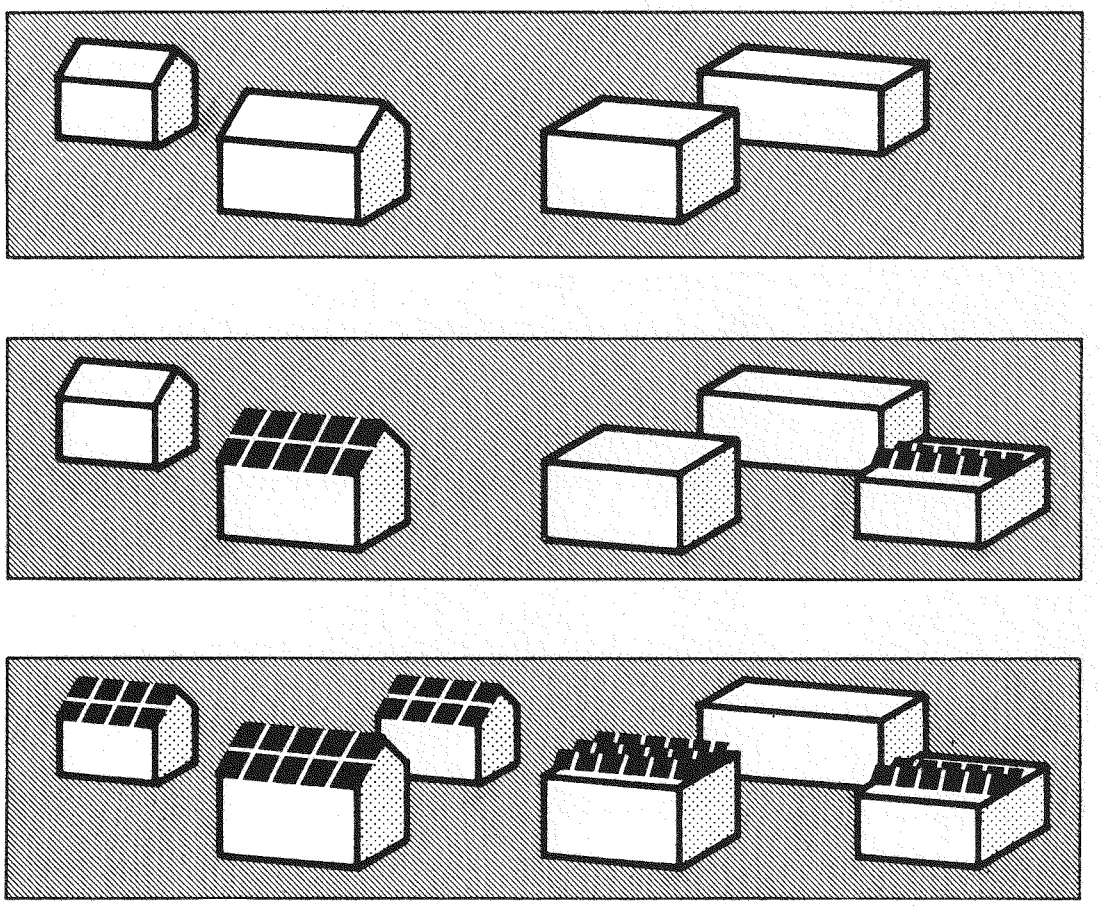
HCP/M70066-01/3

Solar Heating and Cooling of Buildings (SHACOB) Commercialization Report

Part B — Analysis of Market Development

Volume III — Appendices

September 1977



Prepared For
U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Conservation
and Solar Applications
Task Force on Solar Energy
Commercialization (FEA)

Under Contract No. CR-05-70066-00

May 1978

FEDERAL ENERGY ADMINISTRATION ACTIVITIES

The Federal Energy Administration (FEA) is involved with the development and use of solar energy encompassing a broad range of interests including: the direction of the nation's solar-related endeavors as part of our national energy strategy; the policy, planning and overall coordination of solar energy commercialization; and certain regulatory and resource management functions which affect the use of solar energy.

FEA's legislative authority for solar-related activities is based on a number of laws including PL 93-275, PL 93-438, and PL 94-385. Of significance, the Energy Conservation and Production Act (PL 94-385) authorizes FEA to "provide overall coordination of federal solar energy commercialization activities" and "to carry out a program to develop the policies, plans, implementation strategies, and program definitions for promoting the accelerated utilization and widespread commercialization of solar energy." As part of PL 94-385, the Congress listed several solar energy commercialization activities which it expects FEA to carry out, a few of which include:

- Develop a national plan for the accelerated commercialization of solar energy to include workable options for achieving on the order of 1 million barrels per day of oil equivalency in energy savings by 1985 from a combined total of all solar technologies;
- Develop commercialization plans for each major solar technology;
- Conduct studies and analyses addressing mitigation of economic, legal, environmental, and institutional constraints;
- Develop state solar energy commercialization plans and programs and coordinate with state energy conservation programs; and
- Develop such major commercialization projects as, but not limited to, the "Southwest Project," the "Solar Energy Government Buildings Project," among others.

HCP/M70066-01/3
UC-59 59a,59b,59c

Solar Heating and Cooling of Buildings (SHACOB) Commercialization Report

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Prepared By
Arthur D. Little, Inc.

Prepared For
U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Conservation and Solar Applications
Task Force on Solar Energy Commercialization (FEA)
Washington, DC 20545

Under Contract No. CR-05-70066-00

May 1978

NOTE: This report was prepared for the Task Force on Solar Energy Commercialization, Federal Energy Administration (FEA) prior to the activation of the U.S. Department of Energy (DOE) by the Energy Reorganization Act. FEA's functions have been transferred to DOE.

PREFACE

The Energy Conservation and Production Act (PL 94-385) authorizes the Federal Energy Administration (FEA) to "provide overall coordination of federal solar energy commercialization activities" and "to carry out a program to develop the policies, plans, implementation strategies, and program definitions for promoting the accelerated utilization and widespread commercialization of solar energy." The Congressional conference report listed several specific actions desired by the Congress including (among others).

- Develop a national plan for the accelerated commercialization of solar energy to include workable options for achieving on the order of 1 million barrels per day of oil equivalency in energy savings by 1985 from a combined total of *all* solar technologies;*
- Develop commercialization plans for *each* major solar technology;
- Conduct studies and analyses addressing mitigation of economic, legal, environmental, and institutional constraints.

In essence, the "National Plan . . . for *all* solar technologies" will be comprised of the combination of "commercialization plans for *each* major solar technology." Analyses of costs, benefits, and strategy options for each of the technologies can be placed in context, coordinated and optimized into an overall commercialization plan for solar energy.

The SHACOB Commercialization Report (PARTS A and B) is the first step toward development of a SHACOB Commercialization *Plan*. PART A, prepared by Midwest Research Institute under FEA Contract No. CR-05-70065-00, addresses *qualitatively* the potential barriers to and incentives for the accelerated commercialization of SHACOB in the residential and commercial sectors. It represents a summary and synthesis of a large amount of recently completed research on all aspects of the market development of solar heating and cooling. PART B, prepared by Arthur D. Little, Inc., contains *quantitative* analyses of the market penetration and the costs and benefits to the government associated with some of the incentives examined in PART A.

The SHACOB Commercialization Report relates closely to the President's proposed National Energy Plan (NEP) in that it analyzes a large number of incentives in terms of their impact on barriers to commercialization, their impact on income and interest groups, and possible administrative mechanisms. The impacts of incentives contained in the NEP are analyzed and compared to the present research, development and demonstration programs, an expanded NEP, and new initiatives.

PART B is divided into three volumes. Volume I contains the executive summary, while the technical report makes up Volume II. Volume III contains appendices which support the technical discussions in Volume II.

* Major solar technologies include: solar heating (including hot water) and cooling of buildings — SHACOB, agricultural and industrial process heat, wind energy conversion systems, photovoltaics, fuels from biomass, solar thermal, and ocean thermal energy conversion.

PART B was prepared by Arthur D. Little, Inc., under FEA Contract No. CR-05-70066-00 for the Federal Energy Administration's Task Force on Solar Energy Commercialization. Norman W. Lutkefedder is Director of the Task Force. Other Task Force members who contributed to this report are: Samuel J. Taylor, Howard L. Walton, Charles Allen, Richard D. Stoll, Howard Magnas, LaVerne P. Johnson, Robert Grubenmann, I-Ling Chow, Stanly Stephenson, Edward Downey, Mike Kutsch, Elaine Smith, Robert Jordan, Jeffrey Milstein, Margaret Sibley, Sally Mott, Ned Dearborn, James H. Berry, Mary Liebert, and Jack Koser.

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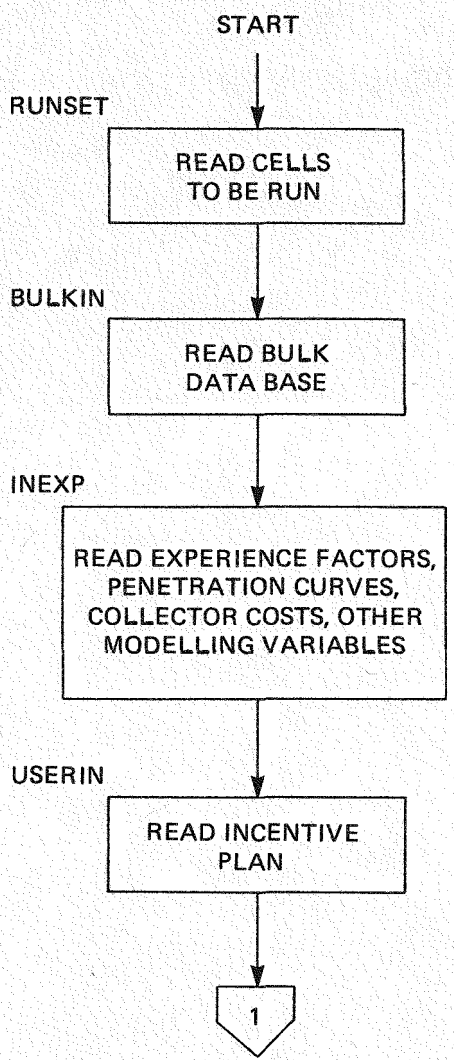
MODEL DOCUMENTATION

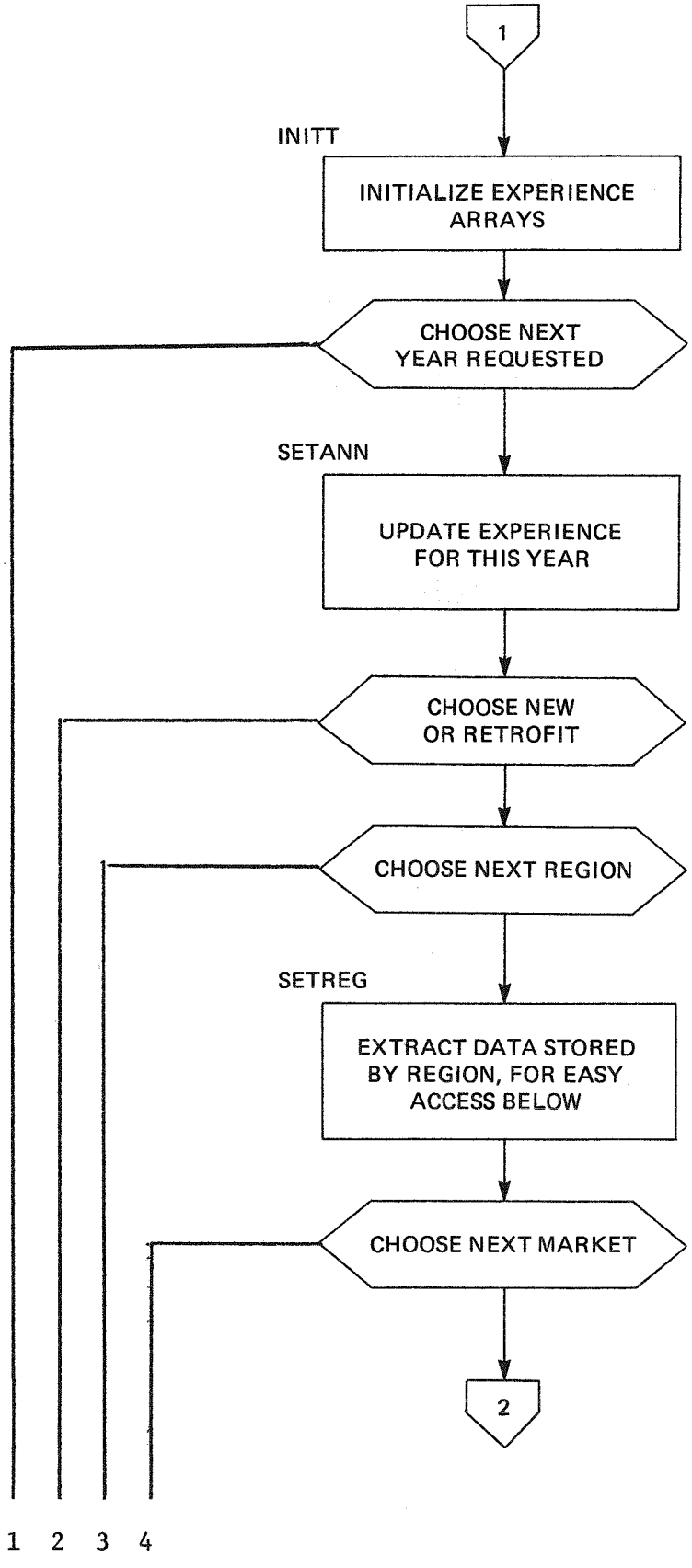
APPENDIX A

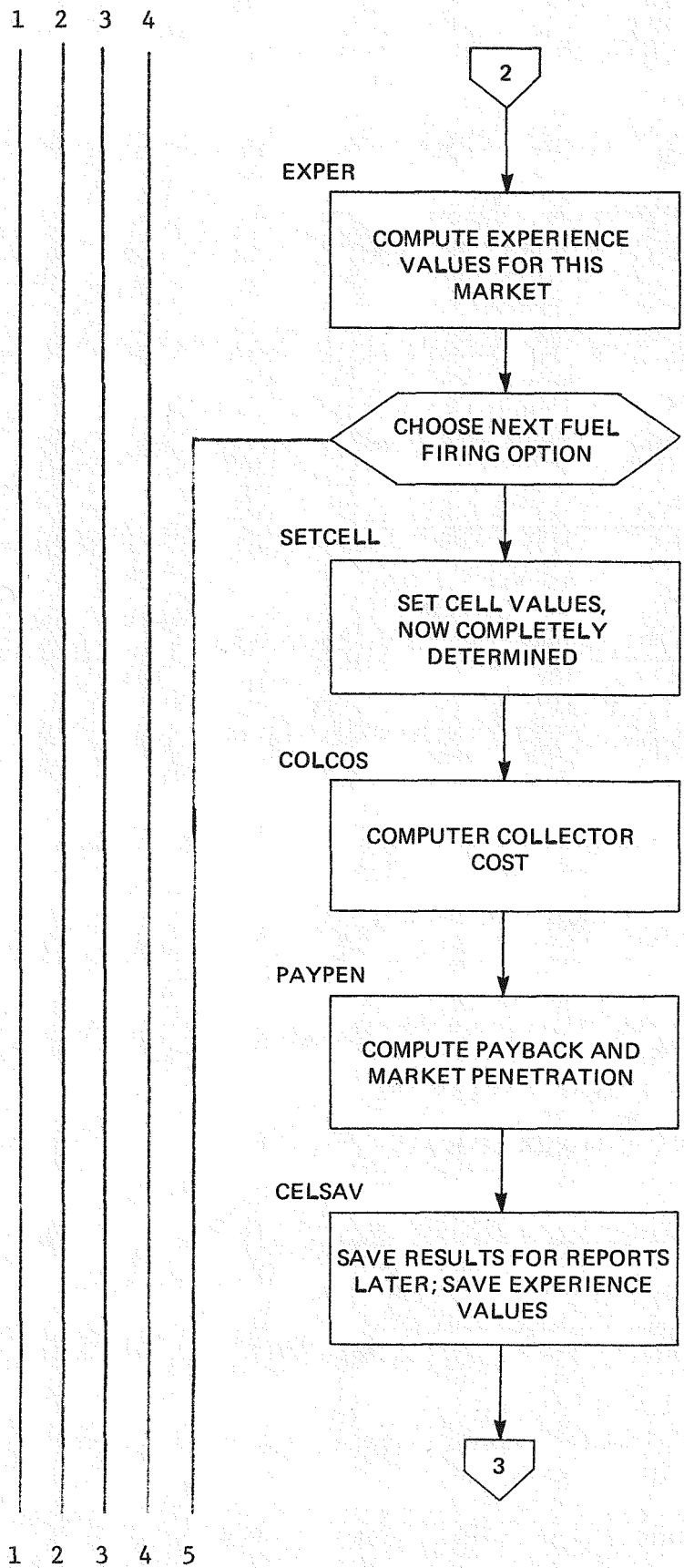
MODEL DOCUMENTATION

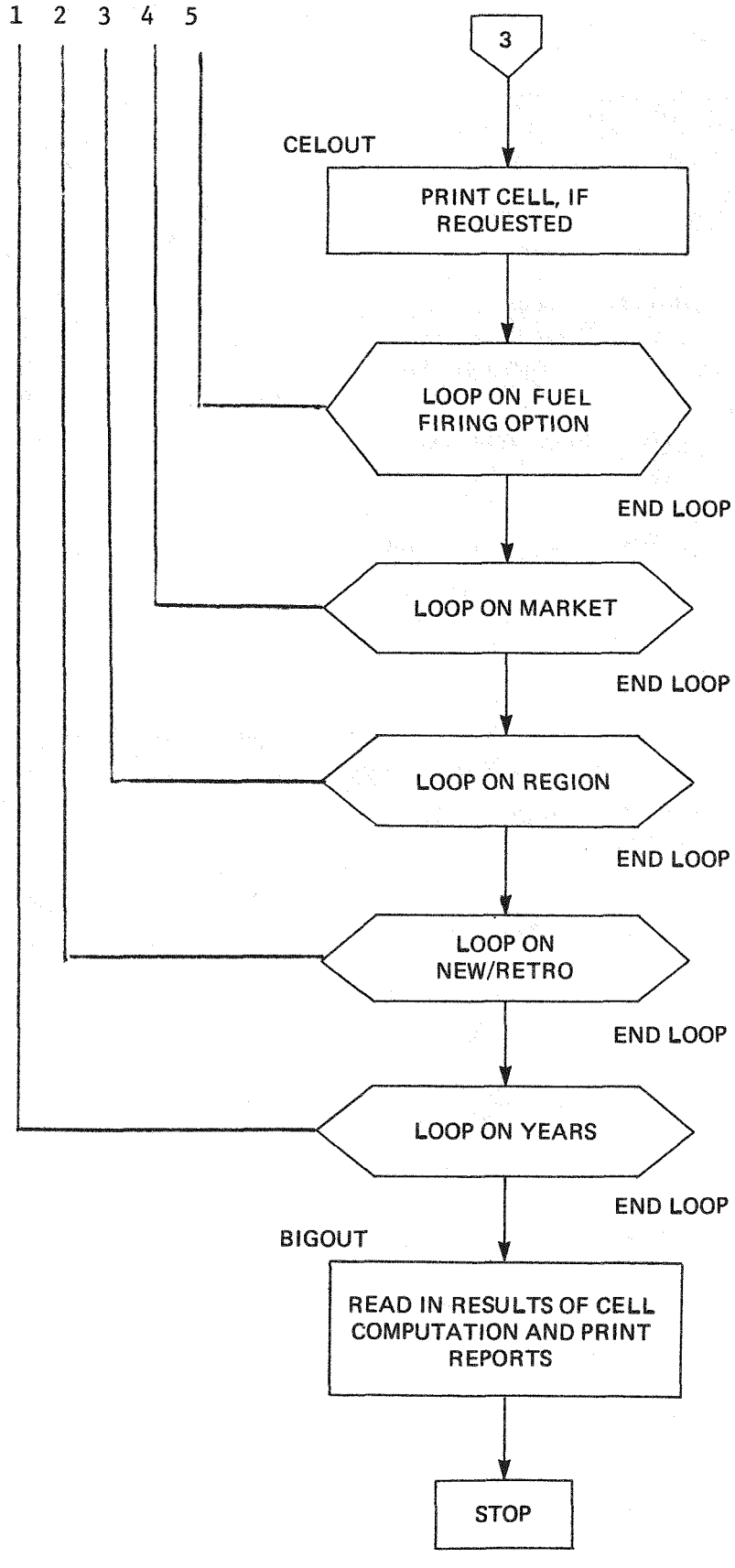
PROGRAM DESCRIPTION

The main program of the SHACOB Commercialization Model is a series of subroutine calls which read input, select cells and cause computations. Results of each cell computation are saved on a scratch file. At the end of the run a final subroutine is called which sums the cell values in different ways to produce different reports. Here is a flowchart of the main program, with each block containing the function of a specific subroutine called and the subroutine name.




1
INITT
INITIALIZE EXPERIENCE ARRAYS
CHOOSE NEXT YEAR REQUESTED
SETANN
UPDATE EXPERIENCE FOR THIS YEAR
CHOOSE NEW OR RETROFIT
CHOOSE NEXT REGION
SETREG
EXTRACT DATA STORED BY REGION, FOR EASY ACCESS BELOW
CHOOSE NEXT MARKET
2
1 2 3 4


1 2 3 4
2
EXPER
COMPUTE EXPERIENCE VALUES FOR THIS MARKET
CHOOSE NEXT FUEL FIRING OPTION
SETCELL
SET CELL VALUES, NOW COMPLETELY DETERMINED
COLCOS
COMPUTER COLLECTOR COST
PAYPEN
COMPUTE PAYBACK AND MARKET PENETRATION
CELSAV
SAVE RESULTS FOR REPORTS LATER; SAVE EXPERIENCE VALUES
3
1 2 3 4 5


1 2 3 4 5
3
CELOUT
PRINT CELL, IF REQUESTED
LOOP ON FUEL FIRING OPTION
END LOOP
LOOP ON MARKET
END LOOP
LOOP ON REGION
END LOOP
LOOP ON NEW/RETRO
END LOOP
LOOP ON YEARS
END LOOP
BIGOUT
READ IN RESULTS OF CELL COMPUTATION AND PRINT REPORTS
STOP

Each subroutine named in the flow diagram is described in the following pages. Additionally, two auxillary subroutines, INCENT (compute incentives for a cell) and PENE (look up in penetration tables) are documented.

SUBROUTINE RUNSET

Purpose:	To read run requests for cells.
Calling Sequence:	CALL RUNSET (IERR, IEND)
Input:	File containing enumeration of years, regions, markets, etc. to run
Output:	Requests are stored in COMMON/LOOPS/ IERR = 1 if input is incorrect IEND = 1 if no input is present
Description:	RUNSET counts the years, regions requested, checks for valid input values, and prepared the arrays in COMMON/LOOPS/. When RUNSET finishes, the main program loops are ready to run.
Subroutines Called:	None

SUBROUTINE BULKIN

Purpose:	Read data base.
Calling Sequence:	CALL BULKIN (IERR)
Input:	Data base on FORTRAN unit 1
Output:	Data stored in COMMON/BASE n/ IERR = 1 if data contained errors
Description:	See description of data base.
Subroutines Called:	None

SUBROUTINE INEXP

Purpose:	Read experience data.
Calling Sequence:	CALL INEXP (IERR)
Input:	Experience data on FORTRAN unit 4
Output:	Data is stored in COMMON/EXP n/ IERR = 1 if the data contained errors
Description:	See description of experience data file.
Subroutines Called:	None

SUBROUTINE USERIN

Purpose:	To read incentive plan data.
Calling Sequence:	CALL USERIN (IERR)
Input:	Incentive plan inputs on FORTRAN Unit 5
Output:	Data stored in COMMON/INCENT/ IERR = 1 if data contained errors
Description:	See description of incentive input file.
Subroutines Called:	None

SUBROUTINE INITT

Purpose:	To initialize production variables.
Calling Sequence:	CALL INITT
Input:	None
Output:	Arrays in COMMON/EXPZ/ are set to starting values.
Description:	N/A
Subroutines Called:	None

SUBROUTINE SETANN

Purpose:	To set experience values for the current year
Calling Sequence:	CALL SETANN
Input:	COMMON/EXP1/,/EXPZ/ contain initial and cumulative production values.
Output:	Same COMMONS are updated.
Description:	Cumulative experience is summed. Government building incentive is added in. Values are sealed up for partial runs.
Subroutines Called:	None

SUBROUTINE SETREG

Purpose:	To extract data from data base COMMONS
Calling Sequence:	CALL SETREG
Input:	COMMON/BASE1/,/BASE2/, etc. contain data as read in by input routines
Output:	COMMON/INTER1/,/INTER2/ contain data extracted from base data for the current year and region.
Description:	SETREG exists to speed up the program by performing whatever computations can be performed at the region-loop level in the program. Fuel shares, building loads, market sizes, etc. are extracted from the data, scaled where necessary, decline or increase rates are applied, a radiation value is chosen etc. These values are stored in an intermediate common area.
Subroutine Called:	None

SUBROUTINE EXPER

Purpose:	To compute collector cost parameters and penetration curve interpolation factors.
Calling Sequence:	CALL EXPER
Input:	COMMON/EXP1/,/EXP2/,/EXP3/ contain current production figures
Output:	Collector cost parameters, etc. in COMMON/CELL1/.
Description:	This subroutine is called at the market-loop level of the program. For a description of the computations involved in collector cost parameters and penetration curve interpolation see Volume II.
Subroutines Called:	None

SUBROUTINE SETCEL

Purpose:	To set all input values for a specific cell.
Calling Sequence:	CALL SETCEL
Input:	Intermediate COMMONS, data base COMMONS, and COMMON/LOOPS/.
Output:	Values in COMMON/CELL1/are set.
Description:	This routine essentially defines the current cell by completing all the values which constitute input to the actual evaluation of the cell. All values in COMMON/CELL1/ are completed by this routine.
Subroutines Called:	None

SUBROUTINE COLCOS

Purpose:	To compute the cost of a solar system.
Calling Sequence:	CALL COLCOS
Input:	COMMON/CELL1/,/INCENT/
Output:	Values in COMMON/CELL2/. Collector cost.
Description:	COLCOS uses building loads and collector efficiencies to size a collector for the current cell, then computes collector system cost and energy cost savings. Incentives are applied to the first cost to arrive at an adjusted first cost for the cell's solar system.
Subroutines Called:	INCENT

SUBROUTINE PAYPEN

Purpose:	To calculate market penetration.
Calling Sequence:	CALL PAYPEN
Input:	Calues in COMMON/CELL1/,/CELL2/
Output:	Payback and penetration values in COMMON/CELL2/
Description:	Using adjusted first cost from subroutine COLCOS, this routine computes the payback period for the solar device, computes an adjusted payback based on non-financial utility factors and applies the penetration logic to the adjusted payback in computing the market penetration for the current cell.
Subroutines Called:	PENE

FUNCTION INCENT

Purpose:	To compute applicable incentives
Calling Sequence:	X = INCENT (FC, GC)
Input:	FC first cost of current cell. Incentive plans in COMMON/ INCENT/
Output:	Function value is set to incentive value. GC is set to government cost of incentives for this cell.
Description:	All current incentives which apply to the current cell are computed and the function value is set to the total of all incentive reductions of first cost.
Subroutines Called:	None

FUNCTION PENE

Purpose:	To perform penetration table lookups.
Calling Sequence:	X = PENE (ITBL, PB)
Input:	ITBL = penetration table number of table to be used. PB = payback to look up COMMON/TABLES/ contains penetration tables
Output:	Function value is set.
Description:	Given a stored penetration table to use and a payback to lookup, the function value is set to the penetration for that payback. Values between entries are linearly interpolated. For payback values which exceed the table entries, the last table entry is used.
Subroutines Called:	None

SUBROUTINE CELSAV

Purpose: To make final accumulations for current cell.

Calling Sequence: CALL CELSAV

Input: COMMON/CELL1/,/CELL2/

Output: COMMON/EXP1/,/EXP2/,/CELL2/

Description: The last computations are made for a cell. Given penetration, the number of units produced is computed. Energy saved is computed. Production experience for the next year is increased by the number of units for this cell.

The values computed for this cell are output to a temporary file for later report generation. (See Subroutine BIGOUT).

Subroutines Called: None

SUBROUTINE CELOUT

Purpose: To print current cell values

Calling Sequence: CALL CELOUT

Input: COMMON/CELL1/,/CELL2/ and print flags

Output: Printed values for all.

Description: CELOUT is a diagnostic subroutine used to generate extremely detailed printouts of the progress of the program, The output from this subroutine is to voluminous to be used for normal runs.

Subroutines Called: None

SUBROUTINE BIGOUT

Purpose:	To print reports at the end of a run
Calling Sequence:	CALL BIGOUT
Input:	Run results on temporary file. User report requests on FORTRAN unit 5
Output:	Printed reports
Description:	Reports are printed which accumulate the run results by year, by market and by region. For a more complete description of these printouts, see the section Output Report Description.
Subroutines Called:	None

FILES

The data read by the program is voluminous, and is contained in three separate disk files. The first file contains relatively un-changing input, related to building inventory, construction projections, collector efficiencies, fuel prices, etc. The second file contains relatively changeable input related to experience functions, penetration curves and collector cost parameters. The third file contains the user's run requests in the form of lists of years, regions, markets, and fuel firing options to be run and the incentive plans to be considered. What follows lists, in order, the contents of each of these three files.

Relatively Un-changing Data-Base File

- *Building Classes and Market Functions* (by market)

  Building inventory and new construction inputs are given in 15 different building types. These are combined internally to form 6 building classes. From these 6 classes, 10 building markets are defined as fractions of the 6 classes. This input defines which building types are run to form which classes, and what fractions are to be used as markets.

- *Number of Buildings per Unit of Input* (by market)

  Residential buildings are input in thousands of building units and commercial buildings are input as millions of square feet. For each building market, this input defines a single building unit as a fraction of an input unit.

- *Retirement Rate for Inventory Buildings* (by building class, by region)

  Each year, the building inventory (retrofit market) is reduced by this number of buildings.

- *Inventory of Buildings Through 1976* (by region, by building type)

  Number of buildings extant in 1976 which represent the retrofit market.

- *Fuel Shares for Existing Inventory* (by fuel, by building class)

  The fraction of buildings in each class using gas, oil, or electric for hot water and space heating.

- *New Building Construction, National* (by year, by building type)

  Building construction has been estimated on a national basis for every year of the modeled time period, for every building type.

- *New Building Construction, Regional* (by year, by region, by building class)

  Building construction has been estimated on a regional basis for the years 1977, 1980, 1985, and 1990, for each region for each building class. The program internally interpolates from these numbers to estimate regional building construction during remaining years.

- *Fuel Shares for New Construction* (by fuel, by building class, by region)

  Fuel shares (see fuel shares for inventory) projected for new construction consist of fuel shares for 1977 and a rate-of-change factor which expresses the increase or decrease of each fuel share in succeeding years.

- *Building Loads for Existing Inventory* (for space heat, hot water, and air conditioning, by region, by building class)

  This input contains a space heating load for gas, oil, and electric fired buildings, a cooling load and the percent of buildings which are air conditioned and the percent of buildings which have heat pumps. The program computes the national figures from the regional. Also given for each load is a rate of change for succeeding years.

- *Building Loads for New Construction*

  This input has the same form and meaning as Building Loads for Existing Inventory.

- *Fuel Prices* (by residential/commercial, by fuel type, by year, by region)

  For residential and commercial applications, the prices of gas, oil and electricity are projected over the study period for every region. The first two cards of this input assign residential or commercial prices to each of the building markets.

- *Fuel Firing Efficiencies* (by fuel option)

  Efficiency in usage of gas for heat, oil for heat, electricity for heat, electricity for air conditioning, heat pumps for heat and heat pumps for air conditioning.

- *Incident Solar Radiation* (by region)

  The average annual Btu's falling on a square foot of collector.

- *Collector Efficiencies for New Construction*

  Same as for Inventory

- *Load to be Assumed by Solar* (by device)

  Throughout the program solar collectors will be sized according to the fraction of a particular building load they are to handle. This input specifies the fraction of hot water, space heat and cooling load which all devices will assume.

Relatively Changeable Modeling Parameters File

Each of the following inputs requires more than a couple of sentences to describe. The reader is referred to the section of Volume II describing these values. The titles given below for each section of this input file are more or less self-explanatory.

- *Penetration Tables* (payback-penetration, by table)

- *Penetration Table Assignments*

  Each building market has an initial and a final penetration curve associated with it using this input.

- *Non-Financial Utilities* (by market, by device, for initial and final penetration curves)

- *Weighting of Non-Financial Utility* (by year, by device)

- *Experience Co-efficients* (by device)

  See Volume II for A, B, G, L, and KM

- *Production, Installation and Penetration*

  Initializing values of collector production and market penetration for the experience functions.

- *Government Building Incentive* (by device)

  An incentive plan that operates directly on the program's experience computations.

- *Experience Multiplier for Partial Runs*

  When running less than all regions, collectors produced are multiplied by this number to compensate for missing regions.

- *Collector Costs*

  See Volume II

- *Fractional Increment of Retrofit Costs* (by device)

  The cost of any retrofit installation is increased over the cost of a new installation by this fraction.

- *Constant Factor of Fuel Prices* (by year, by fuel)

  Fuel price scenarios can be input by multiplying the DATA BASE fuel prices by these values.

Run Requests and Incentives File

- *Cell Selection*

  The user gives the years, regions, markets and fuel firing options to be used in the current run.

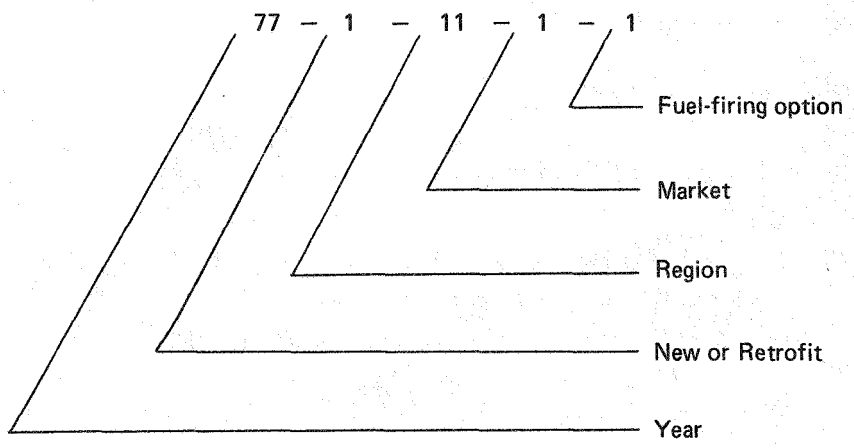
- *Incentive Plans*

  Incentive plans are specified by giving the type of plan (tax credit, low interest loan, etc.), the years during which the plan is effective and the rates or percentages associated with the plan.

DESCRIPTION OF CELL LOGIC AND VARIABLES

Each one of as many as 58,500 cell calculations is labeled with a cell identification.

Cell Identification:



Year: 1977 = "77" 1990 = "90"

New or Retrofit: New = 1
Retrofit = 2

Region: FEA Regions = 1-10
National = 11

Market: Residential Market 1-5
Commercial Markets 6-10

Fuel-firing Option:

Gas heating – no A/C = 1	Fuel = 1	A/C = F
Oil heating – no A/C = 2	Fuel = 2	A/C = F
Electric heating – no A/C = 3	Fuel = 3	A/C = F
Gas heating – with A/C = 4	Fuel = 1	A/C = T
Oil heating – with A/C = 5	Fuel = 2	A/C = T
Electric heating – with A/C = 6	Fuel = 3	A/C = T
Electric heat pump – with A/C = 7	Fuel = 3	H/P = T

For all other cell variables the data is reported in triplet; i.e., three numbers which correspond to:

(1) hot water only
(2) hot water and space heating
(3) hot water, space heating and space cooling

BLOAD = the building load in million Btu/year associated with each building. It is regionalized from national data and decrease by a fixed percentage each year.

LOADP(J) = Percent of the energy load which is saved by solar energy for each solar device, J = 1, 2, 3.

SQFT(J) = Average design size of the solar device in square feet, J = 1, 2, 3.

EFF(J,I) = Solar device efficiencies. Each solar device (hot water; hot water and heating; hot water, heating and space cooling) has either one, two, or three efficiencies associated with it. Total square feet of collector is equal to the thermal load to be saved divided by the product of solar efficiency EFF and indent radiation RADIAT. J = 1, 2, 3; I = 1, 2, 3 (fuel use type)

FUELPH = Fuel price for heating (hot water and space) in 1975 $/MMBtu

FUELPA = Fuel price for space cooling in 1975 $/MMBtu

FFEFF(J) = Fuel firing efficiency, J = 1, 2, 3

$$\text{ACTUAL BUILDING LOAD FOR DEVICE J} = \frac{\text{BLØAD(J)}}{\text{FFEFF(J)}} \quad \text{Device J}$$

IPTBL = ASSIGNED PENETRATION TABLES
IPTBL = 3, 4 implies that Table 3 represents the "initial" penetration curve and Table 4 represents the "final" penetration curve.

MU = μ = weighting between the "initial" and final penetration curves. MU = 1.0 implies full weighting on the initial curve; MU = implies full weighting on the final curve.

$$PENE(EXP_{TOTAL}, APB) = \mu(EXP_{TOTAL}) * PENE_{INITIAL}(APB) + (1-\mu) * PENE_{FINAL}(APB)$$

MU is a function of the appropriate experience level in each cell execution.

RADIAT = incident solar radiation (see EFF)

UTIL(J) = Value of the non-financial utility rating for each device; there are two values, one for the "initial" curve and one for the "final" curve. The UTIL is used to adjust the payback value PB to APB, J = 1, 2, 3.

$$\text{Adjust Payback} = APB = \frac{W_{PB}}{\frac{W_{PB}}{PB} + \left(1 - W_{PB}\right) * UTIL * 0.1}$$

Note: when UTIL = 0.0, APB = PB.

W(J) = Weighting between financial (payback) and non-financial (UTIL) characteristics of each device; J = 1, 2, 3.

COSTA(J) = Constant cost factor for solar energy device per square foot cost; J = 1, 2, 3.

COSTB(J) = Area-related cost factor for solar energy device per square foot cost; J = 1, 2, 3.

COSTN(J) = Exponential cost factor for solar energy device per square foot cost, J = 1, 2, 3.

$$C_{SF} = \text{COST/SQ FT} = C_A + C_B\ (SF)\ C_N$$

where:

C_{SF} = unit cost in $ per square foot;
C_A = production cost component;
C_E = installation cost component;
S_F = size of unit in square feet; and
C_N = installation cost exponent.

OCS(J) = Operating cost saving associated with use of the solar energy devices. Equal to the amount of energy saved annually, times the price of energy, J = 1, 2, 3.

FC(J) = Device first cost; equal to the cost per square foot, CPSQFT, times the device size in square feet, SQFT, J = 1, 2, 3.

ADJFC(J) = Device effective first cost to the purchaser after all economic incentives have been applied. Each incentive reduces the device first cost to fraction of its full first cost, FC; J = 1, 2, 3.

PB(J) = Device payback characteristic (in years); equal to ADJFC divided by the OCS; J = 1, 2, 3.

$$PB(J) = \frac{ADJFC(J)}{OCS(J)} \qquad J = \text{Device index } 1, 2, 3.$$

PVEC(J) = Vector of penetration percentages associated with each of the three devices. The PVEC(J) values sum to the total amount of penetration experience in each cell of the model calculation; J = 1, 2, 3.

NUNIT(J) = Number of units of each type of solar device which are selected for installation in each cell calculation. Derived by multiplying the effective market size, MSIZE by the PVEC percentage; J = 1, 2, 3.

NRG(J) = Total amount of energy saved by installed solar devices in MM Btu/year; J = 1, 2, 3.

MSIZE = Total effective market size in units. The MSIZE is determined from regional figures which are developed for each fuel firing option by breakdown of fuel use.

PCTAC = Percent of units within each fuel type (gas, oil, electricity) which would have space cooling.

PCTHP = Percent of units would be heated and cooled by a heat pump.

GCI(J) = Government cost associated with all financial incentives placed upon the purchase and installation of a solar device for building heating and cooling; J = 1, 2, 3.

BSAV(J, IFUEL) = Amount of fuel savings (MM Btu/year) saved by the installed solar units.

IFUEL = 1 gas
IFUEL = 2 oil
IFUEL = 3 electricity

J = 1, 2, 3.

APB(J) = Adjusted payback, after adjustment through the utility valve UTIL for the "initial" device rating, J = 1, 2, 3.

APB2(J) = Adjusted payback, after adjustment through the utility valve UTIL for the "final" device rating, J = 1, 2, 3.

CPSQFT(J) = Cost per square foot of collector installed; J = 1, 2, 3.

OTHER SYSTEM VARIABLES

Building, Market and Construction Variables

PINV(IBUILDING, IREGION) = Pre '77 inventory by building type, and region, number of units. IBUILDING = 1,6; IREGION = 1, 11.

PSHR(IFUEL, IBUILDING, IREGION) = Pre '77 fuel shares by fuel type, building type and region.

PBTU(ILOAD, IBUILDING, IREGION) = Pre-1977 annual Btu loads by building type, region and fuel firing option.

(1) Heating load – gas fired
(2) Heating load – oil fired
(3) Heating load – electric fired
(4) Hot water load – same as space heating
(5) Cooling load

PRAT(ILOAD, IBUILDING, IREGION) = Percent change in Pre'77 building load.

PAC(IBUILDING, IREGION) = Pre'77 percent air cooling by region.

PRET(IBUILDING, IREGION) = Number of buildings retired each year.

PCTV = Fraction of inventory available as part of the retrofit market each year.

NCON(IBUILDING, IREGION, IYEAR) = New construction (in units for residential and 10^6 S.F. for commercial buildings)

NSHR(JFUEL, IBUILDING, IREGION) = New construction fuel shares

NBTU(ILOAD, IBUILDING, IREGION) = Annual new construction building load (MMBtu/year)

NAC(IBUILDING, IREGION) = Percent new construction air conditioning.

NRAT(ILOAD, IBUILDING, IREGION) = New building load percent change per year.

F$(IFUEL, ITYPE, IREGION, IYEAR) = Fuel cost ($ per MMBtu)
ITYPE = 1 Retail cost
ITYPE = 2 Wholesale cost

KPR(IBUILDING) = Assignment of fuel types for markets
1 ⇒ retail
2 ⇒ wholesale

MKET(IBUILDING) = Market class (1-6) from which IBUILDING = 1, 10 comes.

MPCT(IBUILDING) = Percent building type which comprises building market.

IPFT = Collector sizing option
1 size collect (percent fixed)
sizing option 2 size load (size fixed)

FEF(ILOAD) = Fuel firing efficiencies.
1 = gas – heat
2 = oil – heat
3 = electric – heat
4 = electric – cool
5 = HP_e – heat
6 = HP_e – cool

INSOL(IREGION) = Average annual solar radiation.

CONTROL VARIABLES

Running

YEARS(IYEAR) = Year to run
1 ⇒ run
0 ⇒ do not run

NYR = Number of year to run

KYR = Initial year

REGION(IREGION) = Region to run
1 ⇒ run
0 ⇒ do not run

BLDMKT(IBUILDING) = Building market to run
1 ⇒ run
0 ⇒ do not run

NEWRET = 1 ⇒ new construction
2 ⇒ retrofit

FUELF(ILOAD) = Fuel-firing option to run
1 ⇒ run
0 ⇒ do not run

LHP = 0 no heat pump
1 with heat pump

INCENTIVES

VAL(IVALUE, IPLAN) = Up to six parameter values
IVALUE = 1, 6 for each of each plan
IPLAN = 1, 20.

SPAN(IYEARS, IPLAN) = START(IYEARS = 1) and END(IYEARS = 2) years for each plan, IPLAN = 1, 20.

TYPLN(IPLAN) = Incentive plan type

MPLAN = Maximum number of plans permitted

NPLAN = Maximum number of plans actually used in the computer run

LREG(IREGION, IPLAN) = 1 ⇒ applies to region
0 ⇒ does not apply to region

LMKT(IBUILDING, IPLAN) = 1 ⇒ applies to building market
0 ⇒ does not apply to building market.

OUTPUT REPORT DESCRIPTION

Reports generated from the SHACOB Commercialization Model display units sold, cost estimates, and fuel savings for each device by year, region, and building type. The Year Report is automatically generated while the Region and Building type reports can be controlled by the user. Obviously, the reports can cover only those years, regions, building types, devices, etc., that are executed in the model. Each execution of the model produces a report for each year, both actual and cumulative, for new construction, retrofit, and the combination of the two if desired.

At the discretion of the user, requests for regional and building type reports can be made for any of the years within the model run. Within each of these two reports the user can control whether or not these reports will be produced for the New, Retrofit, or the combination of New and Retrofit. If, for any reason, the user instructs the model to generate a report for a market where data is unavailable, the model will override the request for that report and continue to generate any remaining and valid report requests. Request for these reports is controlled from prepared inputs in the *USER* file (see *USER* file for the formats and inputs used to control reports). Samples of reports are displayed in the attached Tables A-1 through A-4.

Each of the three reports: Year, Region and Building type are identical in format except for the elements on the horizontal axis. The yearly report displays each year beginning with 1977 and ends with 1990. The Region report displays each of the ten FEA regions and the USA as the eleventh category. Execution of *USA* must be run independently from the regional execution. The Building type report displays each of the ten building types hardwired into the model. The first five building types are considered Residential and the remaining five are considered Commercial. Likewise, the penetrations are broken down for Commercial and Residential markets.

Preliminary to the reports described above are the display of input assumptions and controls that were used to prepare these reports.

TABLE A-1

SOLAR IMPACT MODEL

S O L A R I M P A C T M O D E L
NATIONAL ENERGY PLAN 1 SEPT 77
ANNUAL DATA - NEW

		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	(MW)	10.3	25.3	45.0	65.0	92.3	113.2	137.6	153.6	112.2	120.5	125.9	133.2	139.4	146.6
SOLAR UNITS	(MMW)	5.9	11.7	21.9	37.6	60.1	78.9	100.9	117.8	102.0	111.5	116.6	122.4	127.4	133.1
(000 UNITS)	(MC)	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	(ALL)	16.2	37.1	67.0	102.8	152.5	192.3	238.7	271.7	214.4	232.2	242.8	255.8	267.1	279.9
COMMERCIAL	(MW)	0.2	0.5	0.7	1.1	1.4	1.8	1.9	2.1	2.3	2.6	2.8	3.0	3.3	3.6
SOLAR UNITS	(MMW)	0.1	0.1	0.2	0.3	0.5	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.4
(000 UNITS)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.3	0.6	0.9	1.4	1.9	2.5	2.7	3.0	3.3	3.6	3.9	4.3	4.7	5.0
PENETRATION	(MW)	0.49	1.37	2.70	3.28	4.57	5.49	6.55	7.18	5.15	5.43	5.60	5.82	6.01	6.21
RESIDENTIAL	(MMW)	0.28	0.63	1.31	1.89	2.97	3.83	4.81	5.51	4.68	5.02	5.18	5.34	5.49	5.64
(PCT)	(MC)	0.0	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(ALL)	0.77	2.01	4.01	5.18	7.55	9.34	11.37	12.69	9.83	10.46	10.79	11.17	11.51	11.86
PENETRATION	(MW)	0.70	1.61	2.36	3.60	4.59	5.67	5.88	6.38	6.86	7.42	7.89	8.48	9.07	9.63
COMMERCIAL	(MMW)	0.27	0.43	0.72	1.11	1.53	2.10	2.33	2.65	2.94	3.18	3.34	3.53	3.71	3.89
(PCT)	(MC)	0.0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(ALL)	0.97	2.04	3.08	4.71	6.13	7.78	8.22	9.04	9.80	10.60	11.24	12.01	12.79	13.53
COLLECTOR	(MW)	0.5	1.2	2.1	2.8	3.9	4.6	5.4	5.8	4.3	4.5	4.6	4.8	4.9	5.0
SOLD	(MMW)	1.2	2.3	4.1	6.5	10.0	12.7	15.6	17.5	15.0	16.0	16.2	16.5	16.7	16.9
(MIL SQ FT)	(MC)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	(ALL)	1.8	3.5	6.2	9.4	13.9	17.4	21.0	23.5	19.4	20.5	20.9	21.4	21.7	22.1
PVT DOLLARS	(MW)	21.5	34.2	51.2	69.9	87.0	101.1	113.9	120.5	110.3	116.9	120.7	125.8	129.8	134.5
INVESTED	(MMW)	36.4	50.4	80.5	122.9	171.9	211.9	250.6	274.9	275.3	294.1	300.6	308.4	314.0	320.3
(MIL $ $)	(MC)	0.0	0.3	1.1	1.9	2.5	3.0	3.3	3.6	3.1	3.3	3.3	3.4	3.4	3.4
	(ALL)	57.9	84.8	132.8	194.7	261.4	315.9	367.9	398.9	388.7	414.3	424.5	437.5	447.2	458.2
GOV COST OF	(MW)	0.0	14.6	23.2	22.4	28.8	26.9	30.3	32.5	0.5	0.6	0.6	0.7	0.7	0.8
FIN INCENT	(MMW)	0.0	16.6	27.4	31.5	44.5	42.0	48.0	53.3	1.7	1.8	1.8	1.9	2.0	2.1
(MIL $ $)	(MC)	0.0	0.0	0.2	0.3	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.0	31.3	50.8	54.2	73.6	69.3	78.6	86.1	2.2	2.4	2.5	2.6	2.7	2.8
BTU S SAVED	(MW)	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
GAS	(MMW)	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6
BTU S SAVED	(MW)	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.5
OIL	(MMW)	0.1	0.1	0.2	0.3	0.4	0.6	0.8	0.9	0.8	0.9	1.0	1.0	1.1	1.2
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.1	0.2	0.3	0.4	0.7	0.9	1.1	1.3	1.2	1.3	1.4	1.5	1.5	1.6
BTU S SAVED	(MW)	0.1	0.3	0.6	0.8	1.1	1.3	1.5	1.7	1.2	1.3	1.3	1.3	1.3	1.4
ELECTRIC	(MMW)	0.3	0.5	0.8	1.3	2.1	2.6	3.2	3.6	3.0	3.2	3.3	3.3	3.4	3.4
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.4	0.8	1.4	2.2	3.2	3.9	4.7	5.3	4.2	4.5	4.6	4.7	4.7	4.8
BTU S SAVED	(MW)	0.2	0.4	0.7	1.0	1.4	1.7	2.0	2.2	1.6	1.7	1.8	1.9	2.0	2.0
TOTAL	(MMW)	0.3	0.6	1.1	1.7	2.6	3.4	4.2	4.8	4.2	4.5	4.6	4.7	4.9	5.0
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.5	1.0	1.8	2.7	4.0	5.1	6.2	7.0	5.8	6.2	6.4	6.6	6.8	7.0

TABLE A-2

SOLAR IMPACT MODEL

S O L A R I M P A C T M O D E L
NATIONAL ENERGY PLAN 1 SEPT 77
CUMULATIVE DATA = N/R

		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	(MW)	38.1	129.9	281.4	488.7	787.0	1149.3	1590.4	2074.2	2450.4	2860.0	3290.6	3744.5	4218.8	4726.9
SOLAR UNITS	(MWW)	7.5	26.4	66.5	135.2	245.7	394.4	586.8	812.9	1013.1	1232.0	1461.7	1703.2	1956.2	2221.6
(000 UNITS)	(MC)	0.0	0.0	0.1	0.3	0.5	0.7	1.0	1.3	1.5	1.7	2.0	2.2	2.4	2.7
	(ALL)	45.6	156.3	348.0	624.2	1033.2	1544.4	2178.1	2888.4	3464.9	4093.7	4754.2	5450.0	6177.5	6951.2
COMMERCIAL	(MW)	0.7	2.1	4.1	7.1	11.1	16.1	21.4	27.2	33.6	40.6	48.0	56.0	64.5	73.8
SOLAR UNITS	(MWW)	0.2	0.4	0.9	1.7	2.8	4.3	6.1	8.1	10.3	12.8	15.4	18.1	21.0	24.1
(000 UNITS)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.8	2.5	5.0	8.8	13.9	20.4	27.5	35.3	43.9	53.3	63.4	74.1	85.6	97.9
PENETRATION	(MW)	0.42	0.73	1.07	1.39	1.79	2.17	2.58	2.94	3.08	3.23	3.38	3.52	3.66	3.81
RESIDENTIAL	(MWW)	0.08	0.15	0.25	0.38	0.56	0.75	0.95	1.15	1.27	1.39	1.50	1.60	1.70	1.79
(PCT)	(MC)	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(ALL)	0.50	0.88	1.32	1.77	2.35	2.92	3.53	4.09	4.36	4.63	4.88	5.13	5.36	5.60
PENETRATION	(MW)	0.62	0.94	1.23	1.61	2.02	2.44	2.79	3.11	3.41	3.71	3.99	4.26	4.54	4.81
COMMERCIAL	(MWW)	0.14	0.19	0.28	0.39	0.51	0.66	0.79	0.92	1.05	1.17	1.28	1.38	1.48	1.57
(PCT)	(MC)	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(ALL)	0.76	1.13	1.51	2.00	2.53	3.10	3.59	4.04	4.46	4.88	5.26	5.64	6.01	6.39
COLLECTOR	(MW)	2.2	7.2	15.1	25.6	40.4	57.9	78.6	100.8	118.2	136.8	155.9	175.8	196.1	217.6
SOLD	(MWW)	1.8	5.9	14.8	29.2	51.5	80.9	117.5	159.2	196.4	236.1	276.7	318.4	361.0	404.7
(MIL SQ FT)	(MC)	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
	(ALL)	4.0	13.1	29.9	54.9	92.0	139.0	196.4	260.4	315.0	373.3	433.2	494.8	557.8	623.0
PVT DOLLARS	(MW)	96.3	249.3	464.5	743.8	1099.7	1509.3	1974.1	2458.6	2924.1	3425.1	3945.6	4487.6	5047.3	5640.8
INVESTED	(MWW)	56.6	160.0	357.7	662.0	1091.8	1638.6	2297.9	3028.7	3778.4	4582.7	5410.4	6263.5	7140.1	8041.4
(MIL $ $)	(MC)	0.0	0.4	1.8	4.3	7.4	11.1	15.1	19.3	22.9	26.6	30.4	34.2	38.2	42.2
	(ALL)	152.9	409.6	824.0	1410.1	2198.9	3159.0	4287.1	5506.6	6725.3	8034.4	9386.3	10785.4	12225.6	13724.5
GOV COST OF	(MW)	0.0	61.3	151.2	235.6	346.1	447.9	563.4	685.9	687.7	689.5	691.4	693.5	695.6	697.9
FIN INCENT	(MWW)	0.0	29.5	88.1	158.9	260.3	358.7	471.6	598.2	603.1	608.4	613.8	619.5	625.3	631.3
(MIL $ $)	(MC)	0.0	0.1	0.3	0.6	1.0	1.4	1.7	2.1	2.1	2.1	2.2	2.2	2.2	2.3
	(ALL)	0.0	90.9	239.6	395.1	607.4	807.9	1036.7	1286.2	1292.8	1300.0	1307.4	1315.2	1323.2	1331.5
BTU S SAVED	(MW)	0.1	0.4	0.8	1.4	2.3	3.3	4.6	6.0	7.3	8.6	10.1	11.6	13.3	15.1
GAS	(MWW)	0.0	0.1	0.4	0.8	1.6	2.6	4.0	5.6	7.2	9.0	10.9	13.0	15.2	17.6
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.1	0.5	1.2	2.3	3.9	5.9	8.6	11.7	14.5	17.6	21.0	24.7	28.5	32.7
BTU S SAVED	(MW)	0.3	1.0	2.1	3.6	5.7	8.2	11.4	14.9	17.5	20.4	23.4	26.7	30.1	33.6
OIL	(MWW)	0.1	0.4	1.3	2.9	5.4	8.8	13.2	18.2	22.9	27.8	32.9	38.1	43.4	48.9
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.4	1.5	3.4	6.5	11.1	17.1	24.6	33.1	40.3	48.2	56.3	64.8	73.5	82.5
BTU S SAVED	(MW)	0.4	1.3	2.9	4.9	7.8	11.1	15.1	19.3	22.4	25.6	28.9	32.3	35.8	39.3
ELECTRIC	(MWW)	0.4	1.1	2.5	4.7	8.1	12.4	17.7	23.8	29.0	34.4	39.9	45.5	51.1	56.9
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
	(ALL)	0.8	2.5	5.4	9.6	15.9	23.6	32.9	43.1	51.4	60.1	68.9	77.9	87.1	96.4
BTU S SAVED	(MW)	0.8	2.8	5.8	9.9	15.7	22.7	31.1	40.1	47.1	54.6	62.4	70.6	79.1	88.0
TOTAL	(MWW)	0.5	1.7	4.2	8.4	15.1	23.9	34.9	47.6	59.0	71.2	83.7	96.6	109.8	123.4
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
	(ALL)	1.3	4.4	10.0	18.4	30.8	46.6	66.0	87.8	106.2	125.9	146.3	167.4	189.1	211.6

TABLE A-3

SOLAR IMPACT MODEL

SOLAR IMPACT MODEL
NATIONAL ENERGY PLAN 1 SEPT 77 (1985)
ANNUAL DATA = N/R

		S/FAM	L/DEN	CONDO	APTS	MOBIL	HH/INST	HH/OTHR	LH/INST	LH/LESR	LH/OOCU
RESIDENTIAL	(MM)	257.4	45.1	6.6	39.7	27.3	0.0	0.0	0.0	0.0	0.0
SOLAR UNITS	(MMM)	130.3	27.8	4.9	25.3	11.8	0.0	0.0	0.0	0.0	0.0
(000 UNITS)	(MC)	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	387.9	73.0	11.5	65.0	39.2	0.0	0.0	0.0	0.0	0.0
COMMERCIAL	(MM)	0.0	0.0	0.0	0.0	0.0	0.2	1.0	1.3	2.7	1.1
SOLAR UNITS	(MMM)	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.5	0.9	0.4
(000 UNITS)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.0	0.0	0.0	0.0	0.0	0.3	1.4	1.8	3.6	1.5
PENETRATION	(MM)	4.72	3.71	4.08	2.89	4.00	0.0	0.0	0.0	0.0	0.0
RESIDENTIAL	(MMM)	2.39	2.29	3.01	1.84	1.73	0.0	0.0	0.0	0.0	0.0
(PCT)	(MC)	0.00	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0
	(ALL)	7.11	6.00	7.09	4.74	5.73	0.0	0.0	0.0	0.0	0.0
PENETRATION	(MM)	0.0	0.0	0.0	0.0	0.0	7.72	7.00	5.72	5.51	5.51
COMMERCIAL	(MMM)	0.0	0.0	0.0	0.0	0.0	2.98	2.51	1.97	1.96	1.91
(PCT)	(MC)	0.0	0.0	0.0	0.0	0.0	0.01	0.00	0.00	0.00	0.00
	(ALL)	0.0	0.0	0.0	0.0	0.0	10.71	9.51	7.69	7.47	7.42
COLLECTOR	(MM)	12.1	1.4	0.2	1.1	0.5	0.7	0.6	0.3	0.3	0.1
SOLD	(MMM)	23.5	3.9	0.3	2.0	1.1	0.9	0.7	2.3	1.7	0.7
(MIL SQ FT)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	35.6	5.3	0.5	3.1	1.6	1.7	1.2	2.6	2.0	0.8
PVT DOLLARS	(MM)	318.2	44.0	5.3	35.0	16.2	15.5	12.9	8.4	7.1	3.0
INVESTED	(MMM)	453.5	78.5	7.2	46.9	28.5	18.9	14.1	50.9	36.4	14.9
(MIL $ $)	(MC)	2.7	0.2	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
	(ALL)	774.4	122.8	12.4	81.9	44.7	34.6	27.1	59.4	43.6	17.9
GOV COST OF	(MM)	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.5	0.2
FIN INCENT	(MMM)	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	2.7	1.1
(MIL $ $)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	3.3	1.3
BTU $ SAVED	(MM)	0.9	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
GAS	(MMM)	0.9	0.2	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	1.9	0.3	0.0	0.2	0.0	0.1	0.1	0.2	0.1	0.0
BTU $ SAVED	(MM)	1.6	0.4	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0
OIL	(MMM)	2.5	0.8	0.1	0.3	0.1	0.1	0.1	0.3	0.2	0.1
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	4.1	1.2	0.1	0.4	0.2	0.2	0.2	0.3	0.3	0.1
BTU $ SAVED	(MM)	1.9	0.4	0.0	0.2	0.1	0.2	0.1	0.1	0.1	0.0
ELECTRIC	(MMM)	3.4	0.7	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	5.4	1.1	0.1	0.4	0.4	0.3	0.2	0.2	0.2	0.1
BTU $ SAVED	(MM)	4.5	0.9	0.1	0.4	0.2	0.3	0.3	0.2	0.1	0.1
TOTAL	(MMM)	6.8	1.7	0.2	0.6	0.4	0.3	0.2	0.6	0.5	0.2
(TRL BTU)	(MC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	11.3	2.6	0.3	1.0	0.6	0.6	0.5	0.7	0.6	0.3

TABLE A-4

SOLAR IMPACT MODEL

S O L A R I M P A C T M O D E L

NATIONAL ENERGY PLAN 1 SEPT 77 (1990)

CUMULATIVE DATA = RETR

		S/FAM	L/DEN	CONDO	APTS	MOBIL	HH/INST	HH/OTHR	LM/INST	LM/LESR	LM/OOCU
RESIDENTIAL	(HH)	2434.5	441.2	24.1	298.8	108.2	0.0	0.0	0.0	0.0	0.0
SOLAR UNITS	(HHW)	747.9	159.0	8.0	132.2	26.7	0.0	0.0	0.0	0.0	0.0
(000 UNITS)	(HC)	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	3182.6	600.2	32.1	431.0	134.9	0.0	0.0	0.0	0.0	0.0
COMMERCIAL	(HH)	0.0	0.0	0.0	0.0	0.0	1.6	6.8	11.4	17.3	7.5
SOLAR UNITS	(HHW)	0.0	0.0	0.0	0.0	0.0	0.5	2.4	3.4	4.8	2.0
(000 UNITS)	(HC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	0.0	0.0	0.0	0.0	0.0	2.0	11.2	14.8	22.1	9.5
PENETRATION	(HH)	4.00	3.24	3.10	2.02	2.42	0.0	0.0	0.0	0.0	0.0
RESIDENTIAL	(HHW)	1.23	1.17	1.03	0.90	0.60	0.0	0.0	0.0	0.0	0.0
(PCT)	(HC)	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	5.22	4.41	4.13	2.92	3.02	0.0	0.0	0.0	0.0	0.0
PENETRATION	(HH)	0.0	0.0	0.0	0.0	0.0	6.59	6.11	4.24	3.90	3.93
COMMERCIAL	(HHW)	0.0	0.0	0.0	0.0	0.0	2.04	1.68	1.28	1.09	1.06
(PCT)	(HC)	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00
	(ALL)	0.0	0.0	0.0	0.0	0.0	8.63	7.79	5.52	4.99	4.99
COLLECTOR	(HH)	120.4	14.9	0.7	8.6	2.4	5.4	5.0	2.8	1.8	0.8
SOLD	(HHW)	150.7	25.4	0.8	13.2	2.6	5.5	4.4	19.2	11.0	4.6
(MIL SQ FT)	(HC)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	271.1	40.3	1.5	21.8	5.0	10.9	9.5	22.0	12.9	5.4
PVT DOLLARS	(HH)	3083.5	434.6	21.7	299.5	75.3	124.3	117.0	77.3	49.2	21.3
INVESTED	(HHW)	3035.9	530.4	18.5	322.4	75.4	128.1	102.5	460.6	251.6	104.1
(MIL $ $)	(HC)	4.6	0.1	0.0	0.0	0.0	0.8	0.8	0.1	0.1	0.1
	(ALL)	6124.0	965.1	40.2	621.9	150.7	253.3	220.3	537.9	301.0	125.4
GOV COST OF	(HH)	415.2	64.2	3.3	0.0	12.0	0.0	13.2	0.0	5.3	2.3
FIN INCENT	(HHW)	254.9	45.9	1.7	0.0	7.2	0.0	10.6	0.0	25.7	10.6
(MIL $ $)	(HC)	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
	(ALL)	670.3	110.2	5.0	0.0	19.2	0.0	23.9	0.0	31.0	12.9
BTU $ SAVED	(HH)	10.4	1.4	0.1	0.8	0.2	0.3	0.2	0.2	0.1	0.1
GAS	(HHW)	9.1	1.6	0.0	0.8	0.1	0.3	0.2	1.3	0.7	0.3
(TRL BTU)	(HC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	19.5	3.0	0.1	1.6	0.4	0.6	0.4	1.5	0.8	0.4
BTU $ SAVED	(HH)	20.0	5.2	0.4	1.1	0.6	0.6	0.6	0.6	0.4	0.2
OIL	(HHW)	22.3	7.0	0.6	2.6	1.0	0.6	0.6	2.3	1.7	0.8
(TRL BTU)	(HC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	42.4	12.1	1.0	3.8	1.6	1.2	1.2	2.9	2.1	0.9
BTU $ SAVED	(HH)	16.9	2.2	0.1	1.1	0.4	1.3	1.2	0.5	0.3	0.1
ELECTRIC	(HHW)	15.8	2.6	0.1	0.8	0.3	0.7	0.7	1.0	0.7	0.3
(TRL BTU)	(HC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	32.7	4.8	0.1	1.9	0.7	2.0	1.9	1.5	1.0	0.4
BTU $ SAVED	(HH)	47.3	8.7	0.5	3.0	1.2	2.1	2.0	1.2	0.8	0.4
TOTAL	(HHW)	47.3	11.2	0.7	4.2	1.4	1.7	1.4	4.6	3.1	1.3
(TRL BTU)	(HC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(ALL)	94.6	19.9	1.2	7.2	2.6	3.7	3.5	5.8	3.9	1.7

APPENDIX B

MAJOR MODEL ASSUMPTIONS

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MAJOR MODEL ASSUMPTIONS

This Appendix will deal with the underlying assumptions and the resulting data base for the SHACOB Commercialization Model. The major assumptions to be covered are the estimates of the United States building stock, the cost and share of the market of conventional energy sources, the energy demand and fuel firing options existent in the U.S. housing stock, and finally the projected costs and efficiencies of the three solar devices investigated in this study.

United States Building Stock

Table B-1 lists the pre-1977 building inventory by type of market and the annual projection for each category through 1990. As described in Volume II, the residential inventory was developed from the *1970 Census of Housing* and the *Annual Housing Survey: 1973* published by the U.S. Census Bureau and the Department of Housing and Urban Development respectively. The projection of residential housing units through 1990 was based in part on work done for FEA/CEQ updated from inputs from Arthur D. Little's in-house input-output economic model. The commercial and institutional inventory and projections are based on Arthur D. Little estimates; the non-residential activities from 1977 through 1990 have been projected using trend analysis techniques, supplemented by judgments regarding the impact of present and possible future events.

In addition to the inventory and the new construction projects, annual removals were estimated for each major building category from 1977 through 1990. These annual removals (in units for residential, and square footage for commercial/institutional) are subtracted from the pre-1977 inventory by the solar model. Post-1976 new construction has not been added to the existing inventory. Table B-2 highlights these annual removals by total national basis.

All of the building stock data for each year was broken down into the 10 FEA regions for inclusion in the model. Pre-1976 residential inventory was broken into the 10 FEA regions using Bureau of Census data and estimates from Arthur D. Little. Residential new construction was apportioned to the 10 regions based upon projections of gross migration trends and other socio-economic factors. For the non-residential markets, the building stock inventory was broken down on a variety of allocation bases, including personal income, population, hospital bed counts. Again, the non-residential building projections were divided into the 10 regions based upon judgments of national distribution for projected construction activity.

Building Characteristics

The SHACOB Model groups buildings into 3 different configurations at different points during its operation. The volume of building stock (either in units or square feet) is fed into the data base in traditional building sectors. These components are then grouped into six building types representing distinct levels of energy requirements. Finally, these six building load types are sub-divided as to type of ownership. Figure B-1 outlines this relationship of building definitions for the three phases of the model operation.

TABLE B-1

NATIONAL BUILDING ACTIVITY ASSUMPTIONS

	Pre-1977 Inventory	New Construction													
		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Residential (000's Units)															
Single Family	49,175	1,207	1,057	1,000	1,055	1,060	1,080	1,095	1,110	1,130	1,145	1,150	1,160	1,165	1,170
Low Density	10,984	201	186	150	205	205	217	230	240	250	260	270	285	300	320
Multi-Family	12,538	392	307	270	400	405	413	415	425	430	440	450	455	460	470
Mobile Home	3,847	300	300	250	325	350	350	360	365	370	375	380	390	395	400
Total Res.	76,544	2,100	1,850	1,670	1,985	2,020	2,060	2,100	2,140	2,180	2,220	2,250	2,290	2,320	2,360
Commercial (MM Sq.Ft.)															
Warehouses	2,431	205	217	209	206	212	218	225	232	239	245	251	257	264	270
Retail	3,327	138	147	141	139	143	147	152	156	161	165	169	174	178	182
Schools	5,426	120	117	111	108	107	106	105	104	103	103	103	103	103	103
Hospitals	1,731	82	87	89	94	96	99	102	105	108	110	112	115	117	120
Offices/Banks	3,155	69	73	71	69	71	73	75	78	80	82	85	87	90	93
Social	1,347	64	67	67	69	70	70	71	72	73	73	74	74	75	76
Government (1)	4,097	49	52	53	54	55	55	56	56	57	57	58	58	59	59
Religious	1,179	35	37	37	37	37	38	38	39	39	39	40	40	40	40
Restaurants	765	32	34	32	32	33	34	35	36	37	38	39	40	41	42
Hotels	850	26	27	25	24	24	25	25	25	26	26	26	27	27	27
Laundries	155	7	7	7	7	7	7	8	8	8	8	9	9	9	10
Total Comm'l.	24,463	827	865	842	839	855	872	892	911	931	946	966	984	1,003	1,022

(1) Federal, State, and Local

Source: Bureau of Census, Department of Housing and Urban Development, and Arthur D. Little, Inc., estimates

TABLE B-2

U.S. ANNUAL BUILDING REMOVALS 1977-1990

(000's Units)				(MM'S Sq. Ft.)	
Single Family	Low Density	Multi-Family	Mobile Homes	Non-Res. High Hot Water	Non-Res. Low Hot Water
180	40	45	45	30	140

Source: Arthur D. Little, Inc., estimates.

The building types outlined in Figure B-1 above represent the major categories of energy demand. The four residential building types are clearly delineable and require little explanation. The composition of the non-residential buildings into two energy requirement types represents a departure from previous energy demand categorizations. Although there are differences in energy demand in all commercial and institutional buildings, the only significant distinction in terms of energy requirement per square foot is between buildings with high hot water requirements and buildings without the high hot water demand.

Theoretical building loads were constructed for each of the six building types, by type of device (space heating, water heating, air conditioning) and broken down into types of energy (gas, oil, electricity). These theoretical building loads represent "at-the-wall" energy requirements which must be divided by fuel firing efficiencies of the three energy sources to ascertain plant production requirements. The following fuel firing efficiencies were used in this model: gas 0.7; oil 0.6; electric heating 1.0; electric air conditioning 2.1; and heat pump heating 1.4-1.6.

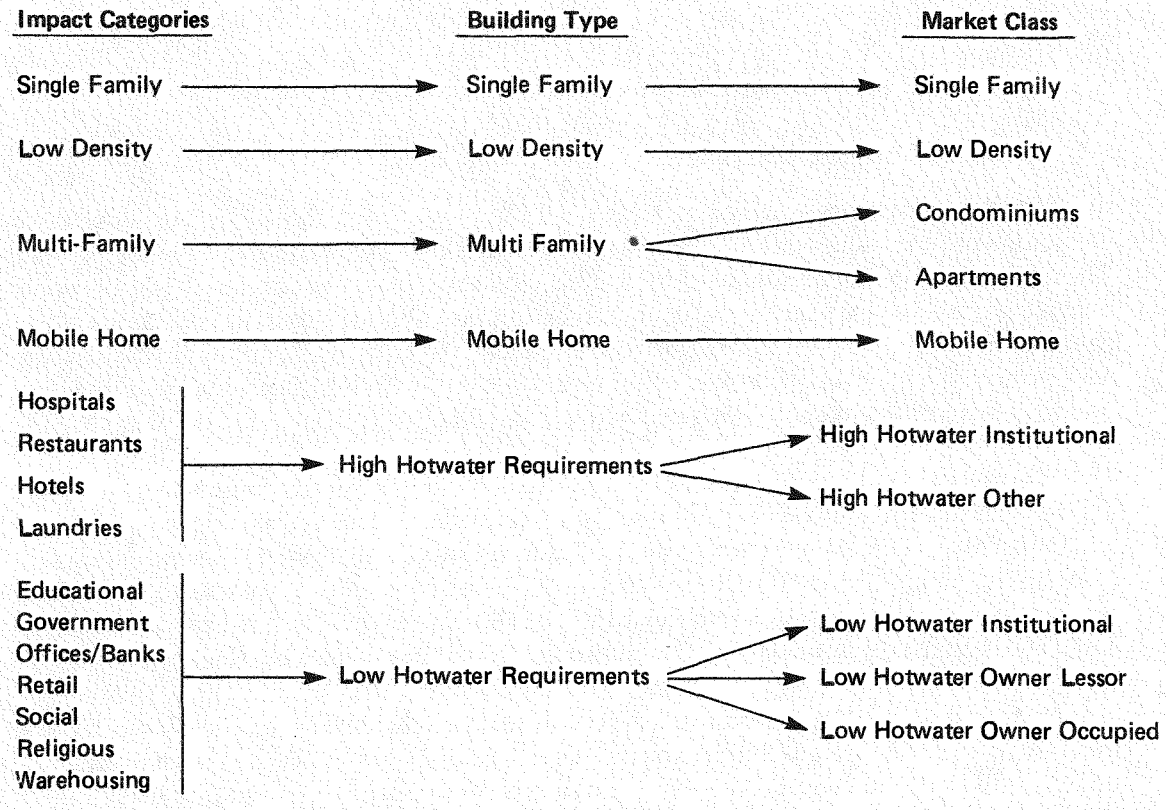
Tables B-3 and B-4 are data print-outs of the model showing building loads for existing inventory and building loads for new construction. The print-out has been labeled to facilitate the understanding of the coding. The decay rates listed for most of the building loads reflect the decrease in energy requirements on an annual basis as the result of greater conservation measures and better construction techniques. The model calculates from the initial building load by this annual decay factor to arrive at specific building loads for any one year.

FUELS

The SHACOB Model assumes that seven fuel firing options exist in the U.S. building stock. Table B-5 outlines these 7 fuel firing options. Fuel Prices were supplied by FEA for inclusion in this project. Tables B-6 through B-15 represent the fuel prices used by year, by region in the data portion of this model.

Fuel shares were also supplied by FEA. Table II-7 in Volume II presented the residential fuel shares by region for the pre-1977 inventory, the 1977 new construction, and the 1990 new construction. Table B-16 is the model data print-out of the fuel shares for both pre-1977 inventory and 1977 new construction. The average annual increase/decrease percentages are used by the model to calculate a particular fuel share in any one year.

Figure B-1. Building Stock Breakdown



Collector Efficiencies and Costs

As described in Volume II, average solar collector efficiencies were calculated for the three solar devices as they pertain to both regions and types of building construction. The annual efficiency of solar water heating tends to be a single-valued function of the solar load and is essentially independent of building type or location. As shown in Table B-17 hot water collector efficiencies for all building types and regions were set at 35%. In space heating and hot water systems, however, the seasonal variation of the heating load causes a considerable spread of variance between building types and regions. For this reason, as shown in Table B-17, collector efficiencies for space heating by the three types of fuel buildings and by regions were calculated. In both of the above collector systems, an increase in efficiencies (due to better manufacturing and installation) have been set at 3.2% annually. Water heating, space heating and cooling systems, on the other hand, have been set at a collector efficiency of 38% (with the exception of low hot water non-residential buildings at 35%) and no percentage increase in efficiency has been assumed.

Collector costs were handled in the model by assuming near-term (present) and growth (future) device cost and installation cost for each system. Table B-18 outlines the values used in the model for this costing function. The growth costs are approached as annual U.S. production of collectors moves toward 80 million square feet per year. These cost elements are for new construction installations only; retrofit costs are determined by inflating the device and installation costs in Table B-18 by 15% for hot water only systems and 25% for the two larger solar systems.

TABLE B-3

BUILDING LOADS – PRE-1977 INVENTORY

(MM BTU's/Unit-Residential
M BTU's/Sq. Ft.-Non-Res.)

	SPACE HEATING						HOT WATER						
Region	GAS	DECAY RATE	OIL	DECAY RATE	ELEC.	DECAY RATE	ALL	DECAY RATE	ELEC.		% A/C		
1	130.0	-1.8	126.0	-1.8	71.0	-1.0	22.0	-0.8	5.0	0.0	27.0	1.0	
2	101.0	-1.8	138.0	-1.8	55.0	-1.0	22.0	-0.8	6.0	0.0	30.0	1.0	
3	94.0	-1.8	127.0	-1.8	51.0	-1.0	22.0	-0.8	7.0	0.0	36.0	1.0	
4	37.0	-0.7	67.0	-0.7	26.0	-0.6	22.0	-0.8	63.0	0.0	48.0	1.0	
5	115.0	-1.8	111.0	-1.8	62.0	-1.0	22.0	-0.8	19.0	0.0	43.0	1.0	
6	36.0	-0.7	66.0	-0.7	26.0	-0.6	22.0	-0.8	70.0	0.0	50.0	1.0	SINGLE
7	99.0	-1.8	95.0	-1.8	53.0	-1.0	22.0	-0.8	19.0	0.0	43.0	1.0	FAMILY
8	125.0	-1.8	121.0	-1.8	68.0	-1.0	22.0	-0.8	17.0	0.0	41.0	1.0	
9	35.0	-0.7	65.0	-0.7	26.0	-0.6	22.0	-0.8	85.0	0.0	50.0	1.0	
10	107.0	-1.8	146.0	-1.8	58.0	-1.0	22.0	-0.8	6.0	0.0	30.0	1.0	
1	96.0	-1.8	93.0	-1.8	50.0	-1.1	15.0	-0.8	5.0	0.0	28.0	1.0	
2	72.0	-1.8	96.0	-1.8	36.0	-1.1	15.0	-0.8	5.0	0.0	31.0	1.0	
3	67.0	-1.8	89.0	-1.8	33.0	-1.1	15.0	-0.8	6.0	0.0	37.0	1.0	
4	26.0	-0.7	46.0	-0.7	18.0	-0.5	15.0	-0.8	36.0	0.0	43.0	1.0	
5	85.0	-1.8	82.0	-1.8	44.0	-1.1	15.0	-0.8	11.0	0.0	34.0	1.0	LOW
6	25.0	-0.7	45.0	-0.7	18.0	-0.5	15.0	-0.8	51.0	0.0	45.0	1.0	DENSITY
7	73.0	-1.8	70.0	-1.8	38.0	-1.1	15.0	-0.8	11.0	0.0	34.0	1.0	
8	92.0	-1.8	89.0	-1.8	48.0	-1.1	15.0	-0.8	10.0	0.0	32.0	1.0	
9	25.0	-0.7	44.0	-0.7	17.0	-0.5	15.0	-0.8	62.0	0.0	45.0	1.0	
10	77.0	-1.8	102.0	-1.8	38.0	-1.1	15.0	-0.8	5.0	0.0	31.0	1.0	
1	55.0	-1.8	54.0	-1.8	26.0	-1.6	13.0	-0.8	4.0	0.0	48.0	1.0	
2	46.0	-1.8	95.0	-1.8	18.0	-1.6	13.0	-0.8	4.0	0.0	53.0	1.0	
3	43.0	-1.8	88.0	-1.8	17.0	-1.6	13.0	-0.8	5.0	0.0	64.0	1.0	
4	14.0	-0.7	25.0	-0.7	9.0	-0.5	13.0	-0.8	34.0	0.0	77.0	1.0	
5	49.0	-1.8	48.0	-1.8	23.0	-1.6	13.0	-0.8	9.0	0.0	67.0	1.0	MULTI-
6	13.0	-0.7	24.0	-0.7	8.0	-0.5	13.0	-0.8	31.0	0.0	81.0	1.0	FAMILY
7	42.0	-1.8	41.0	-1.8	20.0	-1.6	13.0	-0.8	9.0	0.0	67.0	1.0	
8	53.0	-1.8	52.0	-1.8	25.0	-1.6	13.0	-0.8	8.0	0.0	64.0	1.0	
9	13.0	-0.7	24.0	-0.7	8.0	-0.5	13.0	-0.8	38.0	0.0	81.0	1.0	
10	49.0	-1.8	101.0	-1.8	19.0	-1.6	13.0	-0.8	4.0	0.0	53.0	1.0	
1	60.0	-1.6	58.0	-1.6	32.0	-1.6	10.0	-0.8	5.0	0.0	23.0	1.0	
2	47.0	-1.6	64.0	-1.6	26.0	-1.6	10.0	-0.8	6.0	0.0	25.0	1.0	
3	44.0	-1.6	59.0	-1.6	24.0	-1.6	10.0	-0.8	7.0	0.0	30.0	1.0	
4	18.0	-0.5	32.0	-0.5	13.0	-0.5	10.0	-0.8	40.0	0.0	35.0	1.0	
5	52.0	-1.6	52.0	-1.6	28.0	-1.6	10.0	-0.8	10.0	0.0	30.0	1.0	MOBILE HOME
6	23.0	-0.5	40.0	-0.5	17.0	-0.5	10.0	-0.8	44.0	0.0	37.0	1.0	
7	45.0	-1.6	44.0	-1.6	24.0	-1.6	10.0	-0.8	10.0	0.0	30.0	1.0	
8	57.0	-1.6	56.0	-1.6	31.0	-1.6	10.0	-0.8	9.0	0.0	29.0	1.0	
9	17.0	-0.5	30.0	-0.5	12.0	-0.5	10.0	-0.8	53.0	0.0	37.0	1.0	
10	50.0	-1.6	67.0	-1.6	27.0	-1.6	10.0	-0.8	6.0	0.0	25.0	1.0	
1	76.0	-0.6	62.0	-0.6	22.0	-0.6	16.0	-0.8	27.0	0.0	51.0	1.0	
2	80.0	-0.6	74.0	-0.6	26.0	-0.6	16.0	-0.8	27.0	0.0	56.0	1.0	
3	74.0	-0.6	93.0	-0.6	59.0	-0.6	16.0	-0.8	28.0	0.0	56.0	1.0	
4	36.0	-0.4	33.0	-0.4	11.0	-0.4	16.0	-0.8	67.0	0.0	71.0	1.0	
5	56.0	-0.6	53.0	-0.6	19.0	-0.6	16.0	-0.8	27.0	0.0	50.0	1.0	HIGH HOT
6	35.0	-0.4	32.0	-0.4	10.0	-0.4	16.0	-0.8	66.0	0.0	70.0	1.0	WATER
7	58.0	-0.6	47.0	-0.6	16.0	-0.6	16.0	-0.8	27.0	0.0	51.0	1.0	
8	70.0	-0.6	56.0	-0.6	19.0	-0.6	16.0	-0.8	27.0	0.0	50.0	1.0	INSTITUTIONA
9	33.0	-0.4	30.0	-0.4	10.0	-0.4	16.0	-0.8	65.0	0.0	70.0	1.0	
10	76.0	-0.6	72.0	-0.6	24.0	-0.6	16.0	-0.8	26.0	0.0	54.0	1.0	
1	72.0	-1.7	58.0	-1.7	21.0	-1.7	2.0	0.0	41.0	0.0	44.0	1.0	
2	76.0	-1.7	70.0	-1.7	26.0	-1.7	2.0	0.0	37.0	0.0	46.0	1.0	
3	73.0	-1.7	67.0	-1.7	25.0	-1.7	2.0	0.0	34.0	0.0	52.0	1.0	
4	41.0	-1.3	36.0	-1.3	12.0	-1.3	2.0	0.0	74.0	0.0	66.0	1.0	
5	63.0	-1.7	50.0	-1.7	19.0	-1.7	2.0	0.0	36.0	0.0	43.0	1.0	LOW HOT
6	40.0	-1.3	36.0	-1.3	12.0	-1.3	2.0	0.0	72.0	0.0	65.0	1.0	WATER
7	55.0	-1.7	50.0	-1.7	18.0	-1.7	2.0	0.0	30.0	0.0	44.0	1.0	
8	72.0	-1.7	59.0	-1.7	21.0	-1.7	2.0	0.0	38.0	0.0	43.0	1.0	INSTITUTIONAL
9	40.0	-1.3	36.0	-1.3	13.0	-1.3	2.0	0.0	72.0	0.0	66.0	1.0	
10	86.0	-1.7	79.0	-1.7	28.0	-1.7	2.0	0.0	38.0	0.0	47.0	1.0	

TABLE B-4

BUILDING LOADS – NEW CONSTRUCTION

(MM BTU's/Unit-Residential
M BTU's/Sq. Ft.-Non-Res.)

	Space Heating						Hot Water						
Region	Gas & Oil	Decay Rate			Elect	Decay Rate	All	Decay Rate	Elect.		% A/C		
1	112.0	-2.5	0.0	0.0	89.0	-2.0	19.0	-1.7	7.0	0.0	47.0	15.0	
2	87.0	-2.5	0.0	0.0	70.0	-2.0	19.0	-1.7	8.0	0.0	52.0	15.0	
3	81.0	-2.5	0.0	0.0	65.0	-2.0	19.0	-1.7	10.0	0.0	62.0	15.0	
4	33.0	-1.3	0.0	0.0	31.0	-1.1	19.0	-1.7	59.0	0.0	87.0	15.0	SINGLE
5	99.0	-2.5	0.0	0.0	79.0	-2.0	19.0	-1.7	13.0	0.0	70.0	15.0	
6	33.0	-1.3	0.0	0.0	30.0	-1.1	19.0	-1.7	57.0	0.0	91.0	15.0	FAMILY
7	85.0	-2.5	0.0	0.0	68.0	-2.0	19.0	-1.7	13.0	0.0	70.0	15.0	
8	108.0	-2.5	0.0	0.0	86.0	-2.0	19.0	-1.7	12.0	0.0	67.0	15.0	
9	32.0	-1.3	0.0	0.0	30.0	-1.1	19.0	-1.7	69.0	0.0	91.0	15.0	
10	93.0	-2.5	0.0	0.0	74.0	-2.0	19.0	-1.7	8.0	0.0	52.0	15.0	
1	95.0	-2.5	0.0	0.0	68.0	-2.1	13.0	-1.7	5.0	0.0	51.0	15.0	
2	75.0	-2.5	0.0	0.0	54.0	-2.1	13.0	-1.7	6.0	0.0	57.0	15.0	
3	70.0	-2.5	0.0	0.0	50.0	-2.1	13.0	-1.7	7.0	0.0	68.0	15.0	
4	27.0	-1.3	0.0	0.0	24.0	-1.0	13.0	-1.7	47.0	0.0	90.0	15.0	
5	84.0	-2.5	0.0	0.0	60.0	-2.1	13.0	-1.7	11.0	0.0	73.0	15.0	LOW
6	27.0	-1.3	0.0	0.0	24.0	-1.0	13.0	-1.7	46.0	0.0	95.0	15.0	
7	72.0	-2.5	0.0	0.0	52.0	-2.1	13.0	-1.7	11.0	0.0	73.0	15.0	DENSI'
8	91.0	-2.5	0.0	0.0	66.0	-2.1	13.0	-1.7	10.0	0.0	69.0	15.0	
9	26.0	-1.3	0.0	0.0	23.0	-1.0	13.0	-1.7	55.0	0.0	95.0	15.0	
10	80.0	-2.5	0.0	0.0	57.0	-2.1	13.0	-1.7	6.0	0.0	57.0	15.0	
1	58.0	-2.9	0.0	0.0	25.0	-2.5	11.0	-1.7	3.0	0.0	66.0	15.0	
2	50.0	-2.9	0.0	0.0	23.0	-2.5	11.0	-1.7	3.0	0.0	73.0	15.0	
3	46.0	-2.9	0.0	0.0	21.0	-2.5	11.0	-1.7	4.0	0.0	88.0	15.0	
4	16.0	-1.3	0.0	0.0	9.0	-1.0	11.0	-1.7	22.0	0.0	95.0	15.0	
5	52.0	-2.9	0.0	0.0	22.0	-2.5	11.0	-1.7	5.0	0.0	87.0	15.0	MULTI-
6	16.0	-1.3	0.0	0.0	9.0	-1.0	11.0	-1.7	20.0	0.0	100.0	15.0	
7	44.0	-2.9	0.0	0.0	19.0	-2.5	11.0	-1.7	5.0	0.0	87.0	15.0	FAMILY
8	56.0	-2.9	0.0	0.0	24.0	-2.5	11.0	-1.7	5.0	0.0	83.0	15.0	
9	16.0	-1.3	0.0	0.0	9.0	-1.0	11.0	-1.7	24.0	0.0	100.0	15.0	
10	53.0	-2.9	0.0	0.0	24.0	-2.5	11.0	-1.7	3.0	0.0	73.0	15.0	
1	73.0	-2.1	0.0	0.0	52.0	-2.1	8.0	-1.7	7.0	0.0	43.0	15.0	
2	61.0	-2.1	0.0	0.0	44.0	-2.1	8.0	-1.7	8.0	0.0	48.0	15.0	
3	57.0	-2.1	0.0	0.0	41.0	-2.1	8.0	-1.7	10.0	0.0	58.0	15.0	
4	26.0	-1.0	0.0	0.0	19.0	-1.0	8.0	-1.7	38.0	0.0	85.0	15.0	MOBILE HOME
5	64.0	-2.1	0.0	0.0	46.0	-2.1	8.0	-1.7	12.0	0.0	45.0	15.0	
6	26.0	-1.0	0.0	0.0	19.0	-1.0	8.0	-1.7	35.0	0.0	89.0	15.0	
7	55.0	-2.1	0.0	0.0	39.0	-2.1	8.0	-1.7	12.0	0.0	45.0	15.0	
8	70.0	-2.1	0.0	0.0	50.0	-2.1	8.0	-1.7	11.0	0.0	43.0	15.0	
9	26.0	-1.0	0.0	0.0	18.0	-1.0	8.0	-1.7	43.0	0.0	89.0	15.0	
10	65.0	-2.1	0.0	0.0	47.0	-2.1	8.0	-1.7	8.0	0.0	48.0	15.0	
1	72.0	-1.2	0.0	0.0	45.0	-1.2	17.0	-1.7	31.0	0.0	79.0	15.0	
2	62.0	-1.2	0.0	0.0	38.0	-1.2	17.0	-1.7	29.0	0.0	78.0	15.0	
3	56.0	-1.2	0.0	0.0	35.0	-1.2	17.0	-1.7	29.0	0.0	79.0	15.0	
4	24.0	-0.8	0.0	0.0	14.0	-0.8	17.0	-1.7	57.0	0.0	95.0	15.0	
5	49.0	-1.2	0.0	0.0	31.0	-1.2	17.0	-1.7	27.0	0.0	79.0	15.0	HIGH HOT
6	23.0	-0.8	0.0	0.0	14.0	-0.8	17.0	-1.7	56.0	0.0	95.0	15.0	WATER
7	55.0	-1.2	0.0	0.0	34.0	-1.2	17.0	-1.7	23.0	0.0	79.0	15.0	INSTITUTIONA
8	67.0	-1.2	0.0	0.0	41.0	-1.2	17.0	-1.7	29.0	0.0	77.0	15.0	
9	22.0	-0.8	0.0	0.0	14.0	-0.8	17.0	-1.7	50.0	0.0	94.0	15.0	
10	57.0	-1.2	0.0	0.0	35.0	-1.2	17.0	-1.7	31.0	0.0	72.0	15.0	
1	51.0	-3.3	0.0	0.0	35.0	-3.3	2.0	0.0	26.0	0.0	59.0	15.0	
2	48.0	-3.3	0.0	0.0	30.0	-3.3	2.0	0.0	25.0	0.0	55.0	15.0	
3	46.0	-3.3	0.0	0.0	30.0	-3.3	2.0	0.0	24.0	0.0	55.0	15.0	
4	22.0	-2.5	0.0	0.0	13.0	-2.5	2.0	0.0	46.0	0.0	81.0	15.0	
5	43.0	-3.3	0.0	0.0	30.0	-3.3	2.0	0.0	22.0	0.0	59.0	15.0	LOW HOT
6	23.0	-2.5	0.0	0.0	13.0	-2.5	2.0	0.0	44.0	0.0	88.0	15.0	WATER
7	41.0	-3.3	0.0	0.0	31.0	-3.3	2.0	0.0	19.0	0.0	58.0	15.0	INSTITUTION
8	56.0	-3.3	0.0	0.0	40.0	-3.3	2.0	0.0	25.0	0.0	59.0	15.0	
9	22.0	-2.5	0.0	0.0	14.0	-2.5	2.0	0.0	42.0	0.0	89.0	15.0	
10	56.0	-3.3	0.0	0.0	36.0	-3.3	2.0	0.0	26.0	0.0	55.0	15.0	

TABLE B-5

FUEL FIRING OPTIONS

	Water Heating	Space Heating	Air Conditioning
1.	Gas	Gas	None
2.	Oil	Oil	None
3.	Electric	Electric	None
4.	Gas	Gas	Electric
5.	Oil	Oil	Electric
6.	Electric	Electric	Electric
7.	Electric	Heat Pump	Heat Pump

Collector costs were handled in the model by assuming near-term (present) and growth (future) device cost and installation cost for each system. Table B-18 outlines the values used in the model for this costing function. The growth costs are approached as annual U.S. production of collectors moves toward 80 million square feet per year. These cost elements are for new construction installations only; retrofit costs, are determined by inflating the device and installation costs in Table B-18 by 15% for hot water only systems and 25% for the two larger solar systems.

TABLE B-6

REGION 1

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	14.49	14.17	3.37	2.78	3.48	3.15
1978	14.47	14.18	3.38	2.77	3.50	3.20
1979	14.45	14.19	3.38	2.76	3.52	3.25
1980	14.43	14.19	3.39	2.76	3.54	3.31
1981	14.39	14.19	3.54	2.91	3.57	3.34
1982	14.35	14.18	3.69	3.06	3.60	3.37
1983	14.32	14.17	3.84	3.21	3.63	3.40
1984	14.28	14.17	3.99	3.36	3.66	3.43
1985	14.25	14.16	4.14	3.51	3.69	3.47
1986	14.36	14.30	4.32	3.69	3.74	3.51
1987	14.48	14.45	4.49	3.86	3.79	3.56
1988	14.59	14.59	4.67	4.04	3.84	3.61
1989	14.71	14.74	4.84	4.21	3.88	3.66
1990	14.82	14.88	5.02	4.39	3.93	3.70

TABLE B-7

REGION 2

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	16.03	16.44	2.90	2.37	3.32	3.05
1978	15.89	16.45	2.98	2.43	3.41	3.15
1979	15.75	16.46	3.05	2.50	3.50	3.25
1980	15.60	16.48	3.13	2.56	3.59	3.35
1981	15.45	16.49	3.23	2.66	3.62	3.38
1982	15.30	16.50	3.33	2.76	3.66	3.42
1983	15.16	16.51	3.43	2.86	3.69	3.46
1984	15.01	16.52	3.53	2.96	3.73	3.49
1985	14.86	16.53	3.63	3.07	3.77	3.53
1986	14.87	16.70	3.76	3.20	3.81	3.58
1987	14.89	16.87	3.89	3.33	3.86	3.62
1988	14.90	17.05	4.02	3.46	3.91	3.67
1989	14.92	17.22	4.15	3.59	3.96	3.72
1990	14.93	17.39	4.28	3.72	4.01	3.77

TABLE B-8

REGION 3

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	12.12	11.33	2.35	1.99	3.34	3.06
1978	12.06	11.30	2.46	2.08	3.48	3.17
1979	12.00	11.27	2.58	2.17	3.62	3.28
1980	11.94	11.24	2.69	2.25	3.76	3.39
1981	12.03	11.36	2.80	2.36	3.80	3.43
1982	12.11	11.47	2.91	2.47	3.83	3.46
1983	12.20	11.59	3.02	2.58	3.87	3.50
1984	12.29	11.71	3.13	2.69	3.91	3.54
1985	12.37	11.83	3.24	2.80	3.94	3.57
1986	12.46	11.94	3.35	2.91	3.99	3.62
1987	12.54	12.06	3.46	3.02	4.04	3.67
1988	12.62	12.17	3.57	3.13	4.09	3.72
1989	12.70	12.29	3.68	3.24	4.13	3.76
1990	12.79	12.40	3.79	3.35	4.18	3.81

TABLE B-9

REGION 4

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	9.57	9.94	1.88	1.48	3.38	3.06
1978	9.85	10.19	2.00	1.58	3.53	3.17
1979	10.12	10.43	2.12	1.67	3.68	3.28
1980	10.40	10.68	2.24	1.76	3.83	3.40
1981	10.42	10.67	2.37	1.89	3.87	3.43
1982	10.44	10.66	2.49	2.01	3.90	3.47
1983	10.47	10.65	2.61	2.13	3.94	3.51
1984	10.49	10.64	2.74	2.26	3.98	3.54
1985	10.51	10.63	2.86	2.38	4.02	3.58
1986	10.54	10.63	2.99	2.51	4.07	3.63
1987	10.58	10.64	3.13	2.65	4.12	3.69
1988	10.62	10.64	3.26	2.78	4.17	3.74
1989	10.65	10.65	3.39	2.91	4.22	3.79
1990	10.69	10.66	3.62	3.04	4.28	3.84

TABLE B-10

REGION 5

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	10.81	10.62	1.89	1.61	3.06	2.89
1978	10.89	10.72	2.00	1.71	3.14	2.97
1979	10.97	10.82	2.11	1.80	3.22	3.04
1980	11.05	10.92	2.21	1.90	3.30	3.12
1981	11.13	11.03	2.32	2.01	3.35	3.18
1982	11.22	11.14	2.42	2.11	3.41	3.23
1983	11.31	11.24	2.53	2.22	3.47	3.29
1984	11.40	11.35	2.64	2.33	3.53	3.35
1985	11.48	11.46	2.74	2.43	3.58	3.40
1986	11.57	11.57	2.94	2.63	3.64	3.46
1987	11.66	11.68	3.13	2.82	3.69	3.52
1988	11.75	11.79	3.33	3.02	3.75	3.57
1989	11.83	11.89	3.52	3.21	3.80	3.63
1990	11.92	12.00	3.72	3.41	3.86	3.68

TABLE B-11

REGION 6

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	10.70	9.71	1.61	1.12	3.21	2.96
1978	11.70	10.76	1.68	1.18	3.31	3.07
1979	12.70	11.82	1.74	1.24	3.42	3.17
1980	13.70	12.87	1.80	1.30	3.53	3.28
1981	13.54	12.76	1.85	1.44	3.56	3.32
1982	13.38	12.65	1.90	1.58	3.60	3.36
1983	13.21	12.54	1.95	1.71	3.64	3.40
1984	13.05	12.43	1.99	1.85	3.68	3.43
1985	12.89	12.32	2.04	1.99	3.71	3.47
1986	13.03	12.51	2.18	2.25	3.76	3.52
1987	13.17	12.71	2.33	2.52	3.82	3.57
1988	13.31	12.90	2.47	2.79	3.87	3.63
1989	13.45	13.09	2.61	3.05	3.92	3.68
1990	13.59	13.29	2.76	3.32	3.97	3.73

TABLE B-12

REGION 7

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	10.38	9.62	1.53	1.16	3.04	2.86
1978	10.68	9.88	1.58	1.21	3.10	2.92
1979	10.98	10.15	1.63	1.26	3.15	2.98
1980	11.27	10.42	1.69	1.30	3.20	3.04
1981	11.25	10.52	1.69	1.50	3.26	3.09
1982	11.24	10.62	1.70	1.70	3.32	3.15
1983	11.22	10.72	1.71	1.90	3.37	3.21
1984	11.20	10.83	1.71	2.10	3.43	3.26
1985	11.18	10.93	1.72	2.30	3.49	3.32
1986	11.13	11.00	1.94	2.55	3.54	3.38
1987	11.08	11.08	2.16	2.80	3.60	3.43
1988	11.04	11.15	2.39	3.05	3.65	3.49
1989	10.99	11.23	2.61	3.30	3.71	3.54
1990	10.94	11.30	2.83	3.56	3.76	3.60

TABLE B-13

REGION 8

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	9.11	7.80	1.45	1.24	3.21	3.04
1978	9.16	7.91	1.53	1.32	3.27	3.09
1979	9.20	8.02	1.62	1.40	3.34	3.14
1980	9.25	8.13	1.70	1.48	3.40	3.18
1981	9.19	8.14	1.71	1.67	3.46	3.24
1982	9.14	8.15	1.73	1.85	3.51	3.30
1983	9.08	8.15	1.74	2.04	3.57	3.35
1984	9.03	8.16	1.76	2.22	3.63	3.41
1985	8.97	8.17	1.77	2.40	3.68	3.47
1986	9.09	8.36	1.96	2.64	3.74	3.52
1987	9.22	8.55	2.15	2.88	3.79	3.57
1988	9.34	8.73	2.34	3.11	3.84	3.62
1989	9.46	9.92	2.53	3.35	3.89	3.67
1990	9.58	9.10	2.72	3.59	3.94	3.73

TABLE B-14

REGION 9

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	12.07	10.52	1.98	1.60	3.37	3.10
1978	12.68	11.22	2.13	1.71	3.40	3.14
1979	13.30	11.92	2.28	1.82	3.44	3.18
1980	13.92	12.62	2.42	1.93	3.48	3.22
1981	13.76	12.54	2.66	2.17	3.53	3.26
1982	13.60	12.46	2.89	2.40	3.57	3.31
1983	13.43	12.38	3.12	2.63	3.61	3.35
1984	13.27	12.30	3.36	2.86	3.66	3.39
1985	13.11	12.23	3.59	3.10	3.70	3.44
1986	13.14	12.34	3.62	3.12	3.75	3.48
1987	13.17	12.45	3.64	3.15	3.79	3.53
1988	13.20	12.56	3.67	3.18	3.84	3.58
1989	13.23	12.67	3.70	3.21	3.89	3.63
1990	13.26	12.78	3.73	3.24	3.94	3.67

TABLE B-15

REGION 10

ENERGY PRICES IN 1977 DOLLARS PER MILLION BTU'S

(PRICES ASSUMED CONSTANT FROM 1990 ONWARD)

	Electric		Gas		Oil	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
1977	5.45	5.63	2.72	2.16	3.33	3.06
1978	5.85	6.00	2.93	2.37	3.38	3.11
1979	6.24	6.37	3.14	2.58	3.43	3.17
1980	6.64	6.74	3.35	2.80	3.48	3.22
1981	6.61	6.69	3.36	2.80	3.53	3.26
1982	6.59	6.64	3.36	2.80	3.57	3.31
1983	6.56	6.59	3.36	2.80	3.61	3.35
1984	6.54	6.54	3.36	2.81	3.66	3.39
1985	6.51	6.49	3.36	2.81	3.70	3.44
1986	6.61	6.57	3.39	3.14	3.75	3.48
1987	6.71	6.65	3.41	3.46	3.79	3.53
1988	6.81	6.72	3.43	3.79	3.84	3.58
1989	6.91	6.80	3.46	4.12	3.89	3.63
1990	7.01	6.87	3.48	4.44	3.94	3.67

TABLE B-16
FEA
FUEL SHARES
(%)

Region	PRE-1977 INVENTORY GAS	OIL	ELEC.	1977 NEW CONSTRUCTION GAS	OIL	ELEC.	1977-1990 ANNUAL PERCENT INC/DEC. GAS	OIL	ELEC.	
1	0.240	0.520	0.240	0.140	0.410	0.450	-0.663	0.007	0.015	RESIDENTIAL
2	0.430	0.360	0.210	0.040	0.410	0.550	-0.629	-0.012	0.013	
3	0.410	0.320	0.270	0.030	0.150	0.820	-0.621	-0.031	0.007	
4	0.420	0.280	0.300	0.220	0.040	0.740	0.007	-0.629	0.006	
5	0.720	0.150	0.130	0.320	0.090	0.590	-0.019	-0.044	0.013	
6	0.900	0.0	0.100	0.640	0.040	0.320	0.007	0.073	-0.036	
7	0.620	0.040	0.340	0.440	0.090	0.470	-0.007	0.008	0.005	
8	0.770	0.150	0.080	0.320	0.030	0.650	-0.036	0.040	0.011	
9	0.740	0.070	0.190	0.800	0.020	0.180	0.0	0.073	-0.014	
10	0.270	0.300	0.430	0.230	0.020	0.750	-0.032	-0.609	0.010	
TOTAL U.S.	0.580	0.210	0.120	0.320	0.100	0.580	-0.010	0.014	0.003	
1	0.070	0.640	0.290	0.020	0.960	0.0	0.0	0.0	0.0	HIGH HOT WATER NON-RES.
2	0.260	0.440	0.300	0.470	0.490	0.030	-0.009	0.013	-0.021	
3	0.280	0.380	0.340	0.460	0.530	0.210	-0.007	0.013	-0.008	
4	0.400	0.210	0.390	0.510	0.120	0.370	-0.006	0.012	0.004	
5	0.640	0.110	0.250	0.750	0.160	0.090	-0.008	0.013	0.029	
6	0.690	0.030	0.280	0.640	0.010	0.350	-0.008	0.0	0.012	
7	0.710	0.070	0.220	0.790	0.130	0.080	-0.008	0.016	0.038	
8	0.660	0.050	0.290	0.840	0.070	0.090	-0.008	0.010	0.045	
9	0.540	0.120	0.340	0.560	0.020	0.420	-0.007	0.052	0.007	
10	0.540	0.110	0.350	0.520	0.140	0.340	0.001	-0.112	0.020	
TOTAL U.S.	0.480	0.200	0.320	0.560	0.280	0.160	-0.007	0.013	0.0	
1	0.050	0.890	0.060	0.080	0.680	0.240	0.009	0.017	-0.101	LOW HOT WATER NON-RES.
2	0.490	0.440	0.070	0.250	0.480	0.270	-0.010	0.015	-0.023	
3	0.480	0.300	0.220	0.280	0.410	0.310	-0.012	0.017	-0.015	
4	0.530	0.110	0.360	0.390	0.220	0.390	-0.008	0.016	-0.002	
5	0.780	0.150	0.070	0.620	0.120	0.260	-0.008	0.012	0.011	
6	0.660	0.010	0.330	0.680	0.030	0.290	-0.026	0.022	-0.003	
7	0.810	0.120	0.070	0.700	0.060	0.240	-0.011	0.012	0.022	
8	0.870	0.060	0.070	0.600	0.050	0.350	-0.008	0.037	0.006	
9	0.580	0.020	0.400	0.520	0.140	0.340	-0.006	0.010	0.004	
10	0.580	0.020	0.400	0.540	0.120	0.340	-0.009	0.022	0.002	
TOTAL U.S.	0.580	0.250	0.170	0.460	0.220	0.320	-0.007	0.013	0.0	

TABLE B-17

SOLAR COLLECTOR EFFICIENCIES

(Expressed in %)

COLLECTOR EFFICIENCIES AND RATE OF INCREASE, RETROFIT

Annual % Increase in Efficiencies	Gas	Oil	Elect.	Gas	Oil	Elect.	Gas	Oil	Elect.	Gas	Oil	Elect.	
	1.03200	1.03200	0.0										
Hot Water →	0.350	0.350	0.350	0.350	0.350	0.350	Multi-Family			Mobile Home			
Single Family	0.250	0.253	0.266	0.250	0.250	0.269	0.262	0.262	0.287	0.250	0.253	0.273	Region 1
	0.258	0.250	0.271	0.257	0.250	0.280	0.269	0.244	0.299	0.258	0.250	0.278	2
	0.271	0.253	0.282	0.258	0.250	0.283	0.269	0.248	0.301	0.262	0.250	0.280	3
	0.293	0.273	0.305	0.293	0.273	0.303	0.307	0.289	0.323	0.289	0.273	0.301	4
	0.256	0.257	0.276	0.253	0.253	0.273	0.266	0.266	0.291	0.256	0.256	0.276	5
	0.294	0.273	0.304	0.293	0.273	0.303	0.309	0.291	0.321	0.282	0.264	0.293	6
	0.258	0.262	0.276	0.257	0.258	0.278	0.273	0.273	0.295	0.258	0.262	0.280	7
Space Heating	0.253	0.253	0.266	0.193	0.250	0.273	0.274	0.264	0.289	0.256	0.253	0.273	8
	0.295	0.273	0.305	0.293	0.273	0.305	0.309	0.291	0.323	0.293	0.273	0.303	9
	0.257	0.248	0.276	0.256	0.248	0.276	0.266	0.265	0.297	0.257	0.248	0.276	10
	0.257	0.266	0.299	0.217	0.217	0.237							
	0.257	0.258	0.295	0.217	0.217	0.230							
	0.258	0.253	0.266	0.217	0.217	0.230							
	0.283	0.287	0.323	0.225	0.225	0.250							
High Hot Water	0.269	0.269	0.317	0.217	0.220	0.239							
	0.283	0.287	0.314	0.225	0.225	0.250							
	0.269	0.273	0.309	0.205	0.220	0.239							
	0.262	0.269	0.305	0.217	0.217	0.237							
	0.287	0.287	0.322	0.225	0.225	0.248							
	0.257	0.258	0.295	0.215	0.213	0.230							
Cooling →	0.380	0.380	0.380	0.380	0.380	0.350							

Low Density

Low Hot Water

COLLECTOR EFFICIENCIES AND RATE OF INCREASE, NEW CONSTRUCTION

				L/D	M/F							
	1.03200	1.03200	0.0									
Hot Water →	0.350	0.350	0.350	0.350	0.350	0.350	Mobile		Hi H/W		Low H/W	
Single Family	0.253	0.258	0.244	0.256	0.256	0.283	0.239	0.248	0.262	0.276	0.220	0.225
	0.216	0.266	0.253	0.262	0.258	0.285	0.244	0.253	0.269	0.283	0.220	0.227
	0.262	0.269	0.256	0.266	0.262	0.289	0.244	0.256	0.269	0.287	0.220	0.277
	0.293	0.295	0.285	0.291	0.297	0.247	0.273	0.282	0.297	0.247	0.234	0.248
Space Heating	0.256	0.262	0.248	0.258	0.257	0.287	0.243	0.253	0.276	0.291	0.220	0.227
	0.293	0.295	0.285	0.291	0.297	0.247	0.273	0.282	0.299	0.247	0.234	0.248
	0.258	0.269	0.253	0.264	0.264	0.293	0.248	0.257	0.273	0.267	0.225	0.227
	0.253	0.258	0.244	0.256	0.256	0.283	0.239	0.250	0.264	0.280	0.217	0.216
	0.293	0.295	0.287	0.291	0.297	0.247	0.273	0.283	0.301	0.247	0.234	0.244
	0.257	0.264	0.250	0.262	0.257	0.283	0.243	0.253	0.269	0.287	0.217	0.225
Cooling →	0.380	0.380	0.380	0.380	0.380	0.350						

TABLE B-18

SHACOB MODEL SOLAR SYSTEM COSTING
($/Sq Ft collector)

	C_A Device		C_B Installation		C_N Cost Exponent
	Near Φ	Growth Min	Near Φ	Growth Min	
Residential Hot Water	20.20	11.10	343.00	187.00	0.81
Res. Heating/Hot Water	20.20	11.10	343.00	187.00	0.81
Res. Cooling/Hot Water	32.30	21.30	6096.00	3040.00	1.04
Non-Res. Hot Water	19.60	12.90	41.20	27.20	0.27
Non-Res. Heat/Hot Water	19.60	12.90	41.20	27.20	0.27
Non-Res. Cool/Hot Water	39.10	25.80	315.00	210.70	0.47

APPENDIX C

INCENTIVES

APPENDIX C

INCENTIVES

Table IV-1 in Volume II summarizes the various economic and non-economic incentives investigated under the four major packages. All economic incentives were analyzed outside of the model, and their effects translated into dollar impact on first cost. This first cost factor was then inserted into the program where it was permitted to work on penetration levels. Governmental buildings programs were handled differently; the scope of spending was translated into square feet of collectors which was then applied to the experience factor of the model. Non-economic incentives were analyzed and their impact relayed to the model through adjustments of the utility factors.

In addition to the above assumptions, the following factors concerning the handling of incentives within the model should be noted.

- A 10% investment tax credit for the four commercial (noninstitutional) markets was assumed to be in place during the 1977-1980 period. This tax credit then falls to 7% from 1980 through 1990.
- All other incentives were made effective in calendar year 1978. Each of the four programs were analyzed as if they took effect in 1978.
- The NEP residential tax credit was reduced through the period 1978-1984 re the following; 40%/25% from 1977-1980, 30%/20% from 1980-1981, and 25%/15% from 1982 to 1984.
- On tax credits, an implied discount rate of 6.5% was used to reflect an average mid-year solar device investment.
- Government building spending ($100 million in the NEP) was scheduled evenly over the three year time period. Certain assumptions were made regarding average governmental building solar device size, and that portion of the earmarked funds which would be administrative in nature.

Table C-1 is an example of the data printout of the financial incentives in the NEP.

TABLE C-1

FINANCIAL INCENTIVES PRINTOUT

Duration Fr	To	Regions	Customer Class	Percent Credit 1st	2nd	Discount Rate	$ Investment 1st	2nd	
INCENTIVE PLANS			12345678910						
1	78	78	TTTTTTTTTT	TTTFTFFFFF	0.40	0.25	0.06 1000.00	6400.00	0.0
1	79	79	TTTTTTTTTT	TTTFTFFFFF	0.38	0.23	0.06 1000.00	6400.00	0.0
1	80	80	TTTTTTTTTT	TTTFTFFFFF	0.35	0.22	0.06 1000.00	6400.00	0.0
1	81	81	TTTTTTTTTT	TTTFTFFFFF	0.32	0.20	0.06 1000.00	6400.00	0.0
1	82	82	TTTTTTTTTT	TTTFTFFFFF	0.30	0.18	0.06 1000.00	6400.00	0.0
1	83	83	TTTTTTTTTT	TTTFTFFFFF	0.27	0.17	0.06 1000.00	6400.00	0.0
1	84	84	TTTTTTTTTT	TTTFTFFFFF	0.25	0.15	0.06 1000.00	6400.00	0.0
1	76	82	TTTTTTTTTT	FFFFFFTFTT	0.20	0.0	0.06********	0.0	0.0
1	83	90	TTTTTTTTTT	FFFFFFTFTT	0.10	0.0	0.06********	0.0	0.0
-1									

(1) T = Turned On