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A RESIDENTIAL CONSERVATION DATA BASE
FOR THE PACIFIC NORTHWEST
Final Report

A. Usibelli, B. Gardiner, W. Luhrsen,
and A. Meier

November 1983

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A RESIDENTIAL CONSERVATION DATA BASE FOR THE PACIFIC NORTHWEST

FINAL REPORT

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November 1983

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Parts 3 through 5 and Appendixes A through D of this report contain documentation and are not of general interest. They are a separate publication, LBL-18107, and are available from the authors.

ABSTRACT

This report describes and documents a data base of residential electricity conservation measures for the Pacific Northwest and a computer program to manage the data base. In addition, the computer program can aggregate these measures and present region-wide potentials for energy conservation in the form of supply curves of conserved energy. The Bonneville Power Administration (BPA) forecast of residential sector demand in the year 2000 of 7728 average megawatts, could be reduced 42% to approximately 4447 average megawatts if all technically feasible conservation measures costing less than 150 mills were implemented. 87% of the potential savings can be realized at a cost of 40 mills or less.

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This report would not have been possible without the assistance of a number of individuals. Brian O'Regan provided invaluable support in debugging and improving the CPS 2.0 computer model. Robert Clear, Bruce Dickinson, Jeff Harris, and James McMahon, all of the Applied Science Division of the Lawrence Berkeley Laboratory, reviewed the report and provided many important comments. Finally we wish to thank Dave Armstrong, Tim Scanlon, Steve Wright, and Jean Yeats of the Bonneville Power Administration for their assistance with data collection and comments on our work.

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PART ONE
Introduction and Summary Of Results

Introduction

This report describes a residential sector conservation potential data base for the Bonneville Power Administration (BPA) and a computer program to tabulate and assemble the data in forms suitable for planning and forecasting. The project contains the following material:

1. A data base of residential electricity conservation measures, including estimated energy savings per unit and eligible stocks.

2. A computer program that calculates the aggregate potential for conservation, creates "technology cost curves (TCCs)," calculates unit energy consumptions (UECs), and displays the results.

3. Estimates of conservation potential. We have expressed this potential in terms of "supply curves of conserved energy", a technique that shows the potential savings attributed to each conservation measure.

In this section we summarize our key assumptions used in establishing this data base and making our estimates of the conservation potentials. We present a "grand supply curve of conserved electricity" covering all residential end uses with a short comparison with other forecasts. We then present supply curves of conserved electricity for each of the three major end uses: space heating, water heating, and appliances. We discuss briefly the implications of our analysis for each end use.

Part Two presents some important features and limitations of the supply curve approach. An extensive bibliography follows these sections. Volume 2 contains parts Three, Four, and Five with the detailed documentation of enduses and conservation measures for space heating, water heating, and appliances, respectively. Finally, for those interested in the details of the computer model used in our analysis Appendices A through D are included. *

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* Parts Three through Five and Appendices A through D are contained in Volume Two, LBID-843. Volume Two is available from the authors.

There are several unique features of this analysis that will not be seen by the casual reader yet add significantly to the sophistication of the approach and to the flexibility of the computer program. First, we used the Pacific Northwest Residential Energy Survey (Elrick and Lavidge, 1980) to obtain a accurate description of the stock characteristics in the Pacific Northwest. This survey provided detailed information on appliance saturations and energy-related features. By making a series of computerized selections (using SPSS), we constructed a series of "typical" homes for both space and water heating. Thanks to the survey, we also knew what fraction of the total stock each typical case roughly represented. [1]

Second, we designed a subprogram, called Work4, to calculate the energy savings and costs for each typical case, and to combine these results to yield "average" savings and costs. Thus the average energy savings presented in the tables represent a composite of real cases. This feature makes the (often mysterious) UECs and average energy savings more plausible and allows the user to more carefully understand their components.

The computer program CPS 2.0, using Work4, can construct technology cost curves (TCCs) for end uses. Many forecasting models (including BPA's version of the ORNL model) require technology cost curves in order to operate. Updating the TCCs has always been difficult, so the curves are often obsolete. There is, to our knowledge, no other program capable of generating these curves for prototype case data.

The energy savings for many conservation measures critically depend on the measures already implemented. We have incorporated a feature in CPS 2.0 that uses Work4 to re-estimate the savings attributed to each space and water-heating measure if new assumptions are introduced. Work4 is used as a space heating and a water heating simulation model. In addition, we have included condensed weather data for all of the

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[1] In our work with the Survey we identified a number of inconsistencies and data gaps. These problems are discussed in the appropriate documentation sections, below.

major climate zones in the Pacific Northwest.

We believe that we have designed a flexible data base in which additional conservation measures can be easily added (and obsolete ones removed). Existing measures can also be updated as better information becomes available.

Finally, we want to report an analytical failure. We had hoped to use the billing data from the Regional Survey to validate our (and BPA's) baseline assumptions. We constructed several computer programs to compile and tabulate the data, and delete cases with missing elements or incorrect entries. Unfortunately, the number of remaining cases, after deleting those with missing values or obvious errors, was insufficient to yield statistically valid estimates. (These computer programs are not documented in this report, but are available to BPA on request.)

Key Assumptions

In producing these results we have made a number of critical assumptions. Many of these assumptions were established by BPA at the beginning of our project. Those readers not familiar with the supply curve of conserved energy approach or the BPA version of the Oak Ridge National Laboratory (ORNL) Model should refer to Part Two of this report. Each assumption is discussed at the point in our analysis where it was needed, but we summarize them here to remind the reader.

- The discount rate is 3%, expressed in real dollars, i.e., in addition to an assumed general inflation rate.
- Unless explicitly stated otherwise (and explained), all conservation measure costs are contractor costs.
- No utility or government program administrative costs are included.
- Growth of stock and stock characteristics, i.e., saturations, replacement rates, single-family/multifamily proportions, etc. are those listed in the BPA 1982 forecast (BPA, August 1982, Appendix 1). Only occupied houses are considered in our analysis.

- With the exception of some solar measures, there is no fuel switching.

- All prices, unless otherwise indicated are in 1980 dollars.

- Most initial stock characteristics are based on the material contained in the Pacific Northwest Residential Survey (Elrick and Lavidge, 1980).

- No constraints other than physical limitations (i.e., no space to add attic insulation) are included in the eligible fractions determination.

- The conservation potential reflects only changes in efficiency and not changes in the "level of service" or amenity provided by an enduse, i.e., thermostat settings or number of rooms heated.

- The conservation potential displayed in the curves shows potential savings compared to the "frozen efficiency" level, **not** the baseline forecast.

- As requested by BPA, we used a cost of conserved electricity of 15 cents/kWh as the cut-off for non-economic measures. The supply curve approach makes it easy to consider other cut-off prices.

- The supply curves are **not** adjusted for changes in space heating internal gains resulting from more efficient appliances. (Estimates of these effects are presented in Section III page 9 et seq.).

The Grand Supply Curve of Conserved Residential Electricity

We have analyzed 336 residential conservation measures and gathered critical technical, economic and stock data on each. We used the computer program, CPS 2.0, to tabulate the overall technical potential for conservation in the year 2000 (and intermediate years) resulting from the implementation of these measures.

Figure I-1 shows three possible residential electricity futures in the BPA region. The middle line is the BPA 1982 residential forecast. The lower line is the technical potential estimated in this report using a cost of conserved electricity of 15 cents/kWh as the cut-off price for economic measures. The upper line in Figure I-1 is the "frozen efficiencies" projection from which we based our estimates of conservation potential (Please refer to Part Two for an important discussion of the frozen efficiencies projection.) Table I-1 summarizes the three projections for the total consumption and by each end use.[2]

Our estimate of 1990 residential consumption using technologically feasible conservation measures is 37% below the BPA forecast, and 42% below the 2000 forecast. We assume that all conservation measures that have CCEs less than 15 cents/kWh are implemented. Residential electricity consumption in the Pacific Northwest could actually **decline** if these measures were implemented.

The measures that will achieve these enormous savings are shown in the grand supply curve and its associated tables (Figure I-2 and Table I-2 and I-3). There, the year 2000 savings attributed to each conservation measure are plotted and listed. Note that the savings are based on the unvintaged, frozen efficiency projection, **not** the BPA forecast. While we used 15 cents/kWh as the cut-off price, 85% of the potential

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[2] The 1980 "frozen efficiency", forecast, and potential energy use values differ slightly. The small disparity between the frozen and forecast cases is due to minor variations in the ORNL residential model runs from the 1979 base year. The 1980 potential value is lower because of small variations in our specifications of the existing space heating, water heating, and appliance stocks. Refer to Parts 3,4, and 5 for additional details.

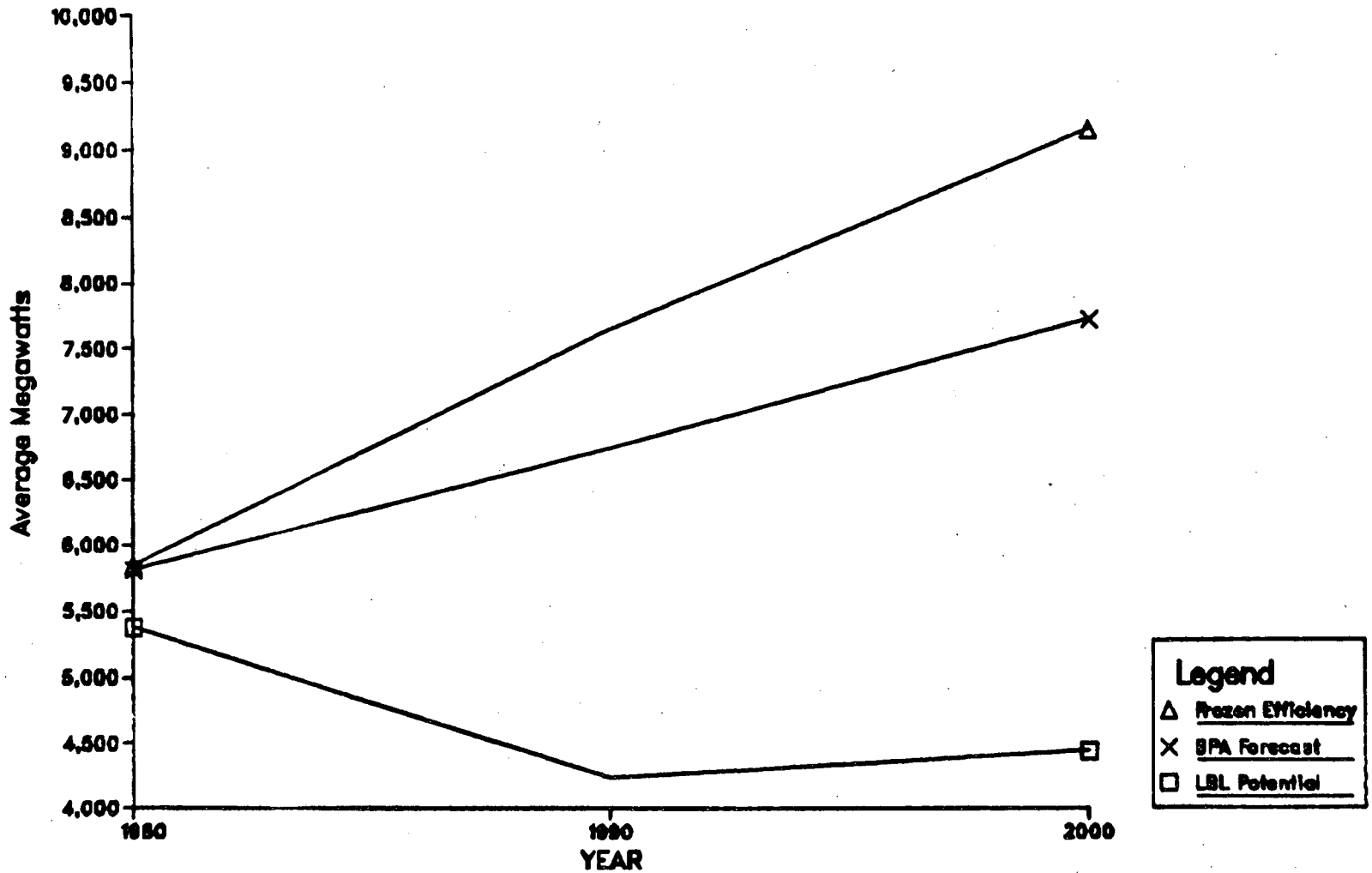

Figure I-1 Comparison of 'Frozen Efficiency', BPA Forecast, and LBL Potential

Source: Table I-1

Table I-1
Pacific Northwest Residential Sector- Electricity

"Frozen Efficiency", Forecast, and LBL Potential Model Runs

(Annual Electricity Use in Average Megawatts)

Sector	1980				1990				2000			
	Frozen	Forecast	Potential*	% Diff**	Frozen	Forecast	Potential*	% Diff**	Frozen	Forecast	Potential*	% Diff**
Space Heat* **	1873	1860	1618	13%	2654	2243	1072	52%	3252	2556	1364	47%
Water Heat** **	1228	1221	1089	11%	1391	1169	963	18%	1548	1292	194	85%
Appliance and Other	2743	2732	2666	2%	3600	3333	2779	17%	4359	3880	2827	27%
Total	5844	5813	5377	8%	7645	6745	4245	37%	9159	7728	4447	42%

* The LBL Potential value is the Frozen Efficiency minus the difference of columns F and G in the enduse tables (I-2, I-4, I-6, and I-8). For example, the year 2000 total of 4447 average megawatts (38.9 Twh) is the Frozen Efficiency of 9159 average megawatts (80.2 Twh) minus the difference of Table I-2 column F (68.4 Twh) and Column G (27.0 Twh).

** Percentage difference between the BPA Forecast and the LBL Potential.

*** Note that these tables do **not** include adjustments in space heating energy use for decreased internal gains due to more efficient water heaters and appliances. We estimate that the **maximum** effect of these changes will be an increase in space heating requirements of approximately 560 average megawatts in the year 2000. For more details refer to Section III, page 9 and Table III-3.

**** The Frozen Efficiency projection may be incorrectly low due to an error by BPA in estimating electric water heating saturations. This results in a exaggerated savings potential and low estimate for the LBL potential (see Section II, below)

An "Average Megawatt" is a Megawatt-year or 8760 Megawatt-hours.

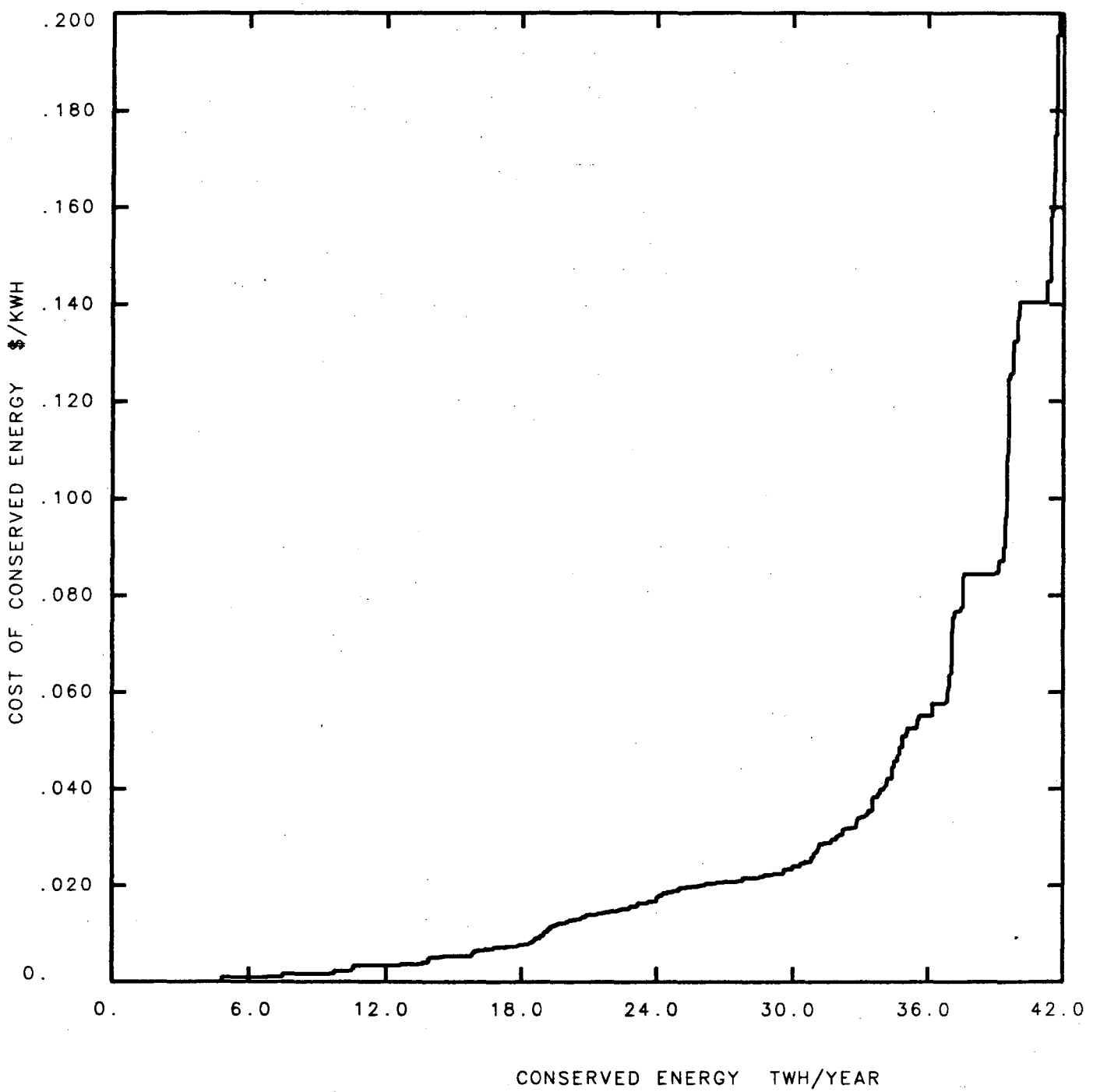

Figure I-2 Grand Residential Conservation Supply Curve for 2000

Source: Table I-3, Column I

Table I-2 Grand Supply Curve End Uses (2000)

2000 ENDUSE TABLE

(A) END USE DESCRIPTION	(B) ID CODE	(C) TOTAL STOCK (1000S)	(D) ADD RATE	(E) DECAY OR REPLACE RATE	(F) BASELINE UEC (KWH/YR)	(F) BASELINE USAGE (GWH)	(G) POTENTIAL UEC (KWH/YR)	(G) POTENTIAL USAGE (GWH)	(H) WORK4 USED	(I) LAST UPDATE
WATER HEATING SINGLE FAMILY	EE34000E00	2845.	.019	-0.	4515.	12844.3	1182.	3361.9	1	8-82
WATER HEATING MF	EE35000E00	415.	.018	-0.	2730.	1131.6	955.	395.8	1	8-82
WATER HEATING MH	EE31000E00	416.	.038	-0.	4225.	1756.8	1166.	484.8	1	8-82
SUBTOTAL		3675.			4281.	15732.8	1154.	4242.5		
REFRIGERATORS-SINGLE DOOR MANUAL	EE40001E00	567.	.010	-0.	750.	425.2	377.	213.9	0	1-83
REFRIGERATORS-PARTIAL AUTO DEFROST	EE40002E00	1435.	.020	-0.	1300.	1865.9	492.	706.7	0	1-83
REFRIGERATORS-TOP MOUNT FREEZER	EE40003E00	2450.	.023	-0.	1825.	4471.9	726.	1778.1	0	1-83
REFRIGERATORS-SIDE BY SIDE,AUTO.DEFROST	EE40004E00	555.	.020	-0.	2650.	1470.0	1009.	560.0	0	1-83
REFRIGERATORS-BOTTOM FREEZER,AUTO DEF.	EE40005E00	176.	.020	-0.	2800.	492.3	839.	147.5	0	1-83
SUBTOTAL		5183.			1683.	8725.4	657.	3406.2		
FREEZERS-CHEST MANUAL DEFROST	EE50001E00	881.	.016	-0.	1475.	1298.9	575.	506.8	0	1-83
FREEZERS-UPRIGHT AUTOMATIC DEFROST	EE50002E00	535.	.016	-0.	3100.	1657.0	1043.	557.7	0	1-83
FREEZERS-UPRIGHT MANUAL DEFROST	EE50003E00	783.	.016	-0.	1750.	1370.2	685.	536.4	0	1-83
SUBTOTAL		2198.			1968.	4326.1	728.	1600.9		
COOKING-ELECTRIC RANGES & OVENS	EE60001E00	4171.	.020	-0.	755.	3149.2	663.	2766.8	0	9-82
SUBTOTAL		4171.			755.	3149.2	663.	2766.8		
TELEVISIONS-COLOR	EE80001E00	4708.	.025	-0.	600.	2824.7	200.	941.6	0	9-82
TELEVISIONS-BLACK & WHITE	EE80002E00	1818.	.010	-0.	200.	363.6	25.	45.4	0	9-82
CLOTHES DRYER-ELECTRIC	EE80003E00	3554.	.026	-0.	1000.	3553.8	796.	2828.8	0	2-83
CLOTHES WASHERS	EE80004E00	3483.	.020	-0.	100.	348.3	100.	348.3	0	9-82
DISHWASHERS	EE80005E00	3416.	.041	-0.	175.	597.8	175.	597.8	0	2-83
SUBTOTAL		16978.			453.	7688.1	280.	4761.9		
WELL WATER PUMPS	EE90001E00	465.	.020	-0.	300.	139.6	220.	102.4	0	9-82
WATERBED HEATERS	EE90003E00	670.	.020	-0.	1400.	937.9	1120.	750.3	0	9-82
SUBTOTAL		1135.			949.	1077.5	751.	852.7		
SPACE HEATING MOBILE HOME-NEW ZONE 1	EN11100E00	164.	.038	.042	5949.	973.1	1032.	168.7	1	2-83
SPACE HEATING MOBILE HOME-NEW ZONE 2	EN11200E00	141.	.038	.042	9860.	1388.2	2160.	304.1	1	2-83
SPACE HEATING MOBILE HOME-NEW ZONE 3	EN11300E00	25.	.038	.042	13575.	337.3	3839.	95.4	1	2-83
SUBTOTAL		329.			8197.	2698.6	1726.	568.3		
SPACE HEATING MOBILE HOME-OLD ZONE 1	EO11100E00	9.	-0.	.042	7760.	72.3	2180.	20.3	1	2-83
SPACE HEATING MOBILE HOME-OLD ZONE 2	EO11200E00	8.	-0.	.042	10549.	84.6	1882.	15.1	1	2-83
SPACE HEATING MOBILE HOME-OLD ZONE 3	EO11300E00	1.	-0.	.042	14145.	20.0	2587.	3.7	1	2-83
SUBTOTAL		19.			9435.	177.0	2083.	39.1		
SPACE HEATING M.F.-NEW ZONE 1	EN15100E00	178.	.018	.018	6347.	1130.7	763.	135.9	1	2-83
SPACE HEATING M.F.-NEW ZONE 2	EN15200E00	47.	.018	.018	8696.	412.6	2048.	97.2	1	2-83
SPACE HEATING M.F.-NEW ZONE 3	EN15300E00	2.	.018	.018	11186.	27.9	3279.	8.2	1	2-83
SUBTOTAL		228.			6889.	1571.3	1058.	241.3		
SPACE HEATING M.F.-OLD ZONE 1	EO15100E00	133.	-0.	.018	6108.	813.0	1194.	159.0	1	2-83
SPACE HEATING M.F.-OLD ZONE 2	EO15200E00	35.	-0.	.018	8869.	314.4	2355.	83.5	1	2-83
SPACE HEATING M.F.-OLD ZONE 3	EO15300E00	2.	-0.	.018	8452.	15.8	2390.	4.5	1	2-83
SUBTOTAL		170.			6708.	1143.2	1449.	246.9		

SPACE HEATING SFD-NEW ZONE 1	EN12100E00	281.	.018	.018	9304.	2610.2	1861.	522.0	1	2-83
SPACE HEATING SFD-NEW ZONE 2	EN12200E00	211.	.018	.018	10815.	2286.8	3370.	712.7	1	2-83
SPACE HEATING SFD-NEW ZONE 3	EN12300E00	41.	.018	.018	13316.	543.2	3913.	159.6	1	2-83
SUBTOTAL		533.			10211.	5440.1	2617.	1394.3		
SPACE HEATING SFD-OLD ZONE 1	E012100E00	210.	-0.	.018	11356.	2380.4	5425.	1137.2	1	2-83
SPACE HEATING SFD-OLD ZONE 2	E012200E00	158.	-0.	.018	19442.	3071.6	9859.	1557.5	1	2-83
SPACE HEATING SFD-OLD ZONE 3	E012300E00	30.	-0.	.018	21028.	640.9	11257.	343.1	1	2-83
SUBTOTAL		398.			15306.	6092.9	7631.	3037.8		
SPACE HEATING SFA-NEW ZONE 1	EN13100E00	214.	.022	.018	7142.	1531.5	679.	145.6	1	2-83
SPACE HEATING SFA-NEW ZONE 2	EN13200E00	97.	.022	.018	8294.	801.9	1604.	155.1	1	2-83
SPACE HEATING SFA-NEW ZONE 3	EN13300E00	47.	.022	.018	10489.	492.0	2550.	119.6	1	2-83
SUBTOTAL		358.			7892.	2825.5	1174.	420.4		
SPACE HEATING SFA-OLD ZONE 1	E013100E00	139.	-0.	.018	9000.	1254.0	2888.	402.3	1	2-83
SPACE HEATING SFA-OLD ZONE 2	E013200E00	63.	-0.	.018	21000.	1319.3	4591.	288.4	1	2-83
SPACE HEATING SFA-OLD ZONE 3	E013300E00	30.	-0.	.018	30000.	914.3	8128.	247.7	1	2-83
SUBTOTAL		233.			14992.	3487.6	4034.	938.5		
LIGHTING-SINGLE FAMILY, NEW	EN74000E00	2137.	.020	.018	1000.	2136.8	561.	1197.9	0	2-83
LIGHTING-MULTI FAMILY, NEW	EN75000E00	272.	.018	.018	750.	204.2	401.	109.0	0	2-83
LIGHTING-MOBILE HOME, NEW	EN71000E00	480.	.038	.042	600.	288.2	367.	176.1	0	2-83
SUBTOTAL		2889.			910.	2629.1	513.	1483.1		
LIGHTING-SINGLE FAMILY, OLD	E074000E00	1487.	-0.	.018	1000.	1487.2	578.	859.3	0	2-83
LIGHTING-MULTI FAMILY, OLD	E075000E00	203.	-0.	.018	750.	152.5	443.	90.1	0	2-83
LIGHTING-MOBILE HOME, OLD	E071000E00	27.	-0.	.042	600.	16.4	375.	10.3	0	2-83
SUBTOTAL		1718.			964.	1656.2	559.	959.6		
TOTAL		40216.				68420.5		26960.2		

Note: Column headings for all Enduse and Conservation Measure Tables are descibed in Appendix C, Volume 2.

Table I-3 Grand Supply Curve Conservation Measures (2000)

	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)
1	SF-TEMPERATURE SETBACK TO 140 DEGREES	ME34000E00	1	0.	349.	13	.400	0.	397.7	.4	45.4
2	MH-TEMPERATURE SETBACK TO 120 DEGREES	ME31000E00	9	0.	549.	13	.600	0.	136.9	.5	61.0
3	MF-TEMPERATURE SETBACK TO 140 DEGREES	ME35000E00	1	0.	80.	13	.440	0.	14.6	.5	62.7
4	MH-TEMPERATURE SETBACK TO 140 DEGREES	ME31000E00	1	0.	202.	13	.400	0.	33.6	.6	66.5
5	SF-COLD WATER LAUNDRY	ME34000E00	5	0.	548.	10	.765	0.	1193.4	1.8	202.8
6	TELEVISIONS-COLOR,SOLID STATE IMPROVE.	ME80001E00	1	0.	400.	10	1.000	0.	1883.1	3.7	417.8
7	MF-COLD WATER LAUNDRY	ME35000E00	5	0.	422.	10	.108	0.	18.9	3.7	419.9
8	MH-COLD WATER LAUNDRY	ME31000E00	5	0.	441.	10	.720	0.	132.1	3.8	435.0
9	SF-TEMPERATURE SETBACK TO 120 DEGREES	ME34000E00	9	0.	596.	13	.400	0.	678.1	4.5	512.4
10	MF-TEMPERATURE SETBACK TO 120 DEGREES	ME35000E00	9	0.	414.	13	.460	0.	78.9	4.6	521.4
11	TELEVISION-B & W,SOLID STATE IMPROVEMENT	ME80002E00	1	0.	150.	10	1.000	0.	272.7	4.8	552.6
12	REFRIG.-SIDE BY SIDE,BUY EFF. MKT MODEL	ME40004E00	1	16.	1290.	19	1.000	.001	715.6	5.6	634.2
13	FREEZER-UPRIGHT AUTO,BUY EFF. MKT.MDL	ME50002E00	1	25.	1860.	21	1.000	.001	994.2	6.5	747.7
14	REFRIG.-BOTTOM FREEZER,BUY EFF. MODEL	ME40005E00	1	19.	1485.	19	1.000	.001	261.1	6.8	777.5
15	FREEZER-CHEST MANUAL,BUY EFF. MKT MODEL	ME50001E00	1	12.	770.	21	1.000	.001	678.1	7.5	855.0
16	REFRIG.-TOP FREEZE-EFF.MKT MODEL/CPES	ME40003E00	1	22.	910.	19	1.000	.002	2229.8	9.7	1109.5
17	FREEZER-UPRIGHT MAN.,BUY EFF.MKT MODEL	ME50003E00	1	33.	975.	21	1.000	.002	763.4	10.5	1196.7
18	REFRIG.-BOTTOM FREEZER,CPES IMPROVEMENT	ME40005E00	2	11.	325.	19	1.000	.002	48.1	10.5	1202.2
19	REFRIG.-SIDE BY SIDE,CPES IMPROVEMENTS	ME40004E00	2	4.	110.	19	1.000	.003	51.4	10.6	1208.0
20	MH-LOW FLOW SHOWRHEADS	ME31000E00	4	40.	813.	20	.850	.003	287.3	10.9	1240.8
21	SF-LOW FLOW SHOWERHEADS	ME34000E00	4	40.	781.	20	.800	.003	1777.5	12.6	1443.7
22	REFRIG.-PARTIAL AUTO,EFF. MKT MODEL/CPES	ME40002E00	1	35.	675.	19	1.000	.004	968.9	13.6	1554.3
23	SPACE HEAT-SFA,OLD CEIL INSL ADD R49 Z3	MO13300E00	4	994.	12811.	30	.680	.004	265.5	13.9	1584.7
24	SPACE HEAT-MF,NEW FLOOR INSL ADD R11 Z3	MN15300E00	6	200.	2339.	30	1.000	.004	5.8	13.9	1585.3
25	SPACE HEAT-SFA,OLD DUCT INSULATION Z3	MO13300E00	12	250.	2780.	30	.092	.005	7.8	13.9	1586.2
26	FREEZER-CHEST MANUAL,CPES IMPROVEMENTS	ME50001E00	2	13.	170.	21	1.000	.005	114.1	14.0	1599.2
27	MH-WATER HEATER WRAP - WALLS	ME31000E00	2	25.	584.	10	.550	.005	133.6	14.1	1614.5
28	FREEZER-UPRIGHT AUTO,CPES IMPROVEMENTS	ME50002E00	2	20.	258.	21	1.000	.005	105.1	14.2	1626.5
29	MF-LOW FLOW SHOWERHEADS	ME35000E00	4	40.	532.	20	.820	.005	180.9	14.4	1647.1
30	SPACE HEAT-SFD,OLD CEIL INSL ADD R49 Z3	MO12300E00	4	821.	8006.	30	.160	.005	39.0	14.5	1651.6
31	SPACE HEAT-MF,NEW FLOOR INSL ADD R11 Z2	MN15200E00	6	200.	1945.	30	1.000	.005	92.3	14.6	1662.1
32	SF-WATER HEATER WRAP - WALLS	ME34000E00	2	25.	547.	10	.800	.005	1245.6	15.8	1804.3
33	SPACE HEAT-SFA,OLD DUCT INSULATION Z2	MO13200E00	13	270.	2420.	30	.101	.006	15.3	15.8	1806.1
34	SPACE HEAT-SFD,OLD DUCT INSULATION Z3	MO12300E00	16	250.	2179.	30	.026	.006	1.7	15.8	1806.3
35	WATERBED,COMFORTER COVER	ME90003E00	2	20.	400.	10	.300	.006	80.4	15.9	1815.4
36	MF-WATER HEATER WRAP - WALLS	ME35000E00	2	25.	457.	10	.880	.006	166.6	16.1	1834.5
37	SPACE HEAT-SFA,OLD CEIL INSL ADD R49 Z2	MO13200E00	4	994.	7848.	30	.611	.006	301.2	16.4	1868.8
38	FREEZER-UPRIGHT MAN.,CPES IMPROVEMENTS	ME50003E00	2	12.	118.	21	1.000	.007	70.4	16.4	1876.9
39	SPACE HEAT-MF,NEW 1-2 GLAZING Z1	MN15100E00	1	200.	1691.	25	1.000	.007	301.3	16.7	1911.3
40	SPACE HEAT-MH,OLD WALL INSL. ADD R11 Z2	MO11200E00	7	400.	3272.	25	1.000	.007	26.3	16.8	1914.3
41	SPACE HEAT-SFD,NEW 1-2 GLAZING Z1	MN12100E00	1	292.	2375.	25	.800	.007	532.9	17.3	1975.1
42	SPACE HEAT-MF,OLD FLOOR INSL ADD R8 Z2	MO15200E00	6	200.	1439.	30	1.000	.007	51.0	17.4	1980.9
43	SPACE HEAT-MF,OLD FLOOR INSL ADD R8 Z3	MO15300E00	6	200.	1421.	30	1.000	.007	2.7	17.4	1981.2
44	SPACE HEAT-SFD,OLD DUCT INSULATION Z2	MO12200E00	17	281.	1971.	30	.050	.007	15.6	17.4	1983.0
45	SPACE HEAT-SFA,NEW 1-2 GLAZING Z1	MN13100E00	1	271.	2124.	25	1.000	.007	455.4	17.8	2035.0
46	SPACE HEAT-MF,OLD CEIL INSL. ADD R11 Z2	MO15200E00	3	160.	1070.	30	1.000	.008	38.0	17.9	2039.3
47	SPACE HEAT-SFD,OLD CEIL INSL. ADD R49 Z2	MO12200E00	4	1067.	7125.	30	.211	.008	237.5	18.1	2066.5
48	SPACE HEAT-MF,OLD CEIL INSL. ADD R11 Z3	MO15300E00	3	160.	1053.	30	1.000	.008	2.0	18.1	2066.7
49	SPACE HEAT-MF,NEW FLOOR INSL ADD R11 Z1	MN15100E00	6	200.	1303.	30	1.000	.008	232.1	18.3	2093.2
50	SPACE HEAT-SFD,OLD HEAT PUMP 2 Z3	MO12300E00	15	250.	2604.	15	.032	.008	2.5	18.3	2093.5

	(A) MEASURE DESCRIPTION		(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)
51	SPACE HEAT-SFA,OLD CEIL INSL ADD R38	Z2	MO13200E00	5	833.	5212.	30	.274	.008	89.7	18.4	2103.7
52	SPACE HEAT-SFA,OLD DUCT INSULATION	Z1	MO13100E00	15	239.	1490.	30	.100	.008	20.7	18.4	2106.1
53	SPACE HEAT-SFD,OLD HEAT PUMP 2	Z2	MO12200E00	16	250.	2549.	15	.063	.008	25.4	18.5	2109.0
54	REFRIG.-SINGLE DOOR,BUY EFF. MKT. MODEL		ME40001E00	1	22.	180.	19	1.000	.009	102.0	18.6	2120.6
55	SPACE HEAT-MH,OLD FLOOR INSL ADD R19	Z3	MO11300E00	5	430.	2857.	25	1.000	.009	4.0	18.6	2121.1
56	SPACE HEAT-SFD,OLD FLOOR INSL ADD R19	Z3	MO12300E00	11	787.	4421.	30	.287	.009	38.6	18.6	2125.5
57	COOKING-ELEC.RANGES/OVENS, BI-RAD. OVEN		ME60001E00	2	25.	200.	18	.300	.009	194.7	18.8	2147.7
58	SPACE HEAT-MH,OLD WALL INSL. ADD R11	Z3	MO11300E00	7	400.	2501.	25	1.000	.009	3.5	18.8	2148.1
59	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z1	MO15100E00	6	200.	1069.	30	1.000	.010	142.2	19.0	2164.3
60	SPACE HEAT-MF,NEW CEIL INSL ADD R11	Z2	MN15200E00	4	160.	828.	30	1.000	.010	39.3	19.0	2168.8
61	SPACE HEAT-SFA,OLD CEIL.INSL ADD R49	Z1	MO13100E00	4	994.	4970.	30	.070	.010	48.5	19.0	2174.4
62	SPACE HEAT-MF,OLD CEIL INSL. ADD R11	Z1	MO15100E00	3	160.	787.	30	1.000	.010	104.8	19.2	2186.3
63	SPACE HEAT-MF,NEW 1-2 GLAZING	Z3	MN15300E00	1	200.	1100.	25	1.000	.010	2.7	19.2	2186.6
64	SPACE HEAT-SFA,NEW INSULATE DOOR	Z3	MN13300E00	8	200.	962.	30	.500	.011	22.6	19.2	2189.2
65	REFRIG.-SINGLE DOOR,CPES IMPROVEMENTS		ME40001E00	2	18.	115.	19	1.000	.011	54.9	19.2	2195.5
66	SPACE HEAT-MH,OLD WALL INSL. ADD R11	Z1	MO11100E00	7	400.	2073.	25	1.000	.011	19.3	19.3	2197.7
67	SPACE HEAT-SFA,OLD FLOOR INSL ADD R19	Z3	MO13300E00	7	690.	3124.	30	1.000	.011	95.2	19.3	2208.6
68	SPACE HEAT-MH,NEW FLOOR INSL ADD R9	Z3	MN11300E00	6	195.	964.	25	1.000	.012	24.0	19.4	2211.3
69	WATERBED,INSULATE SIDES/BOTTOM		ME90003E00	1	20.	200.	10	.800	.012	107.2	19.5	2223.5
70	SPACE HEAT-SFD,OLD CEIL INSL ADD R38	Z3	MO12300E00	5	750.	3262.	30	.448	.012	44.5	19.5	2228.6
71	SPACE HEAT-MH,NEW REDUCE INF 0.3 ACH	Z3	MN11300E00	5	381.	2703.	15	1.000	.012	67.1	19.6	2236.3
72	SPACE HEAT-MF,NEW CEIL.INSL. ADD R11	Z3	MN15300E00	4	160.	688.	30	1.000	.012	1.7	19.6	2236.5
73	SPACE HEAT-SFA,NEW INSULATE DOOR	Z2	MN13200E00	8	200.	847.	30	.500	.012	41.0	19.6	2241.2
74	SPACE HEAT-MH,NEW INSULATE DOOR	Z3	MN11300E00	7	200.	947.	25	1.000	.012	23.5	19.7	2243.8
75	SPACE HEAT-SFD,OLD CEIL INSL ADD R49	Z1	MO12100E00	4	986.	4104.	30	.354	.012	304.5	20.0	2278.6
76	SPACE HEAT-SFA,NEW REDUCE INF 0.25ACH	Z3	MN13300E00	6	380.	2559.	15	1.000	.012	120.0	20.1	2292.3
77	SPACE HEAT-SFD,OLD DUCT INSULATION	Z1	MO12100E00	17	268.	1091.	30	.010	.013	2.3	20.1	2292.6
78	SPACE HEAT-SFD,NEW HEAT PUMP 2	Z3	MN12300E00	9	500.	3314.	15	.500	.013	67.6	20.1	2300.3
79	SPACE HEAT-MH,OLD FLOOR INSL ADD R19	Z2	MO11200E00	5	430.	1934.	25	1.000	.013	15.5	20.2	2302.1
80	SPACE HEAT-SFD,OLD FLOOR INSL ADD R19	Z2	MO12200E00	12	773.	3079.	30	.202	.013	98.1	20.3	2313.3
81	SPACE HEAT-SFD,NEW INSULATE DOOR	Z3	MN12300E00	7	200.	796.	30	.500	.013	16.2	20.3	2315.1
82	SPACE HEAT-SFA,OLD FLOOR INSL ADD R19	Z2	MO13200E00	8	613.	2421.	30	1.000	.013	152.1	20.4	2332.5
83	SPACE HEAT-SFD,OLD REDUCE INF 0.2 ACH	Z3	MO12300E00	10	381.	2451.	15	1.000	.013	74.7	20.5	2341.0
84	SPACE HEAT-MF,NEW 1-2 GLAZING	Z2	MN15200E00	1	200.	881.	25	1.000	.013	41.8	20.5	2345.8
85	SPACE HEAT-SFA,OLD HEAT PUMP 2	Z3	MO13300E00	11	500.	3205.	15	.090	.013	8.8	20.6	2346.8
86	SPACE HEAT-SFD,NEW REDUCE INF 0.25 ACH	Z3	MN12300E00	5	381.	2418.	15	1.000	.013	98.6	20.7	2358.0
87	SPACE HEAT-SFA,NEW 1-2 GLAZING	Z3	MN13300E00	1	240.	1041.	25	1.000	.013	48.8	20.7	2363.6
88	SPACE HEAT-SFD,OLD WALL INSL R11-FILL	Z2	MO12200E00	9	761.	2878.	30	.234	.013	106.4	20.8	2375.8
89	SPACE HEAT-SFD,NEW INSULATE DOOR	Z2	MN12200E00	7	200.	754.	30	.500	.014	79.7	20.9	2384.9
90	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z3	MN15300E00	7	301.	1131.	30	1.000	.014	2.8	20.9	2385.2
91	SPACE HEAT-SFD,NEW REDUCE INF 0.25 ACH	Z2	MN12200E00	5	381.	2289.	15	1.000	.014	484.0	21.4	2440.4
92	SPACE HEAT-SFA,NEW REDUCE INF 0.25ACH	Z2	MN13200E00	6	380.	2234.	15	1.000	.014	216.0	21.6	2465.1
93	SPACE HEAT-MH,NEW FLOOR INSL ADD R9	Z2	MN11200E00	6	195.	780.	25	1.000	.014	109.8	21.7	2477.6
94	SPACE HEAT-SFD,OLD CEIL INSL. ADD R38	Z2	MO12200E00	5	769.	2709.	30	.486	.014	208.0	21.9	2501.4
95	SPACE HEAT-SFA,OLD REDUCE INF 0.2 ACH	Z3	MO13300E00	6	381.	2193.	15	1.000	.015	66.8	22.0	2509.0
96	SPACE HEAT-MH,NEW REDUCE INF 0.3 ACH	Z2	MN11200E00	5	381.	2179.	15	1.000	.015	306.7	22.3	2544.0
97	SPACE HEAT-MF,NEW CEIL INSL. ADD R10	Z1	MN15100E00	4	160.	545.	30	1.000	.015	97.1	22.4	2555.1
98	SPACE HEAT-MH,NEW INSULATE DOOR	Z2	MN11200E00	7	200.	764.	25	1.000	.015	107.6	22.5	2567.4
99	SF-EFFICIENT DISHWASHER		ME34000E00	7	30.	231.	10	.500	.015	328.5	22.8	2604.9
100	SPACE HEAT-MH,OLD DUCT INSULATION	Z3	MO11300E00	9	250.	925.	25	1.000	.016	1.3	22.8	2605.0

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101	SPACE HEAT-MF,NEW REDUCE INFL 0.25ACH Z3	MN15300E00	5	381.	2039.	15	1.000	.016	5.1	22.8	2605.6
102	SPACE HEAT-SFA,NEW CEIL INSL ADD R38 Z1	MN13100E00	4	408.	1328.	30	1.000	.016	284.7	23.1	2638.1
103	SPACE HEAT-SFA,OLD CEIL.INSL ADD R38 Z1	MO13100E00	5	833.	2694.	30	.129	.016	48.4	23.2	2643.7
104	SPACE HEAT-SFD,OLD WALL INSL R11-FILL Z3	MO12300E00	8	813.	2605.	30	.175	.016	13.9	23.2	2645.2
105	SPACE HEAT-SFA,OLD HEAT PUMP 2 Z2	MO13200E00	12	500.	2569.	15	.038	.016	6.1	23.2	2645.9
106	SPACE HEAT-SFD,NEW CEIL.INSL ADD R38 Z1	MN12100E00	4	457.	1424.	30	1.000	.016	399.4	23.6	2691.5
107	SPACE HEAT-SFA,NEW FLOOR INSL ADD R11 Z3	MN13300E00	7	372.	1159.	30	1.000	.016	54.4	23.6	2697.7
108	SPACE HEAT-SFD,OLD REDUCE INF 0.2 ACH Z2	MO12200E00	11	381.	1907.	15	1.000	.017	301.3	23.9	2732.1
109	SPACE HEAT-MF,NEW FLOOR INSL ADD R11 Z2	MN15200E00	7	301.	915.	30	1.000	.017	43.4	24.0	2737.1
110	MH-EFFICIENT DISHWASHER	ME31000E00	7	30.	209.	10	.400	.017	34.8	24.0	2741.1
111	SPACE HEAT-SFA,OLD CEIL INSL ADD R30 Z2	MO13200E00	6	618.	1791.	30	.115	.018	12.9	24.0	2742.6
112	SPACE HEAT-SFA,OLD 1-2 GLAZING Z2	MO13200E00	1	733.	2383.	25	.572	.018	85.6	24.1	2752.3
113	SPACE HEAT-SFA,NEW WALL INSL ADD R12 Z3	MN13300E00	5	515.	1465.	30	1.000	.018	68.7	24.2	2760.2
114	SPACE HEAT-SFD,OLD FLOOR INSL ADD R19 Z1	MO12100E00	12	731.	2078.	30	.203	.018	88.2	24.3	2770.2
115	SPACE HEAT-MH,OLD FLOOR INSL ADD R19 Z1	MO11100E00	5	430.	1352.	25	1.000	.018	12.6	24.3	2771.7
116	SPACE HEAT-MH,NEW CEIL.INSL. ADD R16 Z3	MN11300E00	3	425.	1330.	25	1.000	.018	33.1	24.3	2775.5
117	SF-INSULATING BOTTOM BOARD	ME34000E00	3	10.	64.	10	1.000	.018	181.2	24.5	2796.1
118	SPACE HEAT-SFD,NEW FLOOR INSL ADD R11 Z3	MN12300E00	6	416.	1141.	30	1.000	.019	46.6	24.5	2801.5
119	SPACE HEAT-SFA,OLD FLOOR INSL ADD R19 Z1	MO13100E00	10	526.	1438.	30	1.000	.019	200.4	24.7	2824.3
120	SPACE HEAT-SFA,NEW FLOOR INSL ADD R11 Z2	MN13200E00	7	372.	1009.	30	1.000	.019	97.6	24.8	2835.5
121	SPACE HEAT-MH,OLD DOOR INSLATION Z3	MO11300E00	6	250.	763.	25	1.000	.019	1.1	24.8	2835.6
122	SPACE HEAT-SFA,NEW 1-2 GLAZING Z2	MN13200E00	1	271.	826.	25	1.000	.019	79.9	24.9	2844.7
123	SPACE HEAT-SFA,NEW INSULATE DOOR Z1	MN13100E00	8	200.	536.	30	.500	.019	57.5	25.0	2851.3
124	REFRIG.-BOTTOM FREEZER,1987 IMPROVEMENT	ME40005E00	3	75.	275.	19	1.000	.019	35.6	25.0	2855.3
125	SPACE HEAT-MH,NEW WALL INSL ADD R7 Z3	MN11300E00	4	615.	1820.	25	1.000	.019	45.2	25.1	2860.5
126	SPACE HEAT-SFA,OLD CEIL INSL ADD R38 Z3	MO13300E00	5	833.	2171.	30	.320	.020	21.2	25.1	2862.9
127	SPACE HEAT-SFD,NEW FLOOR INSL ADD R11 Z2	MN12200E00	6	416.	1083.	30	1.000	.020	228.9	25.3	2889.1
128	SPACE HEAT-SFD,NEW INSULATE DOOR Z1	MN12100E00	8	200.	519.	30	.500	.020	72.9	25.4	2897.4
129	SPACE HEAT-SFA,OLD REDUCE INF 0.2 ACH Z2	MO13200E00	7	381.	1619.	15	1.000	.020	101.7	25.5	2909.0
130	SPACE HEAT-SFD,NEW 2-3 GLAZING Z3	MN12300E00	1	365.	1062.	25	.950	.020	41.2	25.5	2913.7
131	SPACE HEAT-SFD,OLD WALL INSL R11-FILL Z1	MO12100E00	9	766.	1977.	30	.312	.020	129.2	25.7	2928.4
132	SPACE HEAT-MF,NEW REDUCE INFL 0.25ACH Z2	MN15200E00	5	381.	1610.	15	1.000	.020	76.4	25.7	2937.2
133	SPACE HEAT-MH,NEW FLOOR INSL. ADD R9 Z1	MN11100E00	6	195.	565.	25	1.000	.020	92.3	25.8	2947.7
134	REFRIG.-SIDE BY SIDE,1987 IMPROVEMENTS	ME40004E00	3	100.	350.	19	1.000	.020	143.1	26.0	2964.0
135	SPACE HEAT-SFD,OLD 1-2 GLAZING Z2	MO12200E00	1	974.	2792.	25	.444	.020	196.0	26.2	2986.4
136	REFRIG.-TOP FREEZER-1987 IMPROVEMENTS	ME40003E00	2	75.	257.	19	1.000	.020	464.0	26.6	3039.4
137	SPACE HEAT-SFD,OLD CEIL INSL ADD R30 Z3	MO12300E00	6	760.	1891.	30	.231	.021	13.3	26.6	3040.9
138	SPACE HEAT-SFD,NEW WALL INSL ADD R12 Z3	MN12300E00	4	703.	1741.	30	.900	.021	63.9	26.7	3048.2
139	SPACE HEAT-MH,NEW REDUCE INF 0.3 ACH Z1	MN11100E00	5	381.	1545.	15	1.000	.021	252.7	27.0	3077.0
140	SPACE HEAT-SFD,NEW 2-3 GLAZING Z2	MN12200E00	1	365.	1010.	25	.950	.021	202.8	27.2	3100.2
141	SPACE HEAT-SFD,NEW REDUCE INF 0.25 ACHZ1	MN12100E00	6	381.	1533.	15	1.000	.021	430.0	27.6	3149.3
142	SPACE HEAT-SFA,NEW WALL INSL ADD R30 Z2	MN13200E00	5	515.	1256.	30	1.000	.021	121.4	27.7	3163.1
143	SPACE HEAT-MH,NEW INSULATE DOOR Z1	MN11100E00	7	200.	545.	25	1.000	.021	89.2	27.8	3173.3
144	LIGHTING-MH,NEW-USE FLUOR.IN KITCHEN	MN71000E00	1	17.	172.	5	.250	.022	20.7	27.8	3175.7
145	LIGHTING-MF,OLD-FLUOR.IN KITCHEN(RENOV.)	MO75000E00	1	17.	172.	5	.300	.022	10.5	27.8	3176.9
146	LIGHTING-SF,OLD-FLUOR.IN KITCHEN(RENOV.)	MO74000E00	1	17.	172.	5	.300	.022	76.7	27.9	3185.6
147	LIGHTING-SF,NEW-FLUOR.IN KITCHEN	MN74000E00	1	17.	172.	5	.700	.022	257.3	28.2	3215.0
148	LIGHTING-MH,OLD-FLUOR.IN KITCHEN(RENOV.)	MO71000E00	1	17.	172.	5	.100	.022	.5	28.2	3215.1
149	LIGHTING-MF,NEW-USE FLUOR.IN KITCHEN	MN75000E00	1	17.	172.	5	.700	.022	32.8	28.2	3218.8
150	SPACE HEAT-SFD,NEW WALL INSL ADD R12 Z2	MN12200E00	4	703.	1656.	30	.900	.022	315.1	28.5	3254.8

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	(A) MEASURE DESCRIPTION		(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)
151	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z2	MO15200E00	7	301.	709.	30	1.000	.022	25.1	28.5	3257.7
152	SPACE HEAT-SFA,OLD 1-2 GLAZING	Z1	MO13100E00	1	726.	1910.	25	.707	.022	188.2	28.7	3279.1
153	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z3	MO15300E00	7	301.	695.	30	1.000	.022	1.3	28.7	3279.3
154	SF-ADDITIONAL WRAP		ME34000E00	12	26.	137.	10	1.000	.022	390.2	29.1	3323.8
155	SPACE HEAT-MH,OLD 1-2 GLAZING	Z1	MO11100E00	1	925.	2381.	25	.400	.022	8.9	29.1	3324.8
156	SPACE HEAT-MH,OLD DOOR INSULATION	Z2	MO11200E00	6	250.	640.	25	1.000	.022	5.1	29.1	3325.4
157	MH-ADDITIONAL WRAP		ME31000E00	12	26.	136.	10	1.000	.022	56.5	29.2	3331.9
158	SF-EFFICIENT CLOTHES WASHER		ME34000E00	6	30.	156.	10	.850	.022	378.2	29.6	3375.1
159	SPACE HEAT-SFA,OLD INSULATE DOOR	Z3	MO13300E00	9	250.	567.	30	.500	.022	8.6	29.6	3376.0
160	MH-INSULATING BOTTOM BOARD		ME31000E00	3	10.	51.	10	1.000	.023	21.3	29.6	3378.5
161	REFRIG.-PARTIAL AUTO,1987 IMPROVEMENTS		ME40002E00	2	60.	180.	19	1.000	.023	190.4	29.8	3400.2
162	SPACE HEAT-MH,NEW CEIL INSL. ADD R16	Z2	MN11200E00	3	425.	1045.	25	1.000	.023	147.1	29.9	3417.0
163	SPACE HEAT-SFD,OLD CEIL INSL. ADD R30	Z2	MO12200E00	6	711.	1550.	30	.142	.023	34.8	30.0	3421.0
164	SPACE HEAT-SFA,OLD 1-2 GLAZING	Z3	MO13300E00	1	1012.	2481.	25	.231	.023	17.5	30.0	3423.0
165	SPACE HEAT-MH,OLD REDUCE INF 0.2 ACH	Z3	MO11300E00	4	381.	1351.	15	1.000	.024	1.9	30.0	3423.2
166	SPACE HEAT-SFA,NEW REDUCE INF 0.25 ACH	Z1	MN13100E00	6	380.	1328.	15	1.000	.024	284.9	30.3	3455.7
167	MF-ADDITIONAL WRAP		ME35000E00	12	26.	127.	10	1.000	.024	52.6	30.3	3461.7
168	SPACE HEAT-MH,NEW WALL INSL. ADD R7	Z2	MN11200E00	4	615.	1438.	25	1.000	.025	202.5	30.5	3484.8
169	SPACE HEAT-MH,OLD CEIL.INSL. ADD R11	Z3	MO11300E00	3	340.	785.	25	.950	.025	1.1	30.5	3485.0
170	SF-PIPE INSULATION		ME34000E00	10	30.	113.	13	.850	.025	273.9	30.8	3516.2
171	SPACE HEAT-SFD,OLD INSULATE DOOR	Z3	MO12300E00	13	250.	506.	30	1.000	.025	15.4	30.8	3518.0
172	SPACE HEAT-SFA,OLD HEAT PUMP 2	Z1	MO13100E00	14	500.	1626.	15	.035	.026	7.9	30.8	3518.9
173	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z1	MN15100E00	7	301.	594.	30	1.000	.026	105.8	30.9	3531.0
174	MF-PIPE INSULATION		ME35000E00	10	30.	105.	13	.880	.027	38.5	31.0	3535.4
175	REFRIG.-SINGLE DOOR,1987 IMPROVEMENTS		ME40001E00	3	50.	130.	19	1.000	.027	54.3	31.0	3541.6
176	SPACE HEAT-MF,OLD 1-2 GLAZING	Z2	MO15200E00	1	625.	1331.	25	1.000	.027	47.2	31.1	3546.9
177	MF-INSULATING BOTTOM BOARD		ME35000E00	3	10.	43.	10	1.000	.027	17.8	31.1	3549.0
178	SPACE HEAT-SFD,OLD 1-2 GLAZING	Z3	MO12300E00	1	1068.	2221.	25	.170	.028	11.5	31.1	3550.3
179	MH-EFFICIENT CLOTHES WASHER		ME31000E00	6	30.	127.	10	.800	.028	42.3	31.1	3555.1
180	SPACE HEAT-SFD,NEW CEIL INSL ADD R30	Z3	MN12300E00	3	457.	827.	30	1.000	.028	33.8	31.2	3559.0
181	SPACE HEAT-MF,OLD 1-2 GLAZING	Z1	MO15100E00	1	625.	1254.	25	1.000	.029	166.9	31.3	3578.0
182	SPACE HEAT-MH,OLD REDUCE INF 0.2 ACH	Z2	MO11200E00	4	381.	1111.	15	1.000	.029	8.9	31.4	3579.0
183	SPACE HEAT-SFD,OLD CEIL INSL ADD R38	Z1	MO12100E00	5	901.	1595.	30	.373	.029	124.7	31.5	3593.3
184	SPACE HEAT-SFD,OLD REDUCE INF 0.2 ACH	Z1	MO12100E00	11	381.	1106.	15	1.000	.029	231.9	31.7	3619.8
185	SPACE HEAT-SFA,OLD INSULATE DOOR	Z2	MO13200E00	10	250.	437.	30	.500	.029	13.7	31.7	3621.3
186	MF-EFFICIENT CLOTHES WASHER		ME35000E00	6	30.	120.	10	.120	.029	6.0	31.7	3622.0
187	SPACE HEAT-SFD,NEW CEIL INSL ADD R30	Z2	MN12200E00	3	457.	788.	30	1.000	.030	166.7	31.9	3641.0
188	MH-PIPE INSULATION		ME31000E00	10	30.	95.	13	.500	.030	19.8	31.9	3643.3
189	SPACE HEAT-MH,NEW CEIL INSL. ADD R16	Z1	MN11100E00	3	425.	735.	29	1.000	.030	120.2	32.0	3657.0
190	SPACE HEAT-MH,OLD 1-2 GLAZING	Z3	MO11300E00	1	925.	1757.	25	.400	.030	1.0	32.0	3657.1
191	SPACE HEAT-SFD,NEW FLOOR INSL ADD R11	Z1	MN12100E00	7	416.	696.	30	1.000	.031	195.2	32.2	3679.4
192	SPACE HEAT-MF,NEW 2-3 GLAZING	Z3	MN15300E00	2	250.	462.	25	.900	.031	1.0	32.2	3679.5
193	SPACE HEAT-SFD,OLD INSULATE DOOR	Z2	MO12200E00	14	250.	404.	30	.971	.032	62.0	32.3	3686.6
194	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z1	MO15100E00	7	301.	484.	30	1.000	.032	64.5	32.4	3694.0
195	SPACE HEAT-SFD,OLD 1-2 GLAZING	Z1	MO12100E00	1	1036.	1873.	25	.589	.032	231.1	32.6	3720.4
196	SPACE HEAT-MF,NEW REDUCE INFL 0.25ACH	Z1	MN15100E00	5	381.	999.	15	1.000	.032	178.1	32.8	3740.7
197	SPACE HEAT-SFA,NEW CEIL INSL ADD R30	Z2	MN13200E00	4	408.	650.	30	1.000	.032	62.8	32.8	3747.9
198	SPACE HEAT-SFD,OLD CEIL INSL ADD R19	Z3	MO12300E00	7	625.	970.	30	.161	.033	4.8	32.8	3748.4
199	SPACE HEAT-SFA,NEW CEIL INSL ADD R30	Z3	MN13300E00	4	408.	624.	30	1.000	.033	29.3	32.9	3751.7
200	SPACE HEAT-MH,OLD CEIL.INSL. ADD R11	Z2	MO11200E00	3	340.	574.	25	.950	.034	4.4	32.9	3752.2

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	(A) MEASURE DESCRIPTION		(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)	
201	SPACE HEAT-SFD,NEW 2-3 GLAZING	Z1	MN12100E00	2	365.	616.	25	.950	.034	164.2	33.0	3771.0	
202	SPACE HEAT-SFA,OLD REDUCE INF 0.2 ACH	Z1	MO13100E00	9	381.	934.	15	1.000	.034	130.1	33.2	3785.8	
203	MF-EFFICIENT DISHWASHER		ME35000E00	7	30.	103.	10	.540	.034	23.0	33.2	3788.5	
204	SPACE HEAT-SFA,NEW FLOOR INSL ADD R11	Z1	MN13100E00	7	372.	550.	30	1.000	.035	117.9	33.3	3801.9	
205	SPACE HEAT-MH,NEW 2-3 GLAZING	Z3	MN11300E00	1	915.	1507.	25	.950	.035	35.6	33.3	3806.0	
206	COOKING-ELEC. RANGES/OVENS,CPES IMPROV.		ME60001E00	1	22.	45.	18	1.000	.036	187.7	33.5	3827.4	
207	SPACE HEAT-MH,OLD 1-2 GLAZING	Z2	MO11200E00	1	925.	1442.	25	.400	.037	4.6	33.5	3827.9	
208	SPACE HEAT-SFD,OLD HEAT PUMP 2	Z1	MO12100E00	16	500.	1101.	15	.053	.038	12.3	33.5	3829.3	
209	SPACE HEAT-SFD,NEW WALL INSL ADD R12	Z1	MN12100E00	5	703.	936.	30	.900	.038	236.4	33.8	3856.3	
210	SPACE HEAT-SFD,OLD FLOOR INSL ADD R30	Z2	MO12200E00	13	913.	1193.	30	.433	.039	81.6	33.9	3865.6	
211	SPACE HEAT-MH,NEW WALL INSL. ADD R7	Z1	MN11100E00	4	615.	885.	25	1.000	.040	144.8	34.0	3882.2	
212	SPACE HEAT-SFA,OLD INSULATE DOOR	Z1	MO13100E00	12	250.	319.	30	.500	.040	22.2	34.0	3884.7	
213	SPACE HEAT-MF,NEW 2-3 GLAZING	Z2	MN15200E00	2	250.	356.	25	.900	.040	15.2	34.0	3886.4	
214	SPACE HEAT-MF,NEW 2-3 GLAZING	Z1	MN15100E00	2	250.	356.	25	.900	.040	57.0	34.1	3893.0	
215	SPACE HEAT-MF,OLD 1-2 GLAZING	Z3	MO15300E00	1	625.	888.	25	1.000	.040	1.7	34.1	3893.1	4 ¢
216	SPACE HEAT-SFA,OLD FLOOR INSL ADD R30	Z3	MO13300E00	8	855.	1071.	30	1.000	.041	32.6	34.1	3896.9	
217	SPACE HEAT-SFA,NEW 2-3 GLAZING	Z3	MN13300E00	2	300.	421.	25	.950	.041	18.7	34.2	3899.0	
218	SPACE HEAT-MH,OLD INSULATE DOOR	Z1	MO11100E00	6	250.	347.	25	1.000	.041	3.2	34.2	3899.4	
219	LIGHTING-SF,NEW-OUTSIDE FLUORESCENT		MN74000E00	2	45.	125.	10	.500	.042	133.5	34.3	3914.6	
220	LIGHTING-MH,NEW-OUTSIDE FLUORESCENT		MN71000E00	2	45.	125.	10	.500	.042	30.0	34.3	3918.1	
221	LIGHTING-MF,OLD-OUTSIDE FLUOR.(RENOV.)		MO75000E00	4	45.	125.	10	.150	.042	3.8	34.3	3918.5	
222	LIGHTING-MF,NEW-OUTSIDE FLUORESCENT		MN75000E00	2	45.	125.	10	.500	.042	17.0	34.3	3920.4	
223	LIGHTING-SF,OLD-OUTSIDE FLUOR.(RENOV.)		MO74000E00	4	45.	125.	10	.250	.042	46.5	34.4	3925.7	
224	LIGHTING-MH,OLD-OUTSIDE FLUOR.(RENOV.)		MO71000E00	4	45.	125.	10	.250	.042	.9	34.4	3925.8	
225	LIGHTING-MH,OLD-FLUOR.IN KITCHEN(LABOR)		MO71000E00	2	35.	172.	5	.100	.044	.5	34.4	3925.9	
226	LIGHTING-SF,OLD-FLUOR.IN KITCHEN(LABOR)		MO74000E00	2	35.	172.	5	.300	.044	76.7	34.5	3934.6	
227	LIGHTING-MF,OLD-FLUOR.IN KITCHEN(LABOR)		MO75000E00	2	35.	172.	5	.300	.044	10.5	34.5	3935.8	
228	SPACE HEAT-SFD,OLD CEIL INSL. ADD R19	Z2	MO12200E00	7	534.	611.	30	.084	.045	8.1	34.5	3936.8	
229	SPACE HEAT-MF,OLD WALL INSL. ADD R8	Z3	MO15300E00	4	694.	778.	30	1.000	.046	1.5	34.5	3936.9	
230	SPACE HEAT-MH,NEW 2-3 GLAZING	Z2	MN11200E00	1	915.	1150.	25	.950	.046	153.8	34.6	3954.5	
231	SPACE HEAT-SFD,OLD FLOOR INSL ADD R30	Z3	MO12300E00	12	925.	1008.	30	.410	.047	12.6	34.7	3955.9	
232	TELEVISION-B & W,1985 IMPROVEMENT		ME80002E00	2	10.	25.	10	1.000	.047	45.4	34.7	3961.1	
233	SPACE HEAT-SFD,OLD CEIL INSL ADD R30	Z1	MO12100E00	6	657.	711.	30	.114	.047	17.0	34.7	3963.1	
234	SPACE HEAT-SFA,NEW WALL INSL ADD R12	Z1	MN13100E00	5	515.	541.	30	1.000	.049	115.9	34.8	3976.3	5 ¢
235	SPACE HEAT-MH,OLD REDUCE INF 0.2 ACH	Z1	MO11100E00	4	381.	631.	15	1.000	.051	5.9	34.8	3977.0	
236	CLOTHES DRYER,MOIST./TEMP SENSOR & INSUL		ME80003E00	1	35.	50.	18	1.000	.051	177.7	35.0	3997.3	
237	SPACE HEAT-SFA,OLD FLOOR INSL ADD R30	Z2	MO13200E00	9	760.	752.	30	1.000	.052	47.2	35.1	4002.7	
238	LIGHTING-SF, NEW- SL LAMP FOR HIGH USE		MN74000E00	3	42.	114.	8	.900	.052	219.2	35.3	4027.7	
239	LIGHTING-MF,NEW-SL LAMP FOR HIGH USE		MN75000E00	3	21.	57.	8	.900	.052	14.0	35.3	4029.3	
240	LIGHTING-MF,OLD-REPLACE HIGH USE WITH SL		MO75000E00	5	21.	57.	8	.900	.052	10.4	35.3	4030.5	
241	LIGHTING-MH,NEW-SL LAMP FOR HIGH USE		MN71000E00	3	21.	57.	8	.900	.052	24.6	35.3	4033.3	
242	LIGHTING-SF,OLD-REPLACE HIGH USE WITH SL		MO74000E00	5	42.	114.	8	.900	.052	152.6	35.5	4050.7	
243	LIGHTING-MH,OLD-REPLACE HIGH USE WITH SL		MO71000E00	5	21.	57.	8	.900	.052	1.4	35.5	4050.9	
244	SPACE HEAT-MF,OLD REDUCE INFL 0.2 ACH	Z2	MO15200E00	5	635.	1000.	15	1.000	.053	35.5	35.5	4054.9	
245	SPACE HEAT-SFA,NEW 2-3 GLAZING	Z1	MN13100E00	2	323.	342.	25	.950	.054	69.6	35.6	4062.9	
246	SPACE HEAT-SFD,OLD INSULATE DOOR	Z1	MO12100E00	14	250.	232.	30	1.000	.055	48.6	35.6	4068.4	
247	CLOTHES DRYER, HEAT PUMP DRYER		ME80003E00	2	500.	660.	18	.300	.055	547.3	36.2	4130.9	
248	SPACE HEAT-MF,OLD REDUCE INFL 0.2 ACH	Z3	MO15300E00	5	635.	952.	15	1.000	.056	1.8	36.2	4131.1	
249	LIGHTING-SF, NEW-SL LAMP FOR MEDIUM USE		MN74000E00	4	84.	171.	10	.900	.058	328.8	36.5	4168.6	
250	LIGHTING-SF,OLD-REPLACE MED. USE WITH SL		MO74000E00	6	84.	171.	10	.900	.058	228.9	36.7	4194.7	

	(A) MEASURE DESCRIPTION		(B) ID CODE	(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)	
251	LIGHTING-MF,OLD-REPLACE MED. USE WITH SL		M075000E00	6	63.	128.	10	.900	.058	23.4	36.8	4197.4
252	LIGHTING-MF,NEW-SL LAMP FOR MEDIUM USE		MN75000E00	4	63.	128.	10	.900	.058	31.4	36.8	4201.0
253	LIGHTING-MH,OLD-REPLACE MED. USE WITH SL		M071000E00	6	42.	85.	10	.900	.058	2.1	36.8	4201.2
254	LIGHTING-MH,NEW-SL LAMP FOR MEDIUM USE		MN71000E00	4	42.	85.	10	.900	.058	36.7	36.8	4205.4
255	SPACE HEAT-MF,OLD WALL INSL. ADD R8	Z2	M015200E00	4	694.	611.	30	1.000	.058	21.6	36.9	4207.9
256	SPACE HEAT-SFD,OLD CEIL INSL. ADD R11	Z2	M012200E00	8	397.	337.	30	.037	.060	2.0	36.9	4208.1
257	SPACE HEAT-SFA,NEW 2-3 GLAZING	Z2	MN13200E00	2	323.	308.	25	.950	.060	28.2	36.9	4211.4
258	LIGHTING-MH,OLD-OUTSIDE FLUOR.(LABOR)		M071000E00	3	65.	125.	10	.250	.061	.9	36.9	4211.5
259	LIGHTING-SF,OLD-OUTSIDE FLUOR.(LABOR)		M074000E00	3	65.	125.	10	.250	.061	46.5	36.9	4216.8
260	LIGHTING-MF,OLD-OUTSIDE FLUOR.(LABOR)		M075000E00	3	65.	125.	10	.150	.061	3.8	36.9	4217.2
261	SPACE HEAT-SFA,OLD 2-3 GLAZING	Z2	M013200E00	2	968.	875.	25	.950	.064	52.2	37.0	4223.2
262	SPACE HEAT-SFA,OLD CEIL.INSL ADD R30	Z1	M013100E00	6	618.	494.	30	.605	.064	41.6	37.0	4227.9
263	SPACE HEAT-SFA,OLD 2-3 GLAZING	Z3	M013300E00	2	1208.	1057.	25	.950	.066	30.6	37.1	4231.4
264	SPACE HEAT-SFA,OLD CEIL INSL ADD R19	Z1	M013100E00	7	457.	341.	30	.171	.068	8.1	37.1	4232.3
265	SPACE HEAT-SFD,NEW 3-4 GLAZING	Z3	MN12300E00	2	511.	406.	25	.950	.072	15.7	37.1	4234.1
266	SPACE HEAT-SFD,NEW 3-4 GLAZING	Z2	MN12200E00	2	511.	389.	25	.950	.075	78.1	37.2	4243.0
267	SPACE HEAT-SFA,OLD FLOOR INSL ADD R30	Z1	M013100E00	11	652.	434.	30	1.000	.077	60.5	37.2	4249.9
268	SPACE HEAT-SFD,OLD 2-3 GLAZING	Z2	M012200E00	2	1220.	915.	25	.950	.077	137.3	37.4	4265.6
269	SPACE HEAT-MH,NEW 2-3 GLAZING	Z1	MN11100E00	1	903.	676.	25	.950	.077	105.0	37.5	4277.6
270	SPACE HEAT-MF,OLD REDUCE INFL 0.2 ACH	Z1	M015100E00	5	635.	687.	15	1.000	.077	91.4	37.6	4288.0
271	SPACE HEAT-MH,OLD CEIL INSL. R11	Z1	M011100E00	3	340.	235.	25	.950	.083	2.1	37.6	4288.3
272	SPACE HEAT-MF,NEW 3-4 GLAZING	Z3	MN15300E00	3	350.	242.	25	.800	.083	.5	37.6	4288.3
273	WELL PUMP,CONSERVATION MEASURE		ME90001E00	1	100.	100.	15	.800	.084	37.2	37.6	4292.6
274	SF-HEAT PUMP		ME34000E00	8	1000.	993.	15	.500	.084	1413.0	39.0	4453.9
275	SPACE HEAT-SFA,OLD HEAT PUMP 1	Z3	M013300E00	10	4080.	4039.	15	.910	.085	112.0	39.1	4466.7
276	SPACE HEAT-SFD,OLD 2-3 GLAZING	Z3	M012300E00	2	1287.	870.	25	.950	.085	25.2	39.2	4469.6
277	SPACE HEAT-MH,OLD DUCT INSULATION	Z2	M011200E00	9	250.	166.	25	1.000	.087	1.3	39.2	4469.7
278	MH-HEAT PUMP		ME31000E00	8	1000.	962.	15	.500	.087	199.9	39.4	4492.5
279	SPACE HEAT-MH,OLD 2-3 GLAZING	Z3	M011300E00	2	1110.	729.	25	.950	.087	1.0	39.4	4492.6
280	SPACE HEAT-SFA,OLD 2-3 GLAZING	Z1	M013100E00	2	881.	563.	25	.950	.090	74.5	39.4	4501.2
281	SPACE HEAT-MH,NEW 3-4 GLAZING	Z3	MN11300E00	2	916.	568.	25	.950	.093	13.4	39.4	4502.7
282	SPACE HEAT-SFD,NEW HEAT PUMP 2	Z2	MN12200E00	9	500.	443.	15	.200	.095	18.7	39.5	4504.8
283	SPACE HEAT-MF,OLD WALL INSL. ADD R8	Z1	M015100E00	4	694.	368.	30	1.000	.096	49.0	39.5	4510.4
284	SPACE HEAT-MF,OLD 2-3 GLAZING	Z2	M015200E00	2	750.	442.	25	.800	.097	12.5	39.5	4511.9
285	SPACE HEAT-SFA,OLD CEIL INSL ADD R11	Z1	M013100E00	8	269.	135.	30	.025	.102	.5	39.5	4511.9
286	SPACE HEAT-SFD,OLD CEIL INSL ADD R19	Z1	M012100E00	7	583.	276.	30	.159	.108	9.2	39.5	4513.0
287	SPACE HEAT-MF,NEW 3-4 GLAZING	Z2	MN15200E00	3	350.	185.	25	.800	.109	7.0	39.5	4513.8
288	SPACE HEAT-SFA,NEW 3-4 GLAZING	Z3	MN13300E00	3	420.	221.	25	.950	.109	9.9	39.5	4514.9
289	SPACE HEAT-SFD,OLD FLOOR INSL ADD R30	Z1	M012100E00	13	870.	406.	30	.518	.109	44.0	39.6	4519.9
290	SPACE HEAT-MH,NEW 3-4 GLAZING	Z2	MN11200E00	2	916.	422.	25	.950	.125	56.5	39.6	4526.4
291	SPACE HEAT-MF,OLD 2-3 GLAZING	Z3	M015300E00	2	750.	344.	25	.800	.125	.5	39.6	4526.4
292	MF-HEAT PUMP		ME35000E00	8	1000.	666.	15	.500	.126	138.1	39.8	4542.2
293	SPACE HEAT-MF,OLD 2-3 GLAZING	Z1	M015100E00	2	750.	330.	25	.800	.130	35.2	39.8	4546.2
294	SPACE HEAT-SFA,OLD HEAT PUMP 1	Z2	M013200E00	11	4001.	2531.	15	.962	.132	153.0	40.0	4563.7
295	SPACE HEAT-SFD,NEW 3-4 GLAZING	Z1	MN12100E00	3	511.	214.	25	.950	.137	57.2	40.0	4570.2
296	SPACE HEAT-MF,NEW 3-4 GLAZING	Z1	MN15100E00	3	350.	146.	25	.900	.137	23.5	40.1	4572.9
297	SF-SOLAR WATER HEATER		ME34000E00	11	1800.	861.	20	.500	.140	1225.0	41.3	4712.7
298	SPACE HEAT-MH,OLD 2-3 GLAZING	Z2	M011200E00	2	1110.	445.	25	.950	.143	3.4	41.3	4713.1
299	MH-SOLAR WATER HEATER		ME31000E00	11	1800.	836.	20	.500	.145	173.8	41.5	4732.9
300	SPACE HEAT-MH,OLD HEAT PUMP	Z3	M011300E00	8	1800.	1020.	15	1.000	.148	1.4	41.5	4733.1

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(A) MEASURE DESCRIPTION	(B) ID CODE	(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)
++ CUT OFF PRICE IS .150 ++									
301 SPACE HEAT-MH,NEW HEAT PUMP	Z3 MN11300E00	8	2900.	1538.	15	1.000	.158	38.2	41.5	4737.5
302 SPACE HEAT-SFD,OLD 2-3 GLAZING	Z1 MO12100E00	2	1259.	454.	25	.950	.159	90.3	41.6	4747.8
303 SPACE HEAT-MH,NEW CHANGE ROOF COLOR	Z1 MN11100E00	9	200.	63.	30	1.000	.163	10.2	41.6	4748.9
304 SPACE HEAT-MH,OLD 2-3 GLAZING	Z1 MO11100E00	2	1110.	390.	25	.950	.163	3.5	41.6	4749.3
305 SPACE HEAT-SFA,OLD 3-4 GLAZING	Z2 MO13200E00	3	968.	333.	25	.950	.167	19.9	41.6	4751.6
306 SPACE HEAT-SFA,NEW 3-4 GLAZING	Z2 MN13200E00	3	458.	156.	25	.950	.168	14.3	41.6	4753.2
307 SPACE HEAT-SFD,OLD 3-4 GLAZING	Z2 MO12200E00	3	1220.	401.	25	.950	.175	60.2	41.7	4760.1
308 SPACE HEAT-SFD,NEW HEAT PUMP 1	Z3 MN12300E00	8	3025.	1415.	15	.400	.179	23.1	41.7	4762.8
309 SPACE HEAT-SFD,OLD 3-4 GLAZING	Z3 MO12300E00	3	1287.	409.	25	.950	.181	11.8	41.7	4764.1
310 CLOTHES WASHER,IMPROVED EFFICIENCY	ME80004E00	1	50.	30.	10	1.000	.195	104.5	41.8	4776.0
311 SPACE HEAT-SFA,OLD 3-4 GLAZING	Z3 MO13300E00	3	1208.	334.	25	.950	.208	9.7	41.8	4777.1
312 MF-SOLAR WATER HEATER	ME35000E00	11	1800.	581.	20	.500	.208	120.4	42.0	4790.9
313 SPACE HEAT-SFD,OLD CEIL INSL ADD R11	Z1 MO12100E00	8	258.	63.	30	.016	.211	.2	42.0	4790.9
314 SPACE HEAT-SFA,OLD 3-4 GLAZING	Z1 MO13100E00	3	881.	233.	25	.950	.217	30.9	42.0	4794.4
315 SPACE HEAT-MH,NEW 3-4 GLAZING	Z1 MN11100E00	2	904.	216.	25	.950	.241	33.5	42.0	4798.3
316 SPACE HEAT-MH,NEW HEAT PUMP	Z2 MN11200E00	8	2900.	925.	15	1.000	.263	130.3	42.2	4813.1
317 SPACE HEAT-SFA,NEW 3-4 GLAZING	Z1 MN13100E00	3	458.	100.	25	.950	.263	20.4	42.2	4815.5
318 SPACE HEAT-SFD,NEW HEAT PUMP 1	Z2 MN12200E00	8	3378.	1025.	15	.800	.276	173.5	42.4	4835.3
319 SPACE HEAT-SFD,OLD HEAT PUMP 1	Z3 MO12300E00	14	3975.	1169.	15	.769	.285	27.4	42.4	4838.4
320 SPACE HEAT-SFD,OLD HEAT PUMP 1	Z2 MO12200E00	15	3817.	1094.	15	.744	.292	128.6	42.5	4853.1
321 SPACE HEAT-SFA,INSTALL HEAT PUMP	Z3 MN13300E00	9	3025.	839.	15	.800	.302	31.5	42.5	4856.7
322 SPACE HEAT-SFD,NEW HEAT PUMP 2	Z1 MN12100E00	10	500.	130.	15	.200	.323	7.3	42.5	4857.5
323 SPACE HEAT-SFD,OLD WALL INSL R12-SIDE	Z3 MO12300E00	9	3216.	506.	30	.800	.324	12.3	42.6	4858.9
324 DISHWASHER,MOTOR EFFICIENCY	ME80005E00	1	150.	50.	10	1.000	.352	170.8	42.7	4878.4
325 SPACE HEAT-MH,OLD DUCT INSULATION	Z1 MO11100E00	9	250.	38.	25	.798	.382	.3	42.7	4878.4
326 SPACE HEAT-SFA,OLD HEAT PUMP 1	Z1 MO13100E00	13	4000.	841.	15	.965	.398	113.1	42.8	4891.3
327 SPACE HEAT-SFD,OLD 3-4 GLAZING	Z1 MO12100E00	3	1259.	177.	25	.950	.407	35.3	42.9	4895.4
328 SPACE HEAT-SFD,OLD WALL INSL R12-SIDE	Z2 MO12200E00	10	3447.	334.	30	.800	.527	42.2	42.9	4900.2
329 SPACE HEAT-MH,OLD HEAT PUMP	Z2 MO11200E00	8	3000.	429.	15	1.000	.586	3.4	42.9	4900.6
330 SPACE HEAT-SFD,NEW HEAT PUMP 1	Z1 MN12100E00	9	3466.	482.	15	.640	.602	86.6	43.0	4910.5
331 SPACE HEAT-MH,NEW HEAT PUMP	Z1 MN11100E00	8	2900.	341.	15	1.000	.713	55.7	43.1	4916.8
332 SPACE HEAT-SFD,OLD WALL INSL R12-SIDE	Z1 MO12100E00	10	3234.	193.	30	.800	.856	32.3	43.1	4920.5
333 SPACE HEAT-SFA,INSTALL HEAT PUMP	Z2 MN13200E00	9	3025.	258.	15	.800	.981	20.0	43.1	4922.8
334 SPACE HEAT-MH,OLD HEAT PUMP	Z1 MO11100E00	8	2003.	152.	15	.960	1.106	1.4	43.1	4923.0
335 SPACE HEAT-SFD,OLD HEAT PUMP 1	Z1 MO12100E00	15	4012.	192.	15	.751	1.753	30.2	43.2	4926.4
336 SPACE HEAT-SFA,INSTALL HEAT PUMP	Z1 MN13100E00	9	3025.	75.	15	.800	3.369	12.9	43.2	4927.9

has a CCE below 4 cents/kWh. Thus, the estimates are not especially sensitive to the cut-off price assumption.

Roughly 500 MW could be saved through "free" (i.e. no-cost) measures. The largest single measure in this category is solid state improvements of color televisions (215 MW). We expect people will trade in their old models without any encouragement. The other free measures conserve hot water through thermostat setback and partial use of cold-water laundry.

A great deal of conservation potential for refrigerators and freezers exists at CCEs below 1 cent/kWh. Most measures involve replacing existing models (as they wear out) with the most efficient now on the market, or even better models already in the prototype stage. Roughly 500 MW could be saved with these measures, although an unknown part of the savings was included in the BPA forecast.

Most of the measures between 0.5 cents/kWh and 3 cents/kWh save space heat. The cheaper measures tend to be the first level of insulation and double glazing for new homes, whereas infiltration reduction and conversions to heat pumps occupy the upper end of this spectrum. A few water heating and miscellaneous measures are also interspersed among the space heating measures. Kitchen light conversions to fluorescents begin to appear at 2.2 cents/kWh.

Above 3 cents/kWh, the higher insulation levels appear, along with triple glazing, and additional insulation for existing homes. The majority of the lighting conservation measures have CCEs in the 3 - 5 cents/kWh range. Altogether, the conservation potential in lights exceeds 50 MW. Clothes dryer improvements could supply as much 60 MW at 5 cents/kWh.

Many of the more difficult and labor intensive space heating conservation measures fall above 6 cents/kWh. These include duct insulation in existing houses and infiltration reduction in multifamily homes. Expensive measures, such as heat pumps and quad glazing, also have CCEs above 7 cents/kWh. High efficiency heat pump water heaters, for example, have a CCE of 9.1 cents/kWh. The electricity savings are quite

small because of the extensive water conservation measures (for showers, clothes washers, etc.) already implemented. Similarly, the electricity savings attributed to space heating heat pumps may be lower than expected because we assumed that all cheaper (lower CCE) measures were implemented first. A well-insulated building leaves less energy for the heat pump to save.

Our analysis shows a roughly similar conservation potential when compared to other studies, although such comparisons must be made with great caution. The Regional Council (1983) estimates an overall savings potential of 2603 MW in 2002, but some of this is already included in the BPA forecast. Moreover, their estimate includes line losses -- a 10% effect -- while ours does not. The Natural Resources Defense Council (NRDC, January 1982) presents model building and appliance standards that could save about 1811 MW, and offer a "low demand" scenario with 2000 residential consumption at 4205 MW. However, they began with a considerably higher UEC for space heating and included savings from a switch to wood heating. The difference appears to be taken out of the "other" category.

Space Heating

We constructed a supply curve of conserved energy for the space heating end use. This is shown in Figure I-3 and summarized in Tables I-4 and I-5. The supply curve indicates that roughly 1888 MW could be conserved by 2000 using conservation measures with CCEs less than 15 cents/kWh. This corresponds to a potential consumption of 1618 MW, or roughly 47% less than the BPA forecast.

The improvements described here imply a mostly-hidden transformation of the housing stock; empty spaces would be filled with insulation, windows would be triple or even quadruple glazed, and leaks would be sealed. The "UA" of typical homes drops from 540 to 230 Btu/hr-F. (See the UA1 value in the Work4 output.) Most houses in the milder regions of the Northwest would use virtually no heat supplied by the furnace, and consumption for those houses in colder regions would drop to about a third of present consumption. "Free" heat supplied by appliances and the sun would carry the homes through most of the winter.

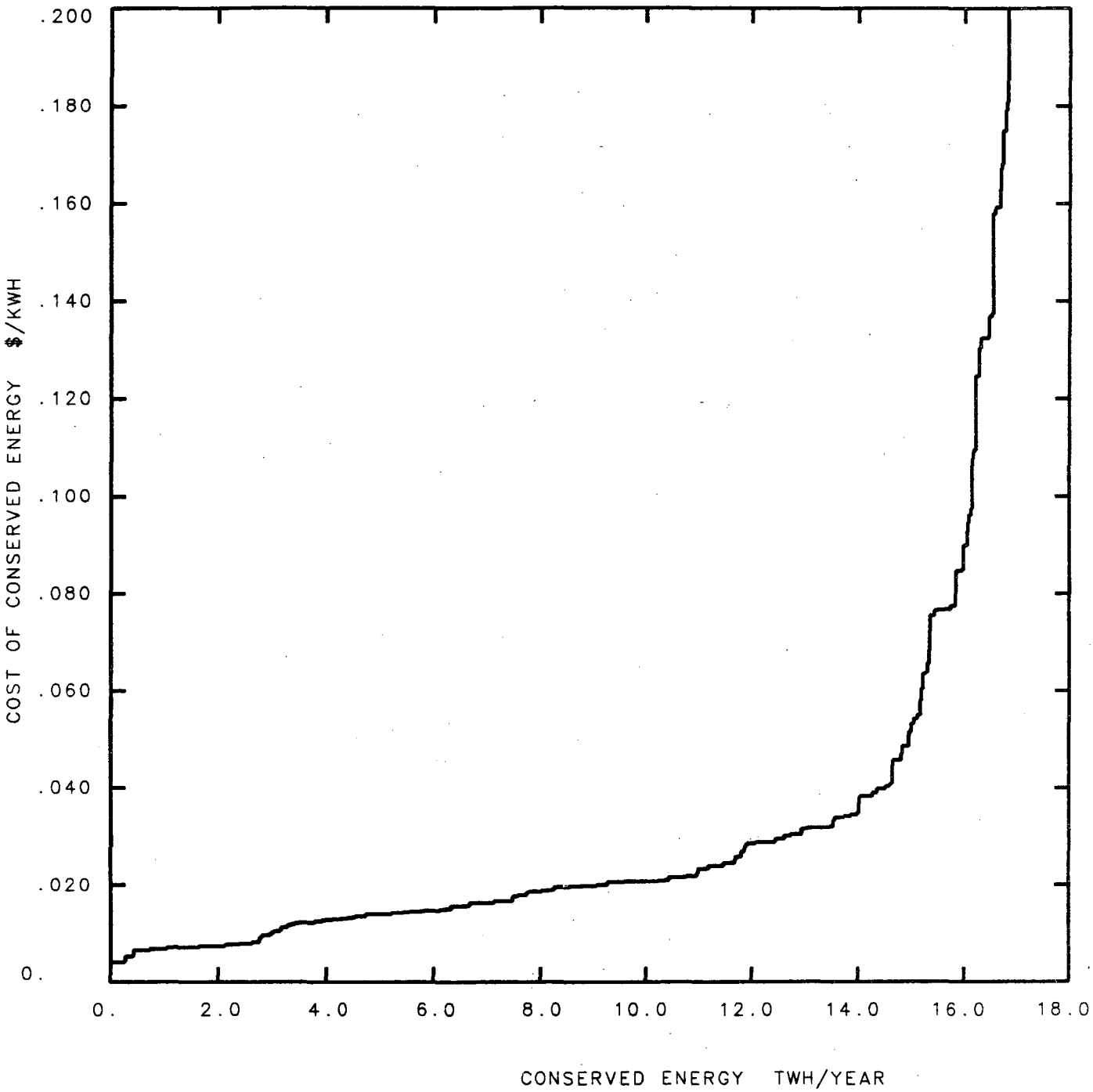

Figure I-3 Space Heating Conservation Supply Curve for 2000

Source: Table I-5,Column I

Table I-4 Space Heating Supply Curve End Uses (2000)

(A) END USE DESCRIPTION	(B) ID CODE	(C) TOTAL STOCK (1000S)	(D) ADD RATE	(E) DECAY OR REPLACE RATE	(F) BASELINE UEC (KWH/YR)	(F) BASELINE USAGE (GWH)	(G) POTENTIAL UEC (KWH/YR)	(G) POTENTIAL USAGE (GWH)	(H) WORK4 USED	(I) LAST UPDATE
SPACE HEATING MOBILE HOME-NEW ZONE 1	EN11100E00	164.	.038	.042	5949.	973.1	1032.	168.7	1	2-83
SPACE HEATING MOBILE HOME-NEW ZONE 2	EN11200E00	141.	.038	.042	9860.	1388.2	2160.	304.1	1	2-83
SPACE HEATING MOBILE HOME-NEW ZONE 3	EN11300E00	25.	.038	.042	13575.	337.3	3839.	95.4	1	2-83
SUBTOTAL		329.			8197.	2698.6	1726.	568.3		
SPACE HEATING MOBILE HOME-OLD ZONE 1	E011100E00	9.	-0.	.042	7760.	72.3	2180.	20.3	1	2-83
SPACE HEATING MOBILE HOME-OLD ZONE 2	E011200E00	8.	-0.	.042	10549.	84.6	1882.	15.1	1	2-83
SPACE HEATING MOBILE HOME-OLD ZONE 3	E011300E00	1.	-0.	.042	14145.	20.0	2587.	3.7	1	2-83
SUBTOTAL		19.			9435.	177.0	2083.	39.1		
SPACE HEATING M.F.-NEW ZONE 1	EN15100E00	178.	.018	.018	6347.	1130.7	763.	135.9	1	2-83
SPACE HEATING M.F.-NEW ZONE 2	EN15200E00	47.	.018	.018	8696.	412.6	2048.	97.2	1	2-83
SPACE HEATING M.F.-NEW ZONE 3	EN15300E00	2.	.018	.018	11186.	27.9	3279.	8.2	1	2-83
SUBTOTAL		228.			6889.	1571.3	1058.	241.3		
SPACE HEATING M.F.-OLD ZONE 1	E015100E00	133.	-0.	.018	6108.	813.0	1194.	159.0	1	2-83
SPACE HEATING M.F.-OLD ZONE 2	E015200E00	35.	-0.	.018	8869.	314.4	2355.	83.5	1	2-83
SPACE HEATING M.F.-OLD ZONE 3	E015300E00	2.	-0.	.018	8452.	15.8	2390.	4.5	1	2-83
SUBTOTAL		170.			6708.	1143.2	1449.	246.9		
SPACE HEATING SFD-NEW ZONE 1	EN12100E00	281.	.018	.018	9304.	2610.2	1861.	522.0	1	2-83
SPACE HEATING SFD-NEW ZONE 2	EN12200E00	211.	.018	.018	10815.	2286.8	3370.	712.7	1	2-83
SPACE HEATING SFD-NEW ZONE 3	EN12300E00	41.	.018	.018	13316.	543.2	3913.	159.6	1	2-83
SUBTOTAL		533.			10211.	5440.1	2617.	1394.3		
SPACE HEATING SFD-OLD ZONE 1	E012100E00	210.	-0.	.018	11356.	2380.4	5425.	1137.2	1	2-83
SPACE HEATING SFD-OLD ZONE 2	E012200E00	158.	-0.	.018	19442.	3071.6	9859.	1557.5	1	2-83
SPACE HEATING SFD-OLD ZONE 3	E012300E00	30.	-0.	.018	21028.	640.9	11257.	343.1	1	2-83
SUBTOTAL		398.			15306.	6092.9	7631.	3037.8		
SPACE HEATING SFA-NEW ZONE 1	EN13100E00	214.	.022	.018	7142.	1531.5	679.	145.6	1	2-83
SPACE HEATING SFA-NEW ZONE 2	EN13200E00	97.	.022	.018	8294.	801.9	1604.	155.1	1	2-83
SPACE HEATING SFA-NEW ZONE 3	EN13300E00	47.	.022	.018	10489.	492.0	2550.	119.6	1	2-83
SUBTOTAL		358.			7892.	2825.5	1174.	420.4		
SPACE HEATING SFA-OLD ZONE 1	E013100E00	139.	-0.	.018	9000.	1254.0	2888.	402.3	1	2-83
SPACE HEATING SFA-OLD ZONE 2	E013200E00	63.	-0.	.018	21000.	1319.3	4591.	288.4	1	2-83
SPACE HEATING SFA-OLD ZONE 3	E013300E00	30.	-0.	.018	30000.	914.3	8128.	247.7	1	2-83
SUBTOTAL		233.			14992.	3487.6	4034.	938.5		
TOTAL		2268.				23436.1		6886.6		

Table I-5 Space Heating Supply Curve Conservation Measures (2000)

	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(I) CUM. TOTAL SAVINGS (AVG MW)
1	SPACE HEAT-SFA,OLD CEIL INSL ADD R49	Z3 M013300E00	4	994.	12811.	30	.680	.004	265.5	.3	30.3
2	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z3 MN15300E00	6	200.	2339.	30	1.000	.004	5.8	.3	31.0
3	SPACE HEAT-SFA,OLD DUCT INSULATION	Z3 M013300E00	12	250.	2780.	30	.092	.005	7.8	.3	31.9
4	SPACE HEAT-SFD,OLD CEIL INSL ADD R49	Z3 M012300E00	4	821.	8006.	30	.160	.005	39.0	.3	36.3
5	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z2 MN15200E00	6	200.	1945.	30	1.000	.005	92.3	.4	46.9
6	SPACE HEAT-SFA,OLD DUCT INSULATION	Z2 M013200E00	13	270.	2420.	30	.101	.006	15.3	.4	48.6
7	SPACE HEAT-SFD,OLD DUCT INSULATION	Z3 M012300E00	16	250.	2179.	30	.026	.006	1.7	.4	48.8
8	SPACE HEAT-SFA,OLD CEIL INSL ADD R49	Z2 M013200E00	4	994.	7848.	30	.611	.006	301.2	.7	83.2
9	SPACE HEAT-MF,NEW 1-2 GLAZING	Z1 MN15100E00	1	200.	1691.	25	1.000	.007	301.3	1.0	117.6
10	SPACE HEAT-MH,OLD WALL INSL. ADD R11	Z2 M011200E00	7	400.	3272.	25	1.000	.007	26.3	1.1	120.6
11	SPACE HEAT-SFD,NEW 1-2 GLAZING	Z1 MN12100E00	1	292.	2375.	25	.800	.007	532.9	1.6	181.4
12	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z2 M015200E00	6	200.	1439.	30	1.000	.007	51.0	1.6	187.2
13	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z3 M015300E00	6	200.	1421.	30	1.000	.007	2.7	1.6	187.5
14	SPACE HEAT-SFD,OLD DUCT INSULATION	Z2 M012200E00	17	281.	1971.	30	.050	.007	15.6	1.7	189.3
15	SPACE HEAT-SFA,NEW 1-2 GLAZING	Z1 MN13100E00	1	271.	2124.	25	1.000	.007	455.4	2.1	241.3
16	SPACE HEAT-MF,OLD CEIL INSL. ADD R11	Z2 M015200E00	3	160.	1070.	30	1.000	.008	38.0	2.2	245.6
17	SPACE HEAT-SFD,OLD CEIL INSL. ADD R49	Z2 M012200E00	4	1067.	7125.	30	.211	.008	237.5	2.4	272.8
18	SPACE HEAT-MF,OLD CEIL INSL. ADD R11	Z3 M015300E00	3	160.	1053.	30	1.000	.008	2.0	2.4	273.0
19	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z1 MN15100E00	6	200.	1303.	30	1.000	.008	232.1	2.6	299.5
20	SPACE HEAT-SFD,OLD HEAT PUMP 2	Z3 M012300E00	15	250.	2604.	15	.032	.008	2.5	2.6	299.8
21	SPACE HEAT-SFA,OLD CEIL INSL ADD R38	Z2 M013200E00	5	833.	5212.	30	.274	.008	89.7	2.7	310.0
22	SPACE HEAT-SFA,OLD DUCT INSULATION	Z1 M013100E00	15	239.	1490.	30	.100	.008	20.7	2.7	312.4
23	SPACE HEAT-SFD,OLD HEAT PUMP 2	Z2 M012200E00	16	250.	2549.	15	.063	.008	25.4	2.8	315.3
24	SPACE HEAT-MH,OLD FLOOR INSL ADD R19	Z3 M011300E00	5	430.	2857.	25	1.000	.009	4.0	2.8	315.7
25	SPACE HEAT-SFD,OLD FLOOR INSL ADD R19	Z3 M012300E00	11	787.	4421.	30	.287	.009	38.6	2.8	320.1
26	SPACE HEAT-MH,OLD WALL INSL. ADD R11	Z3 M011300E00	7	400.	2501.	25	1.000	.009	3.5	2.8	320.5
27	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z1 M015100E00	6	200.	1069.	30	1.000	.010	142.2	3.0	336.8
28	SPACE HEAT-MF,NEW CEIL INSL ADD R11	Z2 MN15200E00	4	160.	828.	30	1.000	.010	39.3	3.0	341.3
29	SPACE HEAT-SFA,OLD CEIL.INSL ADD R49	Z1 M013100E00	4	994.	4970.	30	.070	.010	48.5	3.0	346.8
30	SPACE HEAT-MF,OLD CEIL INSL. ADD R11	Z1 M015100E00	3	160.	787.	30	1.000	.010	104.8	3.1	358.8
31	SPACE HEAT-MF,NEW 1-2 GLAZING	Z3 MN15300E00	1	200.	1100.	25	1.000	.010	2.7	3.1	359.1
32	SPACE HEAT-SFA,NEW INSULATE DOOR	Z3 MN13300E00	8	200.	962.	30	.500	.011	22.6	3.2	361.7
33	SPACE HEAT-MH,OLD WALL INSL. ADD R11	Z1 M011100E00	7	400.	2073.	25	1.000	.011	19.3	3.2	363.9
34	SPACE HEAT-SFA,OLD FLOOR INSL ADD R19	Z3 M013300E00	7	690.	3124.	30	1.000	.011	95.2	3.3	374.7
35	SPACE HEAT-MH,NEW FLOOR INSL ADD R9	Z3 MN11300E00	6	195.	964.	25	1.000	.012	24.0	3.3	377.5
36	SPACE HEAT-SFD,OLD CEIL INSL ADD R38	Z3 M012300E00	5	750.	3262.	30	.448	.012	44.5	3.4	382.5
37	SPACE HEAT-MH,NEW REDUCE INF 0.3 ACH	Z3 MN11300E00	5	381.	2703.	15	1.000	.012	67.1	3.4	390.2
38	SPACE HEAT-MF,NEW CEIL.INSL. ADD R11	Z3 MN15300E00	4	160.	688.	30	1.000	.012	1.7	3.4	390.4
39	SPACE HEAT-SFA,NEW INSULATE DOOR	Z2 MN13200E00	8	200.	847.	30	.500	.012	41.0	3.5	395.1
40	SPACE HEAT-MH,NEW INSULATE DOOR	Z3 MN11300E00	7	200.	947.	25	1.000	.012	23.5	3.5	397.8
41	SPACE HEAT-SFD,OLD CEIL INSL ADD R49	Z1 M012100E00	4	986.	4104.	30	.354	.012	304.5	3.8	432.5
42	SPACE HEAT-SFA,NEW REDUCE INF 0.25ACH	Z3 MN13300E00	6	380.	2559.	15	1.000	.012	120.0	3.9	446.2
43	SPACE HEAT-SFD,OLD DUCT INSULATION	Z1 M012100E00	17	268.	1091.	30	.010	.013	2.3	3.9	446.5
44	SPACE HEAT-SFD,NEW HEAT PUMP 2	Z3 MN12300E00	9	500.	3314.	15	.500	.013	67.6	4.0	454.2
45	SPACE HEAT-MH,OLD FLOOR INSL ADD R19	Z2 M011200E00	5	430.	1934.	25	1.000	.013	15.5	4.0	456.0
46	SPACE HEAT-SFD,OLD FLOOR INSL ADD R19	Z2 M012200E00	12	773.	3079.	30	.202	.013	98.1	4.1	467.2
47	SPACE HEAT-SFD,NEW INSULATE DOOR	Z3 MN12300E00	7	200.	796.	30	.500	.013	16.2	4.1	469.0
48	SPACE HEAT-SFA,OLD FLOOR INSL ADD R19	Z2 M013200E00	8	613.	2421.	30	1.000	.013	152.1	4.3	486.4
49	SPACE HEAT-SFD,OLD REDUCE INF 0.2 ACH	Z3 M012300E00	10	381.	2451.	15	1.000	.013	74.7	4.3	494.9
50	SPACE HEAT-MF,NEW 1-2 GLAZING	Z2 MN15200E00	1	200.	881.	25	1.000	.013	41.8	4.4	499.7

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	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)
51	SPACE HEAT-SFA,OLD HEAT PUMP 2	Z3 MO13300E00	11	500.	3205.	15	.090	.013	8.8	4.4	500.7
52	SPACE HEAT-SFD,NEW REDUCE INF 0.25 ACH	Z3 MN12300E00	5	381.	2418.	15	1.000	.013	98.6	4.5	512.0
53	SPACE HEAT-SFA,NEW 1-2 GLAZING	Z3 MN13300E00	1	240.	1041.	25	1.000	.013	48.8	4.5	517.5
54	SPACE HEAT-SFD,OLD WALL INSL R11-FILL	Z2 MO12200E00	9	761.	2878.	30	.234	.013	106.4	4.6	529.7
55	SPACE HEAT-SFD,NEW INSULATE DOOR	Z2 MN12200E00	7	200.	754.	30	.500	.014	79.7	4.7	538.8
56	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z3 MN15300E00	7	301.	1131.	30	1.000	.014	2.8	4.7	539.1
57	SPACE HEAT-SFD,NEW REDUCE INF 0.25 ACH	Z2 MN12200E00	5	381.	2289.	15	1.000	.014	484.0	5.2	594.4
58	SPACE HEAT-SFA,NEW REDUCE INF 0.25ACH	Z2 MN13200E00	6	380.	2234.	15	1.000	.014	216.0	5.4	619.0
59	SPACE HEAT-MH,NEW FLOOR INSL ADD R9	Z2 MN11200E00	6	195.	780.	25	1.000	.014	109.8	5.5	631.6
60	SPACE HEAT-SFD,OLD CEIL INSL. ADD R38	Z2 MO12200E00	5	769.	2709.	30	.486	.014	208.0	5.7	655.3
61	SPACE HEAT-SFA,OLD REDUCE INF 0.2 ACH	Z3 MO13300E00	6	381.	2193.	15	1.000	.015	66.8	5.8	662.9
62	SPACE HEAT-MH,NEW REDUCE INF 0.3 ACH	Z2 MN11200E00	5	381.	2179.	15	1.000	.015	306.7	6.1	698.0
63	SPACE HEAT-MF,NEW CEIL INSL. ADD R10	Z1 MN15100E00	4	160.	545.	30	1.000	.015	97.1	6.2	709.0
64	SPACE HEAT-MH,NEW INSULATE DOOR	Z2 MN11200E00	7	200.	764.	25	1.000	.015	107.6	6.3	721.3
65	SPACE HEAT-MH,OLD DUCT INSULATION	Z3 MO11300E00	9	250.	925.	25	1.000	.016	1.3	6.3	721.5
66	SPACE HEAT-MF,NEW REDUCE INFL 0.25ACH	Z3 MN15300E00	5	381.	2039.	15	1.000	.016	5.1	6.3	722.1
67	SPACE HEAT-SFA,NEW CEIL INSL ADD R38	Z1 MN13100E00	4	408.	1328.	30	1.000	.016	284.7	6.6	754.6
68	SPACE HEAT-SFA,OLD CEIL.INSL ADD R38	Z1 MO13100E00	5	833.	2694.	30	.129	.016	48.4	6.7	760.1
69	SPACE HEAT-SFD,OLD WALL INSL R11-FILL	Z3 MO12300E00	8	813.	2605.	30	.175	.016	13.9	6.7	761.7
70	SPACE HEAT-SFA,OLD HEAT PUMP 2	Z2 MO13200E00	12	500.	2569.	15	.038	.016	6.1	6.7	762.4
71	SPACE HEAT-SFD,NEW CEIL.INSL ADD R38	Z1 MN12100E00	4	457.	1424.	30	1.000	.016	399.4	7.1	808.0
72	SPACE HEAT-SFA,NEW FLOOR INSL ADD R11	Z3 MN13300E00	7	372.	1159.	30	1.000	.016	54.4	7.1	814.2
73	SPACE HEAT-SFD,OLD REDUCE INF 0.2 ACH	Z2 MO12200E00	11	381.	1907.	15	1.000	.017	301.3	7.4	848.6
74	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z2 MN15200E00	7	301.	915.	30	1.000	.017	43.4	7.5	853.5
75	SPACE HEAT-SFA,OLD CEIL INSL ADD R30	Z2 MO13200E00	6	618.	1791.	30	.115	.018	12.9	7.5	855.0
76	SPACE HEAT-SFA,OLD 1-2 GLAZING	Z2 MO13200E00	1	733.	2383.	25	.572	.018	85.6	7.6	864.8
77	SPACE HEAT-SFA,NEW WALL INSL ADD R12	Z3 MN13300E00	5	515.	1465.	30	1.000	.018	68.7	7.6	872.6
78	SPACE HEAT-SFD,OLD FLOOR INSL ADD R19	Z1 MO12100E00	12	731.	2078.	30	.203	.018	88.2	7.7	882.7
79	SPACE HEAT-MH,OLD FLOOR INSL ADD R19	Z1 MO11100E00	5	430.	1352.	25	1.000	.018	12.6	7.7	884.1
80	SPACE HEAT-MH,NEW CEIL.INSL. ADD R16	Z3 MN11300E00	3	425.	1330.	25	1.000	.018	33.1	7.8	887.9
81	SPACE HEAT-SFD,NEW FLOOR INSL ADD R11	Z3 MN12300E00	6	416.	1141.	30	1.000	.019	46.6	7.8	893.2
82	SPACE HEAT-SFA,OLD FLOOR INSL ADD R19	Z1 MO13100E00	10	526.	1438.	30	1.000	.019	200.4	8.0	916.1
83	SPACE HEAT-SFA,NEW FLOOR INSL ADD R11	Z2 MN13200E00	7	372.	1009.	30	1.000	.019	97.6	8.1	927.2
84	SPACE HEAT-MH,OLD DOOR INSLATION	Z3 MO11300E00	6	250.	763.	25	1.000	.019	1.1	8.1	927.4
85	SPACE HEAT-SFA,NEW 1-2 GLAZING	Z2 MN13200E00	1	271.	826.	25	1.000	.019	79.9	8.2	936.5
86	SPACE HEAT-SFA,NEW INSULATE DOOR	Z1 MN13100E00	8	200.	536.	30	.500	.019	57.5	8.3	943.0
87	SPACE HEAT-MH,NEW WALL INSL ADD R7	Z3 MN11300E00	4	615.	1820.	25	1.000	.019	45.2	8.3	948.2
88	SPACE HEAT-SFA,OLD CEIL INSL ADD R38	Z3 MO13300E00	5	833.	2171.	30	.320	.020	21.2	8.3	950.6
89	SPACE HEAT-SFD,NEW FLOOR INSL ADD R11	Z2 MN12200E00	6	416.	1083.	30	1.000	.020	228.9	8.6	976.8
90	SPACE HEAT-SFD,NEW INSULATE DOOR	Z1 MN12100E00	8	200.	519.	30	.500	.020	72.9	8.6	985.1
91	SPACE HEAT-SFA,OLD REDUCE INF 0.2 ACH	Z2 MO13200E00	7	381.	1619.	15	1.000	.020	101.7	8.7	996.7
92	SPACE HEAT-SFD,NEW 2-3 GLAZING	Z3 MN12300E00	1	365.	1062.	25	.950	.020	41.2	8.8	1001.4
93	SPACE HEAT-SFD,OLD WALL INSL R11-FILL	Z1 MO12100E00	9	766.	1977.	30	.312	.020	129.2	8.9	1016.1
94	SPACE HEAT-MF,NEW REDUCE INFL 0.25ACH	Z2 MN15200E00	5	381.	1610.	15	1.000	.020	76.4	9.0	1024.9
95	SPACE HEAT-MH,NEW FLOOR INSL. ADD R9	Z1 MN11100E00	6	195.	565.	25	1.000	.020	92.3	9.1	1035.4
96	SPACE HEAT-SFD,OLD 1-2 GLAZING	Z2 MO12200E00	1	974.	2792.	25	.444	.020	196.0	9.3	1057.8
97	SPACE HEAT-SFD,OLD CEIL INSL ADD R30	Z3 MO12300E00	6	760.	1891.	30	.231	.021	13.3	9.3	1059.3
98	SPACE HEAT-SFD,NEW WALL INSL ADD R12	Z3 MN12300E00	4	703.	1741.	30	.900	.021	63.9	9.3	1066.6
99	SPACE HEAT-MH,NEW REDUCE INF 0.3 ACH	Z1 MN11100E00	5	381.	1545.	15	1.000	.021	252.7	9.6	1095.4
100	SPACE HEAT-SFD,NEW 2-3 GLAZING	Z2 MN12200E00	1	365.	1010.	25	.950	.021	202.8	9.8	1118.6

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	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)
101	SPACE HEAT-SFD,NEW REDUCE INF 0.25 ACH	Z1 MN12100E00	6	381.	1533.	15	1.000	.021	430.0	10.2	1167.7
102	SPACE HEAT-SFA,NEW WALL INSL ADD R30	Z2 MN13200E00	5	515.	1256.	30	1.000	.021	121.4	10.3	1181.5
103	SPACE HEAT-MH,NEW INSULATE DOOR	Z1 MN11100E00	7	200.	545.	25	1.000	.021	89.2	10.4	1191.7
104	SPACE HEAT-SFD,NEW WALL INSL ADD R12	Z2 MN12200E00	4	703.	1656.	30	.900	.022	315.1	10.8	1227.7
105	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z2 MO15200E00	7	301.	709.	30	1.000	.022	25.1	10.8	1230.6
106	SPACE HEAT-SFA,OLD 1-2 GLAZING	Z1 MO13100E00	1	726.	1910.	25	.707	.022	188.2	11.0	1252.0
107	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z3 MO15300E00	7	301.	695.	30	1.000	.022	1.3	11.0	1252.2
108	SPACE HEAT-MH,OLD 1-2 GLAZING	Z1 MO11100E00	1	925.	2381.	25	.400	.022	8.9	11.0	1253.2
109	SPACE HEAT-MH,OLD DOOR INSULATION	Z2 MO11200E00	6	250.	640.	25	1.000	.022	5.1	11.0	1253.8
110	SPACE HEAT-SFA,OLD INSULATE DOOR	Z3 MO13300E00	9	250.	567.	30	.500	.022	8.6	11.0	1254.8
111	SPACE HEAT-MH,NEW CEIL INSL. ADD R16	Z2 MN11200E00	3	425.	1045.	25	1.000	.023	147.1	11.1	1271.6
112	SPACE HEAT-SFD,OLD CEIL INSL. ADD R30	Z2 MO12200E00	6	711.	1550.	30	.142	.023	34.8	11.2	1275.6
113	SPACE HEAT-SFA,OLD 1-2 GLAZING	Z3 MO13300E00	1	1012.	2481.	25	.231	.023	17.5	11.2	1277.5
114	SPACE HEAT-MH,OLD REDUCE INF 0.2 ACH	Z3 MO11300E00	4	381.	1351.	15	1.000	.024	1.9	11.2	1277.8
115	SPACE HEAT-SFA,NEW REDUCE INF 0.25 ACH	Z1 MN13100E00	6	380.	1328.	15	1.000	.024	284.9	11.5	1310.3
116	SPACE HEAT-MH,NEW WALL INSL. ADD R7	Z2 MN11200E00	4	615.	1438.	25	1.000	.025	202.5	11.7	1333.4
117	SPACE HEAT-MH,OLD CEIL.INSL. ADD R11	Z3 MO11300E00	3	340.	785.	25	.950	.025	1.1	11.7	1333.5
118	SPACE HEAT-SFD,OLD INSULATE DOOR	Z3 MO12300E00	13	250.	506.	30	1.000	.025	15.4	11.7	1335.3
119	SPACE HEAT-SFA,OLD HEAT PUMP 2	Z1 MO13100E00	14	500.	1626.	15	.035	.026	7.9	11.7	1336.2
120	SPACE HEAT-MF,NEW FLOOR INSL ADD R11	Z1 MN15100E00	7	301.	594.	30	1.000	.026	105.8	11.8	1348.3
121	SPACE HEAT-MF,OLD 1-2 GLAZING	Z2 MO15200E00	1	625.	1331.	25	1.000	.027	47.2	11.9	1353.6
122	SPACE HEAT-SFD,OLD 1-2 GLAZING	Z3 MO12300E00	1	1068.	2221.	25	.170	.028	11.5	11.9	1355.0
123	SPACE HEAT-SFD,NEW CEIL INSL ADD R30	Z3 MN12300E00	3	457.	827.	30	1.000	.028	33.8	11.9	1358.8
124	SPACE HEAT-MF,OLD 1-2 GLAZING	Z1 MO15 00E00	1	625.	1254.	25	1.000	.029	166.9	12.1	1377.9
125	SPACE HEAT-MH,OLD REDUCE INF 0.2 ACH	Z2 MO11200E00	4	381.	1111.	15	1.000	.029	8.9	12.1	1378.9
126	SPACE HEAT-SFD,OLD CEIL INSL ADD R38	Z1 MO12100E00	5	901.	1595.	30	.373	.029	124.7	12.2	1393.1
127	SPACE HEAT-SFD,OLD REDUCE INF 0.2 ACH	Z1 MO12100E00	11	381.	1106.	15	1.000	.029	231.9	12.4	1419.6
128	SPACE HEAT-SFA,OLD INSULATE DOOR	Z2 MO13200E00	10	250.	437.	30	.500	.029	13.7	12.4	1421.2
129	SPACE HEAT-SFD,NEW CEIL INSL ADD R30	Z2 MN12200E00	3	457.	788.	30	1.000	.030	166.7	12.6	1440.2
130	SPACE HEAT-MH,NEW CEIL INSL. ADD R16	Z1 MN11100E00	3	425.	735.	29	1.000	.030	120.2	12.7	1453.9
131	SPACE HEAT-MH,OLD 1-2 GLAZING	Z3 MO11300E00	1	925.	1757.	25	.400	.030	1.0	12.7	1454.0
132	SPACE HEAT-SFD,NEW FLOOR INSL ADD R11	Z1 MN12100E00	7	416.	696.	30	1.000	.031	195.2	12.9	1476.3
133	SPACE HEAT-MF,NEW 2-3 GLAZING	Z3 MN15300E00	2	250.	462.	25	.900	.031	1.0	12.9	1476.4
134	SPACE HEAT-SFD,OLD INSULATE DOOR	Z2 MO12200E00	14	250.	404.	30	.971	.032	62.0	13.0	1483.5
135	SPACE HEAT-MF,OLD FLOOR INSL ADD R8	Z1 MO15100E00	7	301.	484.	30	1.000	.032	64.5	13.1	1490.9
136	SPACE HEAT-SFD,OLD 1-2 GLAZING	Z1 MO12100E00	1	1036.	1873.	25	.589	.032	231.1	13.3	1517.3
137	SPACE HEAT-MF,NEW REDUCE INFL 0.25ACH	Z1 MN15100E00	5	381.	999.	15	1.000	.032	178.1	13.5	1537.6
138	SPACE HEAT-SFA,NEW CEIL INSL ADD R30	Z2 MN13200E00	4	408.	650.	30	1.000	.032	62.8	13.5	1544.8
139	SPACE HEAT-SFD,OLD CEIL INSL ADD R19	Z3 MO12300E00	7	625.	970.	30	.161	.033	4.8	13.5	1545.3
140	SPACE HEAT-SFA,NEW CEIL INSL ADD R30	Z3 MN13300E00	4	408.	624.	30	1.000	.033	29.3	13.6	1548.6
141	SPACE HEAT-MH,OLD CEIL.INSL. ADD R11	Z2 MO11200E00	3	340.	574.	25	.950	.034	4.4	13.6	1549.1
142	SPACE HEAT-SFD,NEW 2-3 GLAZING	Z1 MN12100E00	2	365.	616.	25	.950	.034	164.2	13.7	1567.9
143	SPACE HEAT-SFA,OLD REDUCE INF 0.2 ACH	Z1 MO13100E00	9	381.	934.	15	1.000	.034	130.1	13.9	1582.7
144	SPACE HEAT-SFA,NEW FLOOR INSL ADD R11	Z1 MN13100E00	7	372.	550.	30	1.000	.035	117.9	14.0	1596.2
145	SPACE HEAT-MH,NEW 2-3 GLAZING	Z3 MN11300E00	1	915.	1507.	25	.950	.035	35.6	14.0	1600.3
146	SPACE HEAT-MH,OLD 1-2 GLAZING	Z2 MO11200E00	1	925.	1442.	25	.400	.037	4.6	14.0	1600.8
147	SPACE HEAT-SFD,OLD HEAT PUMP 2	Z1 MO12100E00	16	500.	1101.	15	.053	.038	12.3	14.0	1602.2
148	SPACE HEAT-SFD,NEW WALL INSL ADD R12	Z1 MN12100E00	5	703.	936.	30	.900	.038	236.4	14.3	1629.2
149	SPACE HEAT-SFD,OLD FLOOR INSL ADD R30	Z2 MO12200E00	13	913.	1193.	30	.433	.039	81.6	14.4	1638.5
150	SPACE HEAT-MH,NEW WALL INSL. ADD R7	Z1 MN11100E00	4	615.	885.	25	1.000	.040	144.8	14.5	1655.0

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	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)	
151	SPACE HEAT-SFA,OLD INSULATE DOOR	Z1 MO13100E00	12	250.	319.	30	.500	.040	22.2	14.5	1657.6	
152	SPACE HEAT-MF,NEW 2-3 GLAZING	Z2 MN15200E00	2	250.	356.	25	.900	.040	15.2	14.5	1659.3	
153	SPACE HEAT-MF,NEW 2-3 GLAZING	Z1 MN15100E00	2	250.	356.	25	.900	.040	57.0	14.6	1665.8	
154	SPACE HEAT-MF,OLD 1-2 GLAZING	Z3 MO15300E00	1	625.	888.	25	1.000	.040	1.7	14.6	1666.0	
155	SPACE HEAT-SFA,OLD FLOOR INSL ADD R30	Z3 MO13300E00	8	855.	1071.	30	1.000	.041	32.6	14.6	1669.7	4 ¢
156	SPACE HEAT-SFA,NEW 2-3 GLAZING	Z3 MN13300E00	2	300.	421.	25	.950	.041	18.7	14.6	1671.9	
157	SPACE HEAT-MH,OLD INSULATE DOOR	Z1 MO11100E00	6	250.	347.	25	1.000	.041	3.2	14.6	1672.2	
158	SPACE HEAT-SFD,OLD CEIL INSL. ADD R19	Z2 MO12200E00	7	534.	611.	30	.084	.045	8.1	14.7	1673.2	
159	SPACE HEAT-MF,OLD WALL INSL. ADD R8	Z3 MO15300E00	4	694.	778.	30	1.000	.046	1.5	14.7	1673.3	
160	SPACE HEAT-MH,NEW 2-3 GLAZING	Z2 MN11200E00	1	915.	1150.	25	.950	.046	153.8	14.8	1690.9	
161	SPACE HEAT-SFD,OLD FLOOR INSL ADD R30	Z3 MO12300E00	12	925.	1008.	30	.410	.047	12.6	14.8	1692.3	
162	SPACE HEAT-SFD,OLD CEIL INSL ADD R30	Z1 MO12100E00	6	657.	711.	30	.114	.047	17.0	14.8	1694.3	
163	SPACE HEAT-SFA,NEW WALL INSL ADD R12	Z1 MN13100E00	5	515.	541.	30	1.000	.049	115.9	15.0	1707.5	
164	SPACE HEAT-MH,OLD REDUCE INF 0.2 ACH	Z1 MO11100E00	4	381.	631.	15	1.000	.051	5.9	15.0	1708.2	5 ¢
165	SPACE HEAT-SFA,OLD FLOOR INSL ADD R30	Z2 MO13200E00	9	760.	752.	30	1.000	.052	47.2	15.0	1713.6	
166	SPACE HEAT-MF,OLD REDUCE INFL 0.2 ACH	Z2 MO15200E00	5	635.	1000.	15	1.000	.053	35.5	15.0	1717.6	
167	SPACE HEAT-SFA,NEW 2-3 GLAZING	Z1 MN13100E00	2	323.	342.	25	.950	.054	69.6	15.1	1725.6	
168	SPACE HEAT-SFD,OLD INSULATE DOOR	Z1 MO12100E00	14	250.	232.	30	1.000	.055	48.6	15.2	1731.1	
169	SPACE HEAT-MF,OLD REDUCE INFL 0.2 ACH	Z3 MO15300E00	5	635.	952.	15	1.000	.056	1.8	15.2	1731.3	
170	SPACE HEAT-MF,OLD WALL INSL. ADD R8	Z2 MO15200E00	4	694.	611.	30	1.000	.058	21.6	15.2	1733.8	
171	SPACE HEAT-SFD,OLD CEIL INSL. ADD R11	Z2 MO12200E00	8	397.	337.	30	.037	.060	2.0	15.2	1734.0	
172	SPACE HEAT-SFA,NEW 2-3 GLAZING	Z2 MN13200E00	2	323.	308.	25	.950	.060	28.2	15.2	1737.2	
173	SPACE HEAT-SFA,OLD 2-3 GLAZING	Z2 MO13200E00	2	968.	875.	25	.950	.064	52.2	15.3	1743.2	6 ¢
174	SPACE HEAT-SFA,OLD CEIL.INSL ADD R30	Z1 MO13100E00	6	618.	494.	30	.605	.064	41.6	15.3	1747.9	
175	SPACE HEAT-SFA,OLD 2-3 GLAZING	Z3 MO13300E00	2	1208.	1057.	25	.950	.066	30.6	15.3	1751.4	
176	SPACE HEAT-SFA,OLD CEIL INSL ADD R19	Z1 MO13100E00	7	457.	341.	30	.171	.068	8.1	15.3	1752.4	
177	SPACE HEAT-SFD,NEW 3-4 GLAZING	Z3 MN12300E00	2	511.	406.	25	.950	.072	15.7	15.4	1754.2	7 ¢
178	SPACE HEAT-SFD,NEW 3-4 GLAZING	Z2 MN12200E00	2	511.	389.	25	.950	.075	78.1	15.4	1763.1	
179	SPACE HEAT-SFA,OLD FLOOR INSL ADD R30	Z1 MO13100E00	11	652.	434.	30	1.000	.077	60.5	15.5	1770.0	
180	SPACE HEAT-SFD,OLD 2-3 GLAZING	Z2 MO12200E00	2	1220.	915.	25	.950	.077	137.3	15.6	1785.6	
181	SPACE HEAT-MH,NEW 2-3 GLAZING	Z1 MN11100E00	1	903.	676.	25	.950	.077	105.0	15.7	1797.6	
182	SPACE HEAT-MF,OLD REDUCE INFL 0.2 ACH	Z1 MO15100E00	5	635.	687.	15	1.000	.077	91.4	15.8	1808.1	
183	SPACE HEAT-MH,OLD CEIL INSL. R11	Z1 MO11100E00	3	340.	235.	25	.950	.083	2.1	15.8	1808.3	8 ¢
184	SPACE HEAT-MF,NEW 3-4 GLAZING	Z3 MN15300E00	3	350.	242.	25	.800	.083	.5	15.8	1808.4	
185	SPACE HEAT-SFA,OLD HEAT PUMP 1	Z3 MO13300E00	10	4080.	4039.	15	.910	.085	112.0	16.0	1821.2	
186	SPACE HEAT-SFD,OLD 2-3 GLAZING	Z3 MO12300E00	2	1287.	870.	25	.950	.085	25.2	16.0	1824.0	
187	SPACE HEAT-MH,OLD DUCT INSULATION	Z2 MO11200E00	9	250.	166.	25	1.000	.087	1.3	16.0	1824.2	
188	SPACE HEAT-MH,OLD 2-3 GLAZING	Z3 MO11300E00	2	1110.	729.	25	.950	.087	1.0	16.0	1824.3	
189	SPACE HEAT-SFA,OLD 2-3 GLAZING	Z1 MO13100E00	2	881.	563.	25	.950	.090	74.5	16.1	1832.8	
190	SPACE HEAT-MH,NEW 3-4 GLAZING	Z3 MN11300E00	2	916.	568.	25	.950	.093	13.4	16.1	1834.3	9 ¢
191	SPACE HEAT-SFD,NEW HEAT PUMP 2	Z2 MN12200E00	9	500.	443.	15	.200	.095	18.7	16.1	1836.5	
192	SPACE HEAT-MF,OLD WALL INSL. ADD R8	Z1 MO15100E00	4	694.	368.	30	1.000	.096	49.0	16.1	1842.1	
193	SPACE HEAT-MF,OLD 2-3 GLAZING	Z2 MO15200E00	2	750.	442.	25	.800	.097	12.5	16.1	1843.5	
194	SPACE HEAT-SFA,OLD CEIL INSL ADD R11	Z1 MO13100E00	8	269.	135.	30	.025	.102	.5	16.1	1843.6	10 ¢
195	SPACE HEAT-SFD,OLD CEIL INSL ADD R19	Z1 MO12100E00	7	583.	276.	30	.159	.108	9.2	16.2	1844.6	
196	SPACE HEAT-MF,NEW 3-4 GLAZING	Z2 MN15200E00	3	350.	185.	25	.800	.109	7.0	16.2	1845.4	
197	SPACE HEAT-SFA,NEW 3-4 GLAZING	Z3 MN13300E00	3	420.	221.	25	.950	.109	9.9	16.2	1846.5	
198	SPACE HEAT-SFD,OLD FLOOR INSL ADD R30	Z1 MO12100E00	13	870.	406.	30	.518	.109	44.0	16.2	1851.6	
199	SPACE HEAT-MH,NEW 3-4 GLAZING	Z2 MN11200E00	2	916.	422.	25	.950	.125	56.5	16.3	1858.0	11 ¢
200	SPACE HEAT-MF,OLD 2-3 GLAZING	Z3 MO15300E00	2	750.	344.	25	.800	.125	.5	16.3	1858.1	

(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)	
201 SPACE HEAT-MF,OLD 2-3 GLAZING	Z1 MO15100E00	2	750.	330.	25	.800	.130	35.2	16.3	1862.1	
202 SPACE HEAT-SFA,OLD HEAT PUMP 1	Z2 MO13200E00	11	4001.	2531.	15	.962	.132	153.0	16.5	1879.5	13 ¢
203 SPACE HEAT-SFD,NEW 3-4 GLAZING	Z1 MN12100E00	3	511.	214.	25	.950	.137	57.2	16.5	1886.1	
204 SPACE HEAT-MF,NEW 3-4 GLAZING	Z1 MN15100E00	3	350.	146.	25	.900	.137	23.5	16.5	1888.7	
205 SPACE HEAT-MH,OLD 2-3 GLAZING	Z2 MO11200E00	2	1110.	445.	25	.950	.143	3.4	16.5	1889.1	14 ¢
206 SPACE HEAT-MH,OLD HEAT PUMP	Z3 MO11300E00	8	1800.	1020.	15	1.000	.148	1.4	16.5	1889.3	
++ CUT OFF PRICE IS .150 ++											
207 SPACE HEAT-MH,NEW HEAT PUMP	Z3 MN11300E00	8	2900.	1538.	15	1.000	.158	38.2	16.6	1893.7	
208 SPACE HEAT-SFD,OLD 2-3 GLAZING	Z1 MO12100E00	2	1259.	454.	25	.950	.159	90.3	16.7	1904.0	
209 SPACE HEAT-MH,NEW CHANGE ROOF COLOR	Z1 MN11100E00	9	200.	63.	30	1.000	.163	10.2	16.7	1905.1	
210 SPACE HEAT-MH,OLD 2-3 GLAZING	Z1 MO11100E00	2	1110.	390.	25	.950	.163	3.5	16.7	1905.5	
211 SPACE HEAT-SFA,OLD 3-4 GLAZING	Z2 MO13200E00	3	968.	333.	25	.950	.167	19.9	16.7	1907.8	
212 SPACE HEAT-SFA,NEW 3-4 GLAZING	Z2 MN13200E00	3	458.	156.	25	.950	.168	14.3	16.7	1909.4	
213 SPACE HEAT-SFD,OLD 3-4 GLAZING	Z2 MO12200E00	3	1220.	401.	25	.950	.175	60.2	16.8	1916.3	
214 SPACE HEAT-SFD,NEW HEAT PUMP 1	Z3 MN12300E00	8	3025.	1415.	15	.400	.179	23.1	16.8	1918.9	
215 SPACE HEAT-SFD,OLD 3-4 GLAZING	Z3 MO12300E00	3	1287.	409.	25	.950	.181	11.8	16.8	1920.3	
216 SPACE HEAT-SFA,OLD 3-4 GLAZING	Z3 MO13300E00	3	1208.	334.	25	.950	.208	9.7	16.8	1921.4	
217 SPACE HEAT-SFD,OLD CEIL INSL ADD R11	Z1 MO12100E00	8	258.	63.	30	.016	.211	.2	16.8	1921.4	
218 SPACE HEAT-SFA,OLD 3-4 GLAZING	Z1 MO13100E00	3	881.	233.	25	.950	.217	30.9	16.9	1924.9	
219 SPACE HEAT-MH,NEW 3-4 GLAZING	Z1 MN11100E00	2	904.	216.	25	.950	.241	33.5	16.9	1928.8	
220 SPACE HEAT-MH,NEW HEAT PUMP	Z2 MN11200E00	8	2900.	925.	15	1.000	.263	130.3	17.0	1943.6	
221 SPACE HEAT-SFA,NEW 3-4 GLAZING	Z1 MN13100E00	3	458.	100.	25	.950	.263	20.4	17.0	1946.0	
222 SPACE HEAT-SFD,NEW HEAT PUMP 1	Z2 MN12200E00	8	3378.	1025.	15	.800	.276	173.5	17.2	1965.8	
223 SPACE HEAT-SFD,OLD HEAT PUMP 1	Z3 MO12300E00	14	3975.	1169.	15	.769	.285	27.4	17.2	1968.9	
224 SPACE HEAT-SFD,OLD HEAT PUMP 1	Z2 MO12200E00	15	3817.	1094.	15	.744	.292	128.6	17.4	1983.6	
225 SPACE HEAT-SFA,INSTALL HEAT PUMP	Z3 MN13300E00	9	3025.	839.	15	.800	.302	31.5	17.4	1987.2	
226 SPACE HEAT-SFD,NEW HEAT PUMP 2	Z1 MN12100E00	10	500.	130.	15	.200	.323	7.3	17.4	1988.0	
227 SPACE HEAT-SFD,OLD WALL INSL R12-SIDE	Z3 MO12300E00	9	3216.	506.	30	.800	.324	12.3	17.4	1989.4	
228 SPACE HEAT-MH,OLD DUCT INSULATION	Z1 MO11100E00	9	250.	38.	25	.798	.382	.3	17.4	1989.4	
229 SPACE HEAT-SFA,OLD HEAT PUMP 1	Z1 MO13100E00	13	4000.	841.	15	.965	.398	113.1	17.5	2002.4	
230 SPACE HEAT-SFD,OLD 3-4 GLAZING	Z1 MO12100E00	3	1259.	177.	25	.950	.407	35.3	17.6	2006.4	
231 SPACE HEAT-SFD,OLD WALL INSL R12-SIDE	Z2 MO12200E00	10	3447.	334.	30	.800	.527	42.2	17.6	2011.2	
232 SPACE HEAT-MH,OLD HEAT PUMP	Z2 MO11200E00	8	3000.	429.	15	1.000	.586	3.4	17.6	2011.6	
233 SPACE HEAT-SFD,NEW HEAT PUMP 1	Z1 MN12100E00	9	3466.	482.	15	.640	.602	86.6	17.7	2021.5	
234 SPACE HEAT-MH,NEW HEAT PUMP	Z1 MN11100E00	8	2900.	341.	15	1.000	.713	55.7	17.8	2027.8	
235 SPACE HEAT-SFD,OLD WALL INSL R12-SIDE	Z1 MO12100E00	10	3234.	193.	30	.800	.856	32.3	17.8	2031.5	
236 SPACE HEAT-SFA,INSTALL HEAT PUMP	Z2 MN13200E00	9	3025.	258.	15	.800	.981	20.0	17.8	2033.8	
237 SPACE HEAT-MH,OLD HEAT PUMP	Z1 MO11100E00	8	2003.	152.	15	.960	1.106	1.4	17.8	2034.0	
238 SPACE HEAT-SFD,OLD HEAT PUMP 1	Z1 MO12100E00	15	4012.	192.	15	.751	1.753	30.2	17.8	2037.4	
239 SPACE HEAT-SFA,INSTALL HEAT PUMP	Z1 MN13100E00	9	3025.	75.	15	.800	3.369	12.9	17.9	2038.9	

There are no surprises in our results; most of the measures thought to conserve energy do in fact offer the greatest potential. Insulation, however, appears much more economic than conversion to heat pumps because of our sequencing procedure (namely, implement all cheaper measures before calculating the savings of the next). There are several procedures available in CPS 2.0 to "turn off" the insulation measures in order to explore the potential when insulation is installed after heat pumps.

Two other studies have examined space heating conservation measures in sufficient detail to permit comparison with our results. The Regional Council study (1983) suggests that the technical and economic potential for conservation beyond that already included in the BPA forecast is about 675 MW. Their assumptions were very similar to ours (although using a 10 cents/kWh cut-off price). Most of the difference can be attributed to the inclusion of more conservation measures in our analysis. The NRDC (Jan, 1982) study concluded that a "high conservation" scenario would result in space heating consuming 1563 MW. Our and NRDC's estimates are nearly the same given the small differences in assumptions.

Water Heating

We constructed a supply curve of conserved energy for the water heating end use. This is shown in Figure I-4 and summarized in Tables I-6 and I-7. The year 2000 consumption, assuming all cost-effective measures were implemented would be 1098 MW less than that forecast by BPA. However, our estimate must be interpreted with caution because BPA made an error in their water heating frozen efficiency forecast (from which we based our estimate of consumption).

The measures having the greatest conservation potential are those applying to single family homes. These include the use of cold water laundry, low flow showerheads, water heater insulation, and conversion to a heat pump or solar. We assumed that high COP heat pump water heaters would appear in 1990 and displace the lower COP models then being installed. CPS 2.0 shows (Measure 31 in Table I-7) that all the lower COP units have been displaced, or "rolled out" by 2000. There is no double-counting of energy savings. The CCEs and energy savings attributed to heat pumps and solar systems would be greater if these measures were implemented prior to the hot water conservation and tank insulation measures. Thanks to Work4, CPS 2.0 can calculate the savings for the heat pump and solar measures, when implemented prior to the conservation measures, with small changes in the data base.

The Regional Council estimated that the conservation potential for water heating was 910 MW, that is, about 17% less than our calculations. We attribute this difference principally to the Regional Council using slightly lower penetrations for some conservation measures. The NRDC study estimated in their "high conservation" scenario that electricity consumption for water heating could fall to 437 MW (including solar) compared to our 194 MW (although probably low due to the error in the baseline assumption). The precise values for some of NRDC's water heating measures are difficult to extract, but we suspect that we have assumed a slightly higher heat pump efficiency.

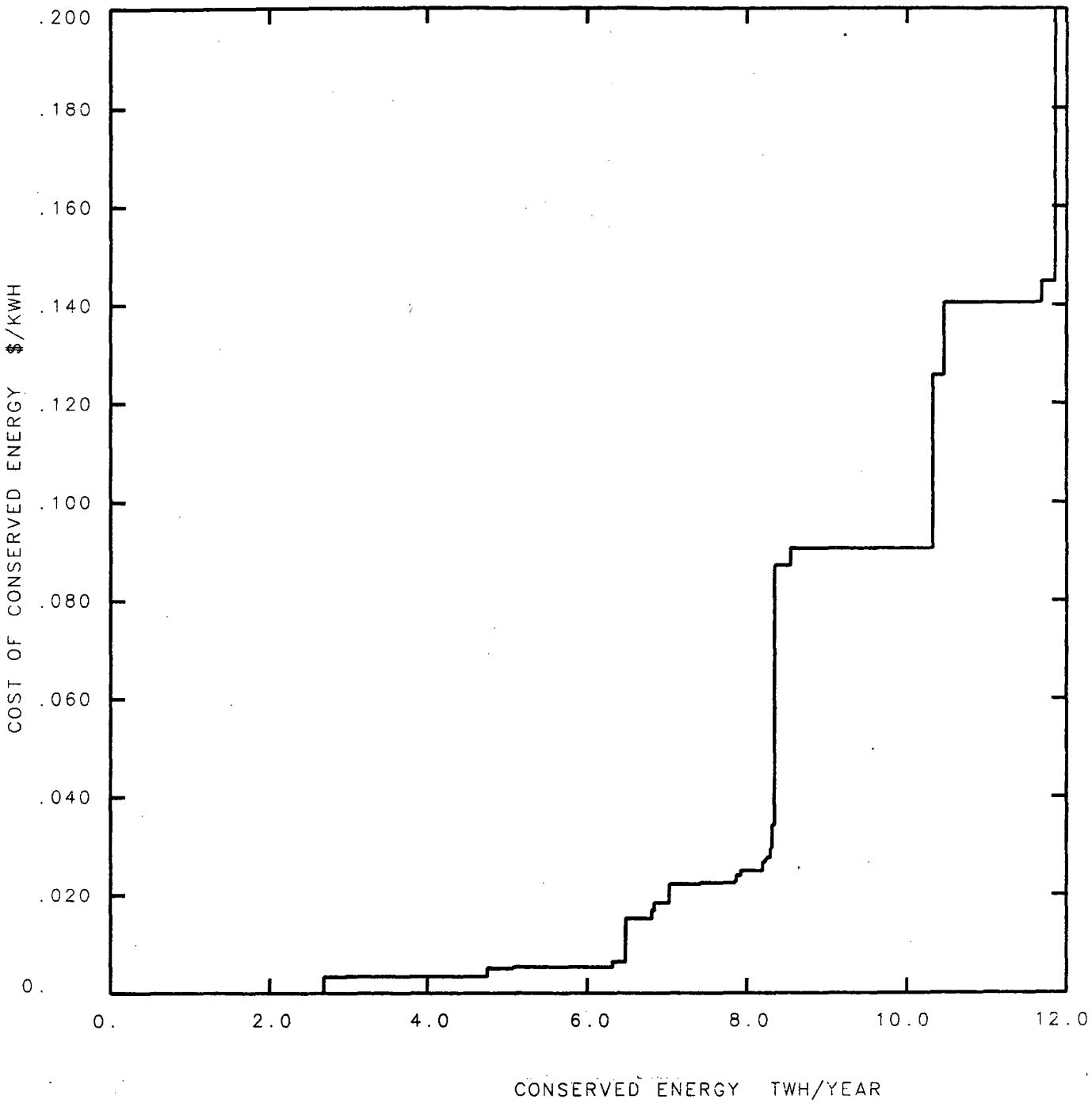

Figure I-4 Water Heating Conservation Supply Curve for 2000

Source: Table I-7, Column I

Table I-6 Water Heating Supply Curve End Uses (2000)

(A) END USE DESCRIPTION	(B) ID CODE	(C) TOTAL STOCK (1000S)	(D) ADD RATE	(E) DECAY OR REPLACE RATE	(F) BASELINE UEC (KWH/YR)	(F) BASELINE USAGE (GWH)	(G) POTENTIAL UEC (KWH/YR)	(G) POTENTIAL USAGE (GWH)	(H) WORK4 USED	(I) LAST UPDATE
WATER HEATING SINGLE FAMILY	EE34000E00	2845.	.019	-0.	4515.	12844.3	1052.	2993.2	1	8-82
WATER HEATING MF	EE35000E00	415.	.018	-0.	2730.	1131.6	955.	395.8	1	8-82
WATER HEATING MH	EE31000E00	416.	.038	-0.	4225.	1756.8	1166.	484.8	1	8-82
SUBTOTAL		3675.			4281.	15732.8	1054.	3873.8		
TOTAL		3675.				15732.8		3873.8		

Table I-7 Water Heating Supply Curve Conservation Measures (2000)

	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)	
1	SF-TEMPERATURE SETBACK TO 140 DEGREES	ME34000E00	1	0.	349.	13	.400	0.	397.7	.4	45.4	
2	MF-TEMPERATURE SETBACK TO 140 DEGREES	ME35000E00	1	0.	80.	13	.440	0.	14.6	.4	47.1	
3	MH-COLD WATER LAUNDRY	ME31000E00	5	0.	441.	10	.720	0.	132.1	.5	62.2	
4	MF-TEMPERATURE SETBACK TO 120 DEGREES	ME35000E00	9	0.	414.	13	.460	0.	78.9	.6	71.2	
5	SF-COLD WATER LAUNDRY	ME34000E00	5	0.	548.	10	.765	0.	1193.4	1.8	207.4	
6	MF-COLD WATER LAUNDRY	ME35000E00	5	0.	422.	10	.108	0.	18.9	1.8	209.6	
7	MH-TEMPERATURE SETBACK TO 120 DEGREES	ME31000E00	9	0.	549.	13	.600	0.	136.9	2.0	225.2	
8	MH-TEMPERATURE SETBACK TO 140 DEGREES	ME31000E00	1	0.	202.	13	.400	0.	33.6	2.0	229.0	
9	SF-TEMPERATURE SETBACK TO 120 DEGREES	ME34000E00	9	0.	596.	13	.400	0.	678.1	2.7	306.4	
10	MH-LOW FLOW SHOWRHEADS	ME31000E00	4	40.	813.	20	.850	.003	287.3	3.0	339.2	
11	SF-LOW FLOW SHOWERHEADS	ME34000E00	4	40.	781.	20	.800	.003	1777.5	4.7	542.2	
12	MH-WATER HEATER WRAP - WALLS	ME31000E00	2	25.	584.	10	.550	.005	133.6	4.9	557.4	
13	MF-LOW FLOW SHOWERHEADS	ME35000E00	4	40.	532.	20	.820	.005	180.9	5.1	578.1	
14	SF-WATER HEATER WRAP - WALLS	ME34000E00	2	25.	547.	10	.800	.005	1245.6	6.3	720.3	
15	MF-WATER HEATER WRAP - WALLS	ME35000E00	2	25.	457.	10	.880	.006	166.6	6.5	739.3	1 ¢
16	SF-EFFICIENT DISHWASHER	ME34000E00	7	30.	231.	10	.500	.015	328.5	6.8	776.8	
17	MH-EFFICIENT DISHWASHER	ME31000E00	7	30.	209.	10	.400	.017	34.8	6.8	780.8	
18	SF-INSULATING BOTTOM BOARD	ME34000E00	3	10.	64.	10	1.000	.018	181.2	7.0	801.4	2 ¢
19	SF-ADDITIONAL WRAP	ME34000E00	12	26.	137.	10	1.000	.022	390.2	7.4	846.0	
20	MH-ADDITIONAL WRAP	ME31000E00	12	26.	136.	10	1.000	.022	56.5	7.5	852.4	
21	SF-EFFICIENT CLOTHES WASHER	ME34000E00	6	30.	156.	10	.850	.022	378.2	7.8	895.6	
22	MH-INSULATING BOTTOM BOARD	ME31000E00	3	10.	51.	10	1.000	.023	21.3	7.9	898.1	
23	MF-ADDITIONAL WRAP	ME35000E00	12	26.	127.	10	1.000	.024	52.6	7.9	904.1	
24	SF-PIPE INSULATION	ME34000E00	10	30.	113.	13	.850	.025	273.9	8.2	935.3	
25	MF-PIPE INSULATION	ME35000E00	10	30.	105.	13	.880	.027	38.5	8.2	939.7	
26	MF-INSULATING BOTTOM BOARD	ME35000E00	3	10.	43.	10	1.000	.027	17.8	8.2	941.8	
27	MH-EFFICIENT CLOTHES WASHER	ME31000E00	6	30.	127.	10	.800	.028	42.3	8.3	946.6	
28	MF-EFFICIENT CLOTHES WASHER	ME35000E00	6	30.	120.	10	.120	.029	6.0	8.3	947.3	
29	MH-PIPE INSULATION	ME31000E00	10	30.	95.	13	.500	.030	19.8	8.3	949.5	3 ¢
30	MF-EFFICIENT DISHWASHER	ME35000E00	7	30.	103.	10	.540	.034	23.0	8.3	952.1	
31	SF-HEAT PUMP WATER HEATER	ME34000E00	8	STOCK DECAYED TO ZERO OR MEASURE ROLLED OUT, NO SAVINGS								
32	MH-HEAT PUMP WATER HEATER	ME31000E00	8	1000.	962.	15	.500	.087	199.9	8.5	975.0	
33	SF-HIGH COP HEAT PUMP WATER HEATER	ME34000E00	13	1600.	1480.	15	.500	.091	1781.7	10.3	1178.4	
34	MF-HEAT PUMP WATER HEATER	ME35000E00	8	1000.	666.	15	.500	.126	138.1	10.5	1194.1	
35	SF-SOLAR WATER HEATER	ME34000E00	11	1800.	861.	20	.500	.140	1225.0	11.7	1334.0	
36	MH-SOLAR WATER HEATER	ME31000E00	11	1800.	836.	20	.500	.145	173.8	11.9	1353.8	
	++ CUT OFF PRICE IS .150 ++											
37	MF-SOLAR WATER HEATER	ME35000E00	11	1800.	581.	20	.500	.208	120.4	12.0	1367.6	

Appliances and Other

We constructed a supply curve of conserved energy for the appliances and other end use. This is shown in Figure I-5 and summarized in Tables I-8 and I-9. In the BPA forecast, "appliances" includes refrigerators, freezers, lighting, and cooking; "other" includes all other miscellaneous residential electricity uses. We have provided conservation measures for all the appliance end uses and additional end uses BPA considers "other", e.g., clothes dryers, clothes washers, dishwashers, water beds and well pumps.

The technical potential is roughly 27%, or 1053 MW, less than the BPA forecast. We believe that the technical potential is considerably greater than this because of the largely unspecified "other" part of this end use. We included a well pump and water bed measure in part to indicate the diversity of end uses concealed within "other", but nevertheless available for conservation measures.

It is difficult to compare our results with other studies. It is not clear, for example, how NRDC treated the "other" portion. They offer a "high conservation" scenario for appliances and lighting using 1838 MW, somewhat below our 2827 MW. The Regional Council (1983) estimates a 499 MW conservation potential, although the assumptions are not nearly as easily comparable as those for space heating. This is considerably less than our 1532 MW (from the frozen efficiency baseline) and about half the difference between the forecast and our potential. The Regional Council appeared to assume much lower penetration rates of efficient appliances.

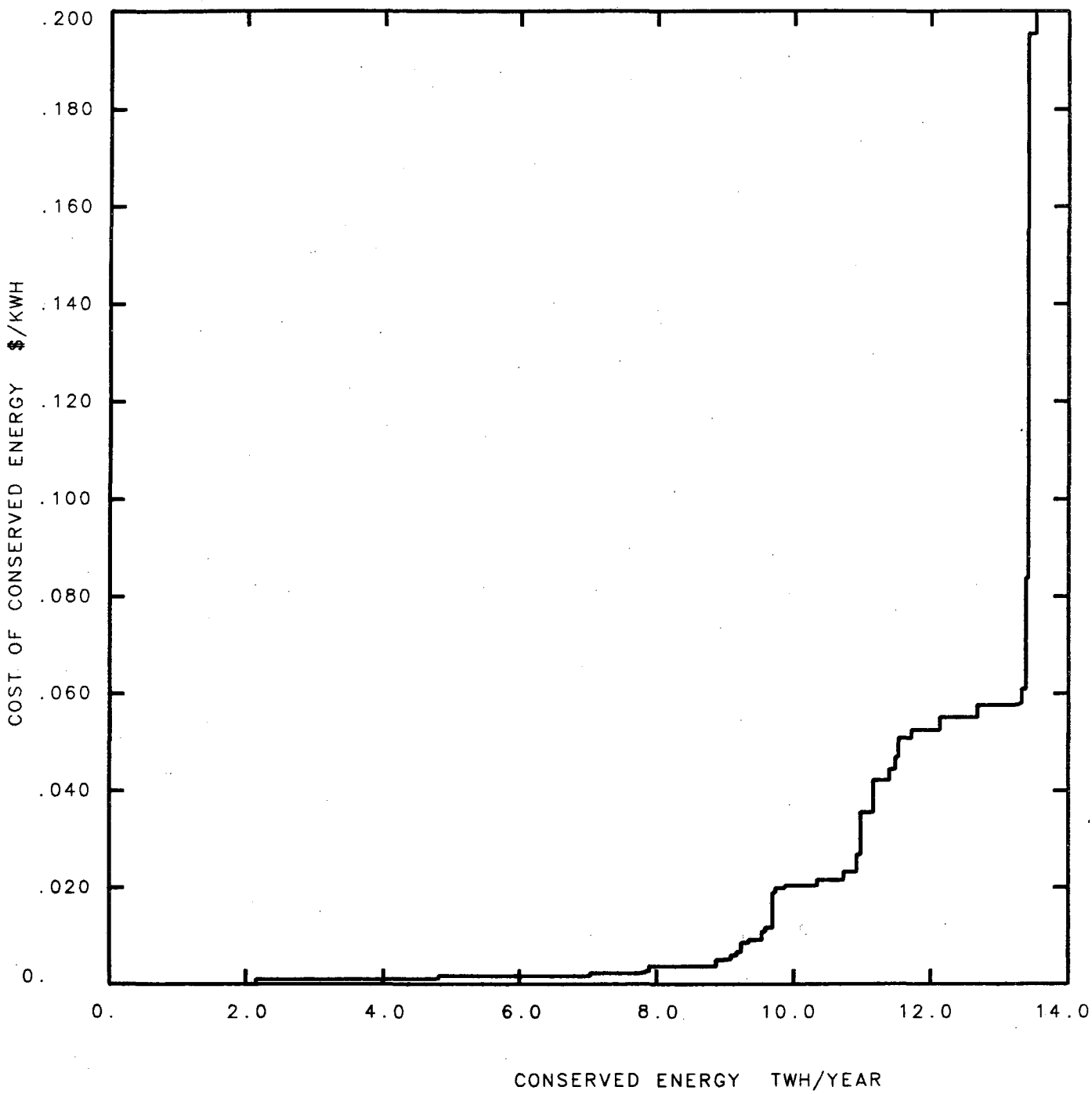

Figure I-5 Appliance Conservation Supply Curve for 2000

Source: Table I-9, Column I

Table I-8 Appliance Supply Curve End Uses (2000)

(A) END USE DESCRIPTION	(B) ID CODE	(C) TOTAL STOCK (1000S)	(D) ADD RATE	(E) DECAY OR REPLACE RATE	(F) BASELINE UEC (KWH/YR)	(F) BASELINE USAGE (GWH)	(G) POTENTIAL UEC (KWH/YR)	(G) POTENTIAL USAGE (GWH)	(H) WORK4 USED	(I) LAST UPDATE
REFRIGERATORS-SINGLE DOOR MANUAL	EE40001E00	567.	.010	-0.	750.	425.2	377.	213.9	0	1-83
REFRIGERATORS-PARTIAL AUTO DEFROST	EE40002E00	1435.	.020	-0.	1300.	1865.9	492.	706.7	0	1-83
REFRIGERATORS-TOP MOUNT FREEZER	EE40003E00	2450.	.023	-0.	1825.	4471.9	726.	1778.1	0	1-83
REFRIGERATORS-BOTTOM FREEZER,AUTO DEF.	EE40005E00	176.	.020	-0.	2800.	492.3	839.	147.5	0	1-83
REFRIGERATORS-SIDE BY SIDE,AUTO.DEFROST	EE40004E00	555.	.020	-0.	2650.	1470.0	1009.	560.0	0	1-83
SUBTOTAL		5183.			1683.	8725.4	657.	3406.2		
FREEZERS-CHEST MANUAL DEFROST	EE50001E00	881.	.016	-0.	1475.	1298.9	575.	506.8	0	1-83
FREEZERS-UPRIGHT MANUAL DEFROST	EE50003E00	783.	.016	-0.	1750.	1370.2	685.	536.4	0	1-83
FREEZERS-UPRIGHT AUTOMATIC DEFROST	EE50002E00	535.	.016	-0.	3100.	1657.0	1043.	557.7	0	1-83
SUBTOTAL		2198.			1968.	4326.1	728.	1600.9		
COOKING-ELECTRIC RANGES & OVENS	EE60001E00	4171.	.020	-0.	755.	3149.2	663.	2766.8	0	9-82
SUBTOTAL		4171.			755.	3149.2	663.	2766.8		
TELEVISIONS-COLOR	EE80001E00	4708.	.025	-0.	600.	2824.7	200.	941.6	0	9-82
TELEVISIONS-BLACK & WHITE	EE80002E00	1818.	.010	-0.	200.	363.6	25.	45.4	0	9-82
CLOTHES DRYER-ELECTRIC	EE80003E00	3554.	.026	-0.	1000.	3553.8	796.	2828.8	0	2-83
CLOTHES WASHERS	EE80004E00	3483.	.020	-0.	100.	348.3	100.	348.3	0	9-82
DISHWASHERS	EE80005E00	3416.	.041	-0.	175.	597.8	175.	597.8	0	2-83
SUBTOTAL		16978.			453.	7688.1	280.	4761.9		
WATERBED HEATERS	EE90003E00	670.	.020	-0.	1400.	937.9	1120.	750.3	0	9-82
WELL WATER PUMPS	EE90001E00	465.	.020	-0.	300.	139.6	220.	102.4	0	9-82
SUBTOTAL		1135.			949.	1077.5	751.	852.7		
LIGHTING-SINGLE FAMILY, NEW	EN74000E00	2137.	.020	.018	1000.	2136.8	561.	1197.9	0	2-83
LIGHTING-MULTI FAMILY, NEW	EN75000E00	272.	.018	.018	750.	204.2	401.	109.0	0	2-83
LIGHTING-MOBILE HOME, NEW	EN71000E00	480.	.038	.042	600.	288.2	367.	176.1	0	2-83
SUBTOTAL		2889.			910.	2629.1	513.	1483.1		
LIGHTING-SINGLE FAMILY, OLD	EO74000E00	1487.	-0.	.018	1000.	1487.2	578.	859.3	0	2-83
LIGHTING-MULTI FAMILY, OLD	EO75000E00	203.	-0.	.018	750.	152.5	443.	90.1	0	2-83
LIGHTING-MOBILE HOME, OLD	EO71000E00	27.	-0.	.042	600.	16.4	375.	10.3	0	2-83
SUBTOTAL		1718.			964.	1656.2	559.	959.6		
TOTAL		34273.				29251.6		15831.2		

Table I-9 Appliance Supply Curve Conservation Measures (2000)

	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)	
1	TELEVISION-B & W,SOLID STATE IMPROVEMENT	ME80002E00	1	0.	150.	10	1.000	0.	272.7	.3	31.1	
2	TELEVISIONS-COLOR,SOLID STATE IMPROVE.	ME80001E00	1	0.	400.	10	1.000	0.	1883.1	2.2	246.1	
3	REFRIG.-SIDE BY SIDE,BUY EFF. MKT MODEL	ME40004E00	1	16.	1290.	19	1.000	.001	715.6	2.9	327.8	
4	FREEZER-UPRIGHT AUTO,BUY EFF. MKT.MDL	ME50002E00	1	25.	1860.	21	1.000	.001	994.2	3.9	441.3	
5	REFRIG.-BOTTOM FREEZER,BUY EFF. MODEL	ME40005E00	1	19.	1485.	19	1.000	.001	261.1	4.1	471.1	
6	FREEZER-CHEST MANUAL,BUY EFF. MKT MODEL	ME50001E00	1	12.	770.	21	1.000	.001	678.1	4.8	548.5	
7	REFRIG.-TOP FREEZE-EFF.MKT MODEL/CPES	ME40003E00	1	22.	910.	19	1.000	.002	2229.8	7.0	803.1	
8	FREEZER-UPRIGHT MAN.,BUY EFF.MKT MODEL	ME50003E00	1	33.	975.	21	1.000	.002	763.4	7.8	890.2	
9	REFRIG.-BOTTOM FREEZER,CPES IMPROVEMENT	ME40005E00	2	11.	325.	19	1.000	.002	48.1	7.8	895.7	
10	REFRIG.-SIDE BY SIDE,CPES IMPROVEMENTS	ME40004E00	2	4.	110.	19	1.000	.003	51.4	7.9	901.6	
11	REFRIG.-PARTIAL AUTO,EFF. MKT MODEL/CPES	ME40002E00	1	35.	675.	19	1.000	.004	968.9	8.9	1012.2	
12	FREEZER-CHEST MANUAL,CPES IMPROVEMENTS	ME50001E00	2	13.	170.	21	1.000	.005	114.1	9.0	1025.2	
13	FREEZER-UPRIGHT AUTO,CPES IMPROVEMENTS	ME50002E00	2	20.	258.	21	1.000	.005	105.1	9.1	1037.2	
14	WATERBED,COMFORTER COVER	ME90003E00	2	20.	400.	10	.300	.006	80.4	9.2	1046.4	
15	FREEZER-UPRIGHT MAN.,CPES IMPROVEMENTS	ME50003E00	2	12.	118.	21	1.000	.007	70.4	9.2	1054.4	
16	REFRIG.-SINGLE DOOR,BUY EFF. MKT. MODEL	ME40001E00	1	22.	180.	19	1.000	.009	102.0	9.3	1066.1	
17	COOKING-ELEC.RANGES/OVENS, BI-RAD. OVEN	ME60001E00	2	25.	200.	18	.300	.009	194.7	9.5	1088.3	1 ¢
18	REFRIG.-SINGLE DOOR,CPES IMPROVEMENTS	ME40001E00	2	18.	115.	19	1.000	.011	54.9	9.6	1094.6	
19	WATERBED,INSULATE SIDES/BOTTOM	ME90003E00	1	20.	200.	10	.800	.012	107.2	9.7	1106.8	
20	REFRIG.-BOTTOM FREEZER,1987 IMPROVEMENT	ME40005E00	3	75.	275.	19	1.000	.019	35.6	9.7	1110.9	
21	REFRIG.-SIDE BY SIDE,1987 IMPROVEMENTS	ME40004E00	3	100.	350.	19	1.000	.020	143.1	9.9	1127.2	
22	REFRIG.-TOP FREEZER-1987 IMPROVEMENTS	ME40003E00	2	75.	257.	19	1.000	.020	464.0	10.3	1180.2	2 ¢
23	LIGHTING-MF,OLD-FLUOR.IN KITCHEN(RENOV.)	MO75000E00	1	17.	172.	5	.300	.022	10.5	10.3	1181.4	
24	LIGHTING-MH,NEW-USE FLUOR.IN KITCHEN	MN71000E00	1	17.	172.	5	.250	.022	20.7	10.4	1183.7	
25	LIGHTING-SF,NEW-FLUOR.IN KITCHEN	MN74000E00	1	17.	172.	5	.700	.022	257.3	10.6	1213.1	
26	LIGHTING-MH,OLD-FLUOR.IN KITCHEN(RENOV.)	MO71000E00	1	17.	172.	5	.100	.022	.5	10.6	1213.1	
27	LIGHTING-MF,NEW-USE FLUOR.IN KITCHEN	MN75000E00	1	17.	172.	5	.700	.022	32.8	10.7	1216.9	
28	LIGHTING-SF,OLD-FLUOR.IN KITCHEN(RENOV.)	MO74000E00	1	17.	172.	5	.300	.022	76.7	10.7	1225.6	
29	REFRIG.-PARTIAL AUTO,1987 IMPROVEMENTS	ME40002E00	2	60.	180.	19	1.000	.023	190.4	10.9	1247.4	
30	REFRIG.-SINGLE DOOR,1987 IMPROVEMENTS	ME40001E00	3	50.	130.	19	1.000	.027	54.3	11.0	1253.6	
31	COOKING-ELEC. RANGES/OVENS,CPES IMPROV.	ME60001E00	1	22.	45.	18	1.000	.036	187.7	11.2	1275.0	3 ¢
32	LIGHTING-MF,OLD-OUTSIDE FLUOR.(RENOV.)	MO75000E00	4	45.	125.	10	.150	.042	3.8	11.2	1275.4	4 ¢
33	LIGHTING-MH,NEW-OUTSIDE FLUORESCENT	MN71000E00	2	45.	125.	10	.500	.042	30.0	11.2	1278.9	
34	LIGHTING-MH,OLD-OUTSIDE FLUOR.(RENOV.)	MO71000E00	4	45.	125.	10	.250	.042	.9	11.2	1279.0	
35	LIGHTING-MF,NEW-OUTSIDE FLUORESCENT	MN75000E00	2	45.	125.	10	.500	.042	17.0	11.2	1280.9	
36	LIGHTING-SF,NEW-OUTSIDE FLUORESCENT	MN74000E00	2	45.	125.	10	.500	.042	133.5	11.4	1296.2	
37	LIGHTING-SF,OLD-OUTSIDE FLUOR.(RENOV.)	MO74000E00	4	45.	125.	10	.250	.042	46.5	11.4	1301.5	
38	LIGHTING-SF,OLD-FLUOR.IN KITCHEN(LABOR)	MO74000E00	2	35.	172.	5	.300	.044	76.7	11.5	1310.2	
39	LIGHTING-MF,OLD-FLUOR.IN KITCHEN(LABOR)	MO75000E00	2	35.	172.	5	.300	.044	10.5	11.5	1311.4	
40	LIGHTING-MH,OLD-FLUOR.IN KITCHEN(LABOR)	MO71000E00	2	35.	172.	5	.100	.044	.5	11.5	1311.5	
41	TELEVISION-B & W,1985 IMPROVEMENT	ME80002E00	2	10.	25.	10	1.000	.047	45.4	11.5	1316.7	5 ¢
42	CLOTHES DRYER,MOIST./TEMP SENSOR & INSUL	ME80003E00	1	35.	50.	18	1.000	.051	177.7	11.7	1336.9	
43	LIGHTING-MF,NEW-SL LAMP FOR HIGH USE	MN75000E00	3	21.	57.	8	.900	.052	14.0	11.7	1338.5	
44	LIGHTING-MH,NEW-SL LAMP FOR HIGH USE	MN71000E00	3	21.	57.	8	.900	.052	24.6	11.7	1341.4	
45	LIGHTING-MF,OLD-REPLACE HIGH USE WITH SL	MO75000E00	5	21.	57.	8	.900	.052	10.4	11.8	1342.5	
46	LIGHTING-SF, NEW- SL LAMP FOR HIGH USE	MN74000E00	3	42.	114.	8	.900	.052	219.2	12.0	1367.6	
47	LIGHTING-SF,OLD-REPLACE HIGH USE WITH SL	MO74000E00	5	42.	114.	8	.900	.052	152.6	12.1	1385.0	
48	LIGHTING-MH,OLD-REPLACE HIGH USE WITH SL	MO71000E00	5	21.	57.	8	.900	.052	1.4	12.1	1385.1	
49	CLOTHES DRYER, HEAT PUMP DRYER	ME80003E00	2	500.	660.	18	.300	.055	547.3	12.7	1447.6	
50	LIGHTING-SF, NEW-SL LAMP FOR MEDIUM USE	MN74000E00	4	84.	171.	10	.900	.058	328.8	13.0	1485.2	

	(A) MEASURE DESCRIPTION	(B) ID CODE		(C) TOT COST	(D) SAVINGS (KWH)	(E) LIFE (YRS)	(H) ELIG FRAC	(G) CCE ($/KWH)	(H) TOTALSAV (GWH)	(I) CUM. TOTAL SAVINGS (TWH)	(AVG MW)
51	LIGHTING-SF,OLD-REPLACE MED. USE WITH SL	M074000E00	6	84.	171.	10	.900	.058	228.9	13.2	1511.3
52	LIGHTING-MF,OLD-REPLACE MED. USE WITH SL	M075000E00	6	63.	128.	10	.900	.058	23.4	13.3	1514.0
53	LIGHTING-MF,NEW-SL LAMP FOR MEDIUM USE	MN75000E00	4	63.	128.	10	.900	.058	31.4	13.3	1517.6
54	LIGHTING-MH,NEW-SL LAMP FOR MEDIUM USE	MN71000E00	4	42.	85.	10	.900	.058	36.7	13.3	1521.7
55	LIGHTING-MH,OLD-REPLACE MED. USE WITH SL	M071000E00	6	42.	85.	10	.900	.058	2.1	13.3	1522.0
56	LIGHTING-MH,OLD-OUTSIDE FLUOR.(LABOR)	M071000E00	3	65.	125.	10	.250	.061	.9	13.3	1522.1
57	LIGHTING-SF,OLD-OUTSIDE FLUOR.(LABOR)	M074000E00	3	65.	125.	10	.250	.061	46.5	13.4	1527.4
58	LIGHTING-MF,OLD-OUTSIDE FLUOR.(LABOR)	M075000E00	3	65.	125.	10	.150	.061	3.8	13.4	1527.8
59	WELL PUMP,CONSERVATION MEASURE	ME90001E00	1	100.	100.	15	.800	.084	37.2	13.4	1532.1
++++	CUT OFF PRICE IS .150 ++++										
60	CLOTHES WASHER,IMPROVED EFFICIENCY	ME80004E00	1	50.	30.	10	1.000	.195	104.5	13.5	1544.0
61	DISHWASHER,MOTOR EFFICIENCY	ME80005E00	1	150.	50.	10	1.000	.352	170.8	13.7	1563.5

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PART TWO
The Supply Curve Approach

Supply Curves of Conserved Energy

Supply curves of conserved energy are a technique of describing the potential for energy conservation. (Several supply curves of conserved electricity are presented in Part One.) Each step on the curve represents a conservation measure. The step's width indicates the potential energy savings and its height represents the action's "cost of conserved energy". The cost of conserved energy is an investment statistic quantifying the economic worthiness of a conservation measure. (See below) The measures are ranked in order of increasing cost of conserved energy.

A supply curve of conserved energy is similar to a supply curve for coal or oil. All show the **potential** energy available from these sources, and are not forecasts of what might actually occur, under various policies and electricity price scenarios that will influence market penetration rates. Supply curves of conserved energy can easily be misinterpreted for this reason.

On the other hand, there are important differences between a conservation supply curve and conventional supply curves. We discuss here some of the assumptions behind supply curves of conserved energy. This discussion is not meant to be exhaustive since a literature on this subject already exists.[1]

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[1] See:

A. Meier, J. Wright, and A.H. Rosenfeld, Supplying Energy Through Greater Efficiency: The Potential for Conservation in California's Residential Sector (University of California Press, 1983)

Solar Energy Research Institute, A New Prosperity. (Andover, MA: Brick House Press, 1981).

A. Meier, A. H.Rosenfeld, and J. Wright,"Supply Curves of Conserved Energy for California's Residential Sector", Energy 7,347-58 (1982).

Cost of Conserved Energy

The economics of conservation measures are expressed in terms of their "cost of conserved energy" or CCE. This is calculated using the formula,

$$\text{cost of conserved energy} = \frac{I}{\Delta E} \cdot \frac{d}{1-(1+d)^{-n}}$$

I = measure cost
ΔE = energy savings
d = discount rate
n = lifetime

The CCE for retrofits can be calculated directly. For example, the CCE for a measure "add R-19 insulation in houses with uninsulated attics", would first require an estimate of the measure's cost (usually assumed to be done by a contractor). A utility program cost can also be included here, but in Figure I-2, we have adopted a consumer perspective (and therefore have several no-cost measures). The annual energy savings may be based on monitored performance, heat loss calculations, or computer simulations. We can expect insulation to be effective for about 25 years, so this is the amortization period. Finally, the discount rate depends upon the institution making the investment. The cost of conserved energy is generally calculated in constant dollars, that is, using a "real" discount rate. Sensitivity tests can be made to check the effect of uncertainty in estimating each of the variables. Generic sensitivity analyses have been done by Meier in his dissertation (see footnote, supra).

Some conservation measures involve substitution of an appliance with improved efficiency. One measure might involve the purchase of more efficient refrigerators (as the old ones wear out). The cost used in the CCE is the incremental cost of the efficient model above the less efficient model that would have ordinarily been purchased. Similarly, the energy savings are the incremental savings of the more efficient unit. The lifetime remains that of the refrigerator.

If the CCE is less than the price of the saved energy, then the measure is economic. The price of the saved energy is called the "comparison energy price". Note that the CCE itself is independent of energy prices. The price of energy to which we compare the CCE may suddenly double, but the CCE is unaffected. A supply curve of conserved energy is also independent of energy prices. An energy price change will not change the curve; however, it may affect the number of measures which are considered cost-effective (i.e. below the comparison energy price cut-off). In the grand electricity curve in Part One, raising the comparison electricity price from 2 cents/kWh through 5 cents/kWh results in measures 133 through 234 becoming economic. Raising energy prices increases the "reserves" of conserved energy.

If energy prices are expected to rise during the period of analysis, then the comparison energy price should represent a weighted average of the projected energy prices. As a lower boundary, the current energy price can be used as the comparison price. This is a very conservative assumption, but is relatively accurate for low electricity price escalation rates and short time horizons. For higher escalation rates, consult the references (footnote,supra). For an electric utility company treating this saved energy as a resource alternative to new generation capacity, long-run marginal cost (LRMC), or "replacement cost" would be a more relevant comparison than the current cost per kWh to customers.

Throughout our analysis we have used "real", that is inflation-removed, interest and energy escalation rates. These are discussed at the appropriate points in the analysis.

Regional Supply Curves of Conserved Energy

There are two kinds of conservation supply curves, "micro" and "regional". A micro supply curve characterizes one water heater or space heating system in a single house. These are useful for just that unit, but may not necessarily reflect the average conditions in that area; they therefore have little policy value. In contrast, regional supply curves of conserved energy show the conservation potential for the entire stock of refrigerators or houses, taking into account the various sub-types in that stock.

To construct regional conservation supply curves, additional information regarding the stock of energy-using equipment is required. First, we need to know the number of units to which a conservation measure **might** be applied, that is, the "stock". Some of the units within the stock will not be physically suitable for this measure. Consider the conservation measure, "add R-19 insulation in houses with uninsulated attics". Some houses will already have been insulated, so these must be excluded. In addition, houses without attics must be excluded from this particular measure (though perhaps eligible for a different one such as rigid foam board on the roof). In the end, only a fraction of the total stock is eligible for this conservation measure. We call this the "eligible stock" or the "eligible fraction" of the total stock. The documentation lists the assumptions used to obtain that eligible fraction.

In the cases of space heating and water heating we have extended this analysis to include "typical" cases that represent a certain portion of the stock. These typical cases represent various prototypes that can be aggregated to arrive at an "average" case. For example, hot water usage in multifamily residences case might be composed of one typical case without a dishwasher, one typical case with a dishwasher, etc.. The details of how we utilize typical cases in our supply curve work are contained in the Work4 documentation (Appendix B).

Even under ideal conditions, conservation measures require some time to implement on a regional scale. We cannot expect to insulate, say, all the attics in the BPA area instantaneously. For this reason, even to estimate the technical potential for energy savings we assume that measures are implemented at a rate that does not cause market dislocations. (Otherwise our assumed cost for each measure would have to be increased substantially.) A "roll-in time" for each measure is included to account for these constraints on potential implementation rates. The roll-in times are best estimates of the minimum time needed to implement a measure (on a regional basis) without increasing its average cost. Once again, they are **not** estimates of the rate of penetration actually expected to occur.

Measures improving new appliance efficiency are treated differently. We assume that these measures are feasible to implement as the appliance wears out and is replaced. We base the CCE on the incremental cost of the improvement when a new unit is purchased. Alternatively, we could assume premature replacement of the appliance with the more efficient model. Then the initial cost would be greater (to account for loss of the appliance's remaining useful life) but would allow more rapid introduction of the appliances. Only a fraction of the total stock of appliances will be replaced each year. We assume that the number of appliances replaced each year equals the total stock divided by the average physical lifetime of the appliance. Refrigerators last 19 years, so 1/19 of the stock will be replaced each year.

Interpreting the Curves

Many of the policy applications of the conservation supply curves are obvious; others are more subtle. These are discussed in detail in previously cited literature. However, we discuss below some of the important assumptions and cautions necessary for valid interpretation of the curves.

Supply curves of conserved energy show the **technical potential.** This potential may never be fully exploited due to constraints in utility programs, consumer reluctance to implement measures, poor quality control, etc. Nevertheless, the supply curves suggest towards what goals programs should be designed. On the other hand, natural market forces will probably tap some of this potential without any assistance. The extent of unassisted consumer implementation of conservation measures is difficult to predict (and is the major difference between a potentials study such as this one and a forecast). Since it will probably vary with the type of measure and its CCE, separation of the measures permits the planner to select his or her own values.

The energy savings reported for a specific conservation measure are based on the assumption that all cheaper (lower CCE) measures have already been implemented. To implement a conservation earlier than shown in the sequence will generally result in greater energy savings

and a lower CCE than shown on the supply curves. In this way, the supply curves are "conservative." We have also not included losses through transmission and distribution (typically 10%). Thus, 10 average MW saved corresponds to 11 average MW of avoided energy production.

We assume that the level of service remains constant through the sequence of measures. Only improvements in energy efficiency are considered; "sacrifice" or "belt-tightening" is avoided. Such an assumption may not always be realistic. In particular, poor people may prefer to convert some of their conserved energy into increased amenity. (It becomes worthwhile to heat a house once the new conservation measures keep the heat in.)

The supply curves are especially sensitive to choice of discount rate and, to a much lesser extent, the costs of measures. Users should always consider the discount rate assumption before drawing policy conclusions from the curves.

The Supply Curves Display the Savings from a "Frozen Efficiency" Baseline

Supply curves of conserved energy display electricity **savings** rather than absolute electricity consumption. Therefore it is essential to carefully define the baseline from which the savings are measured. We used the Bonneville Power Administration's version of the Oak Ridge Residential Model as a basis for our analysis. At our request, BPA produced the so-called "frozen efficiency" projection. We used the frozen efficiency projection as our baseline rather than the conventional BPA forecast. This choice was necessary because we needed to have a baseline in which we knew precisely what conservation measures had been implemented in the future. The BPA forecast does not provide this information; instead we settled for a version of the projection where **no** conservation measures had been implemented. This is equivalent to holding the 1979 efficiencies frozen for the 20 year forecasting period. The frozen efficiency case was derived from a special run conducted by BPA where the variables TIN, (representing the current thermal integrity of new houses) and EUN (representing the current annual energy use of all other end uses) were fixed at their 1979 levels. In addition no programmatic conservation savings were included in the run. Changes in income

and price were included, as the conservation supply curve should be evaluated, relative to the baseline, under similar economic conditions. Table II-1 gives the baseline and "frozen efficiency" residential electricity forecasts. The frozen efficiencies are plotted on all the comparison figures in Part One.

There is an error in BPA's frozen efficiency forecast for the water heating end use. The year 2000 saturation of electric water heaters is too low. Since we calculate 2000 consumption by subtracting our estimated conservation potential from the frozen efficiency baseline, an error of this type results a low estimate of year 2000 consumption for our conservation potential case, as well.

Table II-1 Pacific Northwest Residential Sector- Electricity Baseline and "Frozen Efficiency" ORNL Model Runs (Annual Electricity Use in Average Megawatts[a])						
Sector	1980		1990		2000	
	Frozen	Base	Frozen	Base	Frozen	Base
Space Heat	1873	1860	2654	2243	3252	2556
Water Heat	1228	1221	1391	1169	1548	1292
Other[b]	2743	2732	3600	3333	4359	3880
Total	5844	5813	7645	6745	9159	7728

[a] An average megawatt is 8760 megawatt hours. These values were taken from BPA computer runs.

[b] The category "Other" includes the the ORNL Model end uses: lighting, cooking, refrigeration, freezing, air conditioning, and miscellaneous. Our analysis includes lighting, cooking, refrigeration, freezing, and several miscellaneous end uses (e.g. televisions and waterbeds), in the "Appliances and Other" classification. We haveexcluded air conditioning in our analysis because of the complexity of modelling and its small share of residential electricity use (less than one percent). Consequently, the comparison between the ORNL "Other" category and our appliance-sector conservation potential should be done with care.

The frozen efficiency baseline will overstate future energy consumption because residential energy use is becoming more efficient. The conventional BPA forecasts take this trend into account but in a manner difficult to precisely reconcile with the supply curves. The ORNL Model calculates efficiency improvements by referring to a technology cost curve (TCC) for each end use. Each TCC relates initial investment in energy conservation to the UEC attainable. The optimum investment, and hence UEC used by the model, depends on the energy price and discount

rate. The TCCs are necessarily crude relationships, as well as very aggregated, since one curve typically represents an entire end use. It is impossible to translate a shift in the UEC (i.e, a movement along the TCC) into the specific number of each conservation measure implemented. In other words, when the ORNL Model forecasts a lower UEC in 2000, we do not know what conservation measures the model assumed were implemented to achieve it. [2]

In contrast, the supply curve approach explicitly lists the conservation measures implemented. Each step on the curve corresponds to savings achieved from a measure. The third, and lowest, lines in the comparison figures in Part One represents the conservation potential. To plot these, we assumed that the conservation potential equals all the measures having CCEs less than 15 cents/kWh. We subtracted the savings from the frozen efficiency projection -- the top lines in the figures -- to obtain the technical potential.

The BPA forecast and our conservation potential will have some duplication of conservation measures; we cannot be sure how much because our approaches differ.

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[2] The ORNL Model can accommodate explicit conservation programs, i.e., "insulate 400,000 water heaters," and lower the UEC accordingly. Double counting within the forecast can occur here, too, because the model may have already rolled in some water heater insulation measures via the TCC.

Limitations of a Non-Vintaged Stock Model

Finally, we note a limitation in the applicability of our analysis with respect to the ORNL Residential Model. Houses and many appliances have become significantly more efficient over time. New homes, for example, are usually well-insulated compared to the average of all existing homes, and will therefore use much less electricity for heating. Unfortunately, the BPA version of the ORNL Model treats the housing and appliance stocks as if they are homogeneous. Characterizing the entire stock with a single UEC camouflages the heterogeneity, and sometimes leads to peculiar input assumptions. A single, non-vintaged UEC is difficult to use when developing in conservation supply curves, too, since the supply curves consist of specific measures that may apply to parts of the stock.

We have designed the current data base to be compatible with the current version of the BPA ORNL Model, which only vintages the housing stock (and there only very crudely). However, CPS 2.0 is capable of using a vintaged model if BPA changes to such a version. [3] The data base, not the model, must be revised. In general, the revision involves splitting the "existing" stock into "new" and "old" categories. We have indicated in the measure documentation where the changes must be made.

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[3] The Lawrence Berkeley Laboratory vintaged version of the ORNL model is described in Beyond the Energy Crisis: Opportunity and Challenge (Pergamon Press, 1981). See the chapter, authored by Jim McMahon, on "Residential Enduse Demand Modelling: Improvements to the ORNL Model"

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