PROGRAM PRESTO - PREPARATION OF REFERENCE ENERGY SYSTEMS THROUGH TIME

E. BEARDSWORTH AND G. GOLDSTEIN

MASTER

August 1977

DEPARTMENT OF NUCLEAR ENERGY

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

UNDER CONTRACT NO. EY-76-C-02-0016 WITH THE
UNITED STATES DEPARTMENT OF ENERGY

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Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy \$4.00; Microfiche \$3.00
December 1977 250 copies

ABSTRACT

PRESTO is an interactive computer program to provide a convenient framework for energy accounts to specify quantitatively the flows in the U.S. energy system over time, and to permit manipulation of their values while maintaining internal consistency. Then, once a scenario is defined, several of its attributes and implications are calculated (costs, total resource use, and environmental effects.) It is based on the Reference Energy System methodology, a diagrammatic description of energy flows, but with the explicit incorporation of the time dimension.

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Introduction

PRESTO is an interactive computer program written for use on the INTERCOM system of the Brookhaven National Laboratory Central Scientific Computing Facility. It is based on the Reference Energy System methodology, a diagrammatic description of energy flows in the U.S. energy system, with the addition of explicit incorporation of the time dimension.

The purpose of PRESTO is to provide a convenient energy accounting framework in which to specify quantitatively the flows in the U.S. energy system over time (the next 100 years), in such a way that each energy activity variable varies smoothly and reasonably over time, while bearing a consistent relationship to the other energy flows at each point in time. Then, once a given scenario is defined, several of its attributes and implications are readily calculated and output in a convenient format.

Basic Structure

Figure 1 shows the simplified reference energy system, with "activity" indexes indicated. Each energy activity has been assigned an index number (i.e., total distributed electricity is activity #32, total coal mined is #29, electricity generated by coal steam is #11).

Initial Data Set

A complete, consistent set of data must be specified to initialize PRESTO. This consists of values for each of the up to ten reference years, which also must be provided as input. This initial data set must already exhibit self-consistency in each reference year. For example:

$$X_{20} = X_6 + X_{34}$$

and

$$X_{31} = X_7 + X_8 + X_9 + X_{10} + X_{11} + X_{12}$$

Figure 1. Presto - Flow Chart.

Table 1 shows a sample base case specification. The first record contains a title. The second record has the list of reference years, and the rest have the values for each of the sixty variables. Once this initial data set is established, a series of interactive commands enable the user to make changes in the energy totals. At all times, a value will be specified for each activity variable, in each of the reference years.

Program Structure

Upon starting, PRESTO reads the case title, the list of reference years, and the input data file. Then costs are read in, a command list is printed, and a COMMAND WAIT state is entered. (See Figure 2.) The seven basic commands include activity level changes and printing, output, and control functions.

1. Activity Level Changes

Activity level changes are specified in the format:

IACT1, IYR, AMT, IACT1

where

- IYR must be one of the ten reference years
- AMT is a floating point number specifying a change to be made (in Quads)
- IACT1 }
- IACT2 } are activity variable indexes

Table 2 shows the complete list of activity level change commands. The "MODE" can be set as either one in which old values replace new values (MODE = 0 "New Value") or where they are added and subtracted from existing values (MODE = 1 "Delta").

In the "Delta" mode, when only IACT1 is entered (enter IACT2 =0) the amount is added to variable #IACT1 for the year IYR. If a value for IACT2 is entered

TABLE 1

BASE CASE SPECIFICATION

	HIGH	1975	1980	1985	1990	2000	2010	2020	2040	2060	2075
1	0.00	0.06	0.16	0.36	2.64	4.78	7.80	8.88	13.04	14.11	
2	3.00	3.36	3.56	4.07	4.96	8.09	11.75	14.31	22.42	24.19	
3	0.00	0.00	0.00	0.00	0.00	0.00	4.16	4.73	6.95	7.53	
4	1.70	4.49	8.05	11.48	17.18	19.14	17.81	17.79	17.86	17.11	
5	8.50	9.38	10.07	10.64	14.99	16.33	17.43	37.41	54.88	82.01	
6	5.60	5.27	4.87	5.04	3.55	3.04	1.97	1.30	1.52	1.66	
7	0.00	0.02	0.05	0.13	0.91	1.66	2.70	3.08	4.52	4.89	
8	1.04	1.16	1.22	1.39	1.73	2.81	4.10	5.01	7.84	8.45	
9	0.00	0.00	0.00	0.00	0.00	0.00	1.46	1.65	2.43	2.64	
10	0.59	1.55	2.80	4.00	6.00	6.70	6.20	6.20	6.20	5.94	
11	2.93	3.25	3.52	3.70	5.22	5.72	6.09	13.07	19.18	28.67	
12	1.94	1.82	1.69	1.74	1.21	1.04	0.68	0.44	0.16	0.20	
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
14	0.00	0.02	0.04	0.24	1.11	2.50	3.54	4.02	5.91	6.40	
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
17	0.00	0.07	0.19	0.30	0.61	1.87	2.39	2.72	4.00	4.33	
18	48.20	50.50	52.67	55.26	57.58	57.02	56.81	59.32	57.48	56.44	
19	0.00	0.09	0.23	0.54	1.72	4.37	5.93	6.74	9.91	10.73	
20	48.20	50.59	52.90	55.80	59.30	61.39	62.74	66.06	67.39	67.17	
21	12.40	14.67	17.03	19.71	29.91	33.67	37.57	64.48	91.14	127.12	
22	0.00	0.11	0.29	0.46	0.94	2.88	3.68	4.18	6.15	6.66	
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
25	0.00	0.06	0.16	0.36	2.64	4.78	7.80	8.88	13.04	14.11	
26	3.00	3.43	3.69	4.87	8.66	16.42	23.55	27.71	42.12	45.52	
27	0.00	0.00	0.00	0.00	0.00	0.00	4.16	4.73	6.95	7.53	
28	1.70	4.49	8.05	11.48	17.18	19.14	17.81	17.79	17.86	17.11	
29	12.40	14.78	17.32	20.17	30.85	36.55	41.25	68.66	97.29	133.78	
30	52.97	55.49	57.88	60.73	63.27	62.66	62.43	65.19	63.16	62.02	
31	6.49	7.81	9.28	10.96	15.07	17.93	21.22	29.45	40.33	50.79	
32	5.91	7.10	8.45	9.98	13.71	16.31	19.31	26.80	36.70	46.22	
33	3.90	5.29	6.96	9.07	14.92	17.34	20.14	27.07	36.26	45.11	
34	42.60	45.32	48.03	50.77	55.75	58.35	60.77	64.76	66.87	66.51	
35	0.00	0.13	0.28	0.55	0.88	1.69	2.64	4.99	8.05	10.87	
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
38	3.48	3.88	4.26	4.90	6.22	6.61	7.45	8.98	10.83	12.40	
39	2.43	3.18	4.06	4.92	7.25	8.96	10.55	14.64	20.04	25.23	
40	0.02	0.06	0.12	0.16	0.22	0.73	1.31	3.18	5.82	8.57	
41	12.00	12.43	12.23	13.40	14.34	13.87	13.17	10.83	7.32	3.77	
42	12.10	13.27	15.09	16.59	18.93	20.92	22.55	25.46	27.50	28.00	
43	18.50	19.62	20.70	20.77	22.48	23.56	25.05	28.48	32.05	34.74	
44	15.48	16.44	16.77	18.85	21.44	22.17	23.26	24.80	26.20	27.04	
45	18.43	21.06	26.41	31.11	42.35	49.59	57.06	75.21	98.49	120.27	
46	18.52	19.68	20.82	20.93	22.70	24.29	26.36	31.66	37.87	43.31	
47	52.43	57.98	64.00	70.89	86.49	96.05	106.68	131.67	162.56	190.62	
48	65.37	70.27	75.20	80.90	94.12	99.21	103.68	133.85	160.46	195.80	
49	4.70	8.23	12.48	17.79	30.61	44.40	59.78	72.14	102.71	117.07	
50	70.07	78.50	87.68	98.69	124.73	143.61	163.46	205.99	263.17	312.88	
51	0.00	0.12	0.30	0.53	1.25	2.37	3.82	8.04	14.69	21.93	
52	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
53	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
54	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
55	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
56	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
57	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
58	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
59	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	
60	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

Figure 2. Program Flow Chart.

TABLE 2

PRESTO

ACTIVITY LEVEL CHANGE COMMANDS

<u>IACT1</u>	<u>IACT2</u>	
0	0	Scale: multiply all variables in year IYR by AMT.
7-12	7-12(≠)	Electric generation <u>MIX</u> change.
	0	Electric generation <u>TOTAL</u> change, with downstream category pro-rated*.
	38-40	Electric generation <u>TOTAL</u> change, with downstream specified.
13-18	13-18(≠)	Liq & Gas (synfuel) supply <u>MIX</u> change
33	0	Coal to Industry
34	41-43	Liq & Gas (direct) change, with downstream specified
	0	Liq & Gas (direct) change, with downstream pro-rated*
38-40	28-40(≠)	Electric demand reallocation
41-43	41-43(≠)	Liq & Gas demand reallocation
36,37	1-6	By product heat
24	28	Fission-fusion
35	0	R/C Direct Heat (solar, geoth., etc)
51	0	Industrial Direct Heat (solar, geoth., etc)

* Downstream changes in fuels or electricity are distributed among the three demand sectors in proportion to the already existing allocation.

then the amount AMT is deducted from variable #IAC1 and added to variable #IAC2. In other words, that amount is transferred from IAC1 to IAC2.

In the "New Value" mode, AMT replaces the value of variable #IAC1, with the appropriate change to variable #IAC2.

When any change is made that affects adjoining variables, corrected values are computed for those variables so that consistency of the flow network is maintained in that reference year. For example, a change in one of the electrical generation modes (IAC1 = 7 - 12) with IAC2 = 0 will result in a change in the total electric generation--so variables #31, 32, and 38, 39, and 40 are re-computed. (The final demand changes are allocated in proportion to the already existing proportions, or one demand category can be specified). If coal steam is changed, not only will the downstream (demand) variables be corrected, but so will the upstream (supply) variables: #5, 21, and 29.

A decision structure for these corrections is incorporated into the program to permit rapid interactive changes to be made while the program automatically maintains the consistency requirement. Extensive error checking prevents most mistaken instructions from being carried out.

Time Dependence

As changes are made to activity levels in the various reference years, the user must aim towards developing reasonable time-series in each variable. If one activity in one year is altered, the adjoining years' values will likely also require adjustments to maintain smooth variation in time. Experience is helpful in anticipating the disruptions to associated variables when some change is made. That is, a change in one variable may disrupt the time-series of some other variable. When one resource is to be gradually phased out, another

must be brought in to replace it if the total resource consumption is to be maintained constant. This procedure can be less than straightforward, however, because of the interdependencies which the program's decision structure are keeping consistent. The user will have to tune the quantities until all variables have satisfactory time-series.

There is one additional command which scales every activity variable in a given reference year: if $IACT1 = 0$, then all activities in the reference year IYR are multiplied by AMT. This command is useful as the first step in making large changes in the total resource consumption.

2. Print Output

A separate subroutine requests the user to specify a "print directive pair", which indicates which of twelve subsections of the total output are to be printed, as shown in Table 3.

Sections 1 - 8 of the printout contain the activity variables. In Section 9, total cumulative resource use and an approximate attribution of primary resources to end-use categories are calculated. Certain ratios are given in section 10, e.g., the ratio of electricity to total fuels consumed. (This indicates the degree of electrification implied in the scenario.)

Costs are printed in Section 11 and environmental effects in Section 12. Each energy activity in each year is multiplied by appropriate coefficients, to tally total annual system cost, and health and environmental emissions and effects for that scenario.

Costs

Up to five distinct "sets" of costs can be used simultaneously. Each successive cost set is the same as the previous one, with any number of changes

TABLE 3

DND??

ENTER PRINT DIRECTIVE PAIR
1,12

PRESTO - COMPLETE PRINTOUT

PRESTO - ENERGY ACTIVITY LEVELS
U.S. NATIONAL ANNUAL TOTALS (E15 BTU/YR)

HIGH IERS 6/17/77 REV.

1	1GEOTH TO ELE	13SYNFI GEOTH	37 BP HT IND	41 LOAGAS R/C	7 ELECEN GEOTH	25 GEOTH TOTRES
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

2	2SOLAR TO ELE	16SYNFI SOLAR	36 BP HT R/C	42 LOAGAS IND	8 ELECEN SOLAR	26 SOLAR TOTRES
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

3	3FUSION TO ELE	15SYNFI FUSION	35 INEXH HYDCL	43 LOAGAS TRANS	9 ELECEN FUSION	27 FUSION TOTRES
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

4	4FSSION TO ELE	16SYNFI FSSION	51 INEXH PRHT	38 ELEC R/C	10 ELECEN FSSION	28 FSSION TOTRES
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

5	5COAL TO ELE	17SYNFI COAL	34 LOAGAS DIRECT	39 ELEC IND	11 ELECEN COAL	29 COAL TOTRES
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

6	6LOAGAS TO ELE	18LOAGAS REFIN	22 COAL (SYN)	40 ELEC TRANS	12 ELECEN LOAGAS	30 LOAGAS TOTRES
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

7	7COAL IND	19TOTAL SYNFI	44 R/C TOTAL	45 IND TOTAL	46 TRANS TOTAL	47 TOTAL DIRUSE
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

8	24FUSUS FUEL	31TOTAL ELECEN	32 TOTAL ELECEN	48 TOTAL EXHRS	49 TOTAL INEXH	50 TOTAL RESRC
75	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00

CUM RESOURCE USE

1975-2024 1995-2044

1975-2075

9	TOTAL COAL MINED	1424	2782	5736
	TOTAL TIO & GAS	3089	869	1595
	TOTAL FISSON	692		

PRIMARY RESOURCE ATTRIBUTION

R/C	1975	1980	1985	1990	2000	2010	2020	2040	2060	2075
ELEC	8.63	8.29	7.77	7.94	8.57	7.97	7.56	13.01	16.36	22.20
EXH	2.77	4.32	5.93	7.81	11.24	12.97	16.02	15.32	17.79	16.89
LOAGAS	13.19	13.66	13.45	14.69	15.51	14.78	13.86	11.36	7.53	3.85
INEXH	0.00	.02	.03	.21	.95	1.98	2.56	2.24	2.16	1.21
HEAT	0.00	.13	.28	.55	.88	1.69	2.64	4.99	8.05	10.87

IND	1975	1980	1985	1990	2000	2010	2020	2040	2060	2075
ELEC	6.03	6.79	7.41	7.88	9.99	10.81	10.71	21.22	30.28	45.16
EXH	1.93	3.54	5.66	7.84	13.10	17.58	22.68	24.97	32.91	34.38
LOAGAS	13.20	14.58	16.59	18.18	20.48	22.30	23.73	26.71	28.27	28.61
INEXH	0.00	.02	.04	.26	1.26	2.99	4.38	5.27	8.10	8.98
COAL	3.90	5.29	6.96	9.07	14.92	17.34	20.14	27.07	36.26	45.11
HEAT	0.00	.12	.30	.53	1.23	2.37	3.82	8.04	14.69	21.93

TRANS	1975	1980	1985	1990	2000	2010	2020	2040	2060	2075
ELEC	.05	.13	.22	.26	.30	1.88	1.33	4.61	8.79	15.24
EXH	.02	.07	.17	.26	.40	1.83	2.82	5.42	9.56	11.67
LOAGAS	20.33	21.56	22.76	22.77	24.37	25.11	26.36	29.88	32.95	35.50
INEXH	0.00	.03	.06	.33	1.49	3.36	4.86	5.88	9.44	14.44
TOT RESOURCE	70.07	78.50	87.68	98.69	124.73	143.61	163.46	205.99	263.17	312.88

10

CEO	1975	1980	1985	1990	2000	2010	2020	2040	2060	2075
SOL	0.00	.16	0.00	.09	.43	.30	.59	.41	.00	.00
ELEC GEN. MEX	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01
COAL	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01
L&G	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01
R/C	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01
ELEC DIST	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01
IND	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01
TRAN	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01
USE	0.00	.15	0.00	.20	.42	.72	.50	.43	.01	.01

11

TOTAL ANNUAL SYSTEM COST (\$9 DOLLARS)

YEAR	SET1	SET2	SET3	SET4	SET5
1975	138.5	139.3	138.5	138.5	138.5
1980	163.9	165.9	163.9	163.9	163.9
1985	192.7	195.7	192.7	192.7	192.7
1990	229.4	231.2	229.4	229.4	229.4
2000	296.2	301.6	296.2	296.2	296.2
2010	429.3	437.0	429.3	429.3	429.3
2020	556.7	568.7	556.7	556.7	556.7
2040	719.7	719.7	719.7	719.7	719.7
2060	824.5	824.5	824.5	824.5	824.5
2075	824.5	824.5	824.5	824.5	824.5

10	1975	1980	1985	1990	2000	2010	2020	2040	2060	2075
DISCOUNTED PRESENT VALUE OF CUM. SYSTEM COST	47076.0	47771.6	47076.0	47076.0	47076.0	47076.0	47076.0	47076.0	47076.0	47076.0
5	5384.2	5482.0	5384.2	5384.2	5384.2	5384.2	5384.2	5384.2	5384.2	5384.2
10	2170.7	2206.4	2170.7	2170.7	2170.7	2170.7	2170.7	2170.7	2170.7	2170.7
15	1350.6	1369.6	1350.6	1350.6	1350.6	1350.6	1350.6	1350.6	1350.6	1350.6

10	1995	2000	2010	2020	2040	2060	2075
DISCOUNTED PRESENT VALUE OF CUM. SYSTEM COST	43229.4	43857.7	43229.4	43229.4	43229.4	43229.4	43229.4
5	7944.9	8103.7	7944.9	7944.9	7944.9	7944.9	7944.9
10	2620.8	2704.0	2620.8	2620.8	2620.8	2620.8	2620.8
15	1556.7	1613.5	1556.7	1556.7	1556.7	1556.7	1556.7

10	2010	2020	2040	2060	2075
DISCOUNTED PRESENT VALUE OF CUM. SYSTEM COST	38580.0	39093.1	38580.0	38580.0	38580.0
5	9632.2	9791.3	9632.2	9632.2	9632.2
10	4689.3	4787.1	4689.3	4689.3	4689.3
15	3119.1	3181.1	3119.1	3119.1	3119.1

10	2020	2040	2060	2075
DISCOUNTED PRESENT VALUE OF CUM. SYSTEM COST	34648.9	35080.4	34648.9	34648.9
5	10533.3	10684.2	10533.3	10533.3
10	5387.2	5471.1	5387.2	5387.2
15	3612.9	3671.6	3612.9	3612.

specified. In the case shown in Table 4, cost set #2 is the same as #1, but with the fission capital cost (cost coefficient #4) increased from \$600 to \$800. Cost coefficients can vary with time. If more than one point is specified (\$, year #) then straight line interpolations are done to get the costs in the intervening reference years.

Cost Calculation

In each of the ten reference years, the annual energy system cost is computed by multiplying each of the energy activity variables by an appropriate cost coefficient and adding. This is done separately for each cost set. Capital costs (coefficient #1 - 6, 13, and 19) are first annualized, assuming a 30-year plant life (capital recovery factor CRF = 15% and a plant factor PF of 0.8).

$$\text{Annualized Capital Cost } \left(\frac{\$}{10^6 \text{ BTU}} \right) = \text{Capital Cost } \left(\frac{\$}{\text{kW}} \right) \times \frac{\text{CRF}}{29.9 \times \text{PF}}$$

Cummulative discounted present value of these annual cost streams* are also calculated:

$$\text{DPV } (R, Y_0) = \sum_{y=Y_0}^{0276} C(y) \frac{1}{(1 + R)^{y-Y_0}}$$

where $C(y)$ is the annual system cost in the year y , Y_0 is the starting year for the calculation, and R is the discount rate. Four different start years (1975, 1995, 2010, and 2020) and four different discount rates (0, 5, 10, and 15%) are applied for each cost set (See Figure C-5). Outputs for costs are in billions of dollars. Note that $\$1/10^6 \text{ BTU} = \$10^9/10^{15} \text{ BTU}$, therefore:

$$C(y) = \frac{\text{Total Annual System Cost } (\frac{\$10^9}{\text{year}})}{10^6 \text{ BTU}} = \sum_i \text{Energy}_i \left(\frac{10^{15} \text{ BTU}}{\text{year}} \right) \times \text{Cost}_i \left(\frac{\$}{10^6 \text{ BTU}} \right)$$

* The total annual system cost is interpolated for all years, using a cubic spline routine.

TABLE 4

COST DATA FILE

Assoc. Energy Activity Variable		Coeff. no. Set no. (A) No. Points (B)			\$	yr no	\$	yr no	\$	yr no	...
No.											
7	Ce	1	1	1	800.						
8	Ce	2	1	1	800.						
9	Ce	3	1	1	800.						
10	Ce	4	1	1	600.						
11	Ce	5	1	1	450.						
12	Ce	6	1	1	300.						
7	OMe	7	1	1	1.00						
8	OMe	8	1	1	1.00						
9	OMe	9	1	1	.40						
10	OMe	10	1	1	.40						
11	OMe	11	1	1	.50						
12	OMe	12	1	1	.25						
32	Ce	13	1	1	250.						
32	OMe	14	1	1	.52						
27	Ft	15	1	1	.07						
28	Ft	16	1	3	.45	1	.85	5	.95	7	
29	Ft	17	1	2	1.00	1	4.00	10			
30	Ft	18	1	2	2.00	1	5.5	10			
23	Cf	19	1	1	350.						
35	Ch	20	1	1	8.						
13	Cs	21	1	1	5.						
14	Cs	22	1	1	5.						
15	Cs	23	1	1	5.						
16	Cs	24	1	1	5.						
17	Cs	25	1	1	3.						
13	OMs	26	1	1	.40						
14	OMs	27	1	1	.40						
15	OMs	28	1	1	.40						
16	OMs	29	1	1	.40						
17	OMs	30	1	1	.40						
(A) 10	OMs	4	2	1	800.						

NOTES

Ce	Elec. Gen. Capital Cost	\$/kWe
OMe	Elec. Gen. Op. & Mnt.	\$/10 ⁶ BTUc
Ft	Fuel Cost	\$/10 ⁶ BTUt
Cf	Hybrid Capital Cost	\$/kWt
Ch	Heating & Cooling	\$/10 ⁶ BTUt
Cs	Synfuel Capital Cost	\$/10 ⁶ BTU(product)
OMs	Synfuel Op. & Mnt.	\$/10 ⁶ BTU(product)

(A) At least 1 coeff. must be given in at least one additional cost set, as in this example.

(B) Up to ten points can be given, in the reference years, which are referred to by number 1 - 10.

Health and Environmental - Emissions and Effects

The Energy Modeling Data Base (EMDB) provides highly specific coefficients as the individual process level for various emissions and effects resulting from energy conversion and use activities.* These coefficients are in the form of amount of pollutant, or number of injuries, per BTU of energy flow. Coefficients were taken from the Data Base with an attempt to select the most representative or reasonable estimates for the more aggregated energy flow activities in PRESTO. Resulting totals should give an approximate feeling for the relative burdens to the environment imposed in the different scenarios. It should be noted, however, that it is not possible to establish truly meaningful coefficients at that level of aggregation because the individual technologies vary greatly in their characteristic emissions. (Base case fuel allocations in more detailed studies** were used to arrive at pro-rated coefficients for the highly aggregated PRESTO energy activity variables.)

3. Restart

If the data become hopelessly entangled and confused, the user can restart with the original input data file. Tapes 1 and 2 are rewound and the program branches to the beginning.

4. Write Output File

When a case has been suitably modified, it can be saved on an output file TAPE 3 in the same format as the input file (for future use). Before writing the file, the program requests that a new title line be input. TAPE 3 is overwritten each time this command is executed. It is therefore necessary to exit PRESTO, and catalog the output file in order to preserve a case.

* Energy Modeling Data Base, User's Manual, Energy Environmental Group, M. Goldberg, BNL Report No. 19200.

** Sourcebook, BNL Report No. 50483.

5. Select Print

During modifications, it is sometimes desirable to see portions of the data. The select print option allows any number of energy activity variable index numbers to be specified for quick printout. PRESTO asks how many variables are to be printed and what their indexes are.

example: 4, 37, 38, 42, 50

A special option exists to get a compact printout of all variables:

1, -1

6. Stop

This command terminates the program after rewinding TAPE 1 and TAPE 2.

7. Mode Change

The MODE is initially set in the "delta" mode, but use of this command allows it to be changed at any time.

Operation

Basic familiarity with INTERCOM is assumed.

ATTACH, TAPE 1, DATA, ID = XXX

- A data file like the one shown in Table 5 must be ATTACHed as TAPE 1

ATTACH, TAPE 2, COSTS, ID = XXX

- A costs file (Table 4) must be ATTACHed as TAPE 2.

REQUEST, TAPE 3, *PF

- A permanent file TAPE 3 should be REQUESTed.

ATTACH, PRESTO, ID = XXX

- The program file PRESTO is ATTACHed and executed.

- After stopping PRESTO, output file TAPE 3 can be CATALOGed for future use as an input data file.

TABLE 5
HEALTH & ENVIRONMENTAL EMISSIONS AND EFFECTS COEFFICIENTS

	Energy Activity Index No.	9	8	10	11	12	29	19	33	30	43	42	44
<u>RADIATION</u>													
Population Exposure	10 ³ man-rem	27.0	---	27.0	---	---	---	---	---	---	---	---	---
Kr ⁸⁵ Production	10 ⁶ curies	---	---	24.6	---	---	---	---	---	---	---	---	---
Tritium Production	10 ⁵ curies	1.63	---	8.8	---	---	---	---	---	---	---	---	---
H1 Rad Waste	10 ³ ft ³	---	---	5.5	---	---	---	---	---	---	---	---	---
Spent Blanket	10 ³ ft ³	55.0	---	---	---	---	---	---	---	---	---	---	---
<u>AIR POLLUTION</u>													
CO ₂	10 ⁶ tons	---	---	---	356	302	0.1	---	112.	---	85	85	75
CO	10 ³ tons	---	---	.008	65	0.7	4.0	2.	38	2.5	18	13.4	400
NO _x	"	---	---	1.3	1174	1320	4.8	130.	290	80	43	200	45
SO ₂	"	---	---	---	643	1138	3.4	47.2	603	21.3	113	393	15
Particulates	"	---	---	0.6	66	97	17.2	-11.5	1240	2.9	36	77	62
Hydrocarbons	"	---	---	0.03	19.6	33	2.6	-1.7	19.1	24	18	10	47
Land Use	10 ⁶ acre·yr	0.89	1.07	0.89	0.88	0.87	0.26	-0.05	.0008	0.08	---	---	---
Deaths	#	0.17	---	6.4	4.8	2.4	81	-91	0.4	0.6	---	---	---
Injuries	10 ³	0.017	---	0.2	0.44	0.2	1.6	-0.9	0.03	0.05	---	---	---
Man Days Lost	10 ³	0.33	---	11.2	17.4	8.9	112	-89.	1.05	2.3	---	---	---
Solid Waste	10 ⁶	---	---	3.4	58.7	---	1.0	8.6	.003	0.04	---	---	---

a) Units are per 10¹⁵ BTU per year

b) Negative coefficients give credit for coal transportation effects included in #11 but which do not apply for synfuel production