusively for the solar system from all other pipes installed within the structure. Given such an elusive basis, cost-certification procedures capable of preventing fraudulently inflated claims are likely to involve substantial red tape.

An alternative is to base the subsidy only on the costs of selected, easily distinguishable elements (such as the collector, storage tank, and control devices) which are purchased from a solar equipment distributor. This would exclude materials such as pipes and ducts which are normally obtained by the heating, electrical, plumbing or sheet metal contractor from building materials outlets, and some of which would be used for conventional features of the home's mechanical

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* Problems of collusion in both retrofit and new construction are probably unavoidable since both buyer and seller profit from overstated costs. The situation is in part analogous to that of automobile repairs, where collusion is generally believed to account for a substantial part of claim costs that reflect repairs either unrelated to the accident giving rise to the claim, overstated in amount, or not performed at all. In new construction, the situation is further complicated by the difficulty of actually determining the labor and material costs of the installed system (a real problem for the builder) and the fact that cost overstatement can take place within the context of a larger purchase (the sale of the house including its solar aspects) for which genuine proof of purchase can be produced.

systems. The subsidy could be based on actual cost as evidenced by bills from the solar component seller, subject to possible spot-check verification against catalogue or dealer's price lists to the trade.* Special allowances are possible to account for collectors and storage tanks that in some cases are assembled on-site rather than in the factory.** This approach would reduce opportunities for fraud and simplify the logistics of cost certification procedures. It would also provide equal benefit levels to do-it-yourselfers (who represent a substantial portion of the solar hot water market at the present time) without getting into the complications of calculating the amount and value of "sweat equity" invested in the solar installation.

3. Adjusting Allowable Percentages to Reflect Reduced Cost Basis

A final issue that must be resolved in cost-based subsidy formulas is raised by the implicit reduction in subsidy amount that accompanies a cost definition less than total installed costs. This report has earlier discussed the importance of providing rebate or tax expenditure incentives in an amount that is at or above a "threshold" proportion of total costs if a truly effective incentive program is desired. If such a target figure is agreed upon, it must be adjusted to reflect the deflating effect of any "eligible cost" definition lower than total costs. The compensating increase in percent may be substantial in the case of space heating systems, where collectors, tank and control system (a possible incentive base) generally account for only two-thirds of the installed cost. The requisite increase for hot water systems would be even greater, since the basic manufactured components typically consti-

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*Reliance on list prices could result in excessive subsidies if manufacturers are able to sell components at substantial discounts.

**President Carter's proposed solar tax credit implicitly addressed the difficulty of cost certification by distinguishing between new and existing homes. In retrofits to an existing home, where labor costs are easier to document, "qualified solar energy expenditures", as used in the bill, would appear to include the full costs of installation, while in new homes eligible expenditures are limited to materials, equipment, and labor costs associated with onsite assembly of collectors and storage tanks if not shipped pre-assembled from the manufacturer.

tute only half of total installed costs.*

For example, an incentive stated as 30% of solar hot water system costs, but limited to collectors, tank, and control system that accounted for only 1/2 of the system cost, would provide an amount equal to only 15% of the system's total cost ($225 in the case of a $1500 installed system). Conversely, to provide a subsidy of $450 to that purchaser -- that is, 30% of the total installed price -- an incentive based on those three elements would need to be set at 60%. Thus the "technical" issue of defining eligible costs may be a sleeper within the legislation establishing an incentive program. Unless appropriate adjustments are made, it could significantly diminish the program's actual market impact (with the concommitant increase in wasted "windfall" benefits already discussed).

D. THE SPECIAL PROBLEMS OF QUALIFYING PASSIVE SOLAR HOMES

The language used in many of the solar incentive bills introduced during the last two Congressional sessions is ambiguous in respect to whether or not "passive" solar systems are to be eligible for support.** Administering a procedure to qualify passive homes could prove extremely complex and costly. The "collector" in passive systems is effectively the entire house. This makes it exceedingly difficult to certify a passive home's solar performance characteristics and to isolate the costs uniquely attributable to the solar features. The home's thermal load can not be identified since "collector" loss is included in house heat loss; this in turn makes it impossible to distinguish what the structure's thermal load would have been in the absence of the solar "system".

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*To the extent that consumers are responsive to the stated size of the percentage of costs, the resulting "higher" apparent subsidy levels might increase the market impact of the program. However, given the many uncertainties involved with systems, and the possibility of dealer misrepresentation, it is essential that measures be taken to ensure that consumers understand the actual amount of benefit offered under any subsidy formula put into effect.

**"Passive" systems, in contrast to "active" systems generally employ no mechanical devices to collect, distribute, or store the solar energy. Instead, these functions are performed by basic architectural features of the home itself (most notably south facing windows) designed to capture solar heat during cold spells and to minimize heat loss. Heavy bodied walls and floors provide the thermal storage.

Certifying eligible costs for passive solar systems poses equally formidable problems, since the distinctly solar cost is, in a very literal sense, embedded in total construction costs. In New Mexico, where a solar tax credit has been in effect for over a year and where 50% of the applications for the credit are for passive systems, public officials have devised a methodology to calculate the solar portion of construction expenses.* However, the success of this approach seems to depend heavily upon the relatively low-volume of credit applications and on the state's explicit policy of liberality in granting the credit. Neither of these conditions is likely to characterize a national solar incentive program.

Since most passive applications are unique, certification would require an expensive case-by-case review of each passive home's blueprints and cost specifications by highly-skilled personnel. Even if volume of passive applications were sufficiently low to make the administrative costs of such a design review relatively insignificant, attempting to include passive systems with a solar incentive program raises thorny issues such as defining the point at which larger windows are "solar" features rather than homeowner design preferences. A related question is whether or not passive homes should be included in the ambit of solar programs, as opposed to more general energy conservation design standards for new construction.

However, while making passive solar home designs eligible for solar subsidies would pose adminstrative difficulties, such designs can be as efficient as and perhaps more cost-effective than collector-based "active" solar systems. This is particularly true in parts of the country, such as the Southwest, where passive systems may present an optimal approach to using the sun's energy. Since these systems incorporate desirable changes in housing design that may contribute as successfully as other approaches to the national goal of energy conservation, a continued effort should be made to try and overcome the admin-

*This procedure rather ingeniously computes a "solar window cost" using a "solar fenestration percentage" defined as the difference between the percentage of south facing walls consisting of windows minus the percentage of wall area oriented to the north, east, and west given over to windows (See Exhibit VI-1). While New Mexico's regulations properly encourage south glazing and reduce potentially complex calculations to a simple formula, they unavoidably tend to over-emphasize special devices, such as water drums and "bead walls", whether cost effective or not.

EXHIBIT VI-1

WORKFORM USED TO DETERMINE PORTION OF PASSIVE SOLAR COSTS ELIGIBLE FOR NEW MEXICO'S INCOME TAX CREDIT

(Note: This form is completed by the applicant)

1. Consider the vertical wall area between the ceiling level and floor level of the North, East, and West Walls and non-solar South walls of the house. Determine the percentage of fenestration or window area within this band. ______ % N,E,W, FENESTRATION

2. Calculate the percentage of window area or fenestration contained with the designated South Solar Walls. ______ % SOLAR SOUTH WALLS

3. Subtract N,E,W, percentage of STEP 1 from South percentage of STEP 2.

   ______ % SOUTH − ______ % N.E.W. = ______ % SOUTH SOLAR FENESTRATION IN EXCESS OF NON-SOLAR FENESTRATION

4. Multiply this "Solar Fenestration Percentage" by the material cost of the South Solar Fenestration.

   ______ SOLAR FENESTRA. x $ ______ MATERIAL COST = $ ______ SOLAR WINDOW FENESTRATION

5. To this Solar Window Cost Add:

   a) Cost of movable insulation for your South Windows (Do not include drapery costs) $ ______

   b) Cost of any architectural elements that are particular to solar heating. (Supply complete details.) $ ______

   c) 50% of cost of skylights if they have movable insulation. (No credit given if insulation is not provided). $ ______

   d) Cost of hardware especially for the solar system that would not have been used in normal construction. $ ______

   TOTAL OF LINES 4 AND 5 . . . . $ ______

This total amount is used on Line 1 of the New Mexico State Bureau of Revenue Form PIT-16 "APPLICATION FOR PERSONAL INCOME TAX CREDIT FOR SOLAR HEATING/COOLING EQUIPMENT PURCHASE."

istrative barriers that make them difficult to include in a Federal incentive program. Should passive homes be made eligible for a solar incentive, one way to at least partially alleviate the administrative expense of qualifying passive systems would be to have the applicant for the incentive pay a fee to cover the expensive, case-by-case review required.

E. CONDITIONING ELIGIBILITY ON STATE ACTION

Enactment of a solar incentive program will provide the Federal government with the leverage to encourage state action aimed at removing certain potential barriers to widespread solar energy use. However, before deciding to apply this leverage, there should be sufficient evidence that these barriers, in fact as well as in theory, are severe and prevalent enough to warrant encumbering a Federal program with special requirements and conditions, and to deprive citizens in some states of its benefits.

Individual eligibility for any given Federal incentive might be conditioned on the applicant's home state having acted in the following areas:

- Property Tax Assessments: Including the cost of solar installations in the assessment basis can severely diminish the attractiveness of using solar energy. Annual savings may be reduced by as much as 20-70% (See Table VI-1). Even homeowners who are insensitive to the taxes' impact on "solar economics" are likely to be deterred from using solar if they expect that, unlike conventional systems, solar utilization will increase their property tax liabilities. Thus, it may be desirable for the Federal government to condition receipt of Federal subsidies on state action that prevents the imposition of property tax assessments on residential solar systems.*

  While such a prerequisite would deny subsidies to solar users in non-complying states, this risk seems relatively minimal since in areas where property taxes are imposed on solar improvements there will presumably be little effective demand for solar, even with a Federal incentive. (Representatives of the Solar Energy Industry interviewed as part of this study report that the handling of solar homes by local property tax assessors has

*Due to home rule provisions in some state constitutions, a few states could comply with such a requirement only to the extent of granting localities the option to exempt solar from property taxes.

TABLE VI-1

EFFECT OF INCREASED PROPERTY TAX ASSESSMENTS ON SOLAR SAVINGS

Total Solar System Cost	Increased Annual Tax Liability (1.2, 2.5, 3.5 Effective Rates)	Change in % Annual Solar Savings*
$1,500	$22.50	-19%
	37.50	-31%
	52.50	-44%
$10,000	$150.00	-30%
	250.00	-51%
	350.00	-71%

*Savings calculation assumes that:

1) Hot water load = 16 mbtu
2) Space heating load = 50 mbtu } total annual thermal load = 66 mbtu
3) Cost of electricity = 4.6¢/kwhr or $14.97 mbtu
4) Total annual hot water bill = $239
   Total annual heat and hot water bill = $988
5) Solar collector savings 50% annually or:

   $120 for hot water;
   $494 for combined heat and hot water.

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materialized as a real problem in several states, most notably California.) To some extent, however, the need for Federal action in respect to this issue may be precluded by the strong momentum already evident at the state level towards enactment of property tax exemptions for solar users.*

- Utility Rates - Electric utilities tend to regard solar customers as more expensive to serve than their other customers for reasons discussed in detail in Chapter Eight, and therefore may request state regulatory commissions to authorize special rate increases for their solar customers. Institution of such "commitment

*12 states require localities to exempt solar equipment: Arizona, Nevada, Hawaii, Kansas, Illinois, Maryland, Massachusetts, Michigan, Montana, North Dakota, New Jersey, Oregon); 5 have passed solar exemption provisions, but leave room for local discretion (Connecticut, Georgia, New Hampshire, Virginia and Vermont) and 28 have solar property tax exemptions pending. (National Solar Information Center, July 1977. See Appendix B.)

charges" can dramatically decrease the annual dollar savings produced by solar equipped homes' reduced consumption of conventional energy.

- Building Codes - Enactment of building codes with special solar provisions can increase the cost of installing solar systems or seriously restrict their use. In areas of the country where local building officials have already had to rule on solar installations, attempts have been made to incorporate into local building codes standards which disadvantage solar systems. States can help prevent this problem by creation of model solar codes or, where feasible, by outright prohibition of restrictive provisions.

While utility rates* and building codes** that have a negative impact on solar utilization are less pressing concerns than the property tax status of solar improvements, it may nonetheless be desirable to disqualify residents of a given state from receiving Federal subsidies while such discriminatory rates and code provisions exist. The Canadian government has had no compunction in making similar demands upon Provinces that wish to be eligible for its new $1.4 billion home insulation program. To qualify for the program, a Province is required to exempt insulation materials from sales taxes and to enact certain energy conservation measures -- reduced speed limits, upgraded insulation standards for new buildings and so on. However, this type of leverage might be more appropriately applied within the context of an incentive program actually administered through the states.

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*To our knowledge, only one utility to date, the Public Service Commission of Colorado, has attempted to institute a commitment charge rate schedule, which was withdrawn a year later after considerable public protest. In contrast, solar installations in states with no property tax exemption provisions regularly add to the property's assessment basis.

**In one Florida county an effort has been made to require that only master plumbers and master electricians install solar systems. Since installation represents a substantial portion (35-50%) of total system cost, such a requirement significantly increases total solar costs. A recent attempt by the town officials of Coral Gables, Florida to pass an ordinance restricting solar applications to roofs not facing the street, would have prevented all homeowners with south and street facing roofs from using solar.

F. REGIONAL CONSIDERATIONS AND THE ROLE OF THE STATES

A case can be made on the grounds of both equity and impact for administering a solar incentive program in a manner that (1) permits Federal funds to be concentrated in prime market areas, and (2) allows benefit levels to be tailored to the often dramatic variations in the economics of solar use among regions of the country. A direct way to accomplish this would be to channel incentives through the states. This would also enhance integration of Federal assistance with existing and contemplated state initiatives in support of residential solar energy use. However, the varied capabilities of state governments to administer solar incentives at this time argues against such an approach, particularly insofar as a priority of program design is the speed with which visible results can be achieved.

Given the substantial regional variations in the economic attractiveness of solar, a dollar of Federal subsidy will produce different market impacts in different regions. The subsidy that multiplies solar sales in Florida may induce only a small number of purchases in the Pacific Northwest where electricity is cheap and cloudy days the rule. These local contrasts in receptivity to solar have two implications that should be addressed in the design of a Federal solar incentive program:

- First, a nationally uniform subsidy formula is likely to oversubsidize recipients in areas where solar is most attractive and where a much lower subsidy might obtain the desired level of market response.

- Second, insofar as the overriding objective of Federal support is to accelerate solar sales and to foster the emergence of supportive installation and service industries, priority of allocating whatever monies are available might be given to those regions where climate and fuel prices promise the largest market response per dollar of subsidy provided.

Perhaps the most direct way to sensitize a Federal subsidy program to regional variations would be to administer the incentives (be they grants, rebates, or loans) through the states. Monies might be distributed by applying a formula analogous to Revenue Sharing or CDBG formulas, that incorporates measures of local solar potential, while also allowing for regional differences in population, growth rates, and size of housing stock.*

However, in practice, the disadvantages of a state administered subsidy program may outweigh the advantages:

- Involving the states this directly is likely to require longer lead times and higher administrative costs, since most states presently do not have the capacity to administer such a program.**
- Devising a universal formula whose intent is to favor certain regions would be a highly charged, politically difficult, and potentially lengthy process.
- Such a degree of fine-tuning may be unnecessary given the transitional, short-term nature of the program and the fact that, precisely because of regional differences in solar receptivity, even a nationally uniform level of benefit per recipient will result in higher usage of the program in those areas where solar is most suitable at present.

A related issue concerns whether or not an incentive program must make specific allowance for the fact that nine states already offer some form of tax benefit to homeowners installing solar energy devices and 16 other states have comparable legislation pending.*** Here the chief

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*Another approach to distributing more funds to areas where impact and/or need is likely to be greatest is to allocate subsidies to individuals on a basis similar to the Fair Market Rents program, i.e. providing a solar subsidy based upon the difference between the area's average cost of space and hot water heating/room and the individual's cost or between the national average cost of space and hot water heating/room and the area's average cost. However, this seems to be an overly complex approach requiring a program administration that is a far cry from the desirable, relatively automatic claims-processing IRS model.

**Under HUD's Solar Hot Water Initiative, conceived as a concentrated market support program, grants are being channelled through ten states to 10,000 homeowners. The initial difficulties that have been encountered throw light on the problems states face in disbursing funds quickly, screening systems for compliance with established standards, and performing other administrative functions inherent in a solar incentive program. States were selected primarily on the basis of high residential electric bills. This criteria was chosen as the simplest measure of immediate market potential for solar.

***See Appendix B for a detailed tabulation of state action to date.

worry is that the combined effect of Federal/state incentives may be so great as to provide an inappropriately large subsidy to individual purchasers and to over-stimulate the market in some states, causing bottlenecks in supply and inflation in the prices of solar components. For example, if a Federal incentive provided 30% of the total system cost, a resident of Oklahoma installing a $1,500 solar hot water system could secure a $375 credit from the state and $450 from the Federal government -- a total credit equal to 55% of system cost.

As pointed out in a recent ERDA study based on ERDA-sponsored research:

> ...it is important that the Federal incentive package be designed so as to complement, rather than substitute for, the [state] incentives already enacted.*

The study then suggests that one method of achieving this result would be to provide Federal incentives through the states on a matching fund basis. This would reward and build on the efforts of the states that have already displayed some initiative and encourage other states to share in the costs of advancing solar in their regions. Such an approach, however, would still be subject to the qualifications concerning the complexity and cost of utilizing the states as an administrative and financial intermediary.

Alternatively, it would be possible to leave any judgment regarding appropriateness of a combined Federal/state incentive to the states themselves. New Mexico anticipated this issue by specifying in its solar tax credit statute that eligible individuals must choose between taking the state's credit and any Federal benefit that might be made available.

A related policy issue is posed by the present effect of the Federal income tax on state solar incentive programs. Since state taxes are an allowable deduction in determining taxable income for Federal income tax purpose, it would appear that part of the benefits being provided by the reductions in state income tax for solar users are being claimed by the Internal Revenue Service. <u>This implicit Federal tax on state</u>

*Bezdek, et al. op. cit. p. 461

incentives is progressive in its structure. Nevertheless, it would seem to be an unanalyzed and inappropriate effect for which a remedy should be considered through an appropriate alteration in the Internal Revenue Code.

G. ISSUES OF TIMING

Four basic issues of timing enter into the design of a solar incentive program: Should the program be of fixed duration, and, if so, how long? Should the subsidy amount diminish over time? When should the program become effective? Should all residential applications of solar systems be made immediately eligible for incentives, or domestic hot water only?

1. Sunset Provisions: Virtually all proposed incentive solar legislation places a limit of 2 to 10-1/2 years on the program's life. This is obviously appropriate since the program's principal goal, kicking over the solar market, is a transitional one. Should this experience conclusively demonstrate the reliability and cost-effectiveness of using solar energy, then program goals may shift to solarizing the nation's homes, making more open-ended subsidies appropriate. The program's life should be long enough to ensure that homeowners are aware of the incentive and have time to adjust their purchasing decisions accordingly, but not so long that market supports remain in effect after the market has become self-sustaining. A five to seven year useful life would seem to satisfy these criteria.

2. Diminishing Subsidy Levels: The rationale for decreasing subsidy levels over the program's life appears to be a desire to avoid providing "too much" subsidy as solar economics improve in the near term. Here the presumption is that fuel prices can be expected to rise and the costs of solar systems to decline and that, as a result, any targeted level of market impact can be achieved by lower subsidy levels in each successive year of program life. However, there is built-in subsidy erosion attributable to inflation. For example, assuming a 5% annual rate of inflation, a $500 fixed-amount subsidy will be worth only $390 in present dollars five years hence; stepped percentage formulas will suffer a similar implicit deflation as system prices rise. Moreover, any

number of uncertainties (e.g. government policy on natural gas deregulation) will influence the appropriate level of subsidy over even a five or seven-year period. Thus, if any allowance is to be made for adjusting subsidy levels over time, such determinations might be better left to administrative discretion, rather than anticipated in a legislatively mandated formula. Congress could specify the criteria to be used by the appropriate executive official in making any such adjustments. Revision of the formula might be done on a biennial (2-year) rather than on an annual basis in order to allow more predictability in the level of Federal support.

3. Starting Date and Retroactivity: The residential solar incentive proposed in the National Energy Act suggests a commencement date of April, 1977 -- that is, a date that coincides with the public announcement of the legislative initiative. Retroactive coverage may be necessary in order to avoid an interim depression in the market that would result if potential customers had to wait for a future date in order to qualify for the incentive. Such a hiatus in the market, if too prolonged, might even threaten the solvency of the smaller solar manufacturers and distributors. Clear precedent for retroactivity can be found in previous changes in the tax code which also impinge on private and business investment decisions. In the case of a solar incentive, however, a retroactive eligiblity date is not a full solution to the problem; so long as difficult issues of system eligibility remain unresolved, the prospective solar purchaser today still cannot know whether or not he will qualify for the program. A final determination on the starting date for a solar incentive should be made in light of the likely timetable for implementing certification procedures.

4. Possible Short-Term Focus on Solar Hot Water

A number of factors discussed in this Chapter and elsewhere in this report suggest that, in the near term (one to three years), eligibility for incentives might best be limited to solar energy applications for domestic hot water purposes only:

(1) Adequate procedures for system certification are much simpler for solar hot water than for total space heating systems and can be put in place with relative dispatch (though even then there will be problems).

(2) The homeowner's financial risks (from system failure or loss in home resale value) are far less serious for solar water heaters than for space heating systems.

(3) The probable demand for solar space heating over the next five years seems more appropriate to the type and scale of support provided through a demonstration program rather than a broad-based incentive program. Our estimates envisage only 13,000 space heating units installed in single-family houses between 1978 and 1982 in the absence of Federal assistance and a maximum of 66,000 with even the most high-response incentive tested (a 1%, 30-year loan).

(4) As noted earlier, a fixed dollar amount subsidy would be feasible for hot water systems, precluding the need for elaborate cost-certification procedures, but would be far less practical for heating systems.

(5) The results of the market impact analysis indicated that a different incentive mix might be appropriate for supporting solar space heating than for solar domestic hot water alone (See Chapters Three and Four), with some possible role for long-term, low-interest loans in the case of heating systems. Here again, however, it should be emphasized that over the next two years, the anticipated program volume (4,000 to 8,000 units per year at most, assuming extremely liberal financing terms) would not appear to justify mounting a full-scale loan program.

In sum, it may make sense to move ahead with an incentive package for solar hot water while holding back from incentives for space heating until adequate certification procedures are brought in line, local building contractors obtain more familiarity with installing solar systems, and somewhat greater market potential has materialized. In the meantime, demonstration support -- with a fuller degree of review of individual applications -- could concentrate more exclusively than at present upon solar space heating and cooling.

CHAPTER VII

LIMITED POTENTIAL OF INCENTIVES IN MULTI-FAMILY HOUSING SECTOR

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CHAPTER SEVEN

LIMITED POTENTIAL OF INCENTIVES IN MULTI-FAMILY HOUSING SECTOR

A. OVERVIEW

At the present time, an incentive capable of inducing any significant number of multi-family investors to install solar energy systems would probably require an unprecedented level of public subsidy.

In the short run, the types of incentives and subsidy levels which have received serious legislative consideration cannot be expected to have a substantial impact on demand for solar energy in the multi-family rental market. However, for the same reason, establishing such incentives in a form that has low program administrative requirements (e.g., an investment tax credit) would have little downside financial risk from a public cost perspective, and may be desirable simply to indicate the Federal government's recognition of the potential importance of solar in this segment of the housing market.

Our analysis of the requirements for motivating investors to include solar energy systems in larger multi-family projects indicates that there would be significant response only if a package of incentives were provided which essentially eliminated exposure to risk and required little or no capital investment. Such an incentive program for developers and investors has no precedents in the field of housing and would appear to lack political acceptability. Specific objectives for increased use of solar in multi-family projects may be better met in the near term through continuation of "demonstration" programs funding all or a large part of solar costs, particularly if one of the goals is broad geographic distribution of examples of multi-family solar installations.

As experience with operating solar systems grows and the extent and reliability of cost savings become more demonstrable, investors should become willing to invest in solar energy without demanding the level of public assistance that currently appears necessary. At that time, which could be within the next few years, an incentive program oriented to large-scale multi-family housing may be attractive and might offer advantages in terms of administrative economies attendant on the larger size of individual tranactions -- at least for the 10 million units of rental housing in structures of five or more units.

It should also be noted that although rental housing makes up a significant proportion of the total housing stock (25.7 million rental occupied units in 1975, 35% of total occupied units), much of this involves structures of relatively small size. Fully one-third of rental units are in one-family attached and detached houses, and 26% are in 2-4 family structures. Except for those in 2-4 family owner-occupied buildings, these may well fall outside the reach of incentives designed for either larger multi-family rental housing or owner-occupied housing, and may be extremely difficult to attract through any practical incentive program.

B. FUNDAMENTAL BARRIERS TO SOLAR UTILIZATION IN MULTI-FAMILY RENTAL HOUSING

At first glance, several characteristics of multi-family rental housing suggest that it might have particular importance as a focus for solar energy incentives: the size of the market; control of large numbers of units by individual investors;* the larger amounts involved in each transaction; and the possible direct Federal participation in the value of private energy savings.

- Size of Market

  Rental units account for over a third of total occupied housing units (see Table VII-1). Rental units in structures of 5 or more units totalled 9,932,000 in 1975, approximately 14% of all occupied housing units. Structures of 5 or more units are even more significant in terms of new construction, accounting for almost 29% of private housing completions in that year. (See Table VII-2).

- Concentration of Control

  Many owners -- as individuals, or as general partners of investor groups -- control hundreds and often thousands of rental units, have easy access to technical expertise, are accustomed to making real estate investment decisions that balance initial costs and future revenues, can take advantage of economies of scale in design, purchasing and installation of solar equipment, and have continuing professional maintenance operations already in place.

- Larger Individual Transactions

  Solar installations in multi-family structures not only offer the benefits of increased scale just described, but also make a greater variety of incentive programs feasible. The administrative costs involved may be a far smaller part of the total transaction; financing programs that are impractical or too costly where $1500 first costs for single-family homes are involved may be workable in the context of 12, 20 and 50 unit multi-family structures.

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*Our discussion of multi-family housing focuses on rental apartments. An additional, important part of the new housing market consists of cooperatives and condominiums: the latter alone accounted for 13.1% of the new housing units completed in 1974, up from 5.4% in 1970. Unfortunately, the transfer and diffusion of ownership and control from the developer to the individual purchasers raise significant barriers to solar use in this submarket. Existing condo/coop structures require communal decisions for such property improvements as solar energy installations, substantially reducing the likelihood of such investments. And in new construction, there is a decisive difference in perspective between, on the one hand, the developer and mortgagee, who are concerned with controlling first costs and minimizing risks and therefore are unlikely to experiment with solar energy systems at the present time, and, on the other hand, the future owners, whose long-term interest is in reduced operating costs.

TABLE VII-1

TOTAL OCCUPIED HOUSING UNITS, 1975
BY TENURE AND TYPE OF STRUCTURE
(Rental Only)

RENTER OCCUPIED HOUSING UNITS[1]	NUMBER OF UNITS (In 000's)	PERCENT OF TOTAL UNITS	PERCENT OF RENTAL UNITS
Size of Structure[2]			
Mobile Home	519	0.7	2.0
Detached 1 Unit	7,082	9.8	27.6
Attached 1 Unit	1,350	1.9	5.3
Total 1 Unit	8,951	12.4	34.9
2-4 Units	6,772	9.4	26.4
5-9 Units	3,028	4.2	11.8
10-19 Units	2,514	3.5	9.8
20-49 Units	2,058	2.8	8.0
50 or More	2,332	3.2	9.1
	25,656	35.4	100.0
UNITS BY TENURE			
Total Renter-Occupied Housing Units	25,656	35.4%	100.0%
Owner-Occupied Housing Units	46,867	64.6	
Total Occupied Housing Units	72,523	100.0%	

SOURCE: Annual Housing Survey 1975, Part C.

1. "Renter Occupied" denotes any unit occupied by a household other than the owner, including various categories of non-rent paying occupants (relatives, tenant farmers, ministers, etc.).

2. Counts are by tenure, not by total physical units within each class of structure. For example, a two-family structure owned by a single household occupying one of its units, with the other unit rented out, adds one unit to the inventory "rental occupied housing units, 2-4 units," and one unit to "owner occupied housing units."

3. Totals may not add due to rounding.

TABLE VII-2

PRIVATE HOUSING COMPLETIONS
BY SIZE OF STRUCTURE, 1975

UNIT SIZE	NUMBER OF UNITS	PERCENT OF TOTAL	PERCENT OF MULTI-FAMILY
50 or More	109,000	8.4%	25.3%
20-49	86,000	6.7	20.0
10-19	92,000	7.1	21.4
5-9	85,000	6.5	19.7
Total 5 or More	372,000	28.7%	87.4%
2-4	59,000	4.5	13.7
Total 2 or More	430,000	33.2%	100.0%
1	866,000	68.2	
Total	1,296,000	100.0%	

SOURCE: Department of Commerce/HUD, Construction Reports, Characteristics of New Housing, 1975, Publication C-25-75-13 (November, 1976)

NOTE: Totals may not add due to rounding.

- Possible Federal Sharing of Private Energy Savings

  Federal financial incentives may to some degree be easier to justify because of the potential for automatic recapture of part of the benefits that result: solar reductions in conventional energy use may be directly reflected in greater operating income in the near or long term, increasing the amount of project revenue directly subject to federal income taxation, or decreasing the amount of available tax shelter*.

However, these possible attractions of multi-family rental housing as a setting for incentives appear to be more than offset by a number of present obstacles to solar-energy use in such housing that make it an unlikely area for early adoption of solar and likely to prove highly resistant to the limited allures that politically acceptable incentives can provide. A brief review of the major problem areas is presented in this section as a necessary introduction to consideration of possible incentive options.

1. Economic Difficulties in the Multi-Family Rental Market

Perhaps the most important problem facing solar today is presented by the continuing economic difficulties from which the multi-family rental market is only beginning to recover. Marketable rent levels in many areas of the country have not kept pace with the major increases experienced in the operating costs of existing rental properties -- real estate taxes, maintenance and operating expenses, the costs of financing acquisition or re-financing properties in portfolio. Inflation in land and construction costs, combined with high mortgage interest rates in recent years, have made unsubsidized rental construction infeasible in a number of areas. While there are now some indications of possible improvement in these conditions, it is an essentially inhospitable climate for the introduction of solar energy technology with its relatively high first costs and unproven long-term performance.

*Whether this will involve a net benefit or net loss to the Treasury in the long run -- let alone in relation to any solar installations induced by incentives -- will in large part be determined by the depreciation treatment accorded solar equipment and the additional tax-deductable interest associated with financing such installations.

2. Limited Extent of Energy Cost Savings Currently Demonstrable for Solar Equipment

At the present time, there are few areas of the country in which the savings potential from solar energy systems even begins to approach the levels that would make investment in solar economically attractive from the perspective of the multi-family rental developer or investor. This helps to explain why, of the several thousand solar systems installed over the past several years, only a handful have been in multi-family structures -- most probably funded through demonstration programs.* The limited financial attractiveness of solar energy for multi-family rental units is illustrated in Figure VII-1. This shows the after-tax rate of return, as a function of estimated energy cost savings, for the installation of a solar hot water system costing $1500. As can be seen in that figure, a 10% after-tax return is projected only where present energy cost savings from such a system exceed $185 even assuming a 5% annual increase in future energy cost savings-- a figure unlikely to be accepted by most multi-family property owners today.

The evolution of improved solar economics for multi-family structures in the near term is open to serious question. Some savings should be achievable in multi-family first-costs as compared to single-family units, through lower prices in the larger purchases of equipment involved, through the lower proportion of fixed system costs to collector costs, and through economies of scale in installation.** Solar energy systems in large-scale rental properties are also more likely to receive attention from experienced maintenance personnel on a regular basis, and to be "fiddled with" until output meets expectations. However, in many cases, these savings may be more than offset by the often sizeable collector support costs (which on flat roofed buildings can actually exceed the cost of the collectors) and by additional requirements for

*Although no definitive numbers are available, Franklin Institute staff associated with the National Solar Heating and Cooling Information Center estimate that no more than 4% of the 1,000 solar heated residences in their files are in multi-family buildings.

**Results thus far from HUD's Solar Heating and Cooling Demonstration Program indicate that solar hot water costs for multi-family may be as low as $1000 on the average.

safety accessories, valves, vertical piping and pumps, and other special problems attendant upon multi-family installations.*

3. <u>Greater Comparative Magnitude of the Investment</u>

Solar installations represent an investment of a substantially different magnitude and nature for multi-family rental properties, and are thus less likely to be accepted in this context than in single-family housing.

- First, a larger absolute amount of money is involved. Some individuals may be prepared to invest $1500 in a hot-water system for their own homes, or even $6,000-$10,000 for a heating system, out of a mixture of personal preference and the hedge against fuel price increases it provides. An investor -- even when considering a 12-unit garden apartment type structure -- is risking a far larger amount, and, unlike a homebuyer, will rarely be prepared to substantially increase his own cash investment if that is required.

- Second, solar costs are a significantly higher proportion of the total cost involved for a typical multi-family development. While median single-family new home sales prices exceeded $42,000 in 1976, the average cost of new rental housing built in that year was $17,500 per unit.** A $1000 to $1500 per-unit cost for solar hot water would represent a 6-9% increase in this cost; and a $6000 combined space and water heating installation would increase that cost by over 34%.

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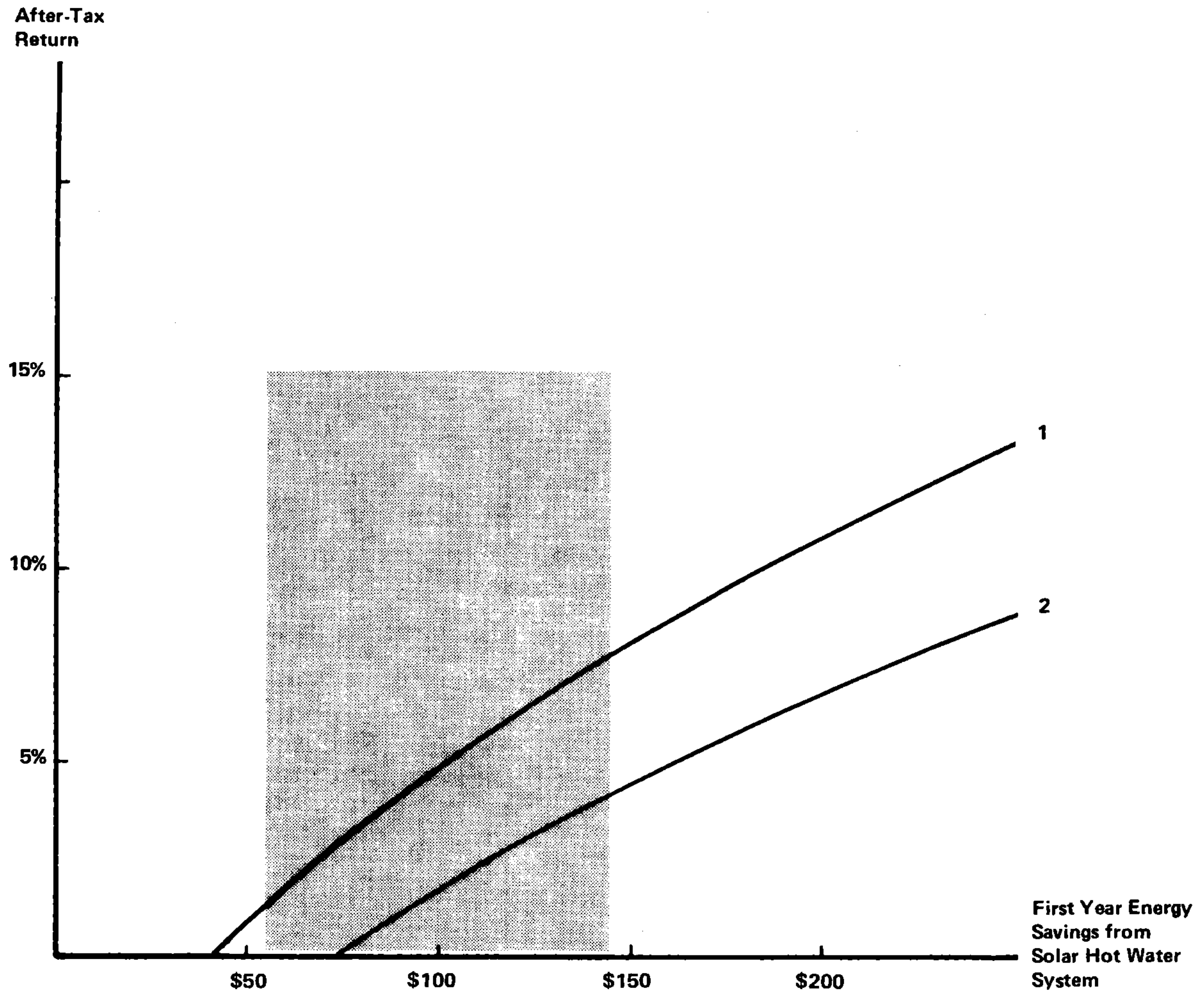
*High-rise structures face particular problems. Roof areas place an upper bound on the amount of collector that can be accommodated; as the ratio of roof to floor area declines, solar energy systems are increasingly limited in the proportion of the building's thermal load they can carry. Larger buildings also frequently use higher temperature conventional heating systems (such as medium pressure steam) which limit the ability to tie in a low temperature solar system and require installation of a separate distribution circuit that could prove prohibitively expensive. For all practical purposes, solar installations in buildings above several stories in height may be limited to hot water only, with some swimming pool and snow melting applications, and virtually no space heating.

The optimal installation of hot water systems may be in low-rise pitched-roof garden apartment projects, which can efficiently use equipment similar to that for single-family homes, avoid the high costs of special collector supports, achieve economies of scale in purchase and installation, and reap the benefits of more professional maintenance. Even here, the economic attractiveness of such an investment to multi-family rental property owners remains to be demonstrated.

**R.S. Means Company, <u>Building Construction Cost Data, 1976</u> (Duxbury, MA. 1976). 75% of all apartments were estimated to cost less than $23,600/unit.

Figure VII-1

AFTER-TAX RETURN ON SOLAR WATER HEATING



Assumptions
- 20 Year Useful Life
- Straight-line Depreciation, Zero Salvage Value
- 50% Tax Rate

1 Energy savings are constant.

2 Energy savings increase 5% per year.

Range of energy savings in survey cities, assuming 50 square feet of collector area and electric water heating.

It can be argued that life-cycle costing analyses may soon demonstrate the long-term advisability of solar investments; but the truly fierce struggle of multi-family developers to control total development costs, the magnitude of solar first costs, and the limited and uncertain return solar systems show at present pose substantial barriers for solar use in multi-family rental housing today. The magnitude of the investment may be an insuperable obstacle to solar heating systems, and even to hot-water systems if additional mortgage financing cannot be obtained for them. The additional equity funds required for purchasing solar equipment in these cases may equal or exceed the owner's or developer's equity in the project as conventionally heated; this amount of investment capital could be used alternatively to purchase or develop another project, rather than a solar energy system.

4. Trend Towards Individual Metering

In recent years, multi-family rental property owners have been increasingly on the outlook for ways to protect their investment from erosion in the face of increasing utility costs, particularly in the case of electrically-heated buildings. Though better weatherproofing and other energy conservation improvements are part of this, there has been a decided trend in the last few years towards shifting utility costs to tenants through individual metering, in such buildings. Many owners of existing properties are converting to separate metering systems where feasible, and lenders are often insisting that new construction be separately metered as a condition of providing financing. Since individual metering largely insulates rental property owners from future increases in utility costs, it eliminates much of the motive for investment in solar energy equipment, and must be recognized as directly competitive with such investments from the rental property owner's perspective. Given the position of both owners and mortgage lenders, this phenomenon poses a serious obstacle to acceptance of solar in multi-family rental properties.*

5. The Investment Perspective in Multi-Family Rental Housing

As the issues raised by the option of individual metering suggest, there are substantial barriers to solar market penetration presented by the decision-making criteria and processes utilized by rental housing owners and developers, over and above the obstacles that result from the physical and institutional characteristics of that market. Interviews with residential real estate developers, income property investors and residential rental property managers suggest a generally shared perspective of the requirements for investment in multi-family rental real estate that makes solar market penetration in this area unlikely in the near term.

Major elements of this investment viewpoint include:

- An emphasis on minimizing avoidable risks

  Multi-family rental real estate development has its own special risks and uncertainties, ranging from cost overruns in new construction to changes in the character of neighborhoods that limit marketable rent levels and the saleability of existing properties. The effort required to manage known difficulties contributes to a general reluctance among such property developers and owners to pioneer innovative changes in design or technology.

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*Although separate metering is properly recognized as having its own desirable energy conservation merits, it raises an important problem for improved energy conservation in multi-family housing. Property owners who convert to separate metering may more easily decide against other property improvements -- such as increased insulation, or even relatively inexpensive weatherproofing measures -- that are cost-effective and highly desirable from an energy conservation perspective, yet beyond the control of tenants. In the long run, it is possible that tenant perceptions of total shelter costs -- rent and utilities -- may compel property owners in highly competitive housing markets to take such steps to reduce heating and hot water costs, even in buildings with separate or "master" metering. But so long as housing markets remain tight, as they are for well-maintained rental properties in many areas today, separate metering may mean continued deferral of other desirable energy conservation investments -- and will almost certainly preclude solar installations with their high costs and high risks for the property owner.

It leads to a preference for investments with relatively assured prospects for adequate continuing returns and long-term capital appreciation. This is particularly true among that class of investors concerned with high maintenance standards who would provide the potential market for solar installations, but also tend to avoid relatively speculative opportunities, such as those posed by the certain first costs but only promised energy savings of most solar energy systems today. This cautious approach towards unproven technologies in general and solar in particular is reinforced by the skepticism of real estate mortgage lenders, who similarly tend to avoid risk, and express their distrust of housing innovations through the restricted availability of financing.

- <u>Preference for Shifting Risk to Other Parties</u>

  Investment in solar energy systems can be viewed as a possible response to a problem inherent in multi-family rental property ownership: high present energy costs and the risk of future fuel price increases. However, owners of income properties (and their sources of permanent mortgage financing) generally prefer approaches that involve shifting such risks to other parties where that is possible. Industrial property tenancies are characterized by net lease terms under which tenants assume direct responsibility for some or all operating expenses and property taxes; commercial leases typically contain escalation clauses obligating tenants to reimburse the property owner for any future increases in taxes and/or operating costs, and in some cases tying the base rent as well to the consumer price index or some other measure of inflation. In multi-family rental housing, conversion to separate metering (as already discussed) or "master metering" provisions that make utility costs a tenant obligation in addition to the rent, can achieve the same result. Where they are possible, such measures will be preferred by many rental property owners over investment in solar equipment.

- <u>Competition for Limited Equity Funds</u>

  Professional income property investors seek to minimize the amount of their own cash investment in individual properties for a number of easily understandable reasons: to limit the amount of cash at risk in each case; to allow for control over the largest possible portfolio of properties (and their potentials for appreciation and mortgage amortization); and to increase their own return by greater use of debt financing (with its lower investment return requirements). Solar energy installations will demand higher equity investments in new projects, and may do so disproportionately if lenders, as it now appears, are reluctant to finance these costs in whole or part. This possible solar investment will be hard pressed to compete against other uses of equity funds available to the investor, such as acquisition or development of other real estate projects, or other measures for reducing project operating costs that appear more cost-effective. Solar investments will also bear the disadvantage of having their primary appeal to those seeking protection against large increases of energy costs in the future; property investors typically discount future benefits substantially in their investment analyses, reflecting the high rate of return desired for uses of their limited equity resource, the effects of inflation, and the uncertainties inherent in projections of future returns.

- <u>Possible Focus on Short-Term Cost Recovery</u>

  For many investors, solar installations may have an even more severe hurdle to pass than the discounting of future benefits in investment analysis. As noted above, the economics of solar multi-family installations are less than compelling when judged by the rate of return that energy savings provide for the investment required, and their attractiveness today depends on the possibility of greater future value: a hedge against energy cost increases and possible quantum jumps in those costs. But if these more speculative benefits are emphasized, investor attention will shift from efforts at quantifying future energy savings to concern with payback periods of the costs involved -- the length of time the investment remains at risk. This emphasis on cost recovery is typical and appropriate for situations such as this, where there is a high degree of uncertainty in the amount and timing of future benefits and in the durability and economic life of the equipment. Short-time horizons are inherent in this frame of reference, and our interviews suggest that three to five years probably defines the outside limits of acceptability; solar energy systems available today have payback periods considerably in excess of this in multi-family applications in most if not all areas.

- <u>Paying for Property Improvements from Cash Flow</u>

  After initial equity investments are made, rental projects are generally expected to be self-sustaining, and to generate cash flow for distribution without major additional infusions of equity capital. Costs of property improvements are considered an element of overall project maintenance, to be paid for from current project cash flow, or, if absolutely necessary, from "replacement reserves" set aside (actually or theoretically) from past cash flow. Refinancing of projects is viewed primarily as a means for investors to realize the accumulated benefits of property appreciation and mortgage amortization without incurring tax liability, rather than as a resource for undertaking property improvements. Second mortgage financing appears equally unlikely. Though sometimes used for necessary property improvements, it is unlikely to be utilized for such a discretionary investment as a solar energy installation. And the higher interest rates, shorter terms and resulting higher debt service will make solar even harder to justify in terms of the limited energy cost savings demonstrable for such investments in most areas today. Thus, retrofitting of solar on existing multi-family rental properties faces more barriers, and appears even less likely, than solar in new construction.

C. THE LIMITS OF POSSIBLE INCENTIVE APPROACHES

1. No Desirable Incentive Options Identified

The types and levels of assistance that might be provided through an incentive program, discussed in the remainder of this chapter, do not appear sufficient to overcome the "barriers" to solar utilization in multi-family rental housing that have been briefly reviewed here. To a considerable extent, this reflects the fact that, compared with single-family homeowners, the developers and owners of multi-family rental properties will make their decision from a more demanding economic perspective and will not display the same diversity of motives. They can uniformly be expected to exclude non-economic aspects of solar use (environmental improvement, conservation of natural resources) from this business decision, and will require solar to be economically competitive (in return and risk) with other possible uses of equity funds. As a result, an incentive program would need to provide a much greater depth of subsidy in consort with mechanisms that would make the residual investment relatively free from significant risks and uncertainties.

While no acceptable incentive program appears likely to be effective today, multi-family housing should be considered as an appropriate setting for a continued demonstration program effort, and the evolution of both solar economics and rental property owner perceptions should be monitored together. As the reliability and extent of savings from available equipment increases, and as owners and developers become aware of these trends, it may be desirable to put a solar incentive in place for this market at some future time.*

2. Deep Level of Incentive Subsidy Required

The incentive analysis presented here is necessarily different from that set forth in the sections of this report dealing with homeowners and homebuyers, who were the major focus of the study. The consumer survey of that market was specifically designed to establish a basis for modeling

*These conclusions apply to larger multi-family rental properties. In the case of 2-4 family owner-occupied rental housing, the best approach at present appears to be extending eligibility of any incentive program aimed at single-family owner-occupied residences to include this group, with appropriate modifications in the terms of the incentive.

response to incentives at different levels of subsidy, and involved use of a formal survey instrument with over 1,500 families in eight cities. In comparison, the assessment of financial incentives for multi-family property owners was based on informal interviews with a relatively small number of property developers, owners and managers of income property, mortgage lenders, and residential investment property syndicators. It is therefore necessary to evaluate incentives in the context of a decision model derived from a more qualitative assessment of the situation.

The frame of reference that we believe to be useful in this setting derives from three aspects of the investment perspective that were consistently expressed: the likelihood that estimates of energy costs savings will not receive full credence; use of a short investment time horizon to reflect uncertainties over the performance and operating lives of available equipment; and discounting of net after tax benefits or costs expected in the future.

Table VII-3 presents a format for considering the depth of incentive that would be required in this context for a $1,500/unit solar energy system. It assumes that the property owner uses a twelve percent discount rate and must be made whole on the solar investment in five years -- that is, that within that time the owner must be assured of covering the full extent of investment exposure from a combination of whatever grant, tax and loan incentives are provided and the energy savings that owner is willing to recognize. The five-year period is at the outside limit of the investment horizons suggested by our interviews.

Various incentive combinations are presented in the table since Federal multi-family housing programs have generally relied on such "packages" of incentives. These include a five-year straight-line depreciation period (assumed as a base, and approximately equivalent to a 9% investment tax credit, as discussed below) and different assumptions as to financing: all cash (unlikely, but a reference point); and different "market" and government-assisted financing programs that might be made available in retrofit or new construction situations. The table shows the <u>additional</u> subsidy that would have to be provided at the outset (as a grant or tax credit) in order to fit these investment criteria, expressed as a percentage of the system cost, for different levels of energy savings that might be recognized by a potential solar purchaser. The balance is assumed to be financed under the terms shown at the heads of the columns.

For example, under the "retrofit system" heading, the table suggests that a purchaser with access only to "market" rate financing (expressed here as a 12% standing second mortgage loan) and willing to recognize an estimate of $100/year in energy costs savings from a solar system would still require a grant or tax credit for 39% of the system's $1,500 first cost (with the balance -- 61% -- to be fully financed at 12%).

As can be seen from the table, substantial proportions of solar first costs would need to be offered in order to satisfy these investment criteria under all situations shown, in amounts that far exceed what might be either appropriate or politically feasible outside of a demonstration program. Several of the investors in this study emphasized that they would want to be assured of full recovery out of incentives alone, and would assume a zero energy savings. While an incentive program is more appropriately oriented towards those who are prepared to recognize some significant benefit from energy cost savings of solar installations, the table suggests that grant or tax credit subsidy requirements are too high even where significant energy cost savings are expected, and even if subsidized loans were also available.

An additional perspective is provided by Table VII-4, which reflects the same depreciation and loan program assumptions and investment criteria as Table VII-3, except that a twenty-year investment horizon is assumed -- a time frame frequently emphasized in residential real estate investment analysis. Even under this general assumption as to operating life (which none of those interviewed was prepared to adopt), it can be seen that neither a loan program nor a grant program by itself appears sufficient even in tandem with a five-year depreciation provision unless substantial energy cost savings are recognized.

The analysis of subsidy requirements presented through these tables is essentially a means of displaying qualitative assessments of investor attitudes as revealed in this study, and should not be taken to express the approach to investment analysis of particular multi-family property

TABLE VII-3: SOLAR HOT WATER INCENTIVE REQUIREMENTS FOR MULTI-FAMILY HOUSING ASSUMING A 5-YEAR INVESTMENT HORIZON

Amount of first-cost subsidy required for $1500/unit system in order to provide full amortization of solar costs from tax benefits and energy savings within 5 years, for various loan alternatives, by level of solar savings recognized.*

	RETROFIT SYSTEM FINANCING PLANS				NEW SYSTEM FINANCING PLANS		
Annual Energy Savings Recognized	All Cash	"Market" 100% Loan 12% Interest No Amortization	"Government" 100% Loan 7½%, 10 Year	"BMIR" 100% Loan 3%, 15 Year	"Market" 50% Loan 9%, 25 Years	"Government" 75% Loan 7½%, 30 Years	"BMIR" 75% Loan 3%, 30 Years
$ 0	64%	54%	51%	45%	58%	54%	51%
25	61	50	47	41	55	50	47
50	58	46	43	36	52	46	43
75	55	42	39	32	48	42	38
100	52	39	35	27	45	38	34
125	49	35	31	22	41	35	30
150	46	31	27	18	38	31	26

*Note: Percentage figure expresses additional first-cost subsidy required as a proportion of per-unit cost of $1500. It is derived as the difference between that first cost and the present value of the after-tax cash flows to a 50% tax-bracket investor assuming a 12% discount rate for all cash inflows and outflows, as follows:

Energy Savings: Values shown are converted to after-tax basis at 50% rate in each of the years in which they are recognized (first five years). Taxation of energy savings results from increase in property's net operating income.

Depreciation: Assumes a five year, straight line write-off.

Downpayment and Financing: Net portion of $1500 first cost not covered by subsidy shown is financed under terms shown at head of each column. Downpayment required is valued at 100% (no discount). Loan payments (net of after-tax benefit of interest deduction) during the first five years, and outstanding mortgage balance at end of year five, are treated as future negative cash flows and discounted to the present at 12% rate.

investors or investors in general. However, it does rely on the investment parameters that appear likely to determine decisions in this area, and suggests that no incentive program can be developed today within acceptable bounds to expand the market for solar in multi-family rental housing. A review of the major possible incentive designs in this area -- grants or tax credits, accelerated depreciation, and subsidized loan programs that would be encountered in attempting to establish an incentive program follows below.

3. Limits of Grants/Rebates and Tax Credits

The primary limitation on these "up front" incentives is that they are not likely to be provided at levels high enough to induce multi-family property owners and developers to install solar energy systems at the present time.

- Tax Credits. The reference point for investment tax credits is the ten percent general investment tax credit, and it is in fact this level of solar tax credit that has been proposed for multi-family rental properties in the National Energy Act. Such a credit may be a more appropriate form of tax incentive for solar investments than the more traditional rapid depreciation provisions of Federal programs concerned with multi-family rental housing. A specific type of heating equipment is the focus of public interest, rather than the "decent home" that can be provided by rental property *per se*, and the expense of the equipment is only a small part of the cost of the entire property. However, as suggested by Tables VII-3 and VII-4 discussed above, a credit at the ten percent level -- or even at two or three times that level -- cannot be expected to have any substantial effect in accomplishing its intended purpose today.

- Rebates/Grants. Professional property investors, as compared with homeowners in general, would appear to be relatively indifferent to the choice between tax credits and rebates or grants, and might in fact prefer the former. Tax benefits that might be obtained by most homeowners only in the year following a solar investment can be effectively realized at or near the time of purchase by a rental property owner through adjustments in payments of estimated tax. And such property owners generally have greater access to sources of interim financing to overcome problems that might be presented by the need to bridge a delay in receipt of benefit. A rebate approach would thus appear to have little or no advantage over tax benefits in this situation, and would have to overcome the potential problems of resistance to "red tape". Moreover, the subsidy would still need to be a substantial amount to be effective -- levels that would effectively approach a "demonstration" program in which the government bears a very large proportion of the costs

TABLE VII-4: SOLAR HOT WATER INCENTIVE REQUIREMENTS FOR MULTI-FAMILY HOUSING ASSUMING A 20-YEAR INVESTMENT HORIZON

Amount of first-cost subsidy required for $1500/unit system in order to provide full amortization of solar costs from tax benefits and energy savings within 20 years, for various loan alternatives, by level of solar savings recognized.*

	RETROFIT SYSTEM FINANCING PLANS				NEW SYSTEM FINANCING PLANS		
Annual Energy Savings Recognized	All Cash	"Market" 100% Loan 12% Interest No Amortization	"Government" 100% Loan 7½%, 10 Year	"BMIR" 100% Loan 3%, 15 Year	"Market" 50% Loan 9%, 25 Years	"Government" 75% Loan 7½%, 30 Years	"BMIR" 75% Loan 3%, 30 Years
$ 0	64%	54%	47%	28%	52%	37%	28%
25	58	46	37	15	44	27	15
50	51	38	28	3	35	16	3
75	45	30	19	(10)	27	5	(10)
100	39	22	10	(22)	19	(6)	(22)
125	33	14	0	(35)	11	(17)	(35)
150	27	6	(9)	(47)	2	(27)	(47)

*Note: Percentage figure expresses additional first-cost subsidy required as a proportion of per-unit cost of $1500. It is derived as the difference between that first cost and the present value of the after-tax cash flows to a 50% tax-bracket investor assuming a 12% discount rate for all cash inflows and outflows, as follows:

Energy Savings: Values shown are converted to after-tax basis at 50% rate in each of the years in which they are recognized (first twenty years). Taxation of energy savings results from increase in property's net operating income.

Depreciation: Assumes a five year, straight line write-off.

Downpayment and Financing: Net portion of $1500 first cost not covered by subsidy shown is financed under terms shown at head of each column. Downpayment required is valued at 100% (no discount). Loan payments (net of after-tax benefit of interest deduction) during the first twenty years, and outstanding mortgage balance at end of year twenty, are treated as future negative cash flows and discounted to the present at 12% rate.

involved. This appears even less acceptable politically than similar benefit levels provided through a tax expenditure approach.

The risks and uncertainties of solar installations in multi-family rental properties, taken together with the limited amounts of cost savings thus far demonstrated for such installations, outweigh the inducement that might be provided through a tax credit or grant that would only modestly reduce a system's cost. Enactment of a credit at such a level is unlikely to increase the rate of adoption of solar in this setting to any significant degree. However, given the extremely limited extent of unassisted solar installations likely in multi-family housing in the near future, it would also bear little downside risk of a "windfall" benefit (or cost). Such an action might therefore be expected to serve as an essentially symbolic declaration that the Federal government supports the potential contribution that solar energy installations can make in the multi-family rental housing market.

4. Limits of Rapid Depreciation as an Incentive Approach

Allowing rapid depreciation for tax purposes of the costs of solar equipment in investment properties is an obvious incentive possible in view of experience with this device in the housing field. It offers advantages typical of tax expenditure incentives: automatic operation, low program administrative costs, and freedom from annual appropriation requirements. Moreover, accelerated depreciation has been a major feature of Federal housing policy, one with which participants in the multi-family market are fully familiar. Housing investment in general is accorded the opportunity of utilizing more rapid depreciation schedules than other real estate investments, and low-income housing is provided additional benefits through preferential treatment of recapture. In addition, Section 167 (k) of the Internal Revenue Code, enacted as part of the Tax Reform Act of 1969, has established a specific precedent for special depreciation treatment as a means to stimulate desired types of property improvements. Under certain conditions, it allows five-year straight-line depreciation of rehabilitation improvements in housing for low and moderate income families.* The Tax Reform Act of 1976

*A 1974 study of the impact of 167(k) concluded that it had been essential in attracting developers to this special rehabilitation market, though its effectiveness was inextricably tied to the availability of high loan-to-value Federal financing for these purposes. Touche Ross and Company, The Impact and Effects of Section 167(k) on Rehabilitation of Multi-Family Property (Final Report to the Department of Housing and Urban Development, May 1974).

extended the life of this section, and implicitly endorsed its effectiveness as an incentive design by adding a parallel provision for rehabilitation of property of historic importance.

A similar five-year write-off can be considered as an incentive option for encouraging solar installations in multi-family rental properties. However, three shortcomings of such an approach limit its desirability for this purpose: the inefficiencies of rapid depreciation incentives in general; the conflict between its focus on short-term returns and the long-term outlook intrinsic to solar; and the more limited return it yields in comparison to the 167(k) and historic structure provisions.

- Inefficiency in Public Expenditure. In practice, accelerated depreciation provisions are understood to be a means for providing housing developers with access to non-debt investment capital. This is accomplished through syndication of interests in the project that passes most of the tax shelter benefits through to passive investors. Such an approach to providing development equity is relatively expensive and inefficient from a public cost perspective.*

- Inconsistency with Assumptions Underlying Solar. Solar energy systems are most attractive when the prospective user gives relatively greater weight to the long-term benefits of reduced energy costs and the accompanying increases in future net operating revenues. "Lifecycle" costing is often urged by solar proponents for this reason. But short-term write-offs emphasize an entirely different perspective on property investments: the ability to recover both the investment and desired return within a comparatively short time.** Such an approach responds directly to developers' perspectives in an effective manner. But, it provides a mixed blessing insofar as the development of an appropriate appreciation of solar energy

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* "Only about half of what the tax shelter subsidy costs the government in lost revenue...ever reaches builders and developers. The remainder goes in the form of payments to the outside investors for the use of their money, and in fees to the syndicators, lawyers and accountants who are needed to put together and sell the tax shelter package." Congressional Budget Office, Real Estate Tax Shelter Subsidies and Direct Subsidy Alternatives, p. xiv (May 1977).

**The study of the 167(k) provision cited previously concluded that developers were attracted to these rehab projects primarily by the immediate return available from the syndication proceeds and related fees, and that passive investors were sought through syndication sales programs that emphasized the short-term payback of their investment and the overall benefits to be received within the first five years. Long-term cash flows or property appreciation were of far less importance. Touche Ross and Company, op.ct., pp. 47-57, 91, 108.

systems in particular, and energy conservation in general, is concerned. Moreover, if the history of comparable tax provision is any guide, it may remain in force beyond the period of its real need, with a continuing distortion of the frame of reference for solar.

- Inadequacy of Benefit Produced. More fundamental shortcomings of a rapid solar write-off are the limited leverage it offers compared to the 167 (k) and historic structure situations, and the apparent inadequacy of the inducement as a means to encourage solar investment.

  The financial incentive of rapid depreciation results from the realization of tax savings earlier rather than later in a project's life, and the comparative benefit must be measured from the reference point of depreciation allowances that would govern in the absence of special provisions.

  - In light of the extremely limited experience available for most commercial solar energy systems, it would appear feasible for an investor to obtain Treasury agreement to a component useful life for solar of a relatively short duration.

  - Even conventional heating equipment is accorded a substantially shorter useful life for depreciation purposes than building shells, and even if solar were allowed no less than the average useful life claimed for conventional HVAC systems, there would be relatively limited room for improvement in the value of that depreciation to an investor. As Table VII-5 shows, such present allowable depreciation for a $1,500/unit solar energy system in new construction, even on this conservative assumption, could be considered to have a present value of approximately $194 to an investor in the 50% tax bracket; the shift to a five-year straight-line write-off would increase this by only about $120 , roughly the equivalent of only 8% of the solar first cost. If shorter useful lives are allowed for solar as a matter of course in the near term,

TABLE VII-5

COMPARATIVE VALUE OF ALTERNATIVE DEPRECIATION SCHEDULES FOR A $1,500 SOLAR HOT WATER INSTALLATION ON A NEW MULTI-FAMILY RENTAL PROPERTY

	PRESENT VALUE[1]
1. Presently available depreciation basis:	$194
2. Incentive depreciation basis: 5 year, straight line	$314
3. Net benefit of availability of incentive depreciation method:	$120
4. Equivalent of net benefit in form of tax credit:	8%

1. Assumes 50% tax bracket investor, discounting at 12% of annual after-tax value of depreciation and after-tax gain or loss on sale after seventh year for outstanding mortgage amount (based on 9%, 25-year mortgage for 75% cost).

2. Presently available life based on average, 22-1/2 year life claimed for conventional HVAC systems (see note in text). Double-declining balance depreciation is available for new housing construction.

reserves to cover expenses of equipment removal if necessary -- multi-family rental property owners (and income property owners in general) might be more prepared to experiment with solar installations.

Utility companies provide one possible base of a leasing system, as discussed in the following chapter. The considerable number of existing leasing companies now operating also suggests that the entrepreneurial skills needed to establish solar leasing operations already exist should this prove to be a profitable avenue of business development. Preferential Federal tax treatment for such leasing ventures should be considered if a solar equipment leasing network does begin to evolve in the near future.

CHAPTER VIII

A NOTE ON THE POSSIBLE PROVISION OF LOW-COST FINANCING THROUGH UTILITIES

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CHAPTER EIGHT

A NOTE ON THE POSSIBLE PROVISION OF LOW-COST FINANCING THROUGH UTILITIES*

The prospects for an active utility role in marketing solar technologies, and the consequent implications for national solar energy policy, raise a number of extremely complex issues that lie well beyond the purview of this study (given its focus upon Federal financial incentives directed at homeowners and housing industry participants). However, at an early stage in our research, interviews with homebuilders and multifamily developers revealed that the entry of utilities into the solar market would, from their perspective, be viewed as highly desirable. In light of this interest, it was decided to investigate briefly the possible involvement of utilities as intermediaries for delivering the types of financial incentives under review in this document. The reader is cautioned, however, that the findings presented here are based on a limited number of interviews and a selected survey of secondary source material.

A. UTILITY INVOLVEMENT FROM A HOUSING USER'S PERSPECTIVE

Should the utilities (or oil distributors) choose to become actively engaged in the residential solar market, there are two basic models of entry open to them -- sale or leasing -- both of which they have used to merchandise home appliances in the past. As sellers of solar equipment, utilities could either arrange loans for their customers through commercial banks or use their own capital to extend credit to their solar customers.

The second alternative, leasing, has two variations: leasing with the option of eventual purchase by the solar customer and leasing in perpetuity on the model of the telephone company. Under either leasing approach, the utilities would install and maintain the system in return

*Throughout this chapter, the discussion of utilities applies also, in many respects, to fuel oil distributors and other possible large-scale sellers/lessers of solar equipment.

for periodic payments covering their expenses, plus profit. The leasing alternative has the considerable advantage from the user's perspective of eliminating not only much of any risk associated with owning solar, but also the typically large first costs.

1. Attractiveness to Homebuilders and Developers

A number of homebuilders and multi-family investors interviewed asserted that the entrance of utilities into the solar field -- whether through leasing or direct sales -- might well be the key to rapid commercialization of solar technologies within the residential market. Several noted that the swift market penetration of electric-heated and "all electric" homes came about primarily as a result of special financial inducements provided to builders by electric utilities.

The involvement of utilities is perceived as attractive by these housing professionals on several grounds:

- First, homebuilders and developers presume that utilities have the technical ability to screen the confusing array of solar hardware currently on the market and select the most reliable systems. Smaller homebuilders in particular feel that they lack the time and, in many cases, the expertise required to perform such a review on their own.

- Second, homebuilders were particularly concerned about access to experienced maintenance personnel and the ability of small solar manufacturers to stand behind their products. Here again, purchase or lease of solar equipment from a utility was seen as bringing with it an assurance of qualified, responsive servicing.

- Third, as noted in Chapter Seven, utility leasing programs may hold particular appeal for multi-family owner/investors because it shifts the risks of solar utilization to the utilities and eliminates the need for any equity investment, thus enabling investors to relax, at least to some degree, the financial return demanded of solar installations.

- Fourth, by purchasing solar equipment in quantity, utilities should be able to secure substantial discounts from solar manufacturers. Presumably, these savings would be shared to some extent with builders, developers, and individual homeowners.

2. Possible Disinterest on the Part of the Homeowners

In contrast to homebuilders and developers, the results of several questions included in our consumer survey suggest that individual homeowners may prove unresponsive should the utilities enter into the marketing of solar equipment. Survey respondents ranked "reduced dependence on utilities" as the third most important factor after initial cost and reduction in utility bills among 15 possible factors that might enter into the decision to purchase a solar energy system. (See Table II-2 in Chapter Two). In addition, homeowners appear relatively indifferent to the possibility of leasing solar energy devices. Only 12% of those surveyed preferred the leasing concept as contrasted with 41% who expressed a strong preference for owning the system outright. (See Table VIII-1). This may reflect the fact that leasing a solar system would, in effect, involve having the utility (or other lessor) own a major structural component of one's home (literally the entire roof in the case of some solar heating arrays). This contrasts markedly with the lease of a conventional household appliance which is a discrete, easily removable piece of equipment.

Table VIII-1

RESPONSE OF PROSPECTIVE HOMEOWNERS TO CHOICE OF OWNING OR LEASING SOLAR EQUIPMENT

Strongly prefer owning	41%
Somewhat prefer owning	17%
No preference	15%
Somewhat prefer leasing	15%
Strongly prefer leasing	12%

B. CURRENT UTILITY PARTICIPATION IN THE SOLAR FIELD

Any serious possibility for utilizing the utilities to deliver Federal solar incentives will depend on the extent to which electric, gas, and fuel oil suppliers spontaneously come to perceive residential solar use as an opportunity for commercial expansion.

A number of such companies have already evinced substantial interest in solar systems, independent of the prospects for Federal subsidy. To date, however, this interest has taken the form of research and demonstration projects rather than more direct forms of business development.

Of approximately 3,000 electric utilities in the country, 116 companies are involved in 295 different projects related to solar energy.* While some of these ventures are concerned with other types of solar technologies, such as wind power, 80% of the projects address themselves to the solar heating and cooling of buildings. The national research arm of the electric utilities, the Electric Power Research Institute, is conducting two solar heating and hot water demonstration projects, one for residential and one for commercial buildings. The majority of the electric utilities' solar projects focus on determining the electrical energy demand characteristics of solar users and the impact these demands will have on the utilities' load factors, since a central concern of the electric power industry is that solar systems will make load management more difficult. Thus, a primary objective for electric utilities' solar research is to provide data to influence the development and utilization of solar so that it will be advantageous both to the solar user and the electric utilities. In line with this objective, EPRI has commissioned development of a profile of a "preferred solar system," basically one with a large storage capacity.

In a recent survey of 242 gas utilities by the American Gas Association (AGA), 54% of respondents had personnel directly involved in solar, 41% were working in system design and testing, and 37% had solar projects underway.** AGA, although involved in no solar demonstration itself, sponsors solar energy seminars for gas industry engineers. Although it is difficult to characterize the gas utilities' solar efforts, they seem to be designed to provide cost and performance data on solar systems: how much of a building's thermal load can solar

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*Electric Power Research Institute, Electric Utility Solar Energy Activities 1976 Survey, EPRI Special Report. Palo Alto, California, January, 1977.

**Solar Energy Utilization: The Gas Industry, Marketing Services Division, American Gas Association, Arlington, Virginia, January, 1977.

systems carry; what is their actual installed cost, and so on.

There is also evidence of interest in solar systems among fuel oil distributors. The New England Fuel Institute, a non-profit trade organization representing 1,200 independent fuel oil distributors, has set up a Solar Energy Research Committee in response to its members' interest. In addition, with funds voluntarily contributed by members, it has funded seven solar hot water installations throughout New England and estimates that 20 additional hot water installations, some of them on distributors' own homes, have been made by distributors independent of the Institute's financing. The principal motivation for fuel distributors' involvement seems to be the hope that solar will provide a new market for the skills of experienced "heat technicians".

At present, basic questions exist as to the complementarity between utilities (particularly electric power companies) and widespread solar energy use which must be resolved before any significant utility participation in the solar market can be expected to materialize. The basic incompatibility arises from the fact that while solar heated homes consume less power on an annual basis than all-electric homes, the power company must still maintain generating capacity for the inevitable days when the solar unit's "back-up" system will be required to provide 100% of the home's energy needs. From the utility's vantage point, the severity of this problem depends upon whether or not solar users within their service areas will be drawing electricity at times of peak demand. The answer to this question may vary considerably, depending upon the regional location and load characteristics of any given utility (i.e., whether its demand peaks during summer or winter months, during daytime or during evening hours; whether its customers are predominantly residential, commercial, or industrial.)* Although natural gas suppliers are less capital intensive than electric utilities and provide a fuel which can be stored, problems of capacity versus energy costs still exist. The relatively high fixed costs of extending service to a solar home are the same as for a conventional one, even though its gas consumption would be less. Thus, for both gas and electric utilities,

*See for example, Dr. Harold Lorsch, Implications of Residential Solar Space Conditioning on Electric Utilities, Franklin Institute Research Laboratories, December, 1976.

solar homes could, under many circumstances, prove more expensive to serve than conventionally heated properties. A number of possibilities now in view -- public policy initiatives such as peak-load pricing, new metering techniques such as telemetrically controlled interruptible service, basic changes in energy supply such as permanent natural gas shortages -- could help to create greater mutuality of interest between utilities and solar users, but their influence, if any, will not be apparent for several years to come.

C. IMPLICATIONS FOR A RESIDENTIAL SOLAR INCENTIVE PROGRAM

As indicated by the above review, the present activities of utilities in the solar field are tentative and exploratory, and the picture for any genuine commercial commitment on their part over the longer run is a mixed one, at best. Nevertheless, to the extent that direct participation by utilities should appear spontaneously in some locations around the country, there may be several attractions from the Federal government's point of view in taking advantage of their market presence in order to help deliver financial incentives to residential adopters of solar energy systems:

- Access to Homeowners. By virtue of their geographic coverage and monthly billing procedures, utilities offer readier access to homeowners than do more conventional sources of home improvement financing, including Title I approved lenders. This capability can be utilized both to help "market" an incentive program, to disseminate relevant technical information to homeowners contemplating a solar investment, and possibly to realize certain economies in the origination and servicing of government subsidized loans.

- Consumer Protection. Utility involvement might relieve the government from some of the burden of certifying solar system performance. Utilities possess the technical capability to exercise a reasonable degree of quality control over whatever solar installations they may carry out. In addition, their public or quasi-public status would obligate them to proceed cautiously in terms of the choice of equipment and the way in which it is marketed, and to provide adequate guarantees of system performance.

- A Means to "Finesse" the First Cost Constraint. To the extent that utility involvement lowers the cost of solar use for homeowners, it also reduces the amount of subsidy the government has to provide to achieve any desired level of market impact. In the longer run, utility leasing programs may have the added advantage of expanding the solar market to households of more moderate income. Leasing eliminates the high first costs of solar and is likely to involve relatively small monthly payments, since utilities can amortize their solar investment over longer time periods than individuals using a typical three- to five-year home improvement loan.

- Cost of Capital. Several commentators discussing the potential benefits of utility entry into the solar field have alluded to their ability to borrow "short" at or near the prime rate.* Presumably the benefits of these lower rates could be at least partially passed on to solar customers in the form of lower interest rates on loans for solar equipment or lower leasing charges. This would mean that a Federal "interest reduction" or "lease supplement" program, if operated through a utility, would have to subsidize a smaller interest differential than if financing at the same below-market rate were to be provided through a commercial bank (which would normally charge at least 12% interest for a home improvement loan.)

  However, it is unclear whether the cost of capital to utilities would really predispose them, in practice, to make low cost financing available. Although their borrowing rates from commercial banks are generally below rates available to individuals, utility representatives interviewed argued strongly that their overall cost of capital is at least as high as conventional mortgage rates, about 9%, and in some cases may be as high as conventional home improvement financing (12-13%). The reason asserted for these costs is that most of the utilities' capital is raised in the bond and equity markets. While AAA utility bonds are currently selling at 8-8-1/2%, costs of raising capital through sale of preferred and common stocks are considerably higher, 10-17%. Moreover, according to those interviewed, utilities are reluctant to use their short-term borrowing ability insofar as it conspicuously raises their debt-equity ratios. This in turn may adversely affect their bond market ratings, and consequently their overall costs of capital.

  It should also be noted that the direct administrative and overhead costs that would be incurred by the utilities in making small consumer loans could be as great if not greater than those incurred by commercial banks.

  While the effect of borrowing on access to capital markets may be a potential obstacle to utility solar involvement, it could be circumvented by establishing separate sister corporations for solar, as has been done in the past by a number

*See for example, ERDA, Interim Policy Options for Removing Barriers and Implementing Incentives to Accelerate Market Penetration for Solar Heating and Cooling Systems, ERDA, p. 22 (April, 1977).

of utilities for their hot water and air conditioner leasing and appliance sales programs.

Another possibility would be for utilities to originate solar loans for their customers on behalf of commercial banks using lines of credit at low rates. This can prove attractive to the banking institution insofar as lending to individuals through the utilities can simplify both the placement of loans and the mechanics of collecting payments.* Since the utility is only acting as an intermediary, the borrowings would not appear on its balance sheet.

No doubt incentives directed at the utilities themselves (special investment tax credits, favorable rate setting allowances) could be structured that might induce them to look more favorably upon entering the solar market. Any such policy would raise a host of complex regulatory issues -- particularly in respect to consumer protection and maintaining competitive markets -- that cannot be adequately addressed here.**

In respect to the central concern of this study -- the design of incentives to encourage residential solar use in the near-term -- the merits and liabilities of encouraging active utility involvement have little immediate relevance. Nevertheless, insofar as a Federal incentive is designed to be administered through commercial lending organizations, thought might still be given to authorizing the participation of those few utilities that may begin to market, lease, and help finance solar devices while the incentive program remains in effect. This would apply specifically to the "interest subsidy to lender" and "Solar Tandem Plan" options discussed in Chapter Four. Utilities providing financing to solar purchasers could, under the former approach,

*According to the First National Bank of Denver, the Public Service Company of Colorado has arranged a $2,000,000 line of credit at close to the prime rate for those of its customers wishing to finance energy conservation improvements in their homes.

**A comparable range of issues has received some attention recently in the context of the National Energy Act, which, among its residential weatherization provisions, would require utilities to advise their customers of the need for energy conservation improvements to their homes, and, if requested, arrange for the work to be carried out and financed. See for example statement of Robert B. Rach, Director, Office of Policy Planning and Evaluation, Federal Trade Commission before the Senate Committee on Banking, Housing, and Currency, on the National Energy Conservation Policy Act, June 28, 1977.

receive interest reduction payments from the government on behalf of their customers; under the Tandem Plan approach, they would be eligible, along with private lenders, to obtain advance purchase commitments for making below-market rate loans to customers installing solar devices in their homes. Several years from now, as solar space cooling systems become more commercially feasible, some policy along these lines may hold greater potential -- since solar space cooling, unlike solar domestic hot water or space heating, promises to be more compatible with the interests of utility companies in smoothing out peaks in energy demand.

V APPENDICES

APPENDIX A

OVERVIEW OF BILLS INTRODUCED INTO THE 94TH AND 95TH CONGRESS AUTHORIZING FEDERAL FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

Eighteen bills were introduced into the 94th Congress that contained incentives for the installation of solar energy equipment in private residential units; and, as of early May, 1977, forty-four bills of comparable intent had been placed in the hopper of the 95th Congress. As can be seen from the table below, most of these bills authorize either tax credits or low-cost loans.

Table A-1

NUMBER OF BILLS INTRODUCED IN CONGRESS BY INCENTIVE TYPE

	Incentive Type			
	Tax Benefit	Direct Loan	Miscel-laneous	Total
94th Congress	7	6	5	18
95th Congress (Through Early May)	15	16	13	44

Several of the tax credit proposals would also make deductions available as an option. Most of the bills that do not call for either credits or a special loan program, would authorize some specific amendment to existing Federal housing programs that would either raise maximum loan ceilings if homes are solar equipped or would generally clarify the eligibility of solar homes for assistance under the given program. Special loan guarantees and accelerated depreciation allowances, with four exceptions, are conspicuously absent among the incentive proposals directed at the residential sector, although they have been incorporated in several proposed bills aimed at encouraging solar use in commercial and industrial structures.

Table A-2 below summarizes the maximum and minimum benefit levels contained in the tax credit, tax deduction, and separate loan proposals submitted in either the 94th or 95th Congress.

Table A-2

HIGH/LOW BENEFIT LEVELS OFFERED BY SOLAR INCENTIVE BILLS INTRODUCED INTO 94TH AND 95TH CONGRESS

		94th Congress	95th Congress
Tax Credit	High	25% of First $8,000 12½% over $8,000	Same as 94th
	Low	$250.	$1,000.
Tax Deduction	High	$4,000	$4,000
	Low	$800	$4,000
Loan	High	100% of Costs 2% Interest 25 Yr.	Same as 94th
	Low	75% of Costs Govt. Rate + ½% 8 Yr.	Same as 94th

The largest subsidy would be provided by the tax credit proposals. Under the formula given, a homeowner installing a $12,000 solar space heating and hot water system would receive a credit of $2,500. The tax credit proposal contained in the President's Energy Plan would make available a maximum credit of $2,000.

Most of the bills become involved to some extent in program design issues, specifying program time limits and conditions under which individuals and systems will be eligible for subsidy. Despite some Congressional concern about the potential for solar incentives to be subsidies for the rich, only five bills to date have restricted eligibility for full subsidy benefits to persons below a specified income level, and four of these are proposals for low-interest loans, a housing program tool traditionally used to improve the availability of financing for families of limited means. Only one of the twenty-two tax benefit proposals (HR. 3988) decreases the benefit as the applicant's income rises.

A number of proposals evidence concern about the consumer protection aspects of encouraging citizens to become solar users. In addition to requirements that systems purchased with Federal monies meet performance and reliability criteria to be specified by the Secretary, eight bills introduced in the 95th Congress require that systems carry a certain percentage of a homes' thermal load. While one bill requires a reasonable 40% of the total space heat and hot water load, the other seven specify that hot water systems alone must provide 100% of the hot water load, an unrealistically high requirement likely to lead to cost-ineffective systems. For a more detailed discussion of this issue, see Chapter Six. In addition to thermal load requirements, eleven bills also specify that systems have a minimum useful life of three or five years.

In almost all legislation, the solar incentive is seen as a transitional time-limited program. Program life for tax measures ranges from two to nine years with most incentives lasting four or less years and virtually all the loan proposals specifying ten year program lives.

The following charts categorize the key provisions of selected bills in terms of:

1. Eligibility Requirements:
   - nature of the applicant
   - type of property (new, existing)
   - type of solar system (hot water, space heating, space cooling)
   - special conditions (e.g. the minimum % of home energy needs provided by the system)
2. The Type of Benefit (Tax Credit, Loan, Etc.) Offered
3. The Specific Terms of the Benefit (Loan Limits, Interest Rates, Etc.)

4. Agency Responsibilities:

- agency administering program
- responsibility for performance criteria

5. Time Limit - Specific Time, if any, for Program Termination

Where boxes are blank, the bill contains no specific language of a relevant nature.

The remaining bills, categorized according to their similarity to those in Table A-3, are summarized in Table A-4.

PROVISIONS OF BILLS INTRODUCED IN CONGRESS AUTHORIZING FEDERAL FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

TYPE OF INCENTIVE: TAX BENEFIT (94TH CONGRESS)

BILL NUMBER	S.28	S.168	S.1379	S.3152	S.3264	HR.5959	HR.6584
SPONSOR	MOSS	DOMENICI	FANNIN	DURKIN	TUNNEY	WYLIE	GUDE
TITLE			"Solar Tax Incentives Act of 1975"		"Solar Energy Incentive Act of 1976"		
ELIGIBILITY •Applicants Residential Only	(Princ. Residence)	(Princ. Residence)		X	(Princ. Residence)		
Res. w/Commerc.			X			X	X
•System Hot Water							X
Heating	X						X
Cooling	X						
Special Conditions				Must Have Useful Life of at Least 3 Years	Must Have Useful Life of at Least 3 Years		40% of Total Heating Needs or All Hot Water
BENEFIT	Tax Credit or Deduction	Tax Credit or Deduction	Tax Credit	Tax Credit	Tax Credit	Tax Credit	Tax Credit or Deduction
TERMS	Credit: 25% of Expenses ($250 Maximum Credit) or Deduction: $1000 Maximum	Credit: 25% of Expenses ($1000 Maximum Credit) or Deduction: $4000 Maximum	Up to 12/31/79 Tax Credit: 25% of Expenses (Maximum Credit: $2000) 1/1/80 to 12/31/84 Tax Credit: 15% of Expenses (Maximum Credit: $1200)	Credit: 25% of Expenses (Maximum Credit: $2000)	Credit: 25% of Expenses (Maximum Credit: $2000), plus the amount of any increase in property tax due to the solar installation OR Tax Deduction: 1st 2yrs.-10%/$800max. 3rd yr. - 5%/$400max.	25% of the First $8000 Expenses. 12-1/2% of $8000+ Expenses	Homeowners may claim a tax credit for solar expenses - no maximum figure available. Owners of income property may amortize solar expenses over a 60 month period.
AGENCY •Administrative	Treasury	Treasury	Treasury	Treasury	Treasury	Treasury	Treasury
•Performance Criteria	National Bureau of Standards	HUD	Secretary of Treasury as Developed by HUD	HUD	HUD	HUD	HUD
TIME LIMIT	None	12/31/79	12/31/79-12/31/84	12/31/80	12/31/80	12/31/79	12/31/80

PROVISIONS OF BILLS INTRODUCED IN CONGRESS AUTHORIZING FEDERAL

FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

TYPE OF INCENTIVE: DIRECT LOAN (94TH CONGRESS)

BILL NUMBER	S.875	S.2163	HR.14008
SPONSOR	HART	ABOUREZK	ROYBAL
TITLE		"Solar Energy Equipment Loan Act"	
ELIGIBILITY ●Applicants Residential Only	Owners (1-4 Family Residences only) and Builders of Residential Structures	X	X
Res. w/Commerc.			
●System Hot Water			X
Heating			X
Cooling			
Special Conditions	40% of total heating needs or all hot water needs.		40% of total heating needs or all hot water needs.
BENEFIT TERMS	Direct Loan 75% of Expenses, Maximum Loan per unit: $6000:1-4 fam. units 5700:5-24" " " 5400:25-99 " " 4800:100-199 " 4500:200+ " " Rate: Gov. Rate + 1/2 % Maturity: 8yrs./1-4 fam. units, 15 yrs./5+ fam. units Builders: Loan Matures upon sale of residence.	Direct Loan Direct Loans By Solar Energy Loan Administration - 100% of Expenses(No Maximum) Rate: 2% Maturity: 25 yrs.	Direct Loan/Grant To Homeowners w/ Incomes less than or equal to median income of their area - $8000 Max. at 3%; 8 yr. Maturity - Only 1/2 Loan Needs to be Repaid.
AGENCY ●Administrative	HUD	Solar Energy Loan Administration (as Specified in Legislat.)	HUD
●Performance Criteria	HUD	HUD	HUD
TIME LIMIT	10 yrs.after enactmt.	10-1/2 yrs.aft. enactmt.	10-1/2 yrs aft. enactmt.

PROVISIONS OF BILLS INTRODUCED IN CONGRESS AUTHORIZING FEDERAL FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

TYPE OF INCENTIVE: MISCELLANEOUS (94TH CONGRESS)

BILL NUMBER	S.2932	HR.13143	HR.15014	HR.15015	HR.15016
SPONSOR	KENNEDY	BAUCUS	BAUCUS	BAUCUS	BAUCUS
TITLE	"Energy Conservation Act of 1976"			"Solar Energy for Homes Act of 1976"	
ELIGIBILITY ●Applicants Residential Only		X	X	X	X
Res. w/Commerc.					
●System Hot Water	X	X	X	X	X
Heating	X	X	X	X	X
Cooling	X	X	X	X	X
Special Conditions	15 yr. useful life; system must generate enough savings to recover costs.				
BENEFIT	Loan Guarantee and Interest Subsidy	Higher Loan Limit	Special Eligibility	Higher Loan Limit	Special Eligibility
TERMS	Loan guarantees to any borrower - interest subsidies for residential use.	FHA Loan Increased by 10% When Increased Cost Results From Solar System	Authorizes Federal Assistance Under Consolidated Farm & Rural Dev. Act. Re: Residential Solar Installations on Family Farms	Permits FHA to increase by not more than 20%: a) Limitation on amount of FHA Loan to Single/Multi-Family Dwelling; b) Limitation on amount of principle obligation of mortgage insured/purchased under any program to cover solar unit costs. Amount of insured home improvement loans increased to cover solar system costs. Community Development Grants can be used to encourage residential solar heating and cooling.	Extends Veterans' Home Loans to cover solar expenses or 20% of value of structure in which the system is installed.
AGENCY ●Administrative	FEA	FHA	FmHA	FHA	VA
●Performance Criteria					
TIME LIMIT	4 Years after enactment.				

PROVISIONS OF BILLS INTRODUCED IN CONGRESS AUTHORIZING FEDERAL FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

TYPE OF INCENTIVE: TAX BENEFIT (95TH CONGRESS)

BILL NUMBER	S.17	S.654	S.1284	HR.61	HR.526	HR.3048
SPONSOR	MC INTYRE	MC CLURE	HUMPHREY	WYLIE	LLOYD	BROYHILL
TITLE	"Renewable Energy & Energy Conservation Act of 1974"	"Solar Energy Incentives Act of 1977"	"Solar Energy and Energy Conservation Act of 1977"			
ELIGIBILITY ●Applicants Residential Only					X	
Res. w/Commerc.	X	X	X	X		X
●System Hot Water	X	X	X	(Commercial Only)		
Heating	X	X	X	X	X	X
Cooling	X	X	X	X	X	X
Special Conditions	3 Yr. Useful Life - Original Use			Original Use;3 yr. Useful Life		
BENEFIT	Tax Credit	Tax Credit	Tax Credit or Deduction	Tax Credit	Tax Credit or Deduction	Tax Credit
TERMS	40% of 1st $1000 expenses, 25% $1000+ expenses but less than $7400 ($2000 max credit) Carryover; no basis increase; prior expenditures clause	25%($2000 max credit) for 1977-81. 15% ($1200 max credit) for 1982-86. Carryover; Carryback.	25% of expenses ($1000 max. credit, of which $250 max is allowed toward purchase of conventional materials);or Tax Deduction: $4000 max. for period in effect (of which $1000 max. is allowed toward purchase of conventional materials). No basis increase; Carryback, Carryover.	25% of expenses up to $8000; Prior Expenditures Clause; No Basis Increase	25% of Expenses($1000 Max. Credit) for Period in Effect. Carryback; Carryover 4 yrs. following unused year; or tax deduction: $4000 Max. for Period in Effect.	25% of 1st $8000 expenses - 12.5% of $8000+ expenses. Carryover (7 yrs.); Carryback (3 yrs.); No Basis Increase; Prior Expenditures Clause.
AGENCY ●Administrative	Treasury	Treasury	Treasury	Treasury	Treasury	Treasury
●Performance Criteria	HUD	HUD	HUD	HUD	HUD	HUD
TIME LIMIT	1977-1981	1977-1986	1977-1981	1977-1981	1977-1980	Begin Taxable Year Following Enactment thru December 31, 1979

PROVISIONS OF BILLS INTRODUCED IN CONGRESS AUTHORIZING FEDERAL FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

TYPE OF INCENTIVE: TAX BENEFIT (95TH CONGRESS) - CONTINUED

BILL NUMBER	HR. 3762	HR. 3968	HR. 3985	HR. 4029	HR. 4225	HR. 5500
SPONSOR	MINISH	VANDER JAGT	MOAKLEY	GILMAN	RYAN	MC CORMACK
TITLE	"Solar Energy Incentive Act"	"Solar Energy & Resources Conservation Act of 1977"				"Energy Conservation Tax Incentives Act of 1977"
ELIGIBILITY ●Applicants Residential Only	X				X	X
Res. w/Commerc.		X	X	X		
●System Hot Water	X	X	X	X	X	X
Heating	X	X	X	X	X	X
Cooling	X	X	X	X	X	X
Special Conditions	Original Use; 3 yr. Useful Life		Original Use; 3 yr. Useful Life	Original Use; 3 yr. Useful Life	Original Use; 5 yr. Useful Life	3 yr. Useful Life
BENEFIT	Tax Credit	Tax Credit	Tax Credit	Tax Credit or Deduction	Tax Deduction	Tax Credit
TERMS	33.3% of 1st $8000 Expenses, also, credit against increased property tax as result of increased assessment on solar home; No Basis Increase; Prior Expenditures Clause.	Residential: 1/1/77-12/31/81 - 50% of Expenses Up to $2500. 1/1/81-12/31/86 - 25% of Expenses Up To $1250	40% of 1st $1500 of expenses; 25% of expenses greater than $1500, but less than $9100. Amount of credit reduced by 9.52% of amt. by which adjusted gross income exceeds $15,000. ($500 max. reduction) Also, investment tax credit of 25% of expenses No basis increase; Carryover; prior expenditures clause.	25% of up to $8000 expenses. Allows Deduction w/respect to amortization of any qualified energy use property based on period of 60 months. No Basis Increase	$1000 max for hot water system expenses, $4500 max for space heating solar systems, $9000 max for space cooling solar systems. If unit performs 2 or more functions, the aggregate allowable amt. is the sum of the dollar amounts corresponding to the function performed. No Basis Increase; Prior Expenses Clause.	25% of expenses. ($2500 max. credit) No credit if: a) local gov. takes improvements resulting from energy conservation into acct. in property tax assessment. b) property acquired by taxpayer w/amts. received by US. Gov. or its agencies. 3 yr. Carryover; Prior Expenses Clause
AGENCY ●Administrative	Treasury	Treasury	Treasury	Treasury	Treasury	Treasury
●Performance Criteria	HUD	Treasury, HUD, ERDA, Bureau of Standards	HUD/ERDA	HUD	HUD	HUD
TIME LIMIT	1977-1982	1977-1986	Enactment - Dec. 31/81.			Jan 1/77 - Jan 1/82.

PROVISIONS OF BILLS INTRODUCED IN CONGRESS AUTHORIZING FEDERAL FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

TYPE OF INCENTIVE: DIRECT LOAN (95TH CONGRESS)

BILL NUMBER	S.395	HR.485	HR.1502	HR.1980	HR.3981	HR.6245	HR.6695
SPONSOR	HART	LEHMAN	HARRINGTON	ROYBALL	DRINAN	LLOYD	GOODLING
TITLE							
ELIGIBILITY ●Applicants Residential Only	X (Builders Also)	(Homeowners and Builders)		(1-4 fam. unit structures)		X	(Owner/occupant of 1-4 fam unit res. structure)
Res. w/Commerc.			X		X		
●System Hot Water	X	X	X	X	X	X	X
Heating	X	X	X	X	X	X	X
Cooling	X	X	X	X	X	X	X
Special Conditions	40% of total heating needs or all hot water needs			40% of total heating needs or all hot water needs.		Original use; 3 yr. useful life	40% of total heating needs, including hot water
BENEFIT	Direct Loan	Direct Loan	Direct Loan	Direct Loan	Grant or Loan	Direct Loan	Direct Loan
TERMS	Establishes $100,000,000 Fund 75% of Expenses Maximum Loan Per Unit: $8,000: 1-4 Fam.Units $7,500: 5-24 " " $7,000: 25-99 " " $6,500:100-199" " $6,000:200+ Fam.Units Rate: Gov.Rate +1/2% Maturity: 15 yrs. Builders: Loan Matures Upon Sale.	Establishes $900,000,000 Fund 75% of Expenses Maximum Loan Per Unit: $6,000: 1-4 Fam.Units $5,700: 5-24 " " $5,400: 25-99 " " $4,800: 100-199" " $4,500: 200+ " " Rate: Gov. Rate +1/2% Maturity: 8 yrs/1-4 fam. units, 15 yrs/ 5+ fam. units.	Establishes $100,000,000 Fund to make 25 yr. loans @ 2% per annum. Up to 10% of proceeds of any loan may be paid to compensate cooperative or non-profit loan referral agent certified & licensed by the Administrator, who assisted the borrower in obtaining qualified solar hardware.	Up to $8,000 of expenses of which only 1/2 must be repaid. Implied income limitation: less than 100% of median income of area in which individual resides. Rate: 3% Maturity: 8 yrs.	1) Indiv. (Gross Income less than $30,000) either: Grant-25% of loan ($1500 max.grant); or Loan-75% of expenses ($10,000 max loan) Rate: Gov. Rate +1/2% - Maturity: 20 years. 2) Community Groups w/ Avg. Indiv. Gross Income less than $30,000 either: Grant-25% of loan ($6000 max grant); or Loan-85% of expenses ($40,000 max.loan) Rate: Same Maturity:30 yrs.	$8000 for expenses in 1-4 fam. unit structure; 50% of expenses ($500,000 max loan) for 5+ fam. unit structures. Rate: Gov. Rate +1/2% Maturity: 15 years (Also Tax Credit Provision)	Establishes $100,000,000 apportioned to each state on basis of ratio of state to national population. $8000 max. loan (includes costs of modifying existing structure) Rate: Gov Rate +1% Maturity: 10 years
AGENCY ●Administrative	HUD	SBA	Solar Energy Loan Admin.(as spec. in leg.)	HUD	HUD	ERDA	HUD
●Performance Criteria	HUD/ERDA	HUD	HUD	HUD	HUD	HUD	HUD
TIME LIMIT	10 yrs. after enactment.		10 yrs. after enactment.	10 yrs. after enactment.		December 31, 1981	10 yrs. after enactment.

PROVISIONS OF BILLS INTRODUCED IN CONGRESS AUTHORIZING FEDERAL FINANCIAL INCENTIVES FOR RESIDENTIAL SOLAR ENERGY USE

TYPE OF INCENTIVE: MISCELLANEOUS (95TH CONGRESS)

BILL NUMBER	HR.1164	HR.1166	HR.3127	HR.3128	HR.3129
SPONSOR	RICHMOND	RICHMOND	BAUCUS	BAUCUS	BAUCUS
TITLE			"Solar Energy for Homes Acts-1977"	"Solar Energy for Homes Acts-1977"	"Solar Energy for Homes Acts - 1977" -(Loan Guarantees for Veterans)
ELIGIBILITY •Applicants Residential Only	(1-4 Family Units)	(Farms)		X	X
Res. w/Commerc.			(Farms)		
•System Hot Water	X	X			
Heating	X	X	X	X	X
Cooling	X	X	X	X	X
Special Conditions					
BENEFIT TERMS	Loan Guarantee 95% of Loan ($8000 Maximum) for solar applications only. Modifies National Housing Act; encourages Community Economic Development related to solar energy.	Special Eligibility Modifies Section 303 of Consolidated Farm & Rural Development Act 1923 to Include Solar Loans & Guarantees	Special Eligibility Changes Consolidated Farm & Rural Dev. Act to Include Solar Equipment Purchase & Installation as "Improvement"	Higher Loan Limit Allows increase up to 20% of loans handled by FHA, FmHA, and GNMA. Covers additional cost of purchasing and installing solar heating and cooling equipment on single/multi-family dwellings. Amends National Housing Act to provide loans for solar expenses under "home improvement" provisions. Amends Housing and Development Act of '74 to encourage community economic development related to solar energy	Higher Loan Limit VA Loan Raised to Equal Either Cost of Purchase+ Installation or 20% of Value of Structure in which System is being Installed - whichever is cheaper.
AGENCY •Administrative				FHA, et. al	VA
•Performance Criteria	HUD	HUD	HUD	HUD	HUD
TIME LIMIT		Terminated: 5 Yrs. After Enactment			

TABLE A-4

OTHER FEDERAL LEGISLATION

94TH CONGRESS

Incentive Type	Bill	Similar to	Variation
Direct Loan	S.2087 (Nelson)	S.875 (Hart)	unit must be purchased from a small business concern. Program administration and performance criteria by SBA.
	H.R.3849 (Gude)	S.875 (Hart)	applies to all homeowners and residential builders.
	H.R.8524 (Gude)	S.875 (Hart)	applies to all homeowners.

95TH CONGRESS

Incentive Type	Bill	Similar to	Variation
Tax Benefit	S.97 (Brooke)	S.17 (McIntyre)	no carryover clause
	S.675 (Bensten)	S.17 (McIntyre)	
	H.R.6245 (Lloyd)	H.R.61 (Wylie)	residential use only
Direct Loan	H.R.825 (Drinan)	H.R.485 (Lehman)	establishes $100,000,000 fund; system must supply 40% of total heating needs or all hot water needs. HUD administered.
	H.R.863 (Drinan)	H.R.485 (Lehman)	limited to structures with 1-4 fam. units; system must be purchased from small business concern; system must supply 40% of total heating needs or all of hot water needs. SBA administered.
	H.R.1616 (Anderson)	H.R.485 (Lehman)	
	H.R.2274 (Yates)	H.R.485 (Lehman)	limited to structures with 1-4 family units; HUD administered.
	H.R.2534 (Steers)	S.395 (Hart)	
	H.R.2634 (Patterson)	H.R.485 (Lehman)	limited to structures with 1-4 family units; system must supply 40% of total heating needs or all of hot water needs.
	H.R.4914 (Fascell)	S.395 (Hart)	limited to structures with 1-4 family units; 25-yr. maturity.
	H.R.5907 (Drinan)	H.R.3981 (Drinan)	

Miscellaneous	H.R.4217 (Richmond)	H.R. 1166 (Richmond)
	H.R.4219 (Richmond)	H.R. 1164 (Richmond)
	H.R.4884 (Baucus)	H.R.3127 (Baucus)
	H.R.4887 (Baucus)	H.R.3128 (Baucus)
	H.R.4890 (Baucus)	H.R.3129 (Baucus)
	H.R.6614 (Baucus)	H.R.3127 (Baucus)
	H.R.6615 (Baucus)	H.R.3128 (Baucus)
	H.R.6616 (Baucus)	H.R.3129 (Baucus)

APPENDIX B

OVERVIEW OF SOLAR FINANCIAL INCENTIVES ENACTED BY STATES

In the absence of solar incentives on the Federal level, a number of states have acted to provide some financial advantages to users of solar energy. In the residential sector, state incentives have primarily taken three forms:

- exemption of solar installations from local property taxes
- exemption of solar equipment from sales tax
- reduction of solar users' state income tax liabilities

There is considerable variation from state to state in the amount of benefit delivered to solar users through property tax measures. In some cases only a portion of the total cost is exempted from adding to the house's assessed value. In other states, the full cost of the solar installation is exempted. Three states go so far as to grant a time-limited property tax deduction to solar users, while Kansas, with the important caveat that the system must carry 70% of the building's thermal load, exempts solar-equipped structures from all property taxes whatsoever. It is also interesting to note that although most of the twenty-one states with property tax legislation require localities to exempt solar installations from property tax, five states allow local discretion because of Home Rule provisions in their state constitution.

While a number of states have enacted property tax incentives, only three presently exempt solar equipment from sales tax. In Arizona and Texas solar equipment is simply not subject to sales tax, whereas in Georgia purchasers must file an application to reclaim the tax paid.

The provisions of income tax legislation are summarized in Table B-1. There are differences between states in the type of tax instrument used to provide the benefit, the refundability of the credit/deduction and the effect of receipt of Federal benefits on an individual's eligibility for state benefits. Of the states with income tax benefits, two count the cost of solar as a deduction, six allow a tax credit and Arizona gives its citizens a choice between a deduction or a credit.

Although eight states have a slightly regressive benefit in that credits/ deductions are not refundable, these same states do allow individuals claiming the state tax benefit to also claim Federal benefits. In contrast, New Mexico allows a refundable credit but does not allow individuals claiming the state's tax credit to claim Federal benefits as well. In addition, the maximum credit allowed in all but one state -- $1,000 -- is less than that generally proposed for Federal credits. It should also be noted that in many states the average state income tax liability, against which a credit would be applied, is relatively small.

A summary listing of all passed and proposed state solar financial incentives as of July 11, 1977 follows in Table B-2.

Table B-1

SUMMARY OF STATE INCOME TAX BENEFITS TO ENCOURAGE RESIDENTIAL UTILIZATION OF SOLAR ENERGY

State		Summary of Provisions	Individual Claim Both State & Fed. Tax Credit	Credit/Refund If No/Minimal Tax Liability	Carryover Provision
Arizona	(1975) (1977)	36-Month Cost-Amortization as a Deduction, or Credit of 25% of Costs (5% decrease per year through 1981, $1,000 max. credit)	Yes	No	Yes
Arkansas	(1977)	Deduction of Total Costs	Yes	No	No
California	(1972)	Credit of 10% of Costs ($1,000 max. credit)	Yes	No	Yes
Hawaii	(1976)	Credit of 10% of Costs	Yes	No	Yes
Idaho	(1976)	Deduction of Costs: 40% for 1st Year, then 20% per Year for Next 3 Years. ($5,000 max. deduction in any one year.)	Yes	No	Yes
Kansas	(1975)	Credit of 25% of Costs ($1,000 max. credit)	Yes	No	Yes
New Mexico	(1975)	Credit of 25% of Costs ($1,000 max. credit)	No	Yes	No
North Dakota	(1977)	Credit of 5% of Costs Per Year for 2 Years.	Yes	No	No
Oklahoma	(1977)	Credit of 25% of Costs ($2,000 max. credit)	Yes	No	Yes

Table B-2

STATE TAX INCENTIVES TO ENCOURAGE RESIDENTIAL SOLAR ENERGY USE AS OF JULY 19, 1977

	Type of Legislation					
	Property Tax Incentives		Income Tax Incentives		Sales Tax Incentives	
	Passed	Proposed	Passed	Proposed	Passed	Proposed
Alabama		E_d		C*		
Arizona	E		C*,D*		E	
Arkansas			D	D		E
California		E	C			
Colorado	R_v					
Connecticut	E_l*	E,E_d				E,E*
Delaware		E				
Florida		E_d		D		E,E*
Georgia	E_l				R	
Hawaii	E		C			
Idaho		E,E_d	D	C		
Illinois	E_d					
Indiana	D	C,D				
Iowa		E				R
Kansas	E		C			
Maine		E				E
Maryland	C_lE_d			C,C*		
Massachusetts	E	D,E,E_d		C,C*,D		
Michigan	E					
Minnesota		E,E_d		C,D		E
Mississippi		E_d*				
Missouri				C		
Montana	E			C		
Nebraska		E		C		
Nevada	E	E				
New Hampshire	E_l					
New Jersey	E_d^o					E
New Mexico			C	C		
New York	D	E,E*,E_d,E_l		C,C*		E
North Carolina		E		C*		
North Dakota	E	D	C			
Ohio		E_d				E
Oklahoma			C,D			
Oregon	E_d			C*		
Pennsylvania		D,E,E_d,R_v				E
Rhode Island		E,E*				
South Carolina		E		C,D		E
South Dakota	D					
Tennessee						E
Texas		E			E	
Utah		E				E
Vermont	E_l	E				E
Virginia	E_l,E_l*	E_l*		C*		E*
Washington		E,E*				E
West Virginia		E				
Wisconsin		E,E_d				E
Total States	21	28	9	16	3	14

Key: C = tax credit
D = tax deduction
E = tax exemption
E_d = tax exemption of the difference between assessed property value with solar and without solar
l = local option
R = tax rebate
R_v = assessment of solar system at reduced value
* = system must meet performance criteria
o = passed but not yet signed

Source: Derived from Printout of State Solar Legislation, National Solar Heating and Cooling Information Center, 5/14/77, Conversations with Mr. Gerald Mara, National Solar Heating and Cooling Information Center, Franklin Institute Research Lab, 7/77, interviews with various state officials 5/77–7/77.

APPENDIX C

METHODOLOGICAL NOTE

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APPENDIX C

METHODOLOGICAL NOTE

The methodology employed in this study consisted of three major components:

(1) a program of open-ended interviews with a diverse array of public and private participants in the housing market and the solar energy industry;

(2) the development of a model for forecasting the market impact of major incentive options based on (a) the results of structured interviews with 1,500 consumers in eight cities, and (b) a comparative review of existing projections of the likely market penetration for residential solar energy systems; and

(3) the development of procedures for estimating the public costs associated with the incentives tested.

Each of these elements is described briefly in this Appendix. A complete documentation of the research methodology can be found in the supplementary volumes to this report. It should be emphasized that the methodologies presented here provide a series of estimates of market penetration and public costs that are best used to compare the relative effectivnesss of various financial incentives. As predictions of what actually will occur, they are subject to considerable future uncertainties (in the solar state-of-the-art, energy supply and demand, the specifics of government policy) and should therefore be regarded as, at best, extremely rough order-of-magnitude estimates.

A. OPEN-ENDED INTERVIEW PROGRAM

During the course of the study, members of the research team explored the study's central concerns with a wide variety of public and private actors including:

- homebuilders and home improvement contractors
- multi-family developers and real estate syndicators
- mortgage lenders
- home improvement lenders
- real estate appraisers

- private mortgage insurers
- solar manufacturers and distributors
- officials in states having solar energy programs
- officials of Federal mortgage credit agencies (FHA, VA, FmHA)
- secondary market entities (FNMA, FHLMC, GNMA)
- officials of other relevant Federal agencies (Treasury, FEA, ERDA, and HEW's Student Guaranteed Loan Program)
- electric and gas utilities; fuel oil distributors
- industry and trade associations
- researchers engaged in parallel study efforts.

These unstructured interviews were designed to fulfill the following purposes:

- to identify and help select the most promising incentive options for detailed quantitative analysis.
- to obtain essential information and expert advice in making the critical assumptions used in the formal market impact and cost analysis.
- to obtain perspectives on the likely impact and workability of incentives as a supplement to the results from the structured consumer interview program.
- to secure insights useful in performing the more qualitative aspects of the incentive analysis (re: factors such as program equity, administrative feasibility and logistics, analogous program precedents and legal concerns).
- to explore underlying issues in respect to the timeliness, overall scope, and detailed design of a Federal incentive program.

The information gleaned from these interviews with persons of informed points of view is as critical as the quantitative cost/impact estimates to the judgments that underlie the basic findings and recommendations of this report.

B. METHODOLOGY FOR MARKET PENETRATION ANALYSIS

1. Key Features of The Model

The purpose of the Solar Adoption Forecasting (SAF) model is to predict sales over time of both solar water heating and combined space and water heating systems under a number of different assumptions about factors influencing solar energy utilization. The model is constructed as a policy analysis tool which can estimate the impact on the demand for solar systems of:

- changes in the systems' price;
- changes in the prices of conventional fuels and thus energy savings; and
- different levels and types of Federal financial incentives.

A distinctive feature of the model is that it was calibrated on data from a market survey of 1,500 new and existing homeowners in eight cities across the country, undertaken specifically to assess consumer response to various Federal financial incentives. The model translates the interview responses into annual projections of solar system volume through a three-step process:

1) Using regression analysis and the survey data, equations were derived to predict the probability of an individual of a particular income bracket and in a particular region purchasing a solar system.

2) The regional purchase probabilities for each system type were weighted and combined to yield an estimate of national purchase probabilities for each of the four income groups.*

3) These national purchase probabilities were input to a time simulation model which forecast the number of units purchased annually through 1985.

In addition to financial variables, such as median solar system cost, energy savings and incentive value, the SAF model incorporates various behavioral phenomena that have been demonstrated to influence the adoption of new products. Phenomena included in the model are:

- Level of awareness, or the degree to which consumers are knowledgeable about all aspects of solar systems.
- Innovativeness, or consumer attitudes toward new products in general.
- Attitudes toward solar systems, particularly their reliability and financial soundness.
- The bandwagon effect, or the extent to which increasing market penetration creates additional demand for solar systems.

*Less than $16,000; $16,000 to $32,000; $32,000 to $48,000; and greater than $48,000.

This section proceeds with a discussion of the data collection process, goes on to a review of the basic structure of the SAF model, and concludes with an examination of the assumptions used in estimating market penetration.

2. Survey Design

The data used to calibrate the purchase probability models comes from a survey of approximately 1,500 new homebuyers and owners of existing homes in eight cities:

- Boston, Massachusetts
- Philadelphia, Pennsylvania
- Jacksonville, Florida
- Columbus, Ohio
- Nashville, Tennessee
- Houston, Texas
- Tuscon, Arizona
- San Jose, California

These cities were selected to provide a spectrum in terms of climate (degree days, solar insolation), the price of energy from conventional sources (oil, gas, electricity), population base, and growth rates. Forty percent of the sample was drawn from the owners of existing homes with the balance divided between individuals actively in the market for a newly built home and individuals planning to build a home on land they already own. Existing homeowners were selected from randomly chosen census tracts; prospective homeowners were identified through local builders, realtors, and architects. While the study does not provide a nationally representative sample in a formal statistical sense, the size and structure of the sample are such that the findings should provide a reliable indicator of the relative impact of various incentives.

The survey instrument described a solar heating system and familiarized the respondent with issues involving savings and price. Respondents were initially asked to state how likely they would be to purchase a solar heating system, assuming various levels of price and savings. A total of eight price savings combinations were used in each interview. Savings were stated in two components: current savings and expected savings in five years, given an assumed fuel price inflation rate of eight percent. Baseline demand was estimated from these results.

In a follow-up section of the survey representative levels of price and savings were fixed, and respondents were asked to state their likelihood of purchase, depending on which financial incentive was used and on the level or value of the particular incentive:

- with a rebate/grant (received at or about the time of purchase) at subsidy levels ranging from 10 to 50% of purchase price;
- with a Federal income tax reduction ranging from 10 to 50% of the purchase price;
- with a 100% subsidized loan (For hot water systems, the loan terms tested ranged from 1% for 20 years to 7% for 10 years. In the case of higher priced, combined space heating/hot water systems, the terms were varied from 1% for as long as 25 years to 7% for 15 years.)
- with a 75%, 30-year subsidized loan, written at interest rates between 1% and 9%. (This question was asked of new homeowners only, since it was presumed that these financing terms could only be made available if the subsidy were applied to a first mortgage loan.)

In each case, the questions incorporated system costs and fuel savings estimates reflecting actual prices and reasonable system designs for the given metropolitan areas. These estimates were derived as follows:

1) A solar system's monthly output for each region, measured in BTU's per square foot of collector area, was determined from climatic data assuming a collector efficiency of 50 percent.

2) The loads of average-sized homes in each region were calculated from NAHB data on house size, assuming an average daily hot water load of 75 gallons per household and adjusting the estimates to allow for regional differences in home heat loss, groundwater temperature, and domestic hot water service temperatures.

3) Using these two solar energy supply and demand curves, the system size necessary to carry 55 to 75 percent of the total load -- generally the most cost effective size range for solar systems -- was derived for each region.

4) Based on data collected from architects designing solar homes in various parts of the country, estimates were made of the likely costs for the several different system sizes derived above. The costs used in the survey were the costs for the system size giving the best financial payback.

5) Finally, the value of the energy savings achieved by the solar units was calculated from a matrix prepared for each city to

determine the likely backup systems for both new and existing homes, and from energy cost data, derived from a recent RERC survey and from phone interviews with a number of utility companies across the country. These energy savings were adjusted to reflect the fact that conventional systems lose a fairly high percentage of the heat they produce up the chimney: conversion efficiencies for space heating were assumed to be 65%, and for hot water heating, 50%. (See Table C-1 for a list of the solar cost and savings numbers used in the market survey).

Several additional sections of the questionnaire dealt with attitudes, some general and some specifically related to solar energy systems. Attitudes concerning system reliability, financial feasibility, quality, and aesthetics were measured. Personality traits such as innovativeness and willingness to take risk were also registered.

The final section of the questionnaire requested demographic data. Respondents were asked into which of several ranges their family income fell. The ranges used were sufficiently broad that the respondent did not have to reveal an exact income, yet were narrow enough so that the model could answer relevent questions regarding income effects. This demographic data -- education, age, family size -- was collected and tabulated to verify the sample's balance.

3. Basic Model Structure

Two principal components characterize the solar adoption forecasting model. First, a recursive equation system predicts the percentage of the population that would purchase a solar energy system if a particular incentive were made available. Second, a time simulation model integrates and translates these percentages into a forecast of units adopted over a given time period.

A recursive equation system predicts values for "p", the percentage who would buy without an incentive, and "f", the percentage of those who would not buy without an incentive, but who are lured by the incentive. "P" changes as a function of both financial variables, such as system price, savings and income, and attitudinal variables such as faith in system reliability and innovativeness. "F" changes as a function of the type and level of incentive, income, and attitudes toward financial risk as well as the value of "p". The value of "p" influences "f" because population segments with high "p's" tend to be relatively more responsive to

TABLE C-1

SOLAR COSTS AND SAVINGS USED IN THE CONSUMER SURVEY

Water Heating System

	System Price[1]			
	New Homes	Retrofit	Average Savings[2,3]	Savings vs. Electric[3]
Boston	$1,500	$1,800	$85/year	$135/year
Columbus	$1,500	$1,800	$120/year	$120/year
Philadelphia	$1,500	$1,800	$120/year	$171/year
Nashville	$1,500	$1,800	$80/year	$80/year
Jacksonville	$1,200	$1,500	$90/year	$157/year
Houston	$1,200	$1,500	$85/year	$124/year
Tucson	$1,200	$1,500	$55/year	$128/year
San Jose	$1,200	$1,500	$55/year	$129/year

Space and Water Heating System
(new homes only)

	System Price	Collector Area (square feet)	Savings vs. Electric[2,3]
Boston	$10,000	500	$63/month
Columbus	$10,000	500	$54/month
Philadelphia	$8,600	400	$63/month
Nashville	$5,000	175	$17/month
Jacksonville	$4,000	125	$23/month
Houston	$3,500	100	$19/month
Tucson	$4,500	150	$31/month
San Jose	$3,500	100	$19/month

1) For 50 square feet of collector.

2) Weighted average savings based on local mix of conventional energy use in existing homes; weightings derived from ADL, Inc. matrix used in selecting sites for HUD Solar Heating and Cooling Demonstration Program. New homeowners in the combined heat and hot water sample were questioned about solar savings relative to conventional electric systems only.

3) Savings estimates do not take into account costs for system operation and maintenance.

incentive programs. The "p" and "f" equations were calibrated using probability of purchase data from the survey. Regression analysis was used to determine coefficient values, to evaluate which functional forms best fit the data, and to determine which variables explained the data best.

The portion of the population intending to buy a solar system is calculated as the sum of those who would buy without an incentive (baseline purchasers) plus those who would buy only if an incentive is available.

$$p_t^* = p_t + [(1 - p_t) \times f_t]$$

where: p_t^* = percentage that will purchase a specified solar system given an incentive.

p_t = percentage that would buy without the incentive.

$(1-p_t)$ = percentage who would not buy without an incentive.

f_t = percentage of those who would not buy without an incentive, who are lured by the incentive.

(NOTE: In the event that no incentive is used, f = 0 and the model gives its baseline prediction.)

The sometimes diverse effects of income on predisposition to purchase a solar system and on receptivity to incentives are included in the model by permitting income to influence both "p" and "f", thereby reflecting in "p*" the overall effect of income on the adoption of solar systems.

The time simulation model translates the "p*'s" into an actual forecast of units installed over a given time period. Forecasts (cumulative) of the number of units at the end of period "t" are given by:

$$Y_t = Y_{t-1} + (k_o \times p_t^* \times \alpha_t \times m_t \times b_t)$$

where: Y_t = the cumulative number of units installed through time "t". $Y_t - Y_{t-1}$ equals the number of units installed during time period "t".

p_t^* = $p_t + (1-p_t) \times f_t$, as above. p* changes over time because system price and energy savings change.

k_o = a parameter used to discount probability estimates given by respondents. The use of such a parameter is standard practice in demand estimation because of the common tendency for respondents to overstate their intentions. The parameter k_o was adjusted by income group to allow for an "eyes larger than pocketbook" effect among low-income groups.

α_t = the awareness parameter, reflecting the average level of knowledge about solar systems. Although the national level of awareness is quite low at present, α_t is expected to rise over time because of national press publicity and word of mouth. Initial values of α_t are higher for new homeowners than for existing homeowners. The survey responses revealed a generally higher level of awareness about solar systems among new homeowners, apparently reflecting the increased opportunities for exposure to solar information that their search for a new home afforded them.

m_t = the market potential -- the number of existing homeowners who have not yet purchased a solar unit as of time t plus the total number of new homeowners. Potential is broken down by income group so that the number of units installed by each group can be predicted. Potential changes over time, reflecting rising population and shifting income distribution.

b_t = the bandwagon effect. "b_t" represents a dynamic aspect of the diffusion of a new product. It accounts for the fact that initially, only those individuals who are innovators will make solar purchases. As more and more systems are installed, the rest of the population actually sees and hears of those systems. These people then become assured that solar energy is both practical and acceptable and begin to join the solar energy "bandwagon". Thus, b_t increases as market penetration increases.

Parameters in the time simulation model were calibrated by imposing restrictions that reflect the assumptions described above, i.e. that α_t is initially higher for new homeowners, that k_o is higher for lower income groups, and then fitting the model to historical data and expert estimates of installations made from 1975 to 1977.

The output of the SAF Model provides market penetration estimates for the years 1978-1985, for each of seven different incentive types and for any incentive levels within the broad ranges for which survey data were collected.

- four different types of tax benefits:
  - -- tax deductions
  - -- tax credits
  - -- non-refundable tax credits
  - -- taxable refundable credits
- rebate (grants)
- 100% loans
- 75% loans

4. Key Assumptions*

- Inflation: A general inflation rate of 5% per year is assumed throughout the 1977 to 1985 period.

- Prices of Conventional Forms of Energy: No major change in Federal energy regulatory policy is assumed to occur during the life of an incentive program. Fuel prices, and so the value of solar energy savings, are assumed to increase at an annual rate of 8%, that is 3% above the general inflation rate. Clearly, if the prices of oil and natural gas are deregulated, these will become quite conservative numbers and the relative economic attractiveness of solar systems will increase.

- Prices of Solar Systems over Time: Some reductions in the costs of solar systems are expected to be achieved during the next seven years. However, the effect of these cost reductions on the system's price will be counterbalanced by inflation. For the purpose of the analysis, therefore, a net annual increase in solar system price of 2% was used, reflecting the assumed general inflation rate of 5% less an annual cost reduction of 3%. This rather pessimistic view of the prospects for system price reduction was supported by interviews with solar manufacturers, who in general expressed concern that the prices of two of the basic collector materials, aluminum and copper, would rise fast enough to undercut much of the economies achievable through higher volume production. Of course, should a major technical breakthrough in collector materials or design occur, system prices could well drop and the market penetration estimates presented in this study might in retrospect prove overly conservative.

- Awareness: Two different types of awareness are included in the SAF model: a general awareness or knowledge about solar systems and an awareness of the availability of financial incentives. The consumer who is fully knowledgeable about solar systems is one who not only has heard of solar hot water and space heating units, but also knows how solar systems work, understands the financial implications of purchasing a system, and understands the changes in home appearance that installing a system necessitates. Awareness is assumed to increase in an "S-shaped" pattern, rising slowly

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* Earlier in the study we developed a "baseline" estimate of the number of solar units installed annually (without incentives), using an adjusted version of A.D. Little's model of market penetration (see Working Paper #2). The adjustments were based on comparative review of the existing literature on solar market penetration and other expert opinions obtained through interviews. These estimates were intended only as a preliminary indication of a reasonable level of market penetration and have now been revised based on consumer response to the survey and the new penetration model.

at first, then more rapidly as large parts of the population are exposed to solar energy, and eventually more slowly again as solar energy becomes commonplace .

Awareness of the availability of an incentive is included as a factor in the "p*" equation. The "p*" equation now becomes:

$$p_t^* = p_t + (1 - p_t) \times f_t \times \beta_t$$

where: β_t = Incentive awareness parameter.

This parameter is implicitly set equal to one in evaluating all incentives except the loans. β was assumed to be lower for loans due to their added complexity and to the possibility that neither the press nor local retailers would publicize loans as strongly or as effectively as tax credits or rebates.

- Limitations on the Number of Consumers Able to Use Tax Credits and Tax Deductions: Under a tax credit incentive, a certain percentage of the solar system's cost is returned to the individual purchaser as a reduction of his Federal income taxes. The tax credit can assume two forms; refundable or non-refundable. Under a non-refundable tax credit, the maximum an individual can receive is the amount of income tax owed, while under a refundable tax credit, the individual receives the full value of the credit even if it is larger than income taxes owed. The non-refundable credit reduces the percentage of solar purchasers among lower income groups since they are unable to take full advantage of the credit. The number of units installed by these income groups are correspondingly reduced. This reduction, although not substantial, grows over time due to the bandwagon factor in the predictive equation. This effect also reduces solar utilization in all income groups because there are fewer total units installed in any one year, thereby shrinking the bandwagon factor in the next year.

  A similar kind of effect occurs with a tax deduction incentive. Since a given percentage of the purchase price is deducted from one's taxable income, the full benefit of the incentive will be unavailable to all individuals having taxable income less than the total amount of the deduction. Thus, paradoxically, as the level of allowable benefit increases, the number of consumers fully able to use it declines. In addition, the value of such an incentive to the consumer is his tax rate times the allowable proportion of the system price. Since the value of the incentive is proportional to the tax rate, it is in absolute terms, higher for higher income groups. Assumptions were made as to what portion of consumers in various income groups could take advantage of the various tax-based incentives (at various subsidy levels).*

* These assumptions were based on data available from Department of the Treasury, Statistics of Income 1975 -- Preliminary Individual Income Tax Returns, Publication 198 (2-77), 1977, and Bureau of the Census, Annual Housing Survey; 1975, Part C (Financial Characteristics of the Housing Inventory.

- Windfalls: It is assumed that 90% of the consumers who would have purchased a system in the absence of an incentive, will take advantage of any rebate or tax benefit that is enacted. Thus, the windfall benefit for tax and rebate incentives is equivalent to the subsidy amount times 90% of the total number of baseline solar purchasers.

  In contrast, it is assumed that a higher percentage of those not lured specifically by the loan program may or may not use it. The proportion of baseline consumers who would actually use a loan incentive was estimated using the following information from the survey:

  1) The percentage who use loans for major home improvements. This was taken as a rough estimate of windfall percentage that was then altered by the next three factors.
  2) A measure provided by respondents that indicated their relative preference for loans as opposed to other incentive types. Those with higher measures are more likely to be in the windfall population.
  3) Attitudes toward buying on credit and toward government involvement in individual affairs. Those with positive attitudes toward these items are more likely to be in the windfall population.
  4) Relative attractiveness of various loan interest rates. The more attractive the interest rates, the larger the windfall effect.

  Using this information, windfall percentages were calculated that differed between new and existing homeowners, and varied according to the attractiveness of the loan.

C. METHODOLOGY FOR PUBLIC COST ANALYSIS

Public costs were estimated in terms of both (1) annual costs (in nominal dollars) over a five-year program life (1978-1982) and (2) the present value* of total public costs for the entire period during which administrative costs will be incurred. (Various low cost loan options involve expenditures for a number of years after the program is terminated).

Total public costs are considered as the aggregate of three basic

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* For the purpose of present value calculations, the analysis applies a discount rate of 7.5% (the approximate yield on long-term Treasury notes). Assumptions concerning general inflation in the economy and changes in solar system costs over time are the same as those used in the market impact projections.

components, each of which is computed separately:

(1) basic subsidy costs;

(2) administrative expense; and

(3) public costs attributable to the tax deductability of interest.

Cost calculations were done for each of the tax benefit and rebate type incentives for which market impacts were estimated. The 75% and 100% loan options were each costed out, assuming three different delivery systems: (1) a direct loan program, (2) a program of interest reduction payments to lenders, and (3) a "Solar Tandem Plan" run through GNMA/FNMA secondary market programs.

Subsidy Costs

In the case of tax benefits and grants/rebates, subsidy costs are a simple function of program volume, as predicted by the Solar Adoption Forecasting Model, and the average subsidy payments to individuals. Where the benefit received varies by income bracket (as with the tax deduction, tax credit, and taxable rebate options), program costs have been computed based on the number of recipients in each income group and their respective average marginal tax brackets. In the case of the low-cost financing options, the computations vary depending on whether or not the government loans principal in addition to providing an interest subsidy, and on whether or not the subsidy itself is absorbed in a lump sum (as under a Tandem Plan) or conveyed in terms of monthly payments over the life of the loan.

Administrative Costs

Administrative costs were calculated in terms of three components (insofar as each component applies to the specific incentive type):

- fixed start up costs;
- a marginal processing cost per assisted unit;
- a marginal annual management/servicing cost per assisted unit. In the case of the direct loan option, this includes an additional marginal annual administrative cost for dealing with default and foreclosure situations.

Table C-2 indicates whether or not these respective components of administrative costs apply to each of the specific consumer-oriented incentive options.

For the grant and low-cost financing options, rough administrative cost breakdowns for existing housing support programs were obtained from the Department of Housing and Urban Development and the Farmer's Home Administration. (These included FmHA's Section 504 and 502 program, HUD's Section 312 Rehab loan program, FHA's Title I insurance for home improvement loans and GNMA's basic tandem plans.) However, it should be emphasized that:

- Since none of these existing programs provide a literal enough analogy to a solar incentive program, an attempt was made to adjust these figures to reflect anticipated differences in terms of the average benefit amount, the target population, the nature of oversight required, and annual volume of operation.

- In reality, the administrative costs associated with any given incentive option could vary by several orders of magnitude, depending on any number of factors: the amount budgeted for promotion of the program; the complexity of the procedures adopted for screening systems, certifying costs, etc.; the degree of consumer protection built into the program; the elaborateness of monitoring and evaluation activities; the extent to which administration is decentralized on an area, state, or local basis; the magnitude of overhead expense (does the program involve a marginal addition to an existing program with appropriate staff capabilities already in place or the creation of an entirely new office or agency?)

Thus, the assumptions on which our administrative cost estimates are based necessarily reflect a number of qualitatively and somewhat arbitrary judgments. As such, the resulting estimates should be interpreted as crude indicators of the relative costs likely to result for the respective incentive options, and as an even rougher approximation of probable levels of expenditure in absolute terms.

The Tax Deductability of Interest

The tax deductions claimed by homeowners for the interest payments on their mortgages have a greater cost to the government than do all the Federal housing programs combined. Although the analysis of these costs raises some difficult problems, their magnitude argues for their consideration.

The incentive options under review will have differing consequences for the amount of Federal revenue foregone due to tax deductions. In the

TABLE C-2

COMPONENTS OF ADMINISTRATIVE COSTS APPLICABLE TO
COSTING MAJOR INCENTIVE OPTIONS

TYPE OF PROGRAM	ADMINISTRATIVE MECHANISM	COMPONENTS OF ADMINISTRATIVE COSTS: START UP	PROCESSING	SERVICING/ MANAGEMENT
Grant	o Direct Federal (HUD)	Yes	Yes	No
	o State Administered with Federal Oversight	Yes	Yes	Yes
Tax Credit/ Deduction	o Treasury	Yes	No	No
Taxable Rebate	o Direct Federal (HUD/Treasury)	Yes	Yes	No
Interest Subsidy Program for Private Loans	o Direct Federal for Private Loans Meeting Federal Standards	Yes	Yes	Yes
Direct Government Loan with Interest Subsidy	o Direct Federal (HUD)	Yes	Yes	Yes*
Solar Tandem Plam	o GNMA/FNMA Purchase of Solar Loans	Yes	Yes	No

* Includes the costs of servicing related to problem loans.

case of grant and tax benefit approaches, a revenue loss to the government will result from those homeowners installing solar only because the Federal benefit is available. The analysis assumes that all new homeowners in this group will still finance the solar purchase as part of their mortgage and that 20% of existing homeowners installing solar will take out conventional home improvement loans.

In the case of below-market financing options, it is also necessary to distinguish the portion of the assisted homeowners receiving the benefit as a "windfall" from those induced to adopt solar by the availability of the incentive itself. The former group will now be deducting interest at a lower rate than if no incentive had been provided (an increase in revenue to government), while the interest deducted by the users induced by the incentive will result in a Federal revenue loss.

Measures of Cost Effectiveness

Each major consumer-oriented incentive was costed on the basis of several subsidy levels and their corresponding program volumes as derived from the market impact analysis. For each of the three market segments (solar hot water in existing homes, solar hot water and combined solar heating/hot water in newly built homes) the public cost model computes each of the three cost components (subsidy costs, administrative expense, tax deductability of interest) and then aggregates these subtotals to arrive at a total public cost figure. The specific subsidy levels used for the purposes of program costing were chosen to encompass a full range of subsidy depths judged as having some plausible degree of political acceptability.

The output of the public cost model and the Solar Adoption model were then used to calculate cost-effectiveness estimates for four different subsidy levels for each of the different incentives. Two different cost-effectiveness ratios were computed for each of the combinations of incentive types and levels, one using the cost of subsidy and administration and the other using the total public cost including the effects of income tax deductions for interest expense. The cost per induced unit was determined for each incentive level and type by dividing the present value of the two different public cost streams by the projected net increase in solar installations during the five-year period, 1978-1982.

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