LA-UR -80-1913

CONF-800828--2

TITLE: PASSIVE INCENTIVE REQUIREMENTS: A REGIONAL ASSESSMENT

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SUBMITTED TO: Pacific Northwest Solar Conference "SOLWEST '80"
6-10 August 1980, Vancouver, British Columbia, Canada

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Form No. 836 R3
St. No. 2629
12/78

UNITED STATES
DEPARTMENT OF ENERGY
CONTRACT W-7405-ENG. 36

PASSIVE INCENTIVE REQUIREMENTS: A REGIONAL ASSESSMENT

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ABSTRACT

The nation's goal of 20% solar contribution by the turn of the century will be achieved, in part, by the construction of residences heated by virtue of their passive solar designs. These designs are not economically competitive against all conventional fuels in all locations. Some degree of government incentive will be required to assure a competitive position for these designs. A methodology is presented which is used to assess the magnitude of the government incentive required to assure feasibility. The methodology is used to provide a regional assessment for the Pacific Northwest under alternative home ownership periods and conventional fuel types.

1. INTRODUCTION

A passive solar incentive program has not been enacted at the federal level. It will be necessary for residential passive design options to be included in the solar tax credit legislation for these designs to achieve a competitive position in all locations. The exact structure of the incentive package will be the result of the political process and is not the subject of this paper, although it is possible to assess the magnitude of the incentive which will be required. The LASL/UNM EASE-II Model is used to provide estimates of the total incentive required. The total incentive is also expressed as a per unit of energy figure. Two residence types are analyzed. Three conventional fuel alternatives are included; fuel prices are specified for each of sixteen locations in the Northwest. Three passive design options are included in the analysis. Space limitations dictate that the results presented here merely highlight the results of the full analysis. The results are presented in mapped and tabular form.

2. METHODOLOGY

Seven basic steps are employed in the estimation of the incentive required to assure economic competitiveness for the selected passive design options. The first step is the specification of architectural design parameters and passive revisions to a conventional tract home. Location specific home heating loads are then computed on the basis of building heat loss factors and annual average heating degree days. The annual thermal performance of the selected passive designs has been estimated using simplified methods developed by LASL Q-11 Solar Energy Group (1, 2). In the fourth step locally estimated passive solar add-on costs are combined with the performance estimates to calculate the total cost of alternatively sized passive heating designs. Conventional energy prices are specified in the fifth step. The maximum affordable add-on cost is then estimated by equating this cost with the stream of displaced fuel costs associated with the design over the home ownership period. The difference between the total design cost, calculated in the fourth step, and the maximum affordable cost is then calculated and defined as the incentive required to guarantee design feasibility. A more thorough discussion of the detailed methodology and additional background information can be found in (3, 4).

The two key calculations in this procedure are the total design cost and the maximum affordable design cost (cost goal). The total design cost is calculated as the product of the collector area requirement (ft^2) and the variable cost of the design ($/$ft^2$ collector area). The variable cost is adjusted for each location according to labor and materials cost indices for that location. The cost goal calculation is based on the idea that a passive design can be defined as feasible when the add-on cost is just equal to the cost of supplying the displaced conventional fuel over the period of home ownership. An annualized fuel cost ($/MMBtu) is used in conjunction with the amount of conventional fuel (MMBtu) displaced by the design to calculate the cost goal. The application of a fixed charge rate assures that the resulting cost goal is in current dollar terms. The difference between these two costs is the amount a consumer will need as an incentive to invest in the design given that he requires the design to break even over his ownership of the residence. The general design and economic parameters and fuel price assumptions are displayed in Table 1 and 2 respectively.

The analysis undertaken in this effort was very extensive. A fair number of combinations of fuel, house and design types as well as alternative home ownership periods were examined. Table 4 shows the specification of the full analysis. Results presented here represent highlights of the full results. The highlighted results include the analysis of a two-story frame house with a Trombe wall (with night insulation) passive design against the three major conventional fuel alternative. Two levels of solar contribution and two home ownership periods are analyzed.

Two home ownership periods have been included to dramatize the effect of this parameter. The ten year ownership period simulates the concerns of the average home owner, who stays in a home between 7 and 10 years on the average. The home owners' primary concern is that the design pay for itself during his occupancy of the residence. This is contrasted with a thirty year ownership period. Thirty years corresponds to the average mortgage period and passive design life. When a thirty year ownership period is used it is more akin to the concerns of the government--that the design break even over its lifetime. The results obtained for these two periods can be directly contrasted to demonstrate the importance of this parameter. The eventual approach to an incentive structure could seriously impact its effectiveness in terms of its ability to alter the demand for residential passive design options.

RESULTS

Highlights of the results of this analysis are presented in Table 3. The total required incentive as well as the required incentive expressed in terms of a dollar per million Btu amount is shown for both a ten and thirty year ownership period for the three major conventional fuel types for new homes in the Northwest--natural gas, electric resistance and electric heat pump. The total cost of the design for a 25% and 50% solar contribution are shown. The incentives reflect the dollar amount the consumer would need to be given to be induced to invest in the design assuming that breaking even over a specific time period would be sufficient to cause him to invest.

The results reflect the magnitude of the local fuel prices. When the alternative energy is cheap, given specific design performance, the incentive required will be very high. The value of the displaced fuel and hence the cost goal will be very low; which in turn will always result in a very high required incentive. Increasing the cost of the backup fuel will always result in a lower required incentive. The effect of cheap energy is exemplified by electricity in most Washinton locales.

The effect of varying the ownership period is quite dramatic. The incentive required to quarantee feasibility given a ten year home ownership period is, in general, several times that required given a thirty year period. This is, perhaps, indicative of the problems of reconciling societal goals with private goals. The investment required by society to bring about the achievement of individual consumer goals of feasibility will be substantually greater than that dictated by more rigorously defined societal concerns. Maps 1 and 2 show the difference in required incentive on a dollar per energy unit basis between the two ownership periods. In many cases no incentive is required given a thirty year ownership period.

CONCLUSIONS

- The ownership period assumption is an extremely important parameter in incentive analysis.
- Natural gas is expensive enough at the present time to require no incentive in most locations in the region.
- Passive designs cannot easily be expected to compete against electric heat pumps.
- Electricity, the primary regional fuel, is cheap in many locations with a fairly high incentive required to achieve feasibility.

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TABLE 1

SUMMARY OF ASSUMPTIONS USED IN INCENTIVE ANALYSIS

Regional Sites	16 SOLMET cities	
Solar System Configuration	Trombe Wall is 18 inches thick [1] surface area to mass ratio is 1.5 ft^3 of storage mass for every ft^2 of glass [2].	
Energy Futures	Constant escalation rates for all locales (in real terms); natural gas = 8%, electric resistance = 4%.	
Energy Conversion Efficiency	Adjustment to account for losses; natural gas = 75%, electric resistance = 100%.	
Economic Parameter Values	(adjusted for inflation where necessary)	
	Time period of Analysis	1980
	Solar System Life	30 yrs.
	Inflation Rate	8%
	Interest Rate (Real	3.5%
	Mortgage Rate (Nominal)	11.5%
	Discount Rate (Nominal)	11.5%
	Income Tax Bracket	30%
	Down Payment	20% of Solar Add-on Costs
	Resale Value	0
	Home Ownership Period	10 yrs. and 30 yrs.
	Operating & Maintenance	1% of Solar Add-on Costs

TABLE 2

FUEL PRICES

State City	Natural 1979 $/MCF	Gas 1979 $/MMBtu	Electric 1979 ¢/kwh	Resistance 1979 $/MMBtu
IDAHO				
Boise	3.74	4.99	2.54	7.44
Lewiston	3.74	4.99	1.88	5.51
Pocatello	3.74	4.99	2.54	7.44
OREGON				
Astoria	4.71	6.28	3.10	9.08
Burns	4.71	6.28	3.07	9.00
Medford	4.80	6.40	3.10	9.08
North Bend	4.71	6.28	3.10	9.08
Pendleton	4.65	6.20	3.10	9.08
Portland	4.71	6.28	3.08	9.02
Redmond	4.65	6.20	3.10	9.08
Salem	4.71	6.28	3.08	9.02
WASHINGTON				
Olympia	3.10	4.13	2.29	6.71
Seattle-Tacoma	3.10	4.13	1.11	3.25
Spokane	3.24	4.32	1.86	5.45
Widbey Island	3.10	4.13	1.39	4.07
Yakima	3.10	4.13	2.44	7.15

TABLE 3

REQUIRED INCENTIVES FOR TROMBE WALL PASSIVE SOLAR DESIGN ($)

Variable Cost - $20/ft^2 Collector Area

State / City	Fuel / Solar Fraction	Natural .25	Gas .50	Electric .25	Resistance .50	Heat .25	Pump .50
IDAHO							
BOISE							
	Total Design Cost	4207	9852	4207	9852	4207	9852
30 yrs. period of analysis							
	total required incentive	0	0	424	740	1303	4138
	$/MMBtu required incentive	0	0	16	14	50	80
10 yrs. period of analysis							
	total required incentive	2906	7295	2580	6657	3188	7850
	$/MMBtu required incentive	111	141	98	129	122	152
LEWISTON							
	Total Design Cost	4916	11652	4916	11652	4916	11652
30 yr. period of analysis							
	total required incentive	0	804	1635	5207	2913	7717
	$/MMBtu required incentive	0	26	65	168	116	249
10 yr. period of analysis							
	total required incentive	3672	9210	3767	9394	4214	10275
	$/MMBtu required incentive	146	298	150	303	168	332
POCATELLO							
	Total Design Cost	4633	10439	4633	10439	4633	10439
30 yr. period of analysis							
	total required incentive	0	0	0	0	855	3043
	$/MMBtu required incentive	0	0	0	0	28	50
10 yr. period of analysis							
	total required incentive	3099	7431	2716	6683	3312	7849
	$/MMBtu required incentive	100	120	88	110	107	129
OREGON							
ASTORIA							
	Total Design Cost	4362	9793	4362	9793	4362	9793
30 yr. period of analysis							
	total required incentive	0	0	0	0	1336	3854
	$/MMBtu required incentive	0	0	0	0	55	81
10 yr. period of analysis							
	total required incentive	2910	6940	2604	6342	3301	7710
	$/MMBtu required incentive	121	147	108	134	137	163
BURNS							
	Total Design Cost	5012	11135	5012	11135	5012	11135
30 yr. period of analysis							
	total required incentive	0	0	0	0	486	2289
	$/MMBtu required incentive	0	0	0	0	15	37
10 yr. period of analysis							
	total required incentive	3110	7417	2732	6679	3423	8029
	$/MMBtu required incentive	98	120	86	107	108	130
MEDFORD							
	Total Design Cost	4509	10464	4509	10464	4509	10464
30 yr. period of analysis							
	total required incentive	0	0	0	1232	1745	4085
	$/MMBtu required incentive	0	0	0	28	77	91
10 yr. period of analysis							
	total required incentive	3120	7735	2859	7221	3538	8555
	$/MMBtu required incentive	137	173	126	161	156	192
NORTH BEND							
	Total Design Cost	3376	7172	3376	7172	3376	7172
30 yr. period of analysis							
	total required incentive	0	0	0	1232	1745	4085
	$/MMBtu required incentive	0	0	0	28	77	91
10 yr. period of analysis							
	total required incentive	2096	4655	1828	4128	2480	5411
	$/MMBtu required incentive	98	110	86	98	116	129
PENDLETON							
	Total Design Cost	4970	11743	4970	11743	4970	11743
30 yr. period of analysis							
	total required incentive	0	0	0	1881	1952	5929
	$/MMBtu required incentive	0	0	0	40	81	125
10 yr. period of analysis							
	total required incentive	3539	8926	3214	8288	3915	9665
	$/MMBtu required incentive	147	188	133	175	162	204

Table 3 (continued)

State City	Fuel Solar Fraction	Natural .25	Gas .50	Electric .25	Resistance .50	Heat .25	Pump .50
PORTLAND							
	Total Design Cost	4592	10821	4592	10821	4592	10821
30 yr. period of analysis							
	total required incentive	0	81	10	1801	1922	6491
	$/MMBtu required incentive	0	2	.5	41	87	149
10 yr. period of analysis							
	total required incentive	3257	8195	2985	7658	3655	8979
	$/MMBtu required incentive	147	188	135	176	165	206
REDMOND							
	Total Design Cost	4362	9982	4362	9982	4362	9982
30 yr. period of analysis							
	total required incentive	0	0	0	0	305	2015
	$/MMBtu required incentive	0	0	0	0	10	35
10 yr. period of analysis							
	total required incentive	2625	6569	2232	5798	2941	7193
	$/MMBtu required incentive	90	114	77	100	100	125
SALEM							
	Total Design Cost	4530	10485	4530	10485	4530	10485
30 yr. period of analysis							
	total required incentive	0	0	0	1385	1823	5163
	$/MMBtu required incentive	0	0	0	31	81	117
10 yr. period of analysis							
	total required incentive	3180	7835	2906	7295	3580	8620
	$/MMBtu required incentive	142	178	130	165	160	196
WASHINGTON							
OLYMPIA							
	Total Design Cost	4260	10036	4260	10036	4260	10036
30 yr period of analysis							
	total required incentive	0	0	0	1168	1491	4596
	$/MMBtu required incentive	0	0	0	24	59	92
10 yr. period of analysis							
	total required incentive	3094	7751	2676	6928	3288	8129
	$/MMBtu required incentive	122	156	106	139	130	164
SEATTLE-TACOMA							
	Total Design Cost	3953	9494	3953	9494	3953	9494
30 yr. period of analysis							
	total required incentive	0	0	1896	5444	2722	7069
	$/MMBtu required incentive	0	0	80	111	114	145
10 yr. period of analysis							
	total required incentive	2860	7337	3232	8074	3522	8547
	$/MMBtu required incentive	120	150	136	165	148	177
SPOKANE							
	Total Design Cost	5581	13563	5581	13563	5581	13563
30 yr. period of analysis							
	total required incentive	0	2559	1779	6093	3008	8510
	$/MMBtu required incentive	0	43	58	101	98	142
10 yr. period of analysis							
	total required incentive	4317	11084	4248	10948	4677	11792
	$/MMBtu required incentive	141	184	139	182	153	196
WIDBEY ISLAND							
	Total Design Cost	3538	11624	3538	11624	3538	11624
30 yr. period of analysis							
	total required incentive	0	1978	941	6516	1972	8542
	$/MMBtu required incentive	0	42	39	138	82	181
10 yr. period of analysis							
	total required incentive	2435	9454	2627	9835	2989	10543
	$/MMBtu required incentive	102	200	110	208	125	223
YAKIMA							
	Total Design Cost	4851	11826	4851	11826	4851	11826
30 yr. period of analysis							
	total required incentive	48	2358	377	3016	2009	6231
	$/MMBtu required incentive	2	44	14	56	74	117
10 yr. period of analysis							
	total required incentive	3281	9695	3281	8742	3854	9866
	$/MMBtu required incentive	121	181	121	164	142	185

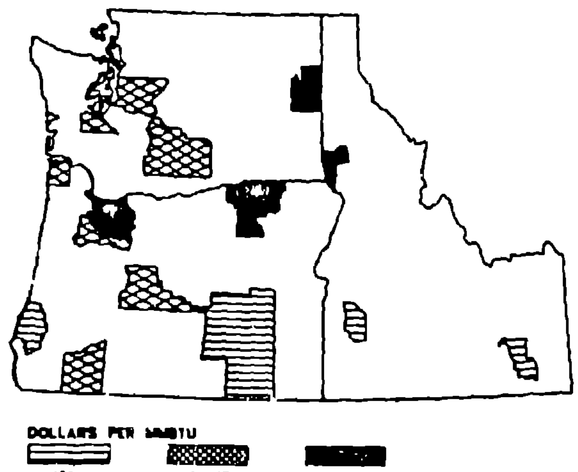
TABLE 4

CASES INCLUDED IN FULL ANALYSIS
(all combinations evaluated)

House Types	1. one story slab on grade ranch style	2. two story frame over unheated basement	
Fuel Types	1. natural gas	2. electric resistance	3. heat pump
Design Types	1. water wall with night insulation	2. Trombe wall with night insulation	3. direct gain with night insulation
Ownership Periods	1. 10 years	2. 20 years	
Solar Fraction	1. 25%	2. 50%	

MAP 1

SOLWEST 80
REQUIRED SOLAR INCENTIVES
TROMBE WALL WITH NIGHT INSULATION
50 PERCENT FRACTION – – 10 YEAR LOAN
FUEL IS ELECTRIC RESISTANCE



MAP 2

SOLWEST 80
REQUIRED SOLAR INCENTIVES
TROMBE WALL WITH NIGHT INSULATION
50 PERCENT FRACTION – – 30 YEAR LOAN
FUEL IS ELECTRIC RESISTANCE